

INFLUENCE OF L1 ON L2 LEARNERS OF KOREAN: A PERCEPTION TEST ON
KOREAN VOWELS AND STOP CONSONANTS

by

ARAM CHO

(Under the Direction of Don R. McCreary)

ABSTRACT

The current study examines the influence of the L1 phonetic environment on L2 learners of Korean. After a review of aspects of the English and Korean languages, focusing on the differences between the two languages' vowels and consonants, the results of a perceptual experiment are presented. The subjects are native English speakers who are learning Korean as a second or a third language. An identification test for Korean back vowels [o] and [ʌ] was conducted, followed by an identification test of nine Korean stops. The results indicate that there are difficulties in perceiving Korean vowels depending on the learners' L1 phonetic system, as well as various syllable structure effects. Furthermore, subjects showed difficulties in identifying stops depending on the consonants' laryngeal settings. The possible influence of subjects' gender and exposure to the L2 language/culture is also discussed.

INDEX WORDS: L1 and L2 phonology, Korean language, L2 perception, stops, vowels

INFLUENCE OF L1 ON L2 LEARNERS OF KOREAN: A PERCEPTION TEST ON
KOREAN VOWELS AND STOP CONSONANTS

by

ARAM CHO

B.A., Chonbuk National University, South Korea, 2006

A Thesis Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment
of the Requirements for the Degree

MASTER OF ARTS

ATHENS, GEORGIA

2010

© 2010

Aram Cho

All Rights Reserved

INFLUENCE OF L1 ON L2 LEARNERS OF KOREAN: A PERCEPTION TEST ON
KOREAN VOWELS AND STOP CONSONANTS

by

ARAM CHO

Major Professor:	Don R. McCreary
Committee:	Hyangsoon Yi
	Victoria Hasko

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
August, 2010

DEDICATION

To my parents

ACKNOWLEDGEMENTS

I am heartily thankful to my supervisor, Dr. Don McCreary, whose encouragement, guidance, and support from the initial to the final level enabled me to develop an understanding of the subject. Without his guidance and persistent help, this thesis would not have been possible. I also thank the members of my graduate committee, Dr. Victoria Hasko and Dr. Hyangsoon Yi for their guidance and suggestions. Thanks to Dr. Mi-Ran Kim for providing me insightful references and information about Korean linguistics.

Special thanks to my friend Nathan Loggins who has been a wonderful advisor and a writing teacher during this project. Also, I am grateful to all participants of my experiments.

I would like to thank my all family members, especially my sister, for supporting me throughout all my studies. I wish to thank my parents, Yong Mi Kim and Yong Hwan Cho, who bore me, raised me, supported me, taught me, and loved me.

Lastly, I offer my regards and blessing to all of those who supported me in any respect during the completion of the project.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS.....	v
LIST OF TABLES.....	viii
CHAPTER	
1 Introduction.....	1
2 Review of Literature	5
2.1 Review of Acoustic Properties of Vowels in Korean and English	8
2.2 Review of Acoustic Properties of Consonants in Korean and English.....	16
3 Identification of Korean Back Vowels by Adult Native Speakers of English.....	22
3.1 Method	23
3.2 Stimuli.....	24
3.3 Procedure	26
3.4 Acoustic Analysis	26
3.5 Statistical Analysis.....	27
4 Identification of Nine Korean Stops by Adult Native Speakers of English	33
4.1 Method	34
4.2 Stimuli.....	35
4.3 Acoustic Analysis	36
4.4 Statistical Analysis.....	38

5 Discussion	42
REFERENCES	49
APPENDICES	
A Example of actual experiments	56
B Answer sheets of Two experiments	57
C Word list of the Vowel tests.....	60
D Word list of the Consonant tests	61
E Additional Features of Korean Language	62
F Interview Questionnaire.....	64
G Consent Form.....	66

LIST OF TABLES

	Page
Table 1: Position of English vowels in vocal tract	10
Table 2: Position of Korean vowels in vocal tract.....	10
Table 3: Average values of F_0 , the first three formants (F_1 , F_2 , F_3), and their standard deviations (in parentheses) for the American speakers' vowels	12
Table 4: Average values of F_0 , the first three formants (F_1 , F_2 , F_3), and their standard deviations (in parentheses) for the Korean speaker's vowels	13
Table 5: Age distribution of participants	24
Table 6: Length of exposure to language/culture	24
Table 7: List of vowels in words.....	25
Table 8: Average values of F_0 , the three formants (F_1 , F_2 , F_3), and their standard deviations for the Korean vowel [Λ] (n=10)	26
Table 9: Average values of F_0 , the three formants (F_1 , F_2 , F_3), and their standard deviations for the Korean vowel [o] (n=10)	27
Table 10: Group Statistics.....	27
Table 11: Independent Sample Test.....	28
Table 12: Descriptive Statistics	29
Table 13: Tests of Between-Subjects Effects	30
Table 14: Post Hoc Tests	31
Table 15: Age distribution of participants	34

Table 16: Length of exposure to language/culture	35
Table 17: List of words in consonants	36
Table 18: Mean and Standard Deviation (SD) of Voice Onset Time for plain stops	36
Table 19: Mean and Standard Deviation (SD) of Voice Onset Time for aspirated stops.....	37
Table 20 Mean and Standard Deviation (SD) of Voice Onset Time for glottalized stops	37
Table 21: Accuracy rate by place of articulation	38
Table 22: Dependent Variable: total	39
Table 23: Tests of Between-Subjects Effects	39
Table 24: Post Hoc Test.....	40

CHAPTER 1

INTRODUCTION

It has long been established that acquiring a second language after reaching puberty decreases accuracy rates of production and perception of the target language (Lenneberg 1967; Bickerton, 1981). In addition to this theory, known as the Critical Period Hypothesis, there have been many studies that have tried to examine the reasons for difficulties in acquiring languages after puberty, which have naturally led to research on adult second language acquisition. Therefore, many researchers have tried to find the main source of difficulties and give an explanation toward a solution to the possible problems for adult L2 learners. Among other categories of L2 achievement, including grammatical knowledge, reading, writing and discourse, the acquisition of accurate pronunciation of a target language has been studied by many linguists and psychologists.

Among these researchers, James Flege has done much research on L2 learners' interference from L1 phonetic categories. Flege (1995) proposes the theory of the Speech Learning Model, which explains that L1 and L2 sounds are related on a position-sensitive phonetic level.

In this theory, second language learners will have a hard time distinguishing and perceiving sounds similar to their L1 phonetic inventory since they perceive and classify them as an equivalent sound that they already have in their native phonetic system. However, marked sounds are often easier for them to acquire. For example, Italian native speakers have better

accuracy in identifying English word-initial stops because English only allows voiced or aspirated stops in word initial position, whereas Italian only allows unaspirated stops in word initial position.

Similarly, one of the theories that attempt to explain differences in second language phonological acquisition between an adult and a child claims that adult second language learners process phonetic input differently due to their pre-existent L1 phonetic categories (Flege, 1987; Flege, Munro, and Mackay, 1995). Taking a similar approach, Jones (1957) argues for levels of difficulties second language learners might face. Among the six difficulties that he mentioned, the first one is identification of the acoustic sounds of the target language that do not exist in the learner's native phonetic inventory; often they cannot distinguish or identify a new sound. Furthermore, this interference may prevent the adult L2 learners from achieving a phonetically accurate perception of the target language (Moyer, 1999). This is in contrast to Flege (1995), who supposes similarity between L1 and L2 causes more difficulty than new sounds do.

To understand better the relationship between learners' perception of a target language and their L1 phonetic system, further experiments are conducted in this study. Through these experiments, we can propose what is the influence of a native phonetic system on identifying the target language.

Depending on the learner's L1, the misperception of phonetic categories may differ by certain degrees or in specific aspects. For example, English-learners whose native language is Spanish have problems in producing consonant-liquid clusters, and they also often substitute a tap or trill for English rhotics (Barlow, 2005). Korean learners who study English as a second language particularly have difficulty with certain consonants such as initial-position /r/ or /l/ and the consonant /θ/ because of the lack of those sounds in their L1 phonetic inventory (Yang, 1996).

Additionally, Korean subjects who learn English as a second language frequently fail to identify certain vowels, such as English /ə/ (Yang, 1996).

Due to the fact that Korean has glottalized stop phonemes (which English does not possess), as well as different syllable structures, the assumption that there will be a problem between the two language learning groups can easily be made. Furthermore, previous studies have shown that L2 learners whose native language is English experience difficulty in perceiving some Korean vowels that do not exist in their L1 phonetic inventories (Kim and Silva, 2003). In particular, the perception of Korean words is problematic for many English learners of Korean. In an attempt to understand the relationship between the Korean and English phonetic inventories, much research has focused on different segmental categories, such as consonants or vowels. However, still more information is needed about the Korean phonemic/phonetic inventory and which specific segments L2 learners most often fail to perceive.

The research questions for this study were based on my personal experience of two years of teaching Korean as a foreign language to native English speakers. In an attempt to understand what would be the most difficult phonetic segment to acquire, the underlying research question of what is the influence of a native phonetic system on identifying the target language was asked. The more specific research questions for this study will be: do most of the native English speakers show difficulty based on the syllable structure of the word? Do most native English speakers distinguish Korean back vowels /o/ and /Λ/? Do most of the native English speakers distinguish the three Korean stops: plain, aspirated, and glottalized?

Therefore, the current study focuses on identification of specific Korean consonants and vowels, and examines what sounds are misperceived and why. First, by reviewing phonetic characteristics of English and Korean stops, the differences between the two languages will be

presented. Second, the investigation of the unique phonetic characteristics which distinguish the individual sounds will help explain the reason for the misperception of certain sounds. Finally, by conducting an identification experiment for Korean language learners whose native language is English and analyzing the results, directions for further research can be suggested.

CHAPTER 2

REVIEW OF LITERATURE

Over the past decades, as a growing number of college students in the U.S. have started learning Korean as a foreign language, issues and concerns about Korean L2 learners have been widely discussed (Wang, 2002). There have been many concerns and issues presented in previous studies that discuss L2 learners' self-motivation (such as a desire to experience a new culture, or a need to enhance their language skills depending on personal demands), as well as general issues related to personal factors of the learners themselves, such as gender, age, and cultural exposure (Sung and Padilla, 1998; Kang, 2007).

However, the problems arising from the language itself still lack more detailed attention. In particular, the problems or difficulties that result from the difference or similarity between learners' L1 and the target language require more information for both learners and instructors of Korean language. For example, do speakers have more trouble with new sounds or sounds similar to their L1? If there is a pattern, which particular phonetic qualities may be the cause of the trouble?

Furthermore, there has been much research that examines the relationship between the phonological memory of subjects' L1 and their target language proficiency. Phonological memory can be defined as information coded phonetically for temporary storage in working or short-term memory. Short-term memory involves storing distinct phonological features for short

periods of time to be read in the process of applying the alphabetic principle to identification (Wagner, Torgenson, & Rashotte, 1999).

There is evidence that phonological memory plays a role in acquiring a foreign language, especially for L2 learning in adults. O'Brien et al (2006) and McAllister et al (2002) investigate the acquisition of L2 phonology by examining the role of L1 as the source of various contributing factors.

It is well known that there is a difference in successfully developing L2 language fluency, which varies by person. Some people easily achieve the target language while other people seem to struggle with it. There could be many different reasons for this, but, as just mentioned, one crucial factor is the difference in L2 learning in individuals' phonological memory (Segalowitz, 1997). O'Brien et al (2006) propose the reason for these differences to be the sound system in their L1 differing from that of the target language; this might pose a challenge for retaining phonological elements from the spoken language within a short period of time, whereas they would instantly and automatically identify the sounds and phonological components of a word when they listen to their native language.

Many researchers argue that acquiring a second language after reaching puberty decreases the accuracy rate of production and perception of the target language. Therefore, the so-called Critical Period Hypothesis (CPH) (Lenneberg 1967; Bickerton, 1981) supports the idea that, since the language system of ones' L1, including the phonetic system, is usually developed at an early age, it is generally considered close to impossible to achieve a perfect, native-like pronunciation or perception when learners begin developing a second language after a certain age. There have been many studies that attempt to examine the reasons for such difficulties.

Among six difficulties that Jones (1957) mentions, the primary one is identifying the acoustic sound of the target language that does not exist in the learner's native phonetic inventory; often they cannot distinguish or identify a new sound. Furthermore, this interference may prevent the adult L2 learners from achieving a phonetically accurate perception of the target language (Moyer, 1999)

Stockwell, Bowen, and Martin (1965) propose a theory following Contrastive Analysis, called Hierarchy of Difficulty, which expresses five degrees of difficulty for L2 learners. Through the careful, systematic analysis of the two different languages, they can reasonably predict phonological difficulties. For example, other researchers have concluded that Stockwell, Bowen and Martin's theory about adult and child second language phonological acquisition shows that adult second language learners process phonetic input differently due to their pre-existent L1 phonetic categories (Flege 1987; Flege, Munro, and Mackay 1995).

Furthermore, this interference may prevent the adult L2 learners from achieving a phonetically accurate perception of the target language. Flege (1991) found that, in an experiment on L1 Spanish learners of English, early learners' Voice Onset Time values for English /t/ are not distinctive from those of English monolinguals, whereas late learners produce /t/ with values that are intermediate between the values of Spanish and the values of English.

However, depending on the learner's L1, the misperception of phonetic categories may differ by varying degrees or in certain aspects. Korean learners who study English as a second language particularly have a problem with producing and perceiving English liquid sounds (Yang, 1996). Many studies argue for levels of difficulties second language learners might face depending on certain consonants and their syllabic environment, such as initial-position /r/ or /l/ and the consonant /θ/, because of the lack of those sounds in their L1 phonetic inventory.

Since Korean is a typologically different language than English, from the word order to the phonological system, L2 learners of Korean might have difficulty in developing their L2 phonetic inventory, which may be blocked by their native language. Therefore, in this paper, I will present more detailed information about the difference between Korean and English and the main source of difficulties in second language acquisition, beginning in the following section with detailed acoustic properties of the two different languages.

2.1 Review of Acoustic properties of Vowels in Korean and English

In distinguishing vowel properties in general, three different qualities are used. The first quality is a classification of tongue height. This refers to the highest part of the body of the tongue when a given vowel is produced. Depending on its height, it is considered a high vowel, a mid vowel, or a low vowel. The second is the degree of backness. Measuring the distance of the highest part of the tongue from the hard palate, vowels are categorized as front, central, or back. The last classification of vowels focuses on lip position. Depending on the roundness of the lips, vowels are distinguished as either rounded or unrounded (Ladefoged, 2001; Jeon, 2005).

The reason why vowels are characterized by these three aspects is because these properties also describe formant frequencies. The formant frequencies are the unique qualitative properties of acoustic sound. In articulatory terms, F1 is related to tongue height while F2 is related to tongue advancement. Overall, the acoustic effect of closing the lips is to lower the frequencies of all three formants. Formant frequencies provide a convenient way of representing a given vowel system and of depicting differences in vowel systems between languages or dialects (Rosner and Pickering, 1994). Non-native vowel perceptions result from learners perceiving L2 vowels according to phonological contrasts in their L1, based on these acoustic properties (Flege, 1992; Ingram and Park, 1997; Ryoo, 2001).

Primarily, vowels are distinguished by the lowest two formants (F1 & F2), with higher formants making more fine-tuned contributions. F_0 is a measure of the frequency of vibration of the vocal folds, which is perceived by pitch. The average vocal fold length is 17 mm for adult females and 17 to 23 mm for adult males; the average rate of vibration of males' vocal folds is about 125 Hz compared to about 200 Hz for females (Negus, 1949).

As many linguistic researchers have shown, the formant values of a vowel are the reflection of the size and shape of the speaker's vocal tract. The first formant is correlated with vowel height, whereas the second formant value corresponds to vowel fronting. Therefore, a lower F1 value indicates a greater degree of tongue height in the oral cavity, and a higher F1 value indicates a sound that is produced with the tongue in a lower position. The lower F2 value corresponds to a lower degree of vowel fronting (a greater value on a scale of backness), and a higher value corresponds to a higher degree of vowel fronting, i.e. a front vowel. By detecting the formant values of vowels, it is possible to make phonetic profiles of different languages.

In L2 phonology, however, any analysis of L2 vowel acquisition is often a difficult job. The complex relationship between phonological categories and their corresponding phonetic correlates make them hard to analyze. Furthermore, while one L2 vowel category might roughly correspond to a particular L1 vowel category, there are rarely exact phonetic similarities (Yang, 1996). Nonetheless, in most cases, comparing vowel formant values can be the best way to distinguish two different vowels.

The following tables indicate the general Korean vowels and English vowels:

Table 1: Position of English Vowels in vocal tract (Jeon, 2001)

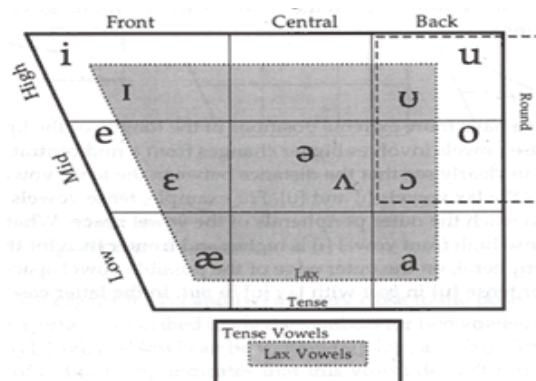
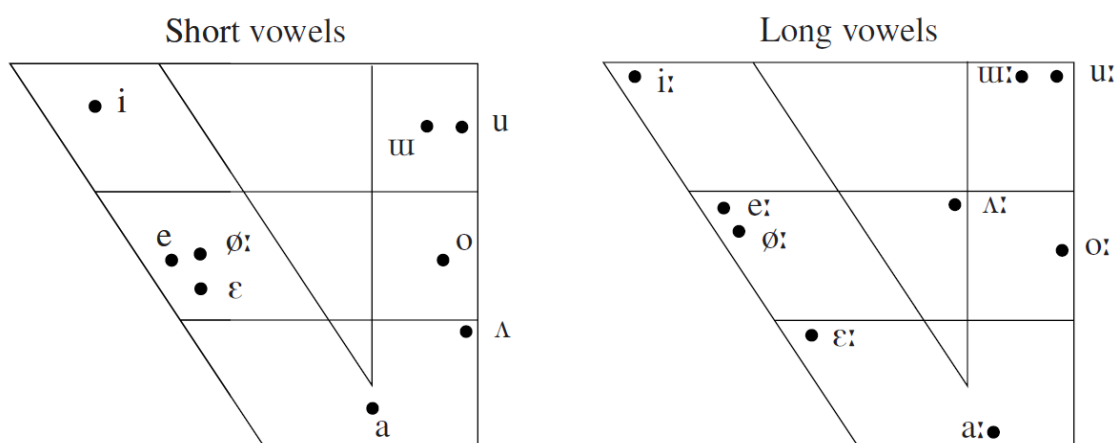


Table 2: Position of Korean vowels in vocal tract (Lee, 1999)



Recently, work on Korean vowels reveal that the long vowels are only found in the speech of older speakers (Yang, 1996). Otherwise, the Korean vowel inventory has 8 monophthongs, whereas the English vowel system includes more than 11. Therefore, it is likely that the Korean system can be categorized and produced as a subset of the English vowel system,

except for one unique Korean vowel [ɯ], which does not occur in the English vowel inventory. However, contrary to the natural assumption that English native speakers would easily distinguish or master Korean vowel pronunciation, in the experiment of Kim and Silva (2003), the results reveal that native English speakers show surprising degrees of difficulty in making distinctions among the back vowels.

The main source of misperception of those vowels is in the different formant frequencies between Korean back vowels and their phonologically equivalent English back vowels. As the above tables show, the general back vowel positions in English are articulated in slightly different places than Korean back vowels. Particularly, the vowel [ʌ] shows the greatest difference between Korean and English. In Korean, this vowel is produced more back in the mouth and lower in position than its English counterpart.

Another significant difference between English and Korean vowels is the comparison between tense and lax vowels. The tense vowels in English are higher and more fronted than the lax vowels. Given this fact, the potential variation in the L2 production of Korean might be increased because there is a possibility that some native English speakers might produce Korean /u/ and /o/ while others might produce the same segments with vowels that approximate the higher, more fronted English /u/ and /o/. Kim and Silva (2003) conducted an experiment on the Korean vowel production of native speakers of American English. They focused on successful production of Korean back vowels, which were commonly considered a difficulty for these students. It was shown that many students had trouble producing the vowels [ʌ] and [o], making them both sound similar to a back rounded vowel [o].

Another difficulty that native English speakers might have is in perceptually distinguishing Korean mid back vowels /o/ and /ʌ/, due to the structural differences of phonetic properties and phonemic distinctions among Korean vowels. Ahn (1997) presents the results of an intelligibility test with respect to vowel production, i.e., the level of difficulty that British native-speaker judges experienced in interpreting Korean-L1 English speakers' pronunciations. The greatest difficulties that the judges had were in discerning the Korean adults' attempt at vowels for [ʌ]: only 45% correct in production and a 35.5 % accuracy rate for perception. It appears the most difficult English vowel to perceive correctly is [o], as there was only a 12.3% accuracy rate. Both of the experiments show clear evidence that English and Korean back vowels are troublesome to both speakers of these two languages.

In addition, Yang (1996) conducted an experiment that measures Korean vowels and English vowels by their formant frequencies. This study shows that there are similarities between certain English vowels and Korean vowels, and that this is the main source of misperceiving a vowel, a finding supporting Flege (1995). The table below is from Yang (1996: 6-7):

Table 3: Average values of F₀, the first three formants (F1, F2, F3), and their standard deviations (in parentheses) for the American speakers' vowels.

	Male				Female			
	F0	F1	F2	F3	F0	F1	F2	F3
O	129 (18)	498 (41)	1127 (93)	2375 (131)	207 (17)	528 (73)	1206 (183)	2824 (143)
ʌ	127 (15)	592 (45)	1331 (71)	2494 (167)	206 (18)	701 (75)	1641 (89)	2901 (108)

Table 4: Average values of F_0 , the first three formants (F_1 , F_2 , F_3), and their standard deviations (in parentheses) for the Korean speaker's vowels.

	Male				Female			
	F_0	F_1	F_2	F_3	F_0	F_1	F_2	F_3
O	170 (25)	453 (47)	945 (134)	2674 (156)	269 (31)	499 (60)	1029 (143)	3068 (159)
△	165 (25)	608 (76)	1121 (110)	2638 (145)	263 (28)	765 (125)	1371 (108)	3009 (183)

The average F_1 range for a vowel [o] for both male and female English speakers is 513 Hz, the F_2 range is 1166.5 Hz. For an English vowel [△], the average rate is 646.5 for F_1 and 1468 for F_2 . The average rate for F_1 of the Korean vowel [o] for both speakers is 476 Hz, and 987 Hz for the F_2 average rate. Also, for the vowel [△], the average F_1 range is 686.5 and the F_2 range is 1246.

According to this analysis, a clear distinction between Korean vowels and English vowels has been shown. There is not a significant difference in formant ranges in the vowel [o]; the range difference in vowel [o] is 653.5 for English and 511 for Korean. However, for vowel [△], the range difference shows a clear distinction; a range difference between F_1 and F_2 of an English vowel [△] is 821.5, whereas it is 559.5 for a Korean vowel.

Therefore, according to this table, Korean speakers do not have significant variation in formant values between the two vowels as compared to American speakers, which means that it

is hard to distinguish these two vowels for native English speakers. Therefore, for the native English speakers, it is hard to distinguish vowels since there is such ambiguity in the Korean vowels' acoustic properties. It is likely that English native speakers misperceive the Korean vowel [ʌ] as [o] due to the fact that a similar range exists in English for the vowel [ʌ] and [o].

Essentially, these studies that show acoustic measurements of Korean vowel pronunciation by native speakers of American English, or vowel production of Korean speakers for the English equivalent, provide empirical evidence that some English-speaking Korean language learners are likely to have difficulty producing or perceiving the Korean back vowels. In Kim and Silva's (2003) experiment, English native speakers who learn Korean as a second language tend to reduce the Korean vowel inventory to one or two vowels less than the original native Korean inventory. This study provides evidence that focuses on the learners' strategies when difficulty arises in L2 pronunciation and how the English (L1) system affects Korean (L2) vowel production.

However, these differences in vowels are not always predicted as troublesome for achieving L2 phonological accuracy. Previous studies (Calarease, 1995; Moyer, 1999; Poullisse and Bongaerts, 1994) show that marked features can sometimes be more easily distinguished than unmarked features. In order to examine if less salient L2 phonetic features can be easily perceived or not, a perceptual experiment on the Korean vowel [ʌ] was conducted and will be presented in the next chapter.

Another feature that possibly will result in low accuracy of target language perception and production, other than characteristics of the vowels of the two languages, is the syllable structure of the L1 and L2 languages. The CV syllable structure is a universal feature of all languages in the world (Battistella, 1990; Cairns and Feinstein, 1982; Greenberg, 1965;

Vennemann, 1988). Therefore, in terms of markedness, CV syllables are unmarked and CVC or CVCC syllables are more marked syllable structures. This means that if L2 learners whose native language only has CV syllables need to produce the target CVCC syllables, many of them tend to make CV or CVC syllables instead of the target CVCC syllable. This will result in the L2 learners choosing to produce the less marked one over the more marked one.

There have been many attempts to explain the relationship of the marked and unmarked syllable structure of languages (CV and CVCC) and how they affect speakers' L2 learning. Some researchers have tested this relationship by using target syllables that have complex codas. They found that complex codas are rarely reduced to CV syllables; instead codas are reduced by one consonant only to CVC (Carlisle, 2001).

In addition, syllable structures have a close relationship with vowel length between consonants. Kabak and Idsardi (2007) mentioned that the coda or onset of a syllable can be used as the main phonological context which can define or restrict characteristics of consonants or their combination. They tried to predict the patterns of epenthesis, which is evoked when the given syllable structure violates the possible syllabic structure in the native language. The results obtained from their experiment suggest that it is true that perceptual epenthesis is evoked when syllable structure violations occur. From their experiment, we can assume that L2 representations can cue feature information from the stimuli, even if the detected features correspond to those that are underspecified in their L1.

Korean syllable structure allows complex codas or double final consonants such as CVCC underlyingly. However, unlike many other languages which allow complex codas in the lexicon, Korean only allows one consonant to surface, which means that Korean restricts the occurrence of consonants in certain syllable positions. For example, only seven consonants

among nineteen consonantal phonemes can be pronounced in coda position (Kabak and Idsardi, 2007). Also, Korean and English have different phonotactic restrictions on consonantal contact, e.g. coda /t/ assimilates to a following nasal in Korean phonology (Ewen and van der Hulst, 2001).

Therefore, the syllable structure of tokens may lead to misperception or misproduction of a target L2 language value. In this paper, different syllable structures will be tested to detect whether the syllable structure affects the accuracy of perception. From the most unmarked syllable structure CV to the more marked syllable structure CVC, a total of four different types of syllable structure will be tested along with two vowels.

2.2 Review of Acoustic properties of Consonants in Korean and English

Just like vowel systems, consonant inventories of world languages share common features but have unique components that differentiate one language from another. Among the consonants of all languages, stops are sounds that are produced by the blocking of air released from the lungs, resulting in air pressure building up when the stream is completely blocked in various positions of the vocal tract and released in a burst of energy. Voiceless stops are one of the most common features in universal language systems and the easiest feature to produce in terms of articulation and aerodynamics (Ladefoged, 2001; Westbury and Keating, 1986)

The articulation of stops generally consists of three steps. First is the closure stage. In this stage, the active articulatory organ closes to the point of articulation and blocks the air that comes from the lungs. The second stage is called a hold stage or compression stage. In this stage, the lungs continually upload the air so that the pressure from the lungs to the closure point is becoming greater. The last stage of the articulation of stops is the release stage or explosion stage.

In this last stage, the compressed air pressure releases from the active articulator. The result of this releasing is known as a plosive or stop (Ladefoged 2001; Jeon 2005)

Since Korean initial stops differ in several intensity characteristics, it is hard for non-native speakers to achieve the correct production. Particularly for native English speakers, whose native language allows only two types of stops in its phonological system (voiced and voiceless), these two categories are normally characterized by VOT ranges in CV transitions. The first two Korean stops, plain (a.k.a lax) stops and aspirated stops, have similar representations in English speakers' native phonetic system, unlike the last type, glottalized stops, which is nonexistent for most English speakers.

The production of glottalized stops is hard even for native Korean speakers. Kang and Guion (2006) conducted an experiment on the production of Korean initial stops for two different groups. They consisted of two groups of bilinguals, whom Kang and Guion compared to a Korean monolingual group to see the mutual influence of the two languages. The first group was Korean-English bilinguals who learned English early in life (3.8); the second group had a later learning age (21.4). Compared to the native Korean group, the late bilingual group produced the glottalized stops with longer VOT than the native Korean monolingual group.

Also, the late groups seemed to have produced English voiceless stops and Korean aspirated stops in a very similar range and produced English voiced stops with similarities to both Korean glottalized and lax stops. As Kang and Guion explained in their paper, the values for lax and aspirated stops are positive, whereas the glottalized stops are negative and this difference is reflected in the sounds of following vowels; vowels following lax and aspirated stops have a more breathy quality, while vowels have a creaky quality after glottalized stops.

In the following section, the perceptual test of glottalized stops for native English speakers will be presented, and further explanation about the result will explain the adaptation of marked glottalized stops by L2 speakers.

English stops are phonetically classified in three different ways; voiced unaspirated, voiceless aspirated and voiceless unaspirated (Kim, 1994; Fry, 1979). However, some researchers classify the English stops as two contrast categories; voiceless and voiced stops (Kang and Guion, 2006) because there is no clear distinction between voiceless unaspirated and voiced unaspirated in terms of VOT values. As many researchers have shown, the VOT values for voiceless unaspirated stops are very similar to those of voiced stops; the salient differences between English stops occur in voiced and voiceless stops. These two different stop categories can be differentiated by VOT values in word initial position.

Therefore, one of the major acoustic properties that distinguish stops is the Voice Onset Time (VOT). Voice Onset Time is the length of time between the stop's release and when the vocal folds start to vibrate (Ladefoged, 2001). Depending on the language, VOT for the same consonants can show variation.

Many researchers have measured the average VOT rates for voiceless and voiced stops in English. Klatt (1975) reported that the average VOT of English voiceless stops is 61 ms, whereas for voiced stops' VOT values are 18 ms. Also, Lisker and Abramson (1964) found that the VOT average for the English voiceless stops is 80ms and 15ms for voiced stops in a monosyllabic word. Therefore, in English, the value of presence or no presence of aspiration plays a more important part than voicing itself (Cassie, 1981; Ohde, 1984). Furthermore, the voiced stops in English are fully voiced only between voiced segments, and are often not voiced

in word-initial position (Fry, 1979), whereas the voiceless stops are always aspirated in word-initial position. Voiceless stops after /s/ and initially in unstressed syllables are unaspirated.

Compared to English consonants, the consonant system of Korean shows specific differences. Ahn (1997) presented the five main features that differentiate Korean consonants from others. The first feature is that no voicing contrast is allowed in the obstruent system. Secondly, Korean has a very limited fricative system, particularly in fortis and lenis [s]. Third, [l] and [r] are presented as a single phoneme, with limited distribution. The fourth feature is that Korean allows only limited consonants (p,t,k,m,n,ŋ,l) in word final position. Finally, the last feature is that there is a three-way contrast on initial obstruent consonants.

Stops in the Korean language include three different types in terms of articulation and manner. Three stops occur in three different manners of articulation that differentiate each other by degree of glottal tension. There are stops generally known as plain stops (slight aspiration), aspirated, and glottalized stops that occur with a strong and tight glottal constriction, respectively. All these stops are voiceless in word-initial position (Kim, Lee, and Lotto, 2003; Kang and Guion, 2005). Also, Korean stops are produced in three different places of articulation. The first stop category occurs as a bilabial, the second occurs as alveolar, and the last velar.

Even though researchers (Silva, 2002; Silva, Choi, and Kim, 2004) have found that younger Korean speakers tend to shorten the VOT for aspirated stops and produce them more close to plain or lenis stops, it is generally reported that VOT values are longest for aspirated stops and intermediate for lenis (slightly aspirated, lax, or plain), and shortest for fortis, which refers to a tight glottal constriction or tensed stop (Cho et al., 2002; Han and Weitzman, 1970; Kim, 1965;) The measurement of average VOT values of aspirated stops are between 71.2 ms to 100.9 ms, while values of plain stops are from 14.6 ms to 94.8 ms. And lastly, the glottalized

stops range from 7.0 ms to 22.4 ms. (Kim and Lotto, 2002) Therefore, the unique quality of VOT of each stop easily separates aspirated stops from the other two stops.

Along with Voice Onset Time for stops, fundamental frequency (F_0) is another factor that can determine the phonetic characteristics for perceiving stops. The rate (or frequency) at which the complex periodic wave of speech repeats is called the fundamental frequency (F_0). The F_0 is actually the greatest common denominator of all the component sine waves (Ladefoged, 2001). See section 2.1 above for more discussion.

Bernstein (1979, 1980) reports that F_0 values have their own perceptual significance: that when F_0 increases, more stimuli are interpreted as voiceless sounds, whereas when F_0 decreases the sound stimuli are characterized as voiced. In Kim's (1994) research, it is also observed that when the F_0 value increases, the subjects changed their voiceless category boundaries to lower VOT values.

The formant frequencies of a word are different depending on the environment of vowels or stops. It is generally known that the fundamental frequency (F_0) of the following vowel in onset position is lowest for plain/ lax stops, higher for glottalized stops, and highest for aspirated stops, and that F_0 for plain/lax stops is significantly lower than aspirated and glottalized stops (Kim et al., 2002). The average value of F_0 for the following vowel also differs depending on the voicing of the preceding stops (Kim, Lee and Lotto, 2003). Keating (1984) mentions that the F_0 for the vowels following voiceless stops is higher than for vowels following voiced stops in many languages.

Many researchers have measured the fundamental frequencies of Korean stops (Han and Weitzman, 1970; Kim and Lotto, 2002). Korean stops that occur in word-initial position are all voiceless. Therefore, F_0 is highest after aspirated stops, relatively high after glottalized stops, and

lowest after the plain/lax stops. The overall average of F_0 values of aspirated stops are between 147.2 Hz and 163.3 Hz for male speakers and 272.2 Hz to 309.9 Hz for female speakers. The F_0 of glottal stops ranges from 142.5 to 150.9 for male subjects and from 239.9 Hz to 285.9 Hz for female subjects (Kim and Lotto, 2002)

In order to test the difficulties that learners might have as a result of the absence of a certain acoustic property of sound in the L1 inventory, or the pre-existence of a similar sound, a perceptual experiment of English native speakers who learned Korean as a second language was conducted and is presented in the following section. The test was focused mostly on the troublesome vowels and consonants discussed above. The perception of the two Korean vowels [ʌ] and [o] were tested, as well as the three sets of the nine stop consonants /p, p^h, p'/, /t, t^h, t'/ and /k, k^h, k'/.

CHAPTER 3

IDENTIFICATION OF KOREAN BACK VOWELS

BY ADULT NATIVE SPEAKERS OF ENGLISH

Each vowel has its own qualitative properties which are determined by formant frequencies (Ladefoged, 2001). However, the sound can be produced differently depending on the person, their dialectal background, and other sociological factors. Furthermore, even the same vowel from the IPA chart has slightly different formant values depending on the language, and all of these factors may cause the misperception of that vowel for second-language learners.

Therefore, I first hypothesize that because of a pre-existent English vowel system, it is likely that L2 learners will misperceive the Korean vowels that are similar to English vowels. In particular, the vowel which shares similar formant values makes it harder to distinguish compared to vowels that have distinctively different formant values.

Secondly, I assume that the syllable structure of the Korean language may block the perception of the Korean vowels. Depending on the syllable structures, it is likely to raise the accuracy of perception if the syllable structure is more simple and universal.

The American English vowel [ʌ] and Korean vowel [ʌ] occur in slightly different places of articulation. The vowel [ʌ] in American English is considered a mid central unrounded vowel (Kenyon, 1950). Furthermore, this English vowel has been shown not to occur in syllable-final position; it must occur in closed syllables. As a result, the Korean vowel [ʌ] gives native

English-speaking Korean learners trouble with pronunciation, due to the different place of articulation and different syllabic environment.

The English vowel [o] is a back rounded high-mid vowel. In American English when this vowel comes at the end of a syllable such as “go” [gou] or when it gets stress, as in “road” [roud], it is realized as a diphthong. Compared to Korean [o], this diphthongized [ou] is articulated higher and is also more tensed.

Besides vocalic properties themselves, the syllabic environment may also be a reason for misperception. Since Korean syllable structure is different than English ([ʌ] may occur in open syllables), I assume that the American students perceive the vowel [o] and [ʌ] according to their L1 syllable structure for each vowel, such as CVCV, versus closed syllable structure, such as CVCCVC.

In this chapter, I attempt to determine the acoustic characteristics which distinguish Korean back vowels from American back vowels and examine the accuracy with which subjects whose native language is English perceive these vowels in an identification task. Data from a perceptual experiment will be reported and analyzed to answer two main questions: first, which Korean vowel is more accurately perceived. The result can be explained by subjects’ native phonetic influence. Then second, whether the syllable structure can affect identification of those vowels.

3.1 Method

Subjects

A total of thirty-six adult native speakers of English participated in the first part of the vowel identification experiment. They were undergraduate/graduate students who previously took or are currently taking a Korean class at the University of Georgia. Subjects who have

Korean parents, family, or close relatives were eliminated from this experiment. All subjects were native English speakers who do not have close relationships with Koreans. Nineteen female and seventeen male volunteers participated in the experiment. The age of subjects was between 18 and 31. All had Korean cultural and language exposure from a minimum of 1 year to a maximum of 10 years, and had formally studied the Korean language from 3 months to 7 years.

Table 5: Age distribution of participants

Age range	18-20	21-23	24-26	27~	Total
Number of subjects	24	9	1	2	36

Table 6: Length of exposure to language/culture

Length	Less than a year	1~2	2~3	3~4	More than 4 years	Total
Number of subjects	3	5	10	15	3	36

3.2 Stimuli

Speakers

The recording was made by using a professional digital recorder Olympus WS-321M. The speakers who recorded the sound files are from Seoul, South Korea, where they use standard Korean; (standard Korean is defined by the National Institute of the Korean Language as “the modern speech of Seoul widely used by the well-cultivated”). It tends to include features that are

found in Seoul only.) Therefore the stimuli reflect standard Korean pronunciation. After recording the sound files, two other Korean Teaching Assistants who come from the capital areas Incheon and Seoul listened to the files and verified the accuracy of the pronunciation.

Word list

Korean fabricated words were designed for this experiment. To identify the vowel sounds, two sets of minimal pairs were designed to test the two different vowels. Test vowels were placed in either word-initial or syllable-initial position. Participants heard an audio file and were given two possible answers to choose from the answer sheet. The possible answers, A or B, were given on the computer screen and subjects were supplied with an answer sheet, on which they could check whether the word is A or B. To avoid subjects' use of reading knowledge and increase the overall reliability, fabricated words were used rather than real Korean words. Tokens were repeated sometimes twice or three times, with different answer choices than in the first presentation. Each vowel was tested twice over a total of 20 questions. For the second presentation, the order of the answers was reversed on the screen.

Table 7: List of Vowels in words

Vowel	Fabricated word
/ʌ /	/ʌbu/, /mʌsu/, /gʌdʒin/, /bʌka/, /jʌngsʌl/, /sʌman/, /jʌnga/
/o /	/obu/, /mosu/, /godʒin/, /jongsʌl/, /boka/, /soman/, /jonga/

3.3 Procedure

Subjects were given a short interview with the investigator before the experiment. They were asked about their background information, from basic personal questions (such as age, gender, and ethnicity), to information about the target language (such as their exposure to the language, and the length of studying the target language). Finally, they self-analyzed their language proficiency, using a four-point scale. After the interview, they listened to the sound clips.

The tokens which contain the Korean vowels [ʌ] and [o] were tested in ten questions. After hearing a sound file, the answer choices appeared on the computer screen, written in the Korean alphabet. Participants were asked to choose the word corresponding to what they heard. The response time for each question was limited to 2.5 seconds.

3.4 Acoustic Analysis

First, all tokens were analyzed for their formant values. Among 20 tokens, ten tokens of [ʌ] and ten tokens of [o] were analyzed. In order to measure each vowel's formant frequency, PRAAT was used, which digitally displays spectrographic information. Vowel onset and offset values were used to determine total vowel duration. Table 8 and 9 list F_0 and the average formant values for the tokens of experiments.

Table 8: Average values of F_0 , the three formants (F1, F2, F3), and their standard deviations for the Korean vowel [ʌ] (n=10)

[ʌ]	F_0	F1	F2	F3
Mean	363.20	846.40	1368.14	2237.65
Standard Deviation	31.23	124.37	278.89	389.06

Table 9: Average values of F₀, the three formants (F1, F2, F3), and their standard deviations for the Korean vowel [o] (n=10)

[O]	F ₀	F1	F2	F3
Mean	369.00	628.37	1397.30	2349.66
Standard Deviation	38.42	87.77	240.08	103.66

3.5 Statistical Analysis

A total of 720 data sets (2 minimal pairs X 10 tokens X 36 students) were analyzed for the experiment. First, in order to test the influence of the native phonetic system, I examined the accuracy rates of two different vowels. The average accuracy rate for the 360 tokens of vowel [ʌ] was about 90 % and the accuracy rate of the 360 tokens of vowel [o] was 80%. The average number of participants who made an error for the vowel [ʌ] is 2.7 per token, whereas the average number of people who made an error of the vowel [o] is 4.7. Therefore, the subjects better identified [ʌ] than [o]. For more accurate statistical analysis, tests were conducted using the program SPSS. To compare two different vowel groups, a t-test was used for analyzing the data. The results are given in the following tables:

Table 10: Group Statistics

	Total Subject Number	Mean	Standard Deviation	Std. Error Mean
[ʌ]	36	8.9722	1.52102	.25350
[o]	36	7.7778	2.37981	.39663

Table 11: Independent Sample Test

	Levene's test for Equality of Variation	T-Test for Equality of Means							
	F	Sig.	T	df	Sig. (2- tailed)	Mean Difference	Std.Error Difference	95% Confidence Interval of the Difference	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
Total Equal varia- nces assu- med	6.457	.013	2.537	70	.013	1.19444	.47073	.25561	2.133 28
Total Equal varia- nces not assu- med			2.537	59.505	.014	1.19444	.47073	.25269	2.136 20

An independent-sample t test was conducted to evaluate the hypothesis that subjects have difficulty in distinguishing the Korean vowel [o] as opposed to the vowel [ʌ]. The test was significant, $t(2)=2.54$, $p < .05$, so the results matched the research hypothesis. Subjects had more difficulty in distinguishing the vowel [ʌ] ($M=8.9$, $SD=1.5$) than the vowel [o] ($M=7.8$, $SD=2.4$). The 95% confidence interval for the difference in means was somewhat wide, ranging from 0.256 to 2.133.

In order to evaluate the relationship between the syllable structure and the correct perception of English native speakers, a one-way analysis of variance was conducted. The independent variable was the syllable structure including four different groups: CV.CV, CV.CVC, CVC.CV, and CVC.CVC. The dependent variable was the accuracy rate of those tokens. The first group is the target inserted in CV.CV syllable structures. The second and third groups consist of CV.CVC and CVC.CV structures, respectively. The last group has the most complex syllable structure, which is CVC.CVC.

Each group consists of a total of five tokens and the total number of tokens is twenty-five. A total of thirty-six subjects whose native language is English participated in this experiment. The table below shows the mean for accuracy rates of tokens and their standard deviation. The mean of each five tokens per group indicates that subjects have the highest accuracy for the basic syllable structure group, which is CV.CV, 4.47 out of 5.00. The least accurate rate is for the CV.CVC structure and its mean is 3.72 out of 5.00.

Table 12: Descriptive Statistics

Dependent Variable: total groups

Group	Mean	Std. Deviation	N
CV.CV	4.4722	.99960	36
CV.CVC	3.7222	.56625	36
CVC.CV	4.1389	1.04616	36
CVC.CVC	4.3889	1.47895	36
Total	4.1806	1.10088	144

Table 13: Tests of Between-Subjects Effects

Dependent Variable: total group

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	12.250(a)	3	4.083	3.549	.016	.071
Intercept	2516.694	1	2516.694	2187.67 5	.000	.940
group	12.250	3	4.083	3.549	.016	.071
Error	161.056	140	1.150			
Total	2690.000	144				
Corrected Total	173.306	143				

a R Squared = .071 (Adjusted R Squared = .051)

Table 13 was used to determine whether the overall ANOVA was significant. The test was significant, $F(3,140) = 3.549$, $p = .016$, $\eta^2 = .071$. Follow-up tests were conducted to evaluate pairwise differences among the means. There was a significant difference ($p < .05$) in the means between groups (Mean Difference = .75) and $p = .021$.

The results of the post hoc comparison are shown in the table 14. Using a Bonferroni test, groups CV.CV and CV.CVC differed significantly from one another. In Table 14, the asterisks

(*) in the Mean Difference column indicate which pairwise comparisons are significant. The results of the one-way ANOVA supported the hypothesis that different types of syllable structure gave a different accuracy rate on the vowel perception test for English native speakers.

Table 14: Post Hoc Tests

Multiple Comparisons

Dependent Variable: Total group

			Mean Difference (I- J)	Std. Error	Sig.	95% Confidence Interval	
						Upper Bound	Lower Bound
Tukey HSD	cv.cv	cv.cvc	.7500(*)	.25281	.018	.0927	1.4073
		cvc.cv	.3333	.25281	.553	-.3240	.9907
		cvc.cvc	.0833	.25281	.988	-.5740	.7407
	cv.cvc	cv.cv	-.7500(*)	.25281	.018	-1.4073	-.0927
		cvc.cv	-.4167	.25281	.355	-1.0740	.2407
		cvc.cvc	-.6667(*)	.25281	.045	-1.3240	-.0093
	cvc.cv	cv.cv	-.3333	.25281	.553	-.9907	.3240
		cv.cvc	.4167	.25281	.355	-.2407	1.0740
		cvc.cvc	-.2500	.25281	.756	-.9073	.4073
	cvc.cvc	cv.cv	-.0833	.25281	.988	-.7407	.5740
		cv.cvc	.6667(*)	.25281	.045	.0093	1.3240
		cvc.cv	.2500	.25281	.756	-.4073	.9073
Bonferroni	cv.cv	cv.cvc	.7500(*)	.25281	.021	.0734	1.4266
		cvc.cv	.3333	.25281	1.000	-.3432	1.0099
		cvc.cvc	.0833	.25281	1.000	-.5932	.7599
	cv.cvc	cv.cv	-.7500(*)	.25281	.021	-1.4266	-.0734

Games-Howell		CVC.CV	-.4167	.25281	.609	-1.0932	.2599
		CVC.CVC	-.6667	.25281	.056	-1.3432	.0099
	CVC.CV	CV.CV	-.3333	.25281	1.000	-1.0099	.3432
		CV.CVC	.4167	.25281	.609	-.2599	1.0932
	CVC.CVC	CV.CV	-.2500	.25281	1.000	-.9266	.4266
		CV.CVC	-.0833	.25281	1.000	-.7599	.5932
	CVC.CV	CV.CVC	.6667	.25281	.056	-.0099	1.3432
		CVC.CV	.2500	.25281	1.000	-.4266	.9266
	CV.CV	CV.CVC	.7500(*)	.19147	.001	.2428	1.2572
		CVC.CV	.3333	.24116	.515	-.3014	.9681
	CVC.CVC	CV.CV	.0833	.29751	.992	-.7023	.8690
		CV.CVC	-.7500(*)	.19147	.001	-1.2572	-.2428
	CVC.CV	CV.CVC	-.4167	.19826	.166	-.9423	.1089
		CVC.CVC	-.6667	.26394	.069	-1.3708	.0374
	CVC.CV	CV.CV	-.3333	.24116	.515	-.9681	.3014
		CV.CVC	.4167	.19826	.166	-.1089	.9423
	CVC.CVC	CV.CV	-.2500	.30193	.841	-1.0468	.5468
		CV.CVC	-.0833	.29751	.992	-.8690	.7023
	CVC.CV	CV.CVC	.6667	.26394	.069	-.0374	1.3708
		CVC.CV	.2500	.30193	.841	-.5468	1.0468

Based on observed means.

* The mean difference is significant at the .05 level.

CHAPTER 4

IDENTIFICATION OF NINE KOREAN STOPS

BY ADULT NATIVE SPEAKERS OF ENGLISH

In the Korean phonetic system, stops are produced with three different manners of articulation; plain (lenis), aspirated, and glottalized (fortis), at three places of articulation: bilabial, alveolar, and velar. According to previous research, including Cho et al. (2002), in word-initial position, as well as in monosyllable production, plain stops are slightly more aspirated and breathy than standard American English stops. The tensed stops are described as unaspirated and laryngealized, while aspirated stops are described as strongly aspirated. In order to identify the three stops, three acoustic properties are used: VOT, fundamental frequency (F_0) of the following vowel, and voice quality at the onset of the following vowel (Cho et al., 2002; Kim et al., 2002).

Studies show that mean VOT values are shortest for glottalized stops, intermediate for plain stops, and longest for aspirated stops; although VOT ranges often overlap between speakers (Han and Weitzman, 1970; Hardcastle, 1973; Kim, 1965). Whereas the VOT values markedly distinguish glottalized stops from aspirated stops, F_0 differences serve to distinguish plain stops from fortis or aspirated stops: F_0 at the onset of vowels following plain stops is generally lower than those following glottalized or aspirated stops (Ahn, 1999; Cho et al., 2002).

In this chapter, by measuring three stops for VOT and fundamental frequency, and comparing the results to the accuracy rates of L2-speakers' identification, I hope to find the

source of the difficulty that non-native speakers might have. This chapter also examines the identification of Korean consonants by native English speakers who study the Korean language by means of another perceptual test. The experiment consisted of nine Korean stops in word initial position. Three sets of initial stops [p/ p^h /pʔ], [k/ k^h/kʔ], and [t/ t^h /tʔ], that are produced in a plain, aspirated, and glottalized manners, will be tested. My hypothesis in this experiment is that lack of awareness of certain properties of the acoustic sound or different phonetic categories can lead to the misperception of a word. In order to compare the accuracy rates of perception between these three sounds, further research in identifying the level of difficulty in perceiving Korean sounds will be conducted.

4.1 Method

Subjects

A total of 30 subjects were chosen from students who are currently taking Korean language classes at the University of Georgia. They were selected from an age range of 18 to 24 years, 11 of whom were male subjects and 19 were female. No subjects who participated in the second experiment for consonant identification participated in the first vowel-identifying experiment. All subjects were volunteers and recruited via email and class announcement.

Table 15: Age distribution of participants

Age range	18-20	21-23	24-26	27~	Total
Number of subjects	9	18	3	0	30

Table 16: Length of exposure to language/culture

Length	Less than a year	1~2	2~3	3~4	More than 4 years	Total
Number of subjects	0	10	9	3	1	30

4.2 Stimuli

Speakers

The same speakers who recorded the sound files for the preceding experiment participated in this experiment as well. The same Olympus WS-321M microphone was used for recording.

Word list

The audio samples consisted of 27 fabricated Korean words. All tokens included one of nine Korean stops and all occurred in word-initial position. The subjects were given three answer choices instead of just two, as opposed to the vowel experiment. All consonants appeared in word-initial position and a total of 27 words (3 types of stops X 3 places of articulation X 3 tokens) were presented to the subjects. The order of the answers was reversed on the screen for the second presentation. The stimuli were given on the computer screen and the subjects were supplied with an answer sheet on which they could check whether the syllable was A, B or C.

Table 17: List of words in consonants

/p/	/para/, /pado/, /pal/
/p ^h /	/p ^h ara/, /p ^h ado/, /p ^h al/
/pʼ/	/pʼara/, /pʼado/, /pʼal/
/k/	/kara/, /kado/, /kal/
/k ^h /	/k ^h ara/, /k ^h ado/, /k ^h al/
/kʼ/	/kʼara/, /kʼado/, /kʼal/
/t/	/tara/, /tado/, /tal/
/t ^h /	/t ^h ara/, /t ^h ado/, /t ^h al/
/tʼ/	/tʼara/, /tʼado/, /tʼal/

4.3 Acoustic Analysis

In order to analyze the acoustic value of the three sets of stops, the program PRAAT was used for analysis and spectrographic information. A total of 27 tokens were analyzed. Among them, 9 were tokens for the plain stops, 9 were aspirated, and the last 9 were glottalized stops.

Table 18: Mean and Standard Deviation (SD) of Voice Onset Time for plain stops

	Bilabial	Alveolar	Velar	F ₀
Mean	57.9 ms	48.1 ms	59.9 ms	289.4 Hz
SD	18.2	15.6	15.0	18.9

Table 19: Mean and Standard Deviation (SD) of Voice Onset Time for aspirated stops

	Bilabial	Alveolar	Velar	F ₀
Mean	71.6 ms	59.4 ms	84.8 ms	285.5 Hz
SD	16	14.4	14.1	30.1

Table 20: Mean and Standard Deviation (SD) of Voice Onset Time for glottalized stops

	Bilabial	Alveolar	Velar	F ₀
Mean	5.4 ms	6.2 ms	23.7 ms	252.4 Hz
SD	4.4	2.7	9.0	29.2

In the data set, the difference among the VOT of the three stops and the F₀ values were presented. Between the plain stops and aspirated stops, there was less difference between them than the glottalized stops. The mean VOT of the plain stops was slightly longer than that of the aspirated stops. Unlike the VOT, F₀ values did not show distinctive differences among the different laryngeal settings of the stops. Only plain stops showed a slightly lower millisecond value than the other two stops. However, the place of articulation could be the cue for detecting difficulty in perceiving certain stops between the plain and aspirated stops. As the chart below shows, however, there was no distinctive difference for accuracy depending on the place of articulation of the stops.

Table 21: Accuracy rate by place of articulation

	Bilabial ㅁ / ㅃ / ㅄ /p/ p ^h / p'/	Alveolar ㄷ / ㅌ / ㄲ /t / t ^h / t'/	Velar ㄱ / ㅋ / ㆁ /k / k ^h / k'/
Total number of correct answers	122	122	121
Total number of wrong answers	85	85	86

4.4 Statistical Analysis

A one-way analysis of variance (ANOVA) was conducted to evaluate the relationship between subjects and the different laryngeal settings of the three sets of stops. The first group (1) indicates the plain stops, the second group (2) is the aspirated stops and the last group (3) is the glottalized stops. The mean for correct answers was lowest for the plain stops for each subject (3.6 out of 9 tokens) and highest for the aspirated stops (6.8 correct answers for a total of 9 tokens). The standard deviation for 27 tokens was 2.8 and the mean of the correct tokens for each subject was 5.2. The result of the ANOVA was significant, $F(2,87)=12.58$, $p=.001$ (Because the p-value is less than .05, we reject the null hypothesis that there are no differences among the groups.) According to Cohen's convention, the η^2 (labeled Partial Eta Squared in the output) of .23 indicates a weak relationship between the subjects' (mis)perception and the manner of articulation of the stops.

Table 22: Dependent Variable: total

Group	Mean	Standard Deviation	Number
1	3.6000	2.49966	30
2	6.8000	1.95466	30
3	5.0333	2.88257	30
Total	5.1444	2.77857	30

Table 23: Tests of Between-Subjects Effects

Dependent Variable: Total group

Source	Type III sum of squares	Df	Mean Square	F	Significant Value	Partial Eta Squared
Corrected Model	154.156(a)	2	77.078	12.582	.000	.224
Intercept	2381.878	1	2381.878	388.811	.000	.817
Group	154.156	2	77.078	12.582	.000	.224
Error	532.967	87	6.126			
Total	3069.000	90				
Corrected Total	687.112	89				

a R Squared = .224 (Adjusted R Squared = .207)

In this table, the overall F test was significant. Therefore, we can assume that there are differences among those three groups. The different mean square explains that those three tested groups (plain, aspirated, and glottalized stops) are significantly different. Because the overall F test was significant, follow-up tests were conducted to evaluate pairwise differences among the means. In table 22, the standard deviations range from 1.95 to 2.88 and the variances (the standard deviation squared) range from 3.82 to 8.30, indicating that the variances are somewhat,

but not drastically, different from each other. The test of homogeneity of variance was nonsignificant, $p = .14$. Because there may be a lack of relevancy associated with the test due to the small sample size, the result of the homogeneity test does not necessarily imply that there are no differences in the population variances. Therefore, the prudent choice for these data would be to use the results of the Dunnett's C test, a multiple comparison procedure that does not require the population variances to be equal.

Table 24: Post Hoc Tests

Multiple Comparisons (Dependent Variable: Total group)

	(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval		
			Lower Bound	Upper Bound		Lower Bound	Upper Bound	Lower Bound
Tukey HSD	1.00	2.00	-3.2000(*)	.63906	.000	-4.7238		-1.6762
		3.00	-1.4333	.63906	.070	-2.9572		.0905
	2.00	1.00	3.2000(*)	.63906	.000	1.6762		4.7238
		3.00	1.7667(*)	.63906	.019	.2428		3.2905
	3.00	1.00	1.4333	.63906	.070	-.0905		2.9572
		2.00	-1.7667(*)	.63906	.019	-3.2905		-.2428
Bonferroni	1.00	2.00	-3.2000(*)	.63906	.000	-4.7601		-1.6399
		3.00	-1.4333	.63906	.082	-2.9934		.1267
	2.00	1.00	3.2000(*)	.63906	.000	1.6399		4.7601
		3.00	1.7667(*)	.63906	.021	.2066		3.3267
	3.00	1.00	1.4333	.63906	.082	-.1267		2.9934
		2.00	-1.7667(*)	.63906	.021	-3.3267		-.2066
Games-Howell	1.00	2.00	-3.2000(*)	.57934	.000	-4.5956		-1.8044
		3.00	-1.4333	.69660	.108	-3.1097		.2431
	2.00	1.00	3.2000(*)	.57934	.000	1.8044		4.5956
		3.00	1.7667(*)	.63587	.020	.2317		3.3016
	3.00	1.00	1.4333	.69660	.108	-.2431		3.1097
		2.00	-1.7667(*)	.63587	.020	-3.3016		-.2317
Dunnett C	1.00	2.00	-3.2000(*)	.57934		-4.6308		-1.7692
		3.00	-1.4333	.69660		-3.1537		.2870
	2.00	1.00	3.2000(*)	.57934		1.7692		4.6308
		3.00	1.7667(*)	.63587		.1963		3.3370
	3.00	1.00	1.4333	.69660		-.2870		3.1537
		2.00	-1.7667(*)	.63587		-3.3370		-.1963

Based on observed means.

* The mean difference is significant at the .05 level.

Using the Dunnett's C test, groups 1 (plain stops) and 2 (aspirated stops) differed significantly from one another. Groups 2 (aspirated stops) and 3 (glottalized stops) also differed significantly from one another. In the above table, the asterisks (*) in the Mean Difference column indicate which pairwise comparisons are significant.

CHAPTER 5

DISCUSSION

The present study examined non-native speakers' accuracy of identifying Korean vowels and consonants word-initially by analyzing acoustic-phonetic properties of Korean vowels and word-initial stop contrasts. Findings from this study show that subjects exhibited difficulty in perceiving the sound that was closer to their native language categories than totally new sounds, a position supporting Flege (1996).

For example, in the consonant identification test, the results show that the word-initial glottalized stops that do not appear in English have higher accuracy rates than the plain stops. The vowel tests also show some similarity, even though the vowels that were tested in the experiments were not as definitively “new” of sounds for English-speakers as the consonants. Since the sound [o] has less accuracy rate than the arguably more distinctive sound [ʌ], we might assume the former is more similar to its English counterpart than the latter. More detailed studies on this topic could be carried out to determine degrees of similarity between the two languages.

However, the syllable structure of the vowel tokens shows different results in relation to Flege's hypothesis: the more marked structure is harder to perceive than the less marked one. In a vowel-perception experiment, these syllables structures played a role in reducing accurate perception in vowel identification. Lastly, the VOT of the consonants may also be a reason for the misperception of Korean stops.

The results show that the perception of Korean vowels [ʌ] and [o] was reasonably successful, more so for / ʌ / (about 90%) than / o / (79.9%). Compared to Korean [ʌ], which is a back vowel but treated more as a central vowel in English, [o], which shares a similar place of articulation, has lower accuracy rates of identification.

Compared with the vowel perception and production experiment that Ahn (1997) conducted with Korean subjects, the accurate rate of vowels of English native speaker is much higher. Even though the subjects of Ahn's and this research are different, (Ahn's subjects were Korean and the current study's participants were American), the result of testing perception of vowels shows big differences; in Ahn's test, Korean subjects only distinguished British vowels [ʌ] with 45% accuracy in production and a 35.5 % correct rate for perception, and [o] with 12.3 % of accurate rate.

The big difference between her experiment and the current study can be explained in that, first Ahn's research tested British vowels, not American English vowels and Ahn's subjects were Korean while the subjects of the current study were American. Secondly, Ahn's subjects were too small in number. As she herself admitted in the paper, the Korean subjects who participated in the identification and production task of British vowels were only three and this is too small to generalize the results.

According to Yang (1996), American English vowels are substantially longer than Korean vowels: the average duration of AE vowels is 251 ms, with a SD of 61 ms, while that of Korean vowels is 86 ms, with an SD of 32 ms. Furthermore, results of the acoustic analysis of vowel tokens show that the biggest difference between the two vowels is the F1 formant.

Therefore, the assumption that the F1 formant plays an important role in distinguishing perceptually between the vowels [ʌ] and [o] is valid.

Moreover, the syllable structure also plays some role in determining accurate vowel perception. The same vowel gives different accuracy rates depending on the structure of its carrier syllable. The results show that the simplest structure CVCV has the lowest error rate, whereas the final closed syllable structures such as CVCVC or CVCCVC have relatively higher error rates.

Regarding the syllable types, the results of the current study are different from Flege's (1996) predictions from the Markedness Theory that states that the more marked features are easier to perceive than unmarked features. It is known that near universal features that many languages commonly have are less marked than the unique features that a certain language may have. In syllable structure, CV is the most common form found in all world languages. The CVCC structure that Korean has is less common than CV structure, and it is therefore the more marked.

However, the syllable structures tested in the current study show the opposite results from what Flege predicts. It shows that the subjects more easily perceived the unmarked features than marked features, i.e. CVCV tokens rather than CVCCVC tokens. As discussed above, this finding is different from the vowel perception test, which shows the more marked feature for consonants (and possibly vowels) is easier to perceive than the less marked one: the results for syllables is in contrast to the results for segments.

This shows that not only the phoneme inventories, but also the syllable structures of the target language, can affect learners' acquisition of a language. English and Korean are quite different from each other in terms of their syllable structure. The Korean syllable structure does

not allow the consonant clusters to surface and the syllable coda position is restricted to only lenis stops, nasals and a lateral. Since the two languages are typologically different, their different syllable structures can be a problem that blocks the accurate vowel perception in the test.

In the previous research of McBride-Chang et al (2005), they show that the syllable structure and “morphological awareness” can be factors that mislead phonological awareness. They argue that phonological awareness can be dependent on learner’s syllable awareness, and also that phonological awareness is more strongly associated with word recognition.

Furthermore, the syllabic nature of the Korean alphabet, Hangeul (syllables, as well as phonemes are indicated in the script) in combining phonemes most often in a CVC(C) pattern, requires that, to become fluent readers, children in Korea have some sense of phoneme onsets as well as the syllabic processes that occur at morpheme boundaries. Therefore, the different syllable awareness of English native speakers’ may reduce the accuracy of perception of Korean, since they are not accustomed to reading "syllabically".

There have been two major approaches to looking at L2 syllable structure: the structural and the typological. The structural approach is illustrated by Broselow (1988) and Osbourne (1996), whereas the typological approach is suggested by the work of Eckman (1991). In the Structural approach, it explains, for example, that Arabic does not allow branching onsets or codas, so an English word like plant cannot be mapped onto a single Arabic syllable. They argue that this could be the explanation for why Arabic speakers mispronounce English words, i.e. by relying on the principles of syllabification in the L1. The second approach suggested that some consonant clusters and certain segments are more difficult than others for L2 learners to acquire, based on their relative markedness.

Likewise, more marked syllable types would be harder to perceive than less marked, as discussed above. These concepts account for the differences in English and Korean syllabification and may result in the misperception of Korean vowels by native English speakers.

In the consonant experiment, the study explored the perception of nine Korean stops in word-initial position. Stops were differentiated primarily by VOT; the different speakers' recordings of the test tokens were analyzed acoustically with results showing that there was more inter-speaker variation in VOT than F_0 ; which can be interpreted as the main source of misperception for participants. Findings from this study show that there is not much difference between places of articulation in terms of accurate perception. The error rates among the three places (bilabial, alveolar, and velar) were almost the same for each listener.

However, the articulation of the stops shows great differences. As the results indicate, non-native speakers of Korean have the most difficulty in perceiving plain stops, next to glottalized stops. The aspirated stops showed relatively high accuracy rates overall. American English does not allow glottalized stops in word-initial position; therefore they could be considered new phonetic sounds for the non-native speakers. However, this result shows that second language learners had difficulty in differentiating between their pre-existing phonetic system and that of the target language.

In general, mean VOT values are shortest for plain stops, intermediate for glottalized stops, and longest for aspirated stops; however, between-speakers VOT ranges often overlap (Han and Weitzman, 1970; Hardcastle, 1973; Kim, 1965). In Korean stops, VOT's of plain stops are produced similarly to English aspirated stops. In addition, Korean glottalized stops, as produced by Korean monolinguals (11 ms), are closer to the VOT value of English voiced stops (14 ms) (Kang & Guion, 2005).

In conclusion, this study suggests that language-specific phonetic details of a target language can explain second language learners' perceptual difficulty with certain sounds. Findings showed the presence of interference from the native English phonetic system in accurate perception of target language stops and vowels based on data from Korean, a language using multiple phonetic-acoustic features for stop contrasts and vowel contrasts.

One limitation of the study is the control condition of the gender of speakers. In general, female speakers have higher pitch and formant values for vowels. Since only female speakers participated in the recording of the experiment, re-testing the tokens with a male voice recording might give a different result for the experiment. Since F1 formants of vowels for female speakers are relatively lower than F1 formants of males (Yang, 1996), the lower formants of the speaker may lead to higher or lower perception rates for listeners.

Another limitation is the control of the subject groups in terms of language exposure. The subjects' variability of exposure to the language and culture varies from one year to a maximum of nine years. Comparing the subjects who had nine years of cultural and language exposure to other subjects, it shows considerable differences in accuracy rates. The only subject who had nine years of exposure presented more than 90% accuracy in identifying vowels.

Language exposure plays an enormous role in second language perception and production. According to previous research, advanced second language learners experience more difficulty than beginners due to language interference. If we control the subject group for level of exposure, this might result in a different conclusion.

In addition, alternating male and female speakers might change the results. In general, females have higher pitch and great VOT values than males, and the different levels of pitch and

VOT may affect understanding words correctly. Therefore, the control of the speakers would lead to different results than the experiments presented here.

However, conducting this research may help with understanding possible difficulties in language learning. Previous research only focused on either acoustic analysis of Korean stops and vowels or second language acquisition based on the different backgrounds of subjects such as gender, length of exposure to the target language, or age of first acquisition of a given language. This study, however, posits a perceptual reason for misperception of Korean stops and vowels, at the same time testing a larger number of participants on both consonant and vowel identification.

REFERENCES

- Ahn, M. Y. (1997). The phonological interlanguage of Korean learners of English. *Ph.D. diss., University of Wales, Cardiff.*
- Barlow, J. A. (2005). Phonological change and the representation of consonant clusters in Spanish: A case study. *Critical Linguistic and Phonetics*, 19(8), 659-679
- Battistella, E. (1990). Markedness: The evaluation superstructure of language. *Albany: The State University of New York Press*
- Bernstein, L.E. (1979). Development differences in labeling VOT continua with varied fundamental frequency. *Journal of the Acoustical Society of America*, 65 (1), S112
- Bernstein, L.E. (1980). Labeling of VOT with fixed versus varied fundamental frequency. *Journal of Acoustic Society of America*, 56 (1), S51-S52
- Bickerton, D. (1981). Roots of Language. *Ann Arbor: Karoma*
- Bot, K., Lowie, W., and Verspoor, M. (2005). Second Language Acquisition: An Advanced Resource Book. *London: Routle/Taylor-Francis*
- Broselow, E. (1988), Prosodic phonology and the acquisition of a second language., In S. Flynn & W. O'Neil (Eds.), *Linguistic theory in second language acquisition* (pp. 295-308). *Dordrecht, The Netherlands: Kluwer*
- Brown, H. D.(2000), Principles of Language Learning and Teaching (4th ed.). *New York: Longman*
- Cairns, C., & Feinstein, M. (1982). Markedness and the theory of Syllable Structure. *Linguistic Inquiry*, 13(2), 193-225

- Calabrese, A. (1995). A constraint-Based Theory of Phonological Markedness and Simplification Process, *Linguistic Inquiry*, 26 (3), 373-463
- Carlisle, R. (2001). Syllable Structure Universals and Second Language Acquisition. *International Journal of English Studies*, 1(1), 1-19
- Cassie, M. (1981). Cross-linguistic differences in fundamental frequency perturbation induced by voiceless unaspirated stops. *Journal of the Acoustic Society of America*, 70 (1), S76-S77
- Cho, T., Jun, S.-A., and Ladefoged, P. (2002). Acoustic and aerodynamic correlates of Korean stops and affricatives. *Journal of Phonetics*, 30 (2), 193-228
- Eckman, F. (1981). On predicting phonological difficulty in second language acquisition. *Studies in Second Language Acquisition*, 4(1), 18-30
- Eckman, F. (1991). The structural conformity hypothesis and the acquisition of consonant clusters in the interlanguage of ESL learners. *Studies in Second Language Acquisition*, 13(1), 23-41
- Ewen, C., and van der Hulst, H. (2001). The phonological structure of words: An introduction. *Cambridge: Cambridge University Press*
- Flege, J. (1987). The Instrumental Study of L2 Speech production: Some Methodological Considerations. *Language Learning*, 37(2), 285-296
- Flege, J. (1988). Factors affecting degree of perceived foreign accent in English Sentence. *Journal of Acoustical Society of America*, 84(1), 70-79
- Flege, J. (1991). Age of learning affects the authenticity of voice-onset-time (VOT) in stop consonants produced in a second language. *Journal of the Acoustical Society of America* 89(1), 395-411

- Flege, J.(1992). Talker and Listener effects on degree of perceived foreign accent. *Journal of Acoustical Society of America*, 91 (1), 370-389
- Flege,J., Munro, M. & MacKay, R.(1995). Factors affecting strength of perceived foreign accent in a second language. *Journal of the Acoustical Society of America*, 97(5), 3125-3134
- Bayley, I. R. and Preston, D. R. (1996). Second Language Acquisition and Linguistic Variation. *Amsterdam: John Benjamins Publishing Company*
- Fry, D.B. (1979). The physics of speech. *Cambridge: Cambridge University Press*
- Greenberg, J. (1965). Some Generalizations concerning Initial and Final consonant Cluster. *Linguistics*, 18(1), 5-34
- Han, M.S., and Weitzman, R.S.(1970). Acoustic features of Korean /P,T,K//p,t,k/ and /ph,th,kh/, *Phonetica* 22(1), 112-128
- Hardcastle, W. J. (1973). Some observations of the tense-lax distinction in initial stops in Korean. *Journal of Phonetics* 1(2), 263-271
- Ingram, J.C.L., Park, S. G.,(1997). Cross-language vowel perception and production by Japanese and Korean learners of English. *Journal of Phonetics*, 25(3), 343-370
- Jeon, S.B. (2005). Introduction to English Phonetics. *Seoul, South Korea: Ulyoo Moonhwasa*
- Jones, D. (1957). An Outline of English Phonetics. *Cambridge: W.Heffer and Sons Ltd.*
- Johnson, K. (2003). Acoustic and Auditory Phonetics (2nd ed). *Oxford, UK: Blackwell*
- Kabak, B. and Idsardi, W. J. (2007). Perceptual Distortions in the Adaptation of English Consonants Clusters: Syllable Structure or Consonantal Contact Constraints?.*Language and Speech*, 50(1), 23-52

- Kang, K.-H. and Guion, S. G. (2006). Phonological system in bilinguals: Age of learning effects on the stop consonant systems of Korean –English bilinguals. *Journal of the Acoustical Society of America*, 119(3), 1672-1683
- Kang, K.-H. (2007). Phonemic Contrast Enhancement in Clear Speech Production: The Case of Korean Stop Production, *The Journal of the Acoustical Society of America*, 121(5), 3043
- Kim, C.W. (1965). On the autonomy of the tensivity feature in stop classification (with special reference to Korean stops), *Word* 21, 339-359
- Kim, M.-R. Cho. (1994). Acoustic characteristics of Korean stops and perception of English Stop consonants. *Doctoral dissertation, University of Wisconsin at Madison*
- Kim, M.-R., Beddor, P. S., and Horrocks, J. (2002). The contribution of consonantal and vocalic information to the perception of Korean initial stops. *Journal of Phonetics* 30(1), 77-100
- Kim, M.-R. Cho and Lotto, A. J. (2002). Acoustic characteristics of Korean stops produced by non-heritage learners. *The Korean Language in America*, 7, 177-187
- Kim, J. E. and Silva, D. J. (2003) Accounting for Back-Vowel Under-Differentiation: An Acoustically-Based Study of English-Speaking Learners of Korean. *The Korean Language in America*, 8, 51-64
- Kim, M.-R., Cho, Lee, J. and Lotto, A. J. (2003). An Investigation of the Manner Contrast in Intervocalic Korean Stop. *The Korean Language in America*, 8, 75-84
- Klatt, D. H. (1975) Voice onset time, frication and aspiration in word-initial consonant clusters, *Journal of Speech, Language and Hearing Research*. 18(4), 686-705
- Ladefoged, P. (2001). Vowels and consonants: an introduction to the sounds of languages. *Oxford, UK:Blackwell*.
- Lee, D. (1998). Korean Phonology: Principle-based Approach. *Germany: Lincon Europa*.

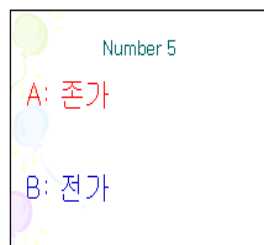
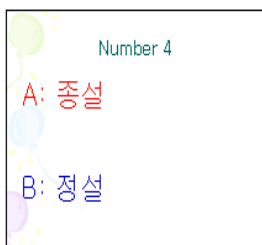
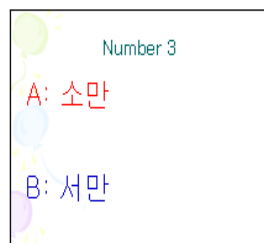
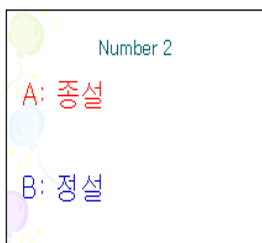
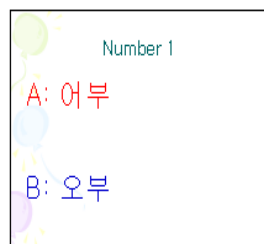
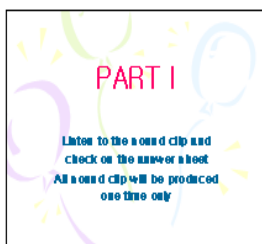
- Lee, H. (1999). Handbook of the International Phonetic Association: A guide to the use of the International Phonetic Alphabet. *Cambridge: Cambridge University Press*
- Lisker, L., and Abramson, A.S. (1964). A cross-language study of voicing in initial stops: Acoustical measurement. *Word* 20, 384-422
- McAllister, R. (2001). Experience as a factor in L2 Phonological acquisition, *Lund University, Dept. of Linguistics, working papers* 49 (2001), 116-119
- McBride-Chang, C., Cho, J.R., Liu, H., Wagner, R., Shu, H., Zhou, A., Cheuk, C., and Muse, A. (2005). Changing models across cultures: Associations of phonological awareness and morphological structure awareness and morphological structure awareness with vocabulary and word recognition in second graders from Beijing, Hong Kong, Korea and the United States, *Journal of Experimental Child Psychology*, 92(2), 140-160
- Moyer, A. (1999). Ultimate Attainment In L2 Phonology: The Critical Factors of Age, Motivation, and Instruction, *Studies in Second Language Acquisition*, 21(1), 81-108
- Negus, V. E. (1949). The comparative Anatomy and Physiology of the Larynx. *New York: Hafner*
- O'Brien, I., Segalowitz, N., Freed, B., and Collentine, J., (2006). Phonological memory predicts second language oral fluency gains in adults, *Studies in Second Language Acquisition*, 29(4), 557-582
- Osbourne, A. (1996). Final cluster reduction in English L2 speech: A case study of a Vietnamese speaker, *Applied Linguistics*, 17(2), 164-181
- Ohde, R. N.(1984). Fundamental Frequency as an acoustic correlate of stop consonant voicing. *Journal of the Acoustic Society of America*, 75 (1), 224-230

- Poulisse, N. and Bongaerts, T. (1994). First Language Use in Second Language Production. *Applied Linguistics*, 15 (1), 36-57
- Rosner, B. S. and Pickering, J. B. (1994). Vowel perception and production. *Oxford, UK : Oxford University Press*
- Ryoo, M.-L. (2001). Vowel quality and consonant voicing: the production of English vowels and Final stops by Korean speakers of English. / *Texas Papers in Foreign Language Education* : 6 (1), 133-146
- Segalowitz, N. (1997). Individual differences in second language acquisition. in A.M.B. de Groot & J. Kroll (Eds.), *Tutorials in bilingualism* (pp. 85-112). *Mahwah, NJ: Erlbaum*
- Sohn, H.-M. (1999). *The Korean Language*. *Cambridge: Cambridge University Press*
- Stockwell, R., Bowen, J. and Martin, J. (1965). *The grammatical structures of English and Spanish*. *Chicago: University of Chicago Press*
- Sung, H. K., and Padilla, A. M. (1998). Student Motivation, Parental Attitudes, and Involvement in the learning of Asian Languages in Elementary and Secondary School. *The Modern Language Journal*, 82 (2), 205-216.
- Trager, G. and Smith, H. (1951). *An Outline of English Structure*. *Studies in Linguistics, Occasional Papers (No.3), Norman, OK: Battenberg Press*
- Vennemann, T. (1988). Preference laws for syllable structure and the explanation of sound change. *New York: Mouton de Gruyter*.
- Wagner, P. K., Torgenson, J. K., and Rashotte, C. A. (1999). Comprehensive test of phonological processing. *Austin, TX: PRO-ED*
- Wang, H.-S., (2003). A review of research on Korean as a foreign language. *The Korean language in America*, 8(1), 7-35

Westbury, J. R., and Keating, P. A. (1986). On the naturalness of stop consonant voicing, *Journal of Linguistics*. 22(1), 145-166

Yang, B. (1996). A comparative study of American English and Korean vowels produced by male and female speakers. *Journal of Phonetics* 24 (2), 245-261

APPENDIX A: EXAMPLE OF ACTUAL EXPERIMENTS



APPENDIX B: ANSWER SHEETS OF TWO EXPERIMENTS

Answer sheet for listening test I

You will listen to the sound clip and check on an appropriate box Part I

[illegible]

A		B	
A		B	
A		B	
A		B	
A		B	
A		B	

Personal Information

Age:

Gender:

What is your ethnicity? (you can choose more than one)

- a. Korean-Heritage b. Asian c. White
 d. African-American d. Hispanic e. Other

How long have you studied Korean? (If there is any lapse in your time of study, explain it as well)

Answer sheet for listening test

You will listen to the sound clip and check on an appropriate box.

1	A		B		C	
2	A		B		C	
3	A		B		C	
4	A		B		C	
5	A		B		C	
6	A		B		C	
7	A		B		C	
8	A		B		C	
9	A		B		C	
10	A		B		C	
11	A		B		C	
12	A		B		C	
13	A		B		C	
14	A		B		C	
15	A		B		C	
16	A		B		C	
17	A		B		C	
18	A		B		C	
19	A		B		C	
20	A		B		C	

APPENDIX C: WORD LIST OF THE VOWEL TESTS

Vowel	Fabricated word
/ʌ /	/ʌbu/, /mʌsu/, /gʌdʒin/, /bʌka/, /jʌngsʌl/, /sʌman/, /jʌnga/
/o /	/obu/, /mosu/, /godʒin/, /jongsʌl/, /boka/, /soman/, /jonga/

APPENDIX D: WORD LIST OF THE CONSONANT TESTS

/p/	/para/, /pado/, /pal/
/p ^h /	/p ^h ara/, /p ^h ado/, /p ^h al/
/p ^ʼ /	/p ^ʼ ara/, /p ^ʼ ado/, /p ^ʼ al/
/k/	/kara/, /kado/, /kal/
/k ^h /	/k ^h ara/, /k ^h ado/, /k ^h al/
/k ^ʼ /	/k ^ʼ ara/, /k ^ʼ ado/, /k ^ʼ al/
/t/	/tara/, /tado/, /tal/
/t ^h /	/t ^h ara/, /t ^h ado/, /t ^h al/
/t ^ʼ /	/t ^ʼ ara/, /t ^ʼ ado/, /t ^ʼ al/

APPENDIX E: Additional Phonological Aspects of the Korean Language

Sohn (1999)

1. Consonant Phonemes of Korean

		Bilabial	Alveo-dental	Palatal	Velar	Glottal
Nasal		M	n		ŋ	
Plosive	Fortis	p'	t'	c'	k'	
	Unaspirated	p	t	c	k	
	Aspirated	p ^h	t ^h	c ^h	k ^h	
Fricatives	Fortis		s'			
	Aspirated		s ^h			H
Liquid			l			
Glides	w*			j		

* bilabial and velar

2. Plosive Allophones in Korean

	Bilabial	Alveo-dental	Palatal	Velar
Word-initial	[p']	[t']	[c']	[k']
Word-initial	[p]	[t]	[c]	[k]

Word-initial	[pʰ]	[tʰ]	[cʰ]	[kʰ]
Intervocalic	[pʰ],[pʰ],[b]	[tʰ],[tʰ],[d]	[cʰ],[cʰ],[j]	[kʰ],[kʰ],[g]
Coda	[pʰ]	[tʰ]	[cʰ]	[kʰ]

/p/ → [b] / [+voice]_[+voice]

/p/ → [pʰ] / { _ #, _C }

3. Syllable Structure

Syllable Structure	Korean	Gloss
CV	[sʰa]	‘cheap’
CVC	[mul]	‘water’
GV	[wi]	‘up’
GVC	[wən]	‘hope (N)’
CGV	[kwi]	‘ear’
CGVC	[pjəŋ]	‘bottle’

APPENDIX F : INTERVIEW QUESTIONNAIRE

Questions for the Interview

Category A: Personal Information

Age:

Gender:

What is your ethnicity? (you can choose more than one)

- a. Korean-Heritage b. Asian c. White d. African-American d. Hispanic e.
Other

Category B: Exposure to Culture and Language

1. How long have you studied Korean? (If there is any lapse in your time of study, explain it as well)
2. At what level of proficiency in Korean would you rank yourself?
 - a. Advanced in general
 - b. Advanced in _____(Fill in the specific area of language in which you are most confident, ex.,writing, reading, listening, vocabulary, ect.)
 - c. Intermediate in general
 - d. Intermediate in _____(Fill in the specific area of language in which you are most confident, ex.,writing, reading, listening, vocabulary, ect.)
 - e. Beginning in general
 - f. Beginning in _____(Fill in the specific area of language in which you are most confident, ex.,writing, reading, listening, vocabulary, ect.)
 - g. _____(Self-describe)
3. How many years/months/days have you been exposed to the Korean language or culture?

4. Do you have any personal relationships with Koreans? If yes, please specify the relationship

Ex., family member, close friends, classmates, teachers, etc.

5. If you have personal relationships with Koreans how would you rate the level of closeness?
- a. Extremely close
 - b. Very close
 - c. Close
 - d. Somewhat close
 - e. Not close
6. Typical day, how much time do you spend in a Korean Language environment out side of the classroom?
- (If you are not taking Korean class currently, go to question 7)
- a. Only in classroom
 - b. Classroom + less than one hour
 - c. Classroom + between 1-2 hours
 - d. Classroom + between 2-3 hours
 - e. Classroom + more than 3 hours
7. Typical day, how much time do you spend in a Korean Language environment ?
- a. Less than hour
 - b. Between 1 -2 hours
 - c. Between 2- 3 hours
 - d. More than 3 hours

Thank you for your participation.

APPENDIX G: CONSENT FORM

CONSENT FORM

I, _____, agree to participate in a research study titled “ Influence of L1 on L2 learners of Korean: A perception test on Korean vowels and stop consonants” conducted by Aram Cho under the direction of Dr.McCreary from the linguistics program at the University of Georgia (mccreary@uga.edu, 706-542-2231).

I understand that my participation is voluntary. I can refuse to participate or stop taking part AT ANY TIME without giving any reason, and without penalty or loss of benefits to which I am otherwise entitled. I can ask to have all of the information about me returned to me, removed from the research records, or destroyed.

The reason for this study is to test the speech perception of second language learners. If I volunteer to take part in this study, I will be asked to do the following things:

- 1) Short interview with investigator – Time commitment: 5-10 min.
- 2) Listen to a series of speech samples of Korean non-existent fabricated words which consist of a similar vowel pair then select the word which has been heard – Time commitment 10 min.
- 3) Be asked to produce the same fabricated Korean words. – Time commitment: 10 min.(This task will be audio-recorded)

The benefit for me is the intrinsic knowledge that I am helping people study and gain understanding about the innate human endowment known as language. The benefit for the student is that the pronunciation skills tested in the study may be related to overall phonological ability in Korean and language proficiency in general. Also, this study will help students not only to improve their Korean pronunciation but also to give them a good opportunity to know what part of the phonetic system of the Korean language they have the most trouble with. No risk or discomfort is expected. The decision to participate or not to participate will not affect your grades or your relationship with the instructor.

No individually-identifiable information about me, or provided by me during the research, will be shared with others without my written permission. I will be assigned an identifying number and this number will be used to identify my responses.

The investigator will answer any further questions about the research, now or during the course of the project.

The audio recordings will be stored on either tapes or CDs in a locked file in park hall 308(Dr. McCreary's office). The tapes will never be publically presented or disseminated in any form and Dr. McCreary will have access. All records and materials will be stored for three years (Oct. 31, 2011), and after that they will be destroyed and the Human Subjects Office will be notified.

I understand that I am agreeing by my signature on this form to take part in this research project and understand that I will receive a signed copy of this consent form for my records.

_____	_____	
Name of Researcher	Signature	Date
Telephone: _____		
Email: _____		

_____	_____	

Name of Participant	Signature	Date

**“ADDITIONAL QUESTIONS OR PROBLEMS REGARDING YOUR RIGHTS AS A
RESEARCH PARTICIPANT SHOULD BE ADDRESSED TO THE CHAIRPERSON,
INSTITUTIONAL REVIEW BOARD, UNIVERSITY OF GEORGIA, 612 BOYD
GRADUATE STUDIES RESEARCH CENTER, ATHENS, GEORGIA 30602-7411;
TELEPHONE (706)542-3199; E-MAIL ADDRESS IRB@UGA.EDU”**