NATIVE LANGUAGE AND NON-LINGUISTIC INFLUENCES ON THE PRODUCTION OF ENGLISH VOWELS BY SPEAKERS OF KOREAN: AN ACOUSTIC STUDY

by

JI-EUN KIM

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ABSTRACT

NATIVE LANGUAGE AND NON-LINGUISTIC INFLUENCES

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This study investigates the production of Korean and English front vowels by ninety-one Koreans, based on their arrival age to the U.S., length of residence in the U.S. and degree of motivation. Subjects' Korean and English productions were analyzed by measuring F1, F2 and duration. Additionally, this study observed other phonological and phonetic features, such as the number of front vowel categories, the distance between the highest and lowest front vowels (Korean /i/~/ɛ/ and English /i/~/æ/), the

distance between the lowest two vowels (Korean /e/~/ɛ/ and English /ɛ/~/æ/) and the lengthening effects based on the voicing of the following consonants.

For Korean production, acoustic analyses show that in terms of the qualities of /i/, vowel duration and the distance between /i/ and /ɛ/, the production of the subjects who arrived in the U.S. before age 11 or those who have lived in the U.S. for more than 8 years is different from other subjects. Hence, one can infer that if people arrive in an L2 environment at an earlier age or live there for a considerable number of years, some L1 features can be changed. In addition, for the distance between Korean /e/ and /ɛ/, older generations tend to manifest a significantly longer distance, suggesting a language shift in Korean.

For English production, all subjects, except for those who arrived in the U.S. before age 11, fail to produce the necessary phonetic distinctions between /i/~/ɪ/ and /ɛ/~/æ/, resulting in a reduction of English vowel categories. On the other hand, the qualities of /i/ and /æ/, vowel duration and the distance between /i/~/æ/ improve, but they never reach native-like production, with the exception of people who arrive in the U.S. before age 11. However, the voicing-dependent vowel duration improves and reaches native-like production for some subjects.

Furthermore, the Korean (L1) and English (L2) productions are compared, and the nature of phonological and phonetic interference of Korean in English pronunciation are explained. Lastly, this study concludes with pedagogical suggestions that may be useful for English learners and instructors.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

One of the issues that is frequently mentioned in the literature on second language (L2) acquisition is the lack of success L2 learners have in acquiring L2 pronunciation: some L2 learners are better able to pronounce the L2 than others. Researchers have tried to explain this pronunciation variance by dividing the differences into two broad categories: linguistic factors and non-linguistic factors. Linguistic factors refer to phenomena that can be attributed to the effects of the learner's first language (L1).[1] With regard to such linguistic factors, a well-documented argument is that one's native language is the most influential factor on L2 pronunciation (Selinker 1972; Hammerly 1973; Suter 1976; Mitleb 1984; Flege 1987; Odlin 1989; Larsen–Freeman & Long 1991; Ingram & Park 1997). On the other hand, non-linguistic factors refer to matters such as one's age of arrival in the L2 environment (AOA), length of residence in the L2 environment (LOR), occupation, time spent listening to and speaking L2, degree of formal instruction and range of social-psychological factors, for example, the degree of motivation or attitude, personality and self-esteem (Suter 1976; Thomson 1991; Larsen-Freeman & Long 1991).

[1] Even though the universal tendencies and markedness also affect L2 learning; these are not considered in this study.

The present study considers both linguistic factors and non-linguistic factors and shows the relation between them, i.e., how the differences in AOA, LOR and the degree of motivation affect the success with which learners produce accurate L2 phonological realizations of which linguistic features. Section 1.1 discusses the motivation for this study, addressing some of the problems in a study of this type, including specific linguistic and non-linguistic factors. In section 1.2, the broad goal is presented, and the specific research question is explicitly raised. Section 1.3 gives a brief overview of the organization of this dissertation.

1.1 Motivation

In terms of understanding how linguistic factors influence second language acquisition, the language that has been the most frequently studied as an L2 is English. Flege and Port (1981), Odlin (1989) and Munro (1993) have investigated the transfer of Arabic pronunciation from native Arabic speakers to English (L2). Other languages that have been compared with English include Vietnamese (Osburne 1996), Thai (Suter 1976) and Japanese (Best & Strange 1992), to name a few.

Such L1 transfer in English pronunciation has also been observed among Korean ESL learners. The majority of these previous studies have been more concerned with the acquisition of English consonants that do not occur contrastively in Korean, such as /r/ versus /l/ and /p/ versus /f/ and so on (Gillette 1980; Lee 1995; Park 1995; Kang & Lee 2001). While not as common as the consonant studies, some research has investigated the acquisition of English vowels by Korean speakers (Bohn and Flege 1992; Kim 1994; Ingram & Park 1997; Koo 2001). The major findings in the English

vowel production of native Korean speakers are the difficulties in perception and production of English /i/~/ɪ/ and /ɛ/~/æ/. The difficulty is due to the differences in vowel systems between English and Korean, since the latter lacks a "tense-lax" distinction in its vowel system. However, in addition to the distinction of these vowels, there are other phenomena related to Korean and English vowels that have rarely been considered in other studies. Therefore, in addition to confirming Korean speakers' difficulty in distinguishing English /i/~/ɪ/ and /ɛ/~/æ/, this study also examines many of the more specific phonological and phonetic features of the Korean vowel system that interfere with Korean speakers' pronunciation of English vowels. This study especially examines how the following linguistic differences affect the production of native Korean speakers' English vowels.[2]

- Differences in the Korean and English inventories of vowel phonemes.
- Differences in acoustic characteristics between phonemically corresponding Korean and English vowels.
- Differences in the acoustic space occupied by the front vowels.
- Differences in the intrinsic vowel duration and the degree of voicing-dependent effect on vowel duration.

This study focuses on the relative distance between vowels, as well as the absolute distance, because it is possible that vowel height, fronting and duration differ

[2] In this study, front vowels were chosen in anticipation of specific first language interference effects, as will be discussed in section 2.

from person to person. In addition, this study assumes that there is a possibility that vowel inventories differ from person to person who share the same L1 and that such differences in vowel inventory may affect the different productions of L2. In order to evaluate these differences, a comparison of the relationship of Korean and English vowel productions of individuals is conducted. Furthermore, this study examines the order in which native Korean speakers acquire the features related to English vowel production. While the order of L2 acquisition has been studied in various aspects of grammar (Larsen-Freeman & Long 1991), it rarely has been studied in pronunciation.

Such specific linguistic interference itself, however, would not be enough to explain the difficulty that many native speakers of Korean encounter when learning English. Therefore, with the assumption that the degree of interference from Korean could be influenced by non-linguistic factors, this study also takes into account these factors. Even though there has not been much research on non-linguistic factors targeting the Korean language as either L1 or L2, research has been conducted on the role of non-linguistic factors in the acquisition of other languages. These studies suggest that AOA is the most important factor in L2 acquisition. Moreover, researchers claim that it is extremely difficult or even impossible for adult learners (i.e., those whose age of arrival is greater than 16 or so) to pronounce the L2 with a native-like accent. However, AOA alone cannot explain the differences among adult learners. Therefore, researchers have tried to explain this variability in pronunciation success in terms of other non-linguistic factors such as LOR and motivation. However, the effects of these factors are debatable. Some reasons contributing to the divergence of the

results and conclusions among these studies include variability among subject pools, the range of scales of categorizing non-linguistic factors, target linguistic features examined, and partial effects of other factors. For example, for young adults, the LOR or the degree of motivation might be an important factor, while for older adults, these factors may not be as important. With regard to range of scales, there is a possibility that those studies which have examined only a narrow range of LOR or motivation values may not see a significant LOR effect or notice motivational effects on L2 pronunciation, while the studies that target wider ranges may recognize the importance of these factors. In addition, some features of pronunciation may be more difficult to acquire or impossible to improve upon, while other features are improved relatively easily. Thus, it could be possible for a learner to have improved a particular aspect of L2 pronunciation in a short period of time while maintaining a more global L1 accent. Therefore, if researchers focus on the degree of native-like pronunciation in a global sense (e.g., by using native English speakers' perceptions), and if researchers target the features that are difficult for L2 speakers to master, they may erroneously conclude that for adult learners, LOR and motivation do not significantly affect one's ability to pronounce L2.

Mindful of such potential limitations when examining non-linguistic factors in L2 acquisition, this study targets adult learners whose AOA, LOR, the degree of motivation (MOTI) and chronological age (AGE) are divided specifically within a wider range. This research also examines more specific aspects of L2 pronunciation and illustrates how the subtle phonetic differences in L2-language output can be affected by non-linguistic factors. Furthermore, as one should not ignore the possibility

that the correlation and partial effect of other factors cause differing results, this study investigates how non-linguistic factors are interrelated.

1.2 The Central Issues

The goals of this study are two-fold: (1) to investigate the various phonetic and phonological characteristics of Korean and English vowel production of native speakers of Korean; and (2) to analyze further L2 English data produced by subjects in terms of both phonological and phonetic L1 interference and non-linguistic factors such as AOA, LOR and motivational effects.

In order to accomplish these goals, this study examines the production of English and Korean vowels from Korean learners who were heterogeneous according to AGE, AOA, LOR and MOTI. The vowels investigated are the Korean vowels ㅇㅣ/i/, ㅇㅔ /e/ and ㅇㅐ/ɛ/ and the English vowels /i ɪ e ɛ æ/. The data were analyzed by measuring the values of the first and second formants (F1 and F2), as well as the durations of the vowels.

In order to achieve the above goals, the acoustic phonetic and statistical analysis focuses on the following specific research questions:

1. How do native Korean speakers produce Korean vowels in terms of linguistic features including phonemic vowel qualities, the number of vowel categories, the acoustic space occupied by front vowels, duration and the degree of voicing-dependent effect of vowel duration?
2. How do AGE, AOA and LOR affect L1 pronunciation?

3. How do native Korean speakers produce English vowels in terms of linguistic features including phonemic vowel qualities, the number of vowel categories, the acoustic space occupied by front vowels, duration and the degree of voicing-dependent effect of vowel duration?
4. How do AGE, AOA, LOR and the degree of motivation to learn English affect L2 pronunciation?
5. How does the production of English by native speakers of Korean differ from that of native speakers of English?
6. How are the Korean vowel productions of native Korean speakers and the English vowel production of native English speakers different?
7. Which features of Korean pronunciation manifest themselves in the production of English of native Korean speakers?
8. How do non-linguistic features affect the degree of Korean interference in English pronunciation?
9. What is the pattern of acquisition of English pronunciation of native Korean speakers; that is, according to which features does the interference remain the longest, and according to which features do they disappear more quickly?
10. Do differences in individual Korean vowel inventories among Koreans affect the production of the number of English vowel categories?

1.3 Organization of the Study

In this dissertation, Chapter 2 presents a contrastive analysis of English and Korean, focusing on the nature of L1 interference in English of Korean learners. Chapter 3 turns its focus toward non-linguistic factors affecting L2 acquisition and includes a discussion on previous studies such as AOA, LOR and Motivation. Chapter 4 presents the methodology employed, including discussions of subjects, materials, data collection and data analysis. Chapters 5 and 6 present the obtained results followed by a discussion; chapter 5 focuses on the production of Korean vowels while chapter 6 focuses on the production of English vowels. Chapter 7 provides a discussion of Korean (L1) interference. Finally, chapter 8 summarizes the main findings and offers suggestions for both teaching ESL and future research in the area of Korean-English contrastive linguistics.

CHAPTER 2

LINGUISTIC FACTORS AFFECTING L2 PRONUNCIATION

2.0 Introduction

This chapter presents the preliminaries relating to the linguistic factors affecting L2 pronunciation and considers how Korean (L1) vowel pronunciation might be transferred to English (L2) vowels. Before looking at the possible features of Korean that might be transferred to English vowels, it is worth reviewing both the concept of L1 transfer and research on L1 transfer in the domain of pronunciation (Section 2.1). In addition, since the target of this study is vowels, it is important to understand the methodology of vowel studies and the general acoustic characteristics of vowels (Section 2.2). This chapter then transitions into a comparison of the phonological and phonetic differences between English and Korean (section 2.3), thereby laying the contrastive ground-work for the subsequent acoustic analysis.

2.1 Transfer in L2 Pronunciation: Definition and Examples

2.1.1 Transfer and Interlanguage

Researchers have firmly established that many features of L1 affect the learning of L2 (Selinker 1972; Hammerly 1973; Suter 1976; Mitleb 1984; Flege 1987; Odlin 1989; Larsen–Freeman & Long 1991; Ingram & Park 1997). As one of the early in-

depth discussions of the L1 effect, Lado's 1957 study establishes the ground-work for the "Contrastive Analysis Hypothesis."

> We assume that the student who comes in contact with a foreign language will find some features of it quite easy and others extremely difficult. Those elements that are similar to his native language will be simple for him [and her], and those elements that are different will be difficult (1957:2).

When researchers discuss the L1 effect on L2, the terms *"interference"* and *"transfer"* are used often. These two terms have been well-documented by prior researchers, among them Weinreich (1953:1) who defines *interference* as follows:

> those instances of deviation from the norms of either language which occur in the speech of bilinguals as a result of familiarity with more than one language.

In Weinreich's (1953) definition, interference refers to any sort of transfer, including first language effects on the second language and second language effects on the first language.[3] *"Transfer"* refers only to the influence of first language on the second language. Lado (1957) mentions that:

[3] Even though this study focuses on L1 transfer to L2 pronunciation, the interference from L2 into L1 also is examined and discussed in chapter 5.

> individuals tend to transfer the forms and meanings, and the distribution of forms and meanings of their native language and culture to the foreign language and culture-both productively when attempting to speak the language and to act in the culture, and receptively when attempting to grasp and understand the language and the culture as practiced by natives (1957:2).

Another frequently used term in L2 study is *interlanguage.* Selinker (1972) defines *interlanguage* (IL), as the linguistic system of adult second language learners use in an L2 system. Here, transfer from the native language has a major role in *interlanguage* (IL) even though some researchers propose that not only transference but also other elements, such as L2 and Universal Gramar (UG), are components of interlanguage (IL) (Major 1987; Gass 1994). In terms of interlanguage, Broselow (1987) claims that the status of interlanguage varies: Some L1 features appear only in the early stage of L2 learning and disappear in later stages, while some features manifest themselves more consistently even later. In addition, it has been argued that interlanguage exhibits common developmental sequences (Larsen-Freeman and Long 1991). As an example among many other findings, interrogatives in L2 learning emerge in a common sequence: at the earliest stage, L2 learners tend to form a statement with only rising intonation (e.g., 'He work today?'). At the next step, they form WH-questions but fail to use the subject-verb inversion or to use an auxiliary verb

(e.g., 'What he is saying?' or 'Where you go?'). At stage three, L2 learners can produce correct "yes" and "no" questions and WH-questions, but they tend to overgeneralize an embedded question (e.g., 'Do you know where is it?'). At stage four, finally they can correctly produce both simple and embedded WH-questions.

2.1.2 Transfer in L2 Pronunciation

Although language transfer occurs in various domains, such as conversation and grammar, it is in pronunciation that transfer is most readily detected (Thompson 1991). Indeed, many L2 pronunciation studies show that the effect of native language transfer is significant. To learn the degree of the effect of various factors (including native language), Suter (1976) examined the English pronunciation of sixty-one non-native speakers. In this study, he noticed that native language proves to be one of the most significant predictors of pronunciation accuracy. Lado (1957) asserts that the more similar the phonemic system is between L1 and L2, the easier it is to learn the L2 phonemic system. Weinreich (1953: 18-19) was also devoted to the field of transfer in phonology in that he systematically presents the various types of transfer. Some of these types of transfer include: (1) *Under-differentiation,* (2) *Over-differentiation* (3) *Reinterpretation of distinction,* and (4) *Phonemic substitution.* Here, "*Under-differentiation*" occurs when the L2 has more categories than L1. For example, Major (2001) claims that a French speaker uses /i/ for English /i/ and /ɪ/ because French has only /i/, and that a Portuguese speaker uses /ɛ/ for English /ɛ/ and /æ/ because Portuguese has only /ɛ/. Bloomfield (1933, 1984) also claims that L2 speakers who do not have a phonemic contrast in their L1 cannot make a distinction between the

phonemes in the L2. On the contrary, *over-differentiation* occurs when the L1 has more categories than L2. *Reinterpretation of distinction* occurs when the L2 speakers distinguish two sounds of L2 by features which are primary in their L1, such features being merely secondary or redundant in L2. To illustrate this distinction, Mitleb (1981) identifies that Jordanian speakers transfer Arabic long-short duration patterns to English tense and lax vowel pairs and thus produce significantly greater ratios of tense to lax vowel durations than native English speakers. Lastly, *phonemic substitution* refers to the substitution of any given sound by the L2 learners with the nearest equivalent in L1. For example, Moulton (1962) mentions that some American English speakers substitute English /k/ for the unfamiliar /x/ of German. Other examples are that native Chinese, Japanese and Korean speakers who have difficulty with the /r/ and /l/ distinction of the English (Odlin 1989); Japanese speakers substitute /s/ for English /θ/ and Thai speakers use /t/ for English /θ/ (Lado 1957).

The aforementioned studies mainly focus on the phonemic differences between the L1 and L2 phonological system. However, even if the L1 and L2 vowel systems are similar and none of these types of errors are shown, the L2 speakers' foreign accent can be still detected. One of the authoritative studies that assert the importance of phonetic description is Flege (1980). Therein, he conveys that since any sound has its own acoustic and articulatory characteristics, two sounds that seem identical are still acoustically different. Given this fact, some researchers have focused on specific phonetic transfers, such as the degree of voicedness, voice onset time, height, fronting, duration and so forth. For example, Flege and Port (1981) find that Saudi Arabian

speakers of Arabic have trouble pronouncing English /p/, claiming that the cause of such a difficulty is not the difference in the phonemic inventories of Arabic and English, but rather it is the different phonetic characteristic of the /p/ in each language. They note that Saudi Arabian speakers fail to control all the articulatory dimensions of English /p/, producing a /p/ in a location between that of Arabic stops and English stops. As an example of duration difference, Flege (1980) shows that the Saudi Arabic speakers pronounce English /d/ with a longer duration than native English speakers due to the fact that the duration of Arabic /d/ is longer than the English counterpart.

One argument in L1 transfer to L2 pronunciation concerns whether it is more difficult to acquire sounds similar to those in L1 or to acquire sounds different from those in L1. Flege (1987) proposes his "speech learning model" and, in so doing, claims that the more advanced L2 learners have difficulty in acquiring "similar" L2 phones rather than "new" L2 phones. He compares English speakers' French pronunciation acquisition of phones that are "similar" to English and "new" L2 phones that do not exist in English. For example, the vowel /u/ is "similar" because it exists in both English and French, while the vowel /y/ is a "new" vowel for English speakers because it does not exist in the English vowel system. The results show that although those English speakers who have much experience in French produce "new" French phones correctly, they still produce "similar" French phones significantly different from native French speakers. Flege asserts that in the case of a similar vowel, the speakers regard the preexistent phonetic category and the new category as the same. Consequently, they do not make a new category. While in the case of a new vowel,

speakers perceive the difference and thus make a new phonetic category. Bohn and Flege (1992) examined the perception of English vowels /i ɪ e ɛ æ/) from two groups of native German speakers: experienced and inexperienced groups. Here, English vowels /i ɪ ɛ/ were regarded as "similar" vowels because the counterpart exists in German: /i ɪ ɛ/, while English /æ/ is regarded as a "new" vowel because the counterpart does not exist. Results show that for the "new" vowel /æ/, experienced Germans hear and distinguish the sound much better than inexperienced Germans. With regard to the "similar" vowels /i ɪ ɛ/, there are no perception differences between experienced and inexperienced groups. Therefore, Bohn and Flege conclude that English experience affects the perception of the "new vowel" but does not affect the perception of the "similar" vowel.

2.2 Vowels in L2 Pronunciation Studies

2.2.1 Studies on L2 Vowel Production

This section focuses on the vowels that are the target of the present study. Stageberg (1981:12) describes the characteristics of vowels as follows:

(a) Vowels are an oral sound and voiced

(b) Vowels are characterized by a free flow of air through the oral cavity

(c) The distinguishing features of the different vowels are determined largely by tongue position.

Since these are determined by the relatively minute difference of tongue position and lip shape, vowels are more difficult to analyze than consonants. Furthermore, the

boundaries of some vowels are unclear. Hence, there has been relatively less research done concerning the acquisition of vowels than consonants.

In those few studies that have been conducted on vowels, evidence that the L1 is an important factor affecting L2 in terms of vowel production is shown in several studies in which the same L2 vowel productions of different L1 speakers are compared. For example, Scholes (1968) shows that native Russian and Greek speakers are unable to distinguish the English vowels /e/ and /æ/ because Russian and Greek phonemic inventories do not have such a distinction. On the other hand, he notices that Persian speakers can distinguish between these two vowels because the /e/~/æ/ distinction exists in their vowel inventory. In addition, Flege, Bohn and Jang (1997) tested the production of English vowels /i ɪ ɛ æ/ produced by native German, Spanish, Mandarin and Korean adults. They found that Korean and German speakers have difficulty in producing English /æ/ because these two languages do not have such a vowel. In addition, they noticed that Korean speakers distinguish less between English /i/ and /ɪ/ and /ɛ/ and /æ/ than German and Spanish speakers, respectively. Such a phenomenon is also explained with regard to the L1 effect because Korean does not have such vowel contrasts.

2.2.2 Methods of Vowel Pronunciation Tests

When examining phonetic aspects of L2 speakers' pronunciations, most researchers have used either acoustic measurements (e.g., Flege 1980; Flege & Hillenbrand 1984; Flege 1987; Kim 1994; Lee 1998) or native speakers' perceptions (e.g., Fathman 1975; Suter 1976; Tahta, Wood & Loewenthal 1981; Thompson 1991;

Munro 1993; Elliott 1995; Flege, Bohn & Jang 1997; Moyer 1999; Piske, MacKay & Flege 2001). Specifically in vowel pronunciation tests, and with respect to acoustic measurements, researchers have compared the formant frequencies and durations of L2 speakers' production with native speakers' production. For example, Flege (1987) recorded and digitized subjects' production and measured vowel formants (F1-F3), which showed the degree of vowel height and fronting and found the differences from the vowel formants of the native speakers of English. On the other hand, when researchers use native speakers' perception, native-speaking listeners identify the pronunciation of non-native speakers along a continuum from native-like pronunciation to heavy foreign accent. For example, in Asher and Garcia's study (1969), native English speakers listened to the taped production of L2 subjects and checked one of the following categories: (a) native speaker, (b) near native speaker, (c) slight foreign accent and (d) definite foreign accent. Citing Tahta, Wood and Loewenthal conducted a study (1981) in which the native speakers evaluated the L2 speakers' L2 pronunciation and placed it into one of three categories: no accent, detectable but slight accent or marked accent. Other studies have used both acoustic measurement and native speakers' rating methods in the same study (Munro 1993; Flege, Bohn & Jang 1997).

Some researchers (Munro 1993; Flege, Bohn & Jang 1997) suggest that using native speakers' perception is the best method to decide the degree of native-like vowel pronunciation. They claim that this method is capable of examining the characteristics of production that are produced by the integration of various vowel production characteristics, such as F1 and F2, duration and formant movement patterns, among

other things. However, this method cannot provide specific information regarding the particular acoustic properties that give rise to a native speaker's judgment of nativeness. For instance, when L2 learners acquire particular qualities of L2 pronunciation earlier than others--even though they are still judged to have a foreign accent--the method using a native speaker's perceptions cannot answer which qualities are similar and which qualities are different from those of native speakers. On the other hand, using acoustic measurements provides more specific information on vowel height, fronting, duration, etc., that helps researchers ascertain which features contribute to foreign accent. Hence, using acoustic measurements would be useful to detect the process of the L2 learning sequence, that is, which specific features of L2 vowel production are affected by L1, in which stage and when they are eliminated.

2.2.3 Acoustic and Articulatory Characteristics of Vowels

Since the present study uses acoustic methods, the more specific acoustic and articulatory characteristics of vowel are discussed in this section. All vowel sounds begin with a single acoustic source signal produced by the glottis, and this sound is transmitted through the resonance filtering effects of the pharynx and oral cavity. At the time of pronunciation, the vocal tract geometry (in particular the oral cavity) produces resonance, and the frequency of this resonance determines what vowels are realized. The frequencies that dominate this resonance differ according to tongue position and the shape of the pharyngeal and oral passages that are affected by the place of constriction. For example, a constriction in the front half of the oral cavity produces a high vowel, while a constriction of the pharynx produces a low vowel. The quality of

each vowel is determined by such resonance spectra, which are called formant frequencies: F1, F2, F3 and so forth (Clark & Yallop 1995; Pickett 1999). Among the main dimensions that determine vowel quality--height, backness and rounding--it has been well-documented that the F1 value is correlated with vowel height: A lower F1 value corresponds to a higher degree of vowel height, while a higher F1 value corresponds to a lower degree of vowel height. The F2 value is correlated with vowel fronting and lip rounding: A lower F2 value corresponds to a lower degree of vowel fronting (i.e., back vowel) and a higher degree of lip rounding, while a higher F2 value corresponds to a higher degree of vowel fronting and a lower degree of lip rounding (Stevens 1998; Pickett 1999). By referencing these formant frequencies, the phonetic profile of the vowels in any language can be distinguished one from another. For example, the English high vowel [i] has an F1 frequency around 250 Hz and an F2 frequency around 2200 Hz. English [u] differs from English [i], in that, even though the F1 values are similar in that both vowels' F1 values are around 250 Hz, typical of high vowels, these show different F2 values: around 800 Hz for [u] and 2200 Hz for [i] (Pickett 1999). Since the values of vowel formants are also affected by the size and the shape of the vocal tract, they may differ slightly from speaker to speaker, depending on the size or configuration of the oral and pharyngeal spaces.

Moreover, these vowel formants differ, at least a little, between vowels of different languages and even between vowels represented by the same phonetic symbol. Nevertheless, L2 learners tend to pronounce the L2 vowel that most closely corresponds

to the L1 vowel manifesting the most similar quality and duration of the L2 vowel. Thus, the L2 learners frequently manifest this sort of phonological L1 interference.

In addition to the vowel formants, another important acoustic parameter associated with vowel characteristics is duration. Many researchers claim that vowel duration is affected by a number of factors: syllable stress, speaking rate, semantic factors, syntactic factors, intrinsic vowel duration, extrinsic vowel duration and so forth. For instance, the duration of the vowels in stressed syllables is typically longer than the duration for unstressed syllables (Oller 1973; Lehiste 1975; Klatt 1976). In terms of semantic features, emphatic or contrastive stress increases the duration of a vowel (Bolinger 1972). While in terms of syntactic features, a vowel at the end of a sentence tends to be longer than a vowel that is within an utterance (Oller 1973).

Additionally, in terms of vowel duration, the more salient features are intrinsic and extrinsic ones. Intrinsic vowel duration has to do with the duration of a sound being determined by its vowel quality. The general belief regarding intrinsic phonetic vowel duration is that low vowel categories such as /a/ and /æ/ are longer than high vowels such as /i/ and /u/ and that tense vowels are longer than the corresponding lax vowels (Peterson & Lehiste 1960; House 1961; Lehiste 1970; Klatt 1976). Lehiste proposes that intrinsic vowel duration is explained automatically and mechanically by jaw position, that is, that the longer duration of a low vowel is due to more movement of the jaw.

On the other hand, Keating (1985) argues that the speaker can control this duration by controlling muscle movement, and thus she interprets intrinsic vowel

duration as language specific. Between intrinsic vowel and extrinsic vowel duration, the more arguable one is extrinsic vowel duration. The general belief regarding extrinsic vowel duration is that vowel duration differs according to the voicing of the following consonants (Belasco 1953; House & Fairbanks 1953; Peterson & Lehiste 1960; Delattre 1962; Chen 1970; Davis & Summers 1989). Some researchers claim that these patterns are physically and universally motivated. Others (Mitleb 1984; Keating 1985), however, claim that they are cognitively and language specifically motivated. Contrary to the widely-held belief that extrinsic vowel duration is universal, Keating (1985) shows that in Polish and Arabic, the vowel duration and the voicing of the following consonant are not related. In addition, she shows that the duration pattern is determined by underlying values for voicing features in Russian. Therefore, she claims that extrinsic vowel duration should be regarded as a cognitive category, not entirely a physical or universal one.

Another interesting argument regarding extrinsic vowel duration is that among the languages that show this tendency, the extent of vowel lengthening in the voiced context varies from language to language. Chen (1970) claims that even among the languages that have the extrinsic vowel duration effect, the degree of lengthening is language specific. For example, vowels are produced with a greater degree of voicing duration before voiced consonants than voiceless consonants in English, as opposed to some other languages such as Arabic or Korean. Therefore, one can expect that L2 learners whose L1 has a lesser degree of voicing-dependent vowel duration will not be

able to reproduce accurately similarly conditioned durational differences of vowels in L2.

2.3 Korean and English Vowels in Comparison

2.3.1 Vowel Inventories of Korean and English

The vowel inventory of standard Korean is composed of seven to ten monophthong vowels: /i e (ɛ) (y) (ø) a ʌ o u ɨ/, as well as several diphthongs. According to Kahng (1990), the vowel system of people whose ages are less than sixty is composed of only eight vowels because /y/ and /ø/ are produced as dipthongs, /wi/ and /we/, respectively. Additionally, Hong (1991) claims that /ɛ/ is in the process of merging with /e/ and has already merged in the younger generation of Standard Korean, Seoul Korean speakers. On the other hand, the American English vowel inventory has at least eleven monophtong vowels: /i ɪ e ɛ æ a o ɔ u ʊ ə/, as well as several diphthongs. For these reasons, it is one of the most complex vowel systems among the world's languages (Burquest 1993). Furthermore, English has at least two vowels that are not in Korean lax vowels: /ɪ/ and /ʊ/.

When we focus on unrounded front vowels, we see that there are categorical phonological differences between the Korean and English vowel systems: While Korean has three front vowels /i e ɛ/[4], English has five front vowels, /i ɪ e ɛ æ/. Moreover, the inventory of front vowel phonemes in English includes the so-called "lax"[5] versions of tense vowels /i/ and /e/, namely /ɪ/ and /ɛ/. These two sounds have

[4] Korean /e/ and /ɛ/ are sometimes transcribed as Korean /ɛ/ and /æ/, respectively (Sohn, 1999; Lee and Ramsey 2000).

[5] Here, the terms "tense" and "lax" are used as convenient "cover terms" for a distinction that is actually more complicated.

been shown to be especially difficult for native Korean learners of English to master (Jun and Cowie 1994; Ingram and Park 1997).

2.3.2 Physical Qualities of Corresponding Korean and English Vowels

In terms of vowel quality, it is known that even between vowels that can be said to represent the same phonemic category, they occupy somewhat different acoustic spaces (Yang 1996). Each vowel has its own qualitative properties, which is determined greatly in part by its formant frequencies.

How do English and Korean differ in terms of vowel quality? The mean degrees of height and of fronting of English and Korean vowels differ, at least a little, even between vowels represented by the same phonetic symbol. In Yang's study (1990), which examined English vowel production as produced by male native English speakers and Korean vowel production as produced by male native Korean speakers, he found that even though the Korean vowel inventory has both /e/ and /ɛ/, neither of these has exactly the same values of the English phonetic values corresponding to /e/ or /ɛ/: English /e/, as realized by native English speakers, has an F1 of 469 Hz (mean value) and an F2 of 2082 Hz; English /ɛ/ has an F1 of 531 Hz and an F2 of 1900 Hz. In contrast, Korean /e/, when spoken by a Korean male speaker has an F1 of 484 Hz and an F2 of 1969 Hz, and Korean /ɛ/ has an F1 of 612 Hz and an F2 of 1879 Hz. That is, Korean /e/ corresponds to a phonetic value lower than English /e/ and higher than English /ɛ/, while Korean /ɛ/ is lower than English /ɛ/ and higher than English /æ/ (Koo 1998). However, L2 speakers tend to pronounce L2 vowels with a quality similar to their corresponding L1 vowels. In addition, Flege (1980) claims that sometimes L2

production occurs in the intermediary position somewhere on a continuum between L1 and L2. Therefore, we may expect that Koreans would produce English vowels with a corresponding Korean vowel realization of similar quality or produce those vowels with an intermediate quality, which is neither the same as Korean nor English vowels.

2.3.3 The Relationship Between Vowel Formant Frequencies and Duration

As mentioned in 2.2.1, one of the prominent differences between the English and Korean vowel systems is the so-called "tense" and "lax" contrasting vowel pairs (e.g., /i/~/ɪ/ and /e/~/ɛ/) in English. Such a contrast does not exist in Korean. In the case of the English contrasting vowel pairs, the "tense" vowel is higher and more fronted than the corresponding "lax" one. For example, Koo (1998) shows that the F1 and F2 of English /i/ for American male native English speakers are around 270 Hz and 2270 Hz, respectively, while the F1 of /ɪ/ is 390 Hz and the F2 is 1950 Hz. In addition, the higher and more fronted vowel is always longer than the lower and more backed vowel (Klatt 1976; Bohn & Flege 1990). Peterson & Lehiste (1960) report that lower and more backed vowels, for example, /ɪ/ and /ɛ/ in the h(V)d context are shorter, with the range in duration from 180 to 200 msec, while the higher and more fronted vowels /i/ and /e/ in the h(V)d context are longer, with the duration ranging from 240 to 260 msec. In addition, Bohn and Flege (1990) show that in the b(V)t context, the duration of the vowel /ɪ/ is 108 msec and the F1 value is 438 msec, while the duration of the vowel /i/ is 131 msec and the F1 value is 263 msec. Therefore, even though English does not use vowel length distinctively, the vowel lengths are, nevertheless, not all the same.

However, as mentioned above, there is no corresponding fourfold contrast in Korean; the relationship between vowel formant frequencies and duration is different than that of English. As Yang (1990) points out with regard to vowel quality, Korean /i/, as spoken by a Korean male, has an F1 of 337 Hz and an F2 of 2230 Hz, qualities that are not the same as either English /i/ or /ɪ/ (Yang 1990). Although Korean /i/ does not have such a formant distinction, it still has a length distinction that differentiates the meanings. For example, /i/ means 'tooth,' while /i:/ means 'two,' and /pi/ means 'rain' while /pi:/ means 'ratio.'[6] Given the above mentioned examples, Korean has a distinction between phonemically long and short vowels; Korean long vowels are pronounced about twice as long as the corresponding short vowels (Sohn 1999). Similar correspondences can be found for /e/ and /e:/ and /ɛ/ vs /ɛ:/, for example, /ne/ 'your' vs. /ne:/ 'four' and /pɛ/ 'ship/pear' vs. /pɛ:/ 'double,' indicating that in Korean, the vowel duration is not correlated with differences in vowel formants. Based on these facts, it is not surprising that Korean speakers have difficulty in distinguishing and producing what is called the "tense/lax" vowel distinctions of English. This prediction is confirmed by a key finding obtained by Kim (1994): Kim makes the specific claim that Koreans whose English learning onset time begins after age 16 cannot successfully distinguish /i/ from /ɪ/ by vowel formants. In addition, Flege, Bohn & Jang (1997) show that Koreans produce a much less /i/~/ɪ/ distinction of formant frequencies than native

[6] Ingram & Park (1997), however, claim that this length contrast seems to be disappearing in the Seoul dialect.

English speakers, asserting that Korean speakers distinguish the English /i/~/ɪ/ by duration, not by spectral quality.

Additionally, there is a noteworthy difference between English long/short vowels and Korean long/short vowels. As mentioned above, in English vowels, higher and more fronted vowels tend to be longer than corresponding lower and more backed vowels. However, Kahng (1990) suggests that in the case of Korean vowels, long vowels tend to be lower than short vowels, with the exception of the high vowel /i/ (Figure 2.1).

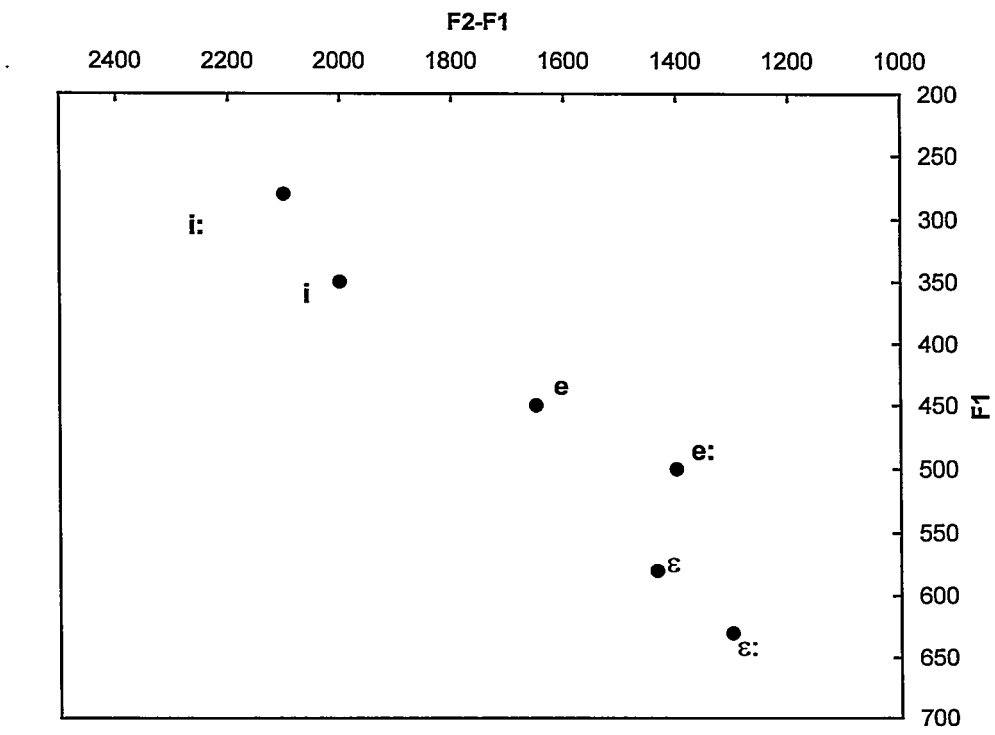

Figure 2.1 The relation of Korean vowel length and height (Kahng 1990: 100)

2.3.4 Vowel Duration and Voicing Dependent Effect

When Yang (1996) compares Korean and English vowels, he demonstrates that Korean vowels appear to be produced with shorter duration than English vowels: the mean duration of Korean is 86 msec while the mean duration of English is 251 msec. Flege (1987) claims that the average duration of L2 vowels produced by L2 learners falls precisely midpoint between the average duration of their L1 vowels. Therefore, we can predict that Koreans will produce English vowels with a shorter duration than native English speakers and such a duration difference may cause the perceived foreign accent.

Briefly mentioned in section 2.2.3, is the concept of intrinsic vowel duration. The vowel duration includes the relation between vowel height and duration: the lower vowels are produced with a longer duration than higher vowels. Such a pattern is more significant in English (House 1961). For example, in English, /æ/ is longer than /e/, which in turn, is longer than /i/. According to Peterson and Lehiste (1960), the intrinsic duration of /æ/ in English is 330 msec, while /i/ is 240 msec. In addition, Flege, Bohn and Jang (1997) also show that the duration of /æ/ is longer (238 msec) than that of /i/ (175 msec). To what degree does such an intrinsic difference appear in Korean vowels?

Another difference between English and Korean concerns the degree of voicing effect on vowel length before voiced and voiceless consonants. The effect is not as obvious in Korean as it is in English. It is known that English vowels are lengthened before voiced consonants (Peterson and Lehiste 1960; House 1961; Delattre 1962; Chen 1970; Klatt 1976; Crystal and House 1988). Since the voicing effect is so prominent in

English, some native speakers distinguish the voiced and voiceless consonants based on the duration of the preceding vowels, not on the voicing of the following consonant. Studies have shown that there is the same tendency to shorten vowels before a voiceless consonant in many other languages, including Korean (Chen 1970; Cho 1996).

However, some researchers claim that such voicing effects on vowel duration are not universal but rather language-specific. For example, Keating (1985) shows that in some languages, such as Polish, Czech, Saudi Arabic and Russian, vowel duration and the voicing of the following consonant are not related. Moreover, the voicing-dependent effect of vowel duration is more salient in English than in some other languages (Keating 1979; Mitleb 1984). This finding means that the extent to which vowels are lengthened before voiced consonants is language specific. With regard to Korean, Chen (1970) has been a pioneer in this type of study. To obtain a cross-linguistic view of voicing effects on vowel length, Chen investigated English, French, Russian and Korean. When the lengths of vowels in minimal pairs, such as /aka/~/aga/ were compared, Chen found that vowels, in general, tend to be longer before voiced consonants and shorter before voiceless consonants, as mentioned above. However, in addition to this tendency, Chen discovered another noteworthy phenomenon. He realized that the degree of voicing effect differs from language to language. For example, in English, the vowel before a voiceless consonant is 61% of its counterpart before a voiced consonant, while in Korean, the vowel before a voiceless consonant is 78% of its counterpart before a voiced consonant. If Chen's claim is valid, Koreans

could produce a smaller difference between the duration of vowels followed by voiced and voiceless consonants in English than native speakers of English.

2.3.5 Vowel Shift and Merger in Korean

One cannot ignore the possibility that recent and current shifts and mergers in the Korean vowel inventory affect Korean speakers' pronunciation of English vowels. One current change in Korean involves vowel raising. Kahng (1990), Hong (1991), and Chae (2001) have all argued that certain Korean vowels are raising, especially in the Seoul dialect, the national standard. For example, they found that Koreans frequently manifest /e/ with formant values normally associated with /i/ and produced /ɛ/ with formant values normally associated with the vowel /e/. Korean researchers such as Kim (1971) and Lee (1971) observed the vowel raising phenomenon as the following: /e/ → /i/ e.g., peta → [pida] 'to cut'; /ɛ/→/e/ e.g. pɛta→ [peda] 'to conceive.' Between these two, the most problematic and salient vowel change is the pronunciation of /ɛ/, whose values (F1 and F2) have come to overlap with those of /e/. Researchers claim that the younger generations who speak the Seoul dialect do not distinguish /ke/ 'crab' and /kɛ/ 'dog' or /pe/ 'hemp cloth' and /pɛ/ 'pear.' Due to this phenomenon, it would appear that a merger of /e/ and /ɛ/ is occurring in Korean (Hong 1991; Lee 1998). One may reasonably expect, therefore, that Koreans may have difficulty in distinguishing the contrasts between English /e/~/ɛ/ or /ɛ/~/æ/.

CHAPTER 3

NON-LINGUISTIC FACTORS AFFECTING L2 PRONUNCIATION

3.0 Introduction

This chapter discusses some of the non-linguistic factors that might be responsible for the adult learners' different L2 proficiencies while focusing on the following: one's age of arrival in the L2 environment (AOA); the length of residence in the L2 environment (LOR); and the degree of motivation to learn L2. Section 3.1 addresses some of the non-linguistic factors that have received the most attention in the literature. Section 3.2 describes studies that have examined age effects on L2 acquisition and gives a brief explanation for a possible reason for the younger learners' superiority of L2 learning, especially in phonology. Section 3.3 focuses on the issues related to informal exposure in L2 environment and presents research that shows contradicting results regarding the effect of LOR, followed by possible reasons for such contradictions. The last section, 3.4, discusses motivation, including some ways to measure the degree of motivation and the difference between integrated and instrumental motivations.

3.1 Factors Affecting L2 Proficiency

Most researchers have firmly established that people who are exposed to a second language (L2) after the age of 16 are virtually incapable of producing perfect or

native-like L2 pronunciation (Asher & Garcia 1969; Fatham 1975; Suter 1976; Long 1990; Larsen-Freeman & Long 1991; Thomson 1991; Kim 1994; Flege, Munro & MacKay 1996). At the same time, however, it can be readily observed that the L2 pronunciation of some adult learners is better than others. Neufeld (1979) even suggested that with certain specialized training some L2 adult learners can produce native-like pronunciation. As a result, some researchers assert that the degree to which a speaker can produce native-like L2 forms is correlated with factors beyond the age at which people begin to acquire an L2 in the target language community. Researchers claim that differing degrees of success in pronunciation can be explained by other non-linguistic factors, such as aptitude, LOR, occupation, gender (Asher & Garcia 1969; Gardner & Lambert 1972; Suter 1976; Tahta, Wood & Loewenthal 1981; Larsen-Freeman & Long 1991; Flege, Bohn & Jang 1997; Moyer 1999; Piske, MacKay & Flege 2001), formal training and social-psychological factors, such as attitude or motivation (Corder 1973; Seliger, et al. 1975; Suter 1976; Gardner 1985; Odlin 1989; Elliott 1995; Moyer 1999), as well as personal differences, including self-esteem, anxiety, identity and so forth (Giles, Taylor & Bourhis 1973; van Els, et al. 1984).

Among these factors, the ones that appear to receive relatively more attention, include AOA, LOR and motivation. For example, in one of the earliest non-linguistic factor studies, Asher and Garcia (1969) examined the English pronunciation of Cuban immigrants. Their results reveal that several factors, such as the age at which the speaker first experiences residence in an L2 environment, length of residence in the L2 environment (LOR) and the sex of the speaker affect L2 pronunciation. In an attempt to

learn the degree of the effect of various factors, Suter (1976) examines the English pronunciation of sixty-one non-native speakers. The variables Suter considered are the age at which the speaker first experiences residence in an English-speaking country, the age at which the speaker is first able to converse meaningfully in English, the number of years the speaker has lived in an English-speaking country, the amount of conversation at home that is spoken in English with native speakers of English and so forth. The results of Suter's study show that the following variables are the most significant predictor of pronunciation accuracy: native language, strength of the speakers' concern about his or her pronunciation of English (motivation) and the amount of conversation at work and at school. On the other hand, Suter shows that the amount of formal classroom training and the sex of the subject are among the factors that bear little relation to pronunciation accuracy. In addition, an experiment of native Italian speakers' English pronunciation conducted by Piske, McKay and Flege (2001) illustrates that the age of L2 acquisition onset and the amount of L1 have a significant effect on L2 pronunciation. On the other hand, they demonstrate that sex, LOR and self-estimated L1 ability do not affect L2 pronunciation accuracy.

3.2 Age

The general belief in L2 learning is that young learners are superior to older L2 learners (Asher and Garcia 1969; Suter 1976; Tahta, Wood & Loewnthal 1981; Thompson 1991; Moyer 1999). Tahta, Wood and Loewenthal (1981) examined the English pronunciation of non-native speakers who had lived in the U.K. for a minimum of two years. They found that the age of acquisition of English as an L2 is a prominent

predictor of L2 pronunciation: if L2 acquisition is begun before age 6, L1 transfer is not manifested; if L2 acquisition begun between age 7-11, L1 transfer is slightly transferred; if it is begun after 12, the L1 accent is markedly transferred. Flege, Munro and MaKay (1996) also agree with the researchers' argument on the younger learners' superior acquisition ability. They examined the production of word-initial English consonants produced by native Italian speakers whose age when first learning English was between 3 to 21 years. In this study, they noticed that people who are exposed to an L2 after the age of 15 cannot produce perfect or native-like L2 pronunciation. In addition, Thomson (1991) examined the English pronunciation of adult Russian-born immigrants who came to the United Stated at different ages. Their length of residence in the United States differed as well as the number of years of education in English they had received. The results show that the age at which the Russian-speaking subjects arrived in the United States determined whether or not they acquired a native-like accent.

In contrast, some researchers claim that older learners are superior to younger learners. However, this argument is limited in several ways, especially in pronunciation acquisition. For example, Asher and Price (1967) suggest that adult learners are superior to children in listening comprehension. Some of the reasons that adult learners are better may involve overall cognitive development. In addition, some researchers claim that while younger learners are better in ultimate attainment, older learners are better at the speed of learning. However, the claim that the older learners are faster at L2 learning also tends to be limited to early syntax and morphology (Fathaman 1975;

Krashen, Long & Scarcella 1979; Seright 1985; Larsen-Freeman & Long 1991). To learn the effect of age on L2 acquisition success, aforementioned researchers conducted a production test targeted at children and found that younger children are inferior in morphology and syntax acquisition, while superior in phonology and pronunciation acquisition.

Then why does such a learning ability difference occur between the ability of younger learners and older learners, especially in pronunciation? One of the major contributions to this question is the Critical Period Hypothesis (CPH). This hypothesis supposes that language learners must be exposed to a language during a certain period of time in order to acquire the native-like language. If language learners are exposed to a language after this critical period, their language production will not be native-like (Penfield & Roberts 1959; Lenneberg 1967; Lamendella 1977). On the other hand, Bialystok (1997) uses the term "Sensitive Period Hypothesis" (SPH) rather than CPH. When the SPH and CPH are compared, CPH is more extreme in that CPH claims that after some specific age there is a definite change in the ability to acquire L2. SPH, however, claims that until some specific age, the ability of L2 acquisition is the highest, and it gradually decreases for a particular period of time. There is some disagreement on the age when CP and SP ends from the researchers who argue that the end point is earlier than age six (Long 1990) to the researchers who claim that there is no CP or SP (Bohn and Flege 1992). Furthermore, some researchers claim that such CP and SP are not the same according to the various components of language (i.e., syntax, phonology, etc.) (Seliger 1978; Hurford 1991). According to this camp of researchers, the CP and

SP of phonology is earlier than that of other language components, such as syntax or morphology. Hence, we can conclude that at least in phonology, the age at which one begins L2 learning is an important factor and the younger learners are superior to the older learners.

In addition to the CP and SP hypotheses, Larsen-Freeman & Long (1991) and Gass (1994) provide helpful explanations for how younger learners can better their L2 learning. Their explanations retain similarities in that they explain with social psychological, cognitive and neurological factors and the amount of input. First, in terms of the social psychological reason, they claim that adults want to protect the identity or ego provided by their native language. Hence, adult learners tend to prefer to speak with their L1 accent. Second, cognitive factors affect the inferior ability of adults to learn L2. Larsen-Freeman & Long (1991) mention that the L2 learning of children and adults involve different processes in that children use their LAD (Language Acquisition Device) as in L1 acquisition, while adults use problem-solving abilities. Neurological factors include a loss of plasticity or flexibility. In one of the earliest studies on this subject, Penfield and Robert (1959) claim that a loss of brain plasticity reduces the L2 language learning ability. Lastly, Larsen-Freeman and Long (1991) and Gass (1994) claim an input explanation. They argued that children are exposed to better and larger input.

3.3 Length of Residence

Even though many previous studies have examined the relationship between L2 pronunciation and the length of residence (LOR) in the L2 environment, the results and

conclusions are divided. Some studies show that the LOR effect is significant even for people who enter the L2 environment after age 16 (Asher & Garcia 1969; Purcell & Suter 1980; Jun & Cowie 1994; Flege, Takagi, and Mann 1995; Flege, Munro and Mackay 1996; Piske, MacKay & Flege 2001). As mentioned earlier, Asher and Garcia (1969) examined the English pronunciation of Cuban immigrants. For their study, native English speakers listened to taped productions of L2 subjects and identified pronunciation along a continuum from native-like to heavy foreign accent. They targeted the range of 1-8 years of residence and found that the people whose LOR is 1 to 4 years have a more prominent L1 accent than people whose LOR is 5 to 8 years. Flege, Bohn and Jang (1997) also show that LOR effect on L2 acquisition is significant even for people who enter the L2 environment after the age of 16. They tested the production of English vowels produced by native German, Spanish, Mandarin and Korean adults and found that the pronunciation of certain vowels become more native-like as LOR increases. In addition, Flege, Takagi and Mann (1995) examined Japanese speakers' production of English /l/ and /r/ and found that the speakers whose LOR is 2 years produce more production errors than speakers whose LOR is more than 10 years.

On the other hand, other studies suggest that the LOR effect is not as important (Fatham 1975; Thompson 1991; Munro 1993; Flege, Munro & MacKay 1996; Piske, Mackay & Flege 2001). For example, Flege Munro and MacKay (1996) investigated the production of eleven English vowels spoken by native Italian speakers and found that the adult learners could not produce English vowels in a native-like manner even though their average LOR was more than 30 years. Thompson (1991) examined the

English pronunciation of adult Russian immigrants and concluded that the correlation of LOR and the degree of native-like L2 pronunciation is insignificant. In addition, Munro (1993) tested English vowel pronunciation produced by native Arabic adults and arrives at the same results. In a similar study, Singleton (1989) distinguishes "real time" from "exposure time." He claims that it is natural: there is no significant relationship between the amount of language input and LOR because the opportunity of experiencing L2 and the time spent listening to and speaking English differs from person to person. He mentions that how long someone lives in an L2 environment is not as important as other studies had shown.

With regard to the above-mentioned contradictory results, the experiments themselves may be problematic. Flege & Fletcher (1992) claim that one possible reason that some studies find for the LOR effect, whereas others do not, is that the researchers themselves examine different ranges of LOR. Flege & Fletcher note that some of the studies that do not find a significant LOR effect on L2 pronunciation look only at a narrow range of LOR values. For example, if a study categorizes subjects into LOR groups based on the number of years the non-native speaker has been in the L2 environment (1, 2, 3, 4 or 5 years), the effect of LOR on a foreign accent may not be significant because the range of LOR is so narrow. Even if the same subjects are subsequently re-categorized into two groups (1 year versus 5 years), the effect of LOR on a foreign accent may still be insignificant because the subjects are in a relatively

early phase of L2 learning.[7] They claim that the range of LOR that has an effect on pronunciation is much longer, for example, more than 10 or 20 years.

Another possible reason for such contradicting results on the effect of LOR may be explained by target linguistic feature. If the target feature is something that cannot be corrected in an even long period, it may result in a insignificant LOR effect. For example, since Korean speakers are not able to distinguish English /i/ and /ɪ/ regardless of LOR, if a researcher targets the distinction of English /i/ and /ɪ/ produced by native Korean speakers, the result would not register a significant LOR effect. On the contrary, if the target feature is something that can be corrected in a short period, it may result in a significant LOR effect. Thus, it can be assumed that it is possible for one to have improved a particular aspect of L2 pronunciation in a short period of time while still maintaining a more global L1 accent. With such an assumption in mind, this study focuses on more specific aspects of English vowel pronunciation and illustrates how each aspect separates very subtle phonetic differences in L2: language output can be correlated with differences of even short lengths of residence.

In addition, the amount of time the speaker spends listening to and speaking English in his or her daily life also may affect the results. As Singleton (1989) claims, if someone has lived in an L2 environment for a long time but has not listened to or spoken L2 much during that time, he or she is not exposed to a "true" L2 environment.

[7] Piske, MacKay & Flege (2001) mention that defining what "early phase" means is difficult. However, Kim (1994) suggests that the subjects who have been in the L2 area for at least 8 years may have reached the limits of second language acquisition. This argument suggests that the "early phase" may be at the most 8 years.

On the other hand, if someone has lived in an L2 environment for a few years and yet he or she listened to and spoke L2 many hours a day, the degree of exposure in the L2 environment will have its rewards.

3.4 Motivation

In addition to AOA and LOR, motivation is one of the frequently studied factors. Ellis (1994:715) mentions that motivation refers to "the effort which learners put into learning an L2 as a result of their need or desire to learn it." Previous research on motivation suggests that the degree of desire to accommodate is a significant factor of L2 learning. For example, if students want to speak more like native L2 speakers than speakers of their own language, their L2 skills will be better than others (Spolsky 1969, Purcell & Suter 1980). In addition, Dornyei (1994) claims that the constant effort and attention on L2 learning would automatically help L2 acquisition.

To measure the degree of motivation, researchers often use questionnaires that call for self-reporting (self-assessment) evaluation. Usually, the subjects are asked to rate the importance of good L2 pronunciation for their work or social life, or they are asked to rate the strength of their concern about their pronunciation of L2. For example, Suter (1976:239) provided the following specific questions, whereby the subjects were asked to rate themselves on a scale of 1 to 5, ranging from "very true" to "not true":

1. I must pronounce English well in order to get a good job.
2. My social status in the United States is frequently determined by how well I pronounce English.

3. Improving my pronunciation of English can be important to me because (a) it will enable me to gain good friends more easily among Americans; (b) it will allow me to meet and converse with more and varied English speaking people; and (c) it should enable me to think and behave as Americans do.
4. My American acquaintances will begin to think of me more as an American than as a member of my own cultural groups.
5. During the years that I have been using English, I have been concerned about pronunciation.

An arguable issue on motivation is the effect of integrated and instrumental motivation. Gardner and Lambert (1972) divide motivation into two types: *integrative motivation* and *instrumental motivation.* Integrative motivation occurs when learners want to integrate into the L2 group. On the other hand, if learners are motivated to learn L2 to achieve a specific purpose, e.g., getting a job, passing a language exam or improving social status and so on, they are regarded as instrumentally motivated. Gardner and Lambert claim that integrative motivation is much better in the long term for L2 learning.

In addition to whether or not a higher degree of motivation causes better L2 acquisition success, still another arguable issue is the effect of success on motivation (Gass 1994). Those learners who succeed in L2 learning are encouraged to try even harder. For example, Strong (1984) found that children whose English proficiency is

better on an entry exam show a greater degree of integrative motivation. Hermann (1980) noticed that between the group which had been instructed for five years and the beginning group, the former one demonstrated more motivation. Therefore, we can predict that motivation and the other factors may be related. In support of that claim, this study examines the following: how motivation is correlated with AOA, LOR or other non-linguistic factors and how these factors are responsible for motivation.

CHAPTER 4

METHODOLOGY

4.0 Introduction

In order to investigate the questions raised in chapter 1, a two-part study was conducted. To show the acoustic characteristics of L1 production, the first portion focuses on the acoustic properties of Korean vowels (L1) as produced by Korean speakers. These findings serve as a basis for comparison of each Korean speaker's L1 and L2 inventories. In the second portion of the research, the production of English (L2) vowels by the same subjects who participated in the Korean vowel experiment is examined and subsequently compared with the English production of native English speakers. Furthermore, how the English pronunciation of native Korean speakers changes as AGE (chronological age), AOA (age of arrival), LOR (length of residence) or MOTI (degrees of motivation) increases is investigated.

The current chapter describes the method used in data collection and acoustic and statistical analysis. Section 4.1 describes the criteria for subjects and explains how they are selected and grouped. Section 4.2 presents the materials used in the study and explains how the data were collected. Section 4.3 discusses how the acoustic measurements were obtained for F1, F2 and the duration of the vowels. Lastly, section

4.4 presents the statistical analyses used in describing and explaining the quantitative data.

4.1 Subjects

4.1.1 The Criteria for Subjects

Ninety one (91) adult native Korean speakers who have lived both in Korea or in the United States were asked to participate for both the English and Korean vowel experiment. The subjects were recruited through an approach that involved social networking and personal contacts. The subject pool was heterogeneous, in regard to AGE, AOA, LOR, MOTI and the time spent listening to and speaking English. To measure the motivation degree, a self-evaluation questionnaire was used (See Appendix A, last four questions). The subjects were asked to rate the importance of good L2 pronunciation for their work and preparation for examinations (to measure the degree of instrumental motivation), as well as their social life (to measure the degree of integrated motivation), using a five-point scale ranging from "very important" to " not important at all." In addition, they rated their strength of concern and effort in pronunciation on a scale of one to five, ranging from "not at all" to "very much." A self-evaluation questionnaire was also used to measure the time per day spent listening to and speaking L2. The subjects marked how many hours they listen to or speak in English (See Appendix A).

Except for AGE, AOA, LOR, MOTI and the time spent listening to and speaking English, as mentioned above, other biological and social factors were

controlled so as to minimize any confounding effects.[8] For example, the effect of biological conditions, including the length of vocal folds, which differs between males and females and thus may affect the quality of pronunciation, was avoided by controlling the gender of the speakers (Yang 1996). In this study, the subjects were all males.[9] In addition, the effect of other factors, such as the degree of education, formal English instruction, dialect, parents' native language being Korean, all of which may affect pronunciation, was excluded by making the sample as homogeneous as possible. For example, the data used in this study came only from individuals who met the following criteria: obtained at least a college education, spent their early to middle childhood years (age 6-9) in the Seoul area and speak the standard Seoul dialect, except for the early AOA subjects, whose age at which they first learned English was also controlled to include the ages between 11 to 15, as that is when most Koreans start to learn English.

4.1.2 The Relationship Among Non-linguistic Independent Variables

As mentioned in section 4.1.1, the subjects of this study was heterogeneous based on AGE, AOA, LOR and MOTI (the average of four questions). Since there exists a possibility that the non-linguistic factors of the subjects are correlated with each other, the relationship among these non-linguistic factors was examined (Table 4.1).

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[8] If the samples are homogeneous, there is a limit to the generalizability of the sample to the population. However, to reduce the effect of other factors that affect the L2 pronunciation acquisition, the necessity of examining a practically homogeneous sample is considered important to the design of this project.

[9] The reason that this study target only male is that it is easy to compare the results of this study to the results of other studies because most other studies targeted males.

The values indicate a strong positive relationship between AGE and AOA (the correlation value is 0.701). Between AGE and LOR, there is a moderate positive relationship (the correlation value is 0.421). There is a moderate to weak negative relationship (the correlation value is -0.342) between AOA and LOR. On the other hand, a weak relationship exists between MOTI and other factors. Hence, an inference we can draw is that, even if we find the effect of non-linguistic factors on pronunciation, the possibility remains that such a result is caused by other factors. For example, even though someone's pronunciation differs as a result of LOR, there is a strong possibility that such difference is caused by AOA.

Table 4.1 The correlations of non-linguistic factors

		AGE	**AOA**	**LOR**	**MOTI**
AGE	r	1.000	.701*	.421*	.156*
	p	.	.000	.000	.000
AOA	r	.701*	1.000	-.342*	.158*
	p	.000	.	.000	.000
LOR	r	.421*	-.342*	1.000	-.086*
	p	.000	.000	.	.000
MOTI	r	.156*	.158*	-.086*	1.000
	p	.000	.000	.000	.

* $p<0.05$ level (two-tailed).

The measurement method of motivation is different from those of other factors, in that the answers of other factors are quantitative and clear (e.g., AOA is 12 years old, LOR is 5 years, AGE is 20 years old, etc.) while the degree of motivation is measured by a self analysis whose scale ranges from "very important" to " not important at all"; there is a possibility that the score can be skewed to some degree because the subjects have not been examined fully their motivation for learning English pronunciation. Consequently, a better approach is to look more carefully at the individual factors that appear on the questionnaire, that may be related to the motivation and see how these factors correlate in some way to the production of the subjects (See chapter 6). In this case, the time spent listening to and speaking English is regarded as being related to the motivation degree with the assumption that highly motivated students may try to listen to and speak more English. We cannot discount that other non-linguistic factors also may be related to the degree of motivation. However, since there is no variance among subjects, these factors are not considered. In addition, since one of the arguable issues about motivation is the effect of instrumental and integrated motivations, how instrumental motivation and integrated motivation are correlated and how these factors relate to the production of the subjects was investigated (See chapter 6). Here, to separate instrumental and integrative motivation, the scales on the question "How important do you think accurate English pronunciation is (in order to get a job or to take a examination)?" and "How important do you think accurate English pronunciation is (for other reasons. i.e., to integrate into the American society?" were used, respectively.

In this section, in addition to the correlation of the factors, AGE, AOA, LOR and MOTI (the average of the four questions), the correlation among MOTI (the average of the ratings of the strength of concern, effort in pronunciation, instrumental motivation and integrated motivation), instrumental motivation, integrated motivation and the time spent listening to and speaking English (Table 4.2) are shown.

Table 4.2 The correlations of non-linguistic factors:
MOTI (Average), instrumental motivation, integrated motivation and the time spent listening to and speaking English

		MOTI			Listening	Speaking
		average	**instrumental**	**integrated**		
average	r	1.000	.761*	.767*	.127*	.119*
	p	.	.000	.000	.000	.000
instrumental	r	.761*	1.000	.605*	.171*	.036*
	p	.000	.	.000	.000	.004
integrate	r	.767*	.605*	1.000	.021	.019
	p	.000	.000	.	.094	.123
Listening to	r	.127*	.171*	.021	1.000	.729*
	p	.000	.000	.094	.	.000
Speaking	r	.119*	.036*	.019	.729*	1.000
	p	.000	.004	.123	.000	.

* $p<0.05$ level (two-tailed).

The values indicate a strong relationship among integrated motivation, instrumental motivation and the average of the motivation. On the other hand, a weak relationship exists between the values of integrated motivation, instrumental motivation

and the average of the motivation and the values of the time spent listening to and speaking English.

4.1.3 The Categorization of Non-linguistic Factors

For the analysis, AGE, AOA, LOR and MOTI are categorized as follows: AGE was grouped according to the 10 year age cohorts: up to age 20 (AGE-1); 21-30 (AGE-2); 31-40 (AGE-3); older than 40 (AGE-4). AOA was grouped into children (less than age 11; AOA-1), adolescent (between the ages of 11 and 17; AOA-2) and adult (age 18 and aboveAOA-3). Since this study does not intend to show the exact age that Critical Period (CP) or Sensitive Period (SP) ends, but rather simply see whether or not the age onset time is an important factor, these groups are not more specific.

In terms of LOR in the United States, speakers were divided into 5 groups: 0 year (LOR-1), 1 month-1 year (LOR-2), 1-5 years (LOR-3), 5-8 years (LOR-4) and more than 8 years (LOR-5). The subjects for the 0 year group consisted of male adults living in Seoul, Korea, while all other subjects had a LOR in the United States greater than one month. The participants in these groups were university students or immigrants living in Texas.[10] The reasons for dividing LOR into these particular five groups: 0 year, 1 month-1 year, 1-5 years, 5-8 years and more than 8 years are (a) it is useful to compare the differences between the subjects who live in Korea and in the United States; (b) it is assumed that a subject's language ability during the first year abroad will be similar to his or her initial language learning ability in Korean; (c) as

[10] However, the target L2 is not Texas-English. Rather, it is Standard American English (SAE), the language to which the subjects are most likely to be exposed (by TV, radio, professors, fellow students, etc.).

most of the subjects were university students finishing their studies in a five-year period, it is expected that they will have a greater sense of accomplishment in an English conversation; and (d) it has been argued that subjects who have been in the L2 area for at least 8 years may have reached the limit of second language acquisition (Kim 1994).

To determine the degree of motivation, the average of scale based on the importance of good L2 pronunciation for work or examination preparation (instrumental motivation), social life (integrated motivation) and the degree of concern and effort for a better pronunciation was then calculated. Next, these categories were re-categorized according to the degree of motivation of less than average (average scale is less than 3; MOTI-1), average (average scale is 3; MOTI-2) and above average (average scale is more than 3; MOTI-3).

4.1.4 Grouping of the Subjects

When we consider that these non-linguistic factors are correlated with each other, to find the effect of only AGE, AOA, LOR or MOTI is not easy. Hence, it is necessary to categorize the subjects in more detail. In this study, based on the above division, the subjects participating in this study were divided into ten (10) combination groups (Table 4.3). For this grouping, three of the most important factors: AOA, LOR and MOTI were considered. For example, the subjects who were included in GROUP-1 are the people whose AOA is younger than 11 years old, who have lived in the United Stated more than 8 years and whose degree of motivation is above average.

Table 4.3 The grouping of subjects

	AOA	LOR	Motivation
GROUP-1	Younger than 11	More than 8 years	Above average
GROUP-2	Between 11 to 17	5 to 8 years	Above average
GROUP-3	18 and above	More than 8 years	Above average
GROUP-4	18 and above	5 to 8 years	Above average
GROUP-5	18 and above	1-5 years	Above average
GROUP-6	18 and above	1-5 years	Below average
GROUP-7	18 and above	1 month-1 year	Above average
GROUP-8	18 and above	0	Above average
GROUP-9	18 and above	0	Average
GROUP-10	18 and above	0	Below average
Extra	The subjects who are not included in above groups		

4.2 Materials and Procedure

To elicit the production of the English vowels /i ɪ e ɛ æ/, subjects were asked to read sentences, each containing a word with the target vowel in the medial position of three contexts: h(V)d (i.e., *heed, hid, hayed, head,* and *had*), b(V)d (i.e., *bead, bid, bayed, bed* and *bad*) and b(V)t (i.e., *beat, bit, bait, bet* and *bat*). By choosing a vowel in a /h(V)d/ context, the fricative /h/ and alveolar /d/ have little influence on vowel

formants (Yang 1996). The /b(V)d/ and /b(V)t/ provide contexts that contain target vowels in authentic words. All words were embedded in the carrier sentence: "*Say*____ *for me*" (See Appendix B).

For the Korean vowel experiment, each subject read sentences containing the Korean vowels /i e ɛ/ in three contexts: h(V)da (i.e., *히다* [hida], *헤다* [heda] and *해다* [hɛda]), b(V)da (i.e., *비다* [bida], *베다* [beda] and *배다* [bɛda]) and b(V)ta (i.e., *비타* [bita], *베타* [beta] and *배타* [bɛta]), all nonsense words. These Korean words were embedded in the carrier sentence: 이건 _____라고하죠 [igən _____ rago hajio], translated as: "That's called ____" (See Appendix B).

Speakers were recorded in a sound-attenuated room using a Sony cassette recorder (Sony Model TCM–59V) and a high-quality microphone (Sony ECM–T6). Before the recording, the speakers filled out a questionnaire, which included questions on age, sex, length of time in the U.S., age of arrival, education, history of English study and so on (Appendix A). Assuming that the subjects needed time to become familiar with the test words, the test stimuli were presented and explained before the recording. The speakers then read a set of randomly ordered cards five times, being instructed to read the sentences at a self-determined, normal speed. If the speakers read at a non-optimal speed (i.e., too fast or too slow), the speaker was re-instructed on the matter of speed. However, re-instruction was needed only once. For analysis, only those data collected for rounds two, three and four were analyzed, as the first trial was expected to be somewhat unnatural, and the fifth trial was expected to be distracted by the " end-of-sequence" phenomenon.

4.3 Acoustic Analysis

The tape-recorded speech signals were digitized (mono sound, 8 bit, 22 kHz sampling rate and 4.5 kHz low pass filter), using Cool Edit 2000 software. The entire interview session for each subject was recorded in separate files and labeled as Subject 1, Subject 2, Subject 3, etc.; these were again divided into separate tokens, such as the following (Figure 4.1):

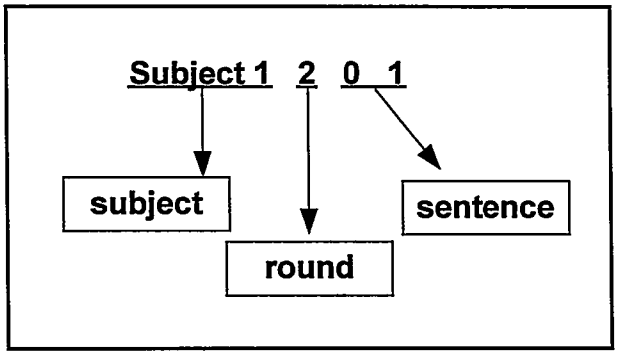

Figure 4.1 Labeling method used in digitizing speech signals

The durations and formants of vowels were then analyzed using the Speech Analyzer software. The duration of each vowel was measured referencing both waveform and spectrogram displays. The vowel onset was determined at the point where (a) the waveform amplitude suddenly rose, and (b) all structures for the first three formants (F1, F2 and F3 for vowels) became clearly discernible in the spectrogram. Vowel offset was determined at the point where the waveform amplitude suddenly fell and clear vowel formant structures disappeared (Figure 4.2). Given that

American English /e/ is most frequently produced as a diphthong, the decision was made to measure both the nuclear (non-glide) and the glide portion of the segment.

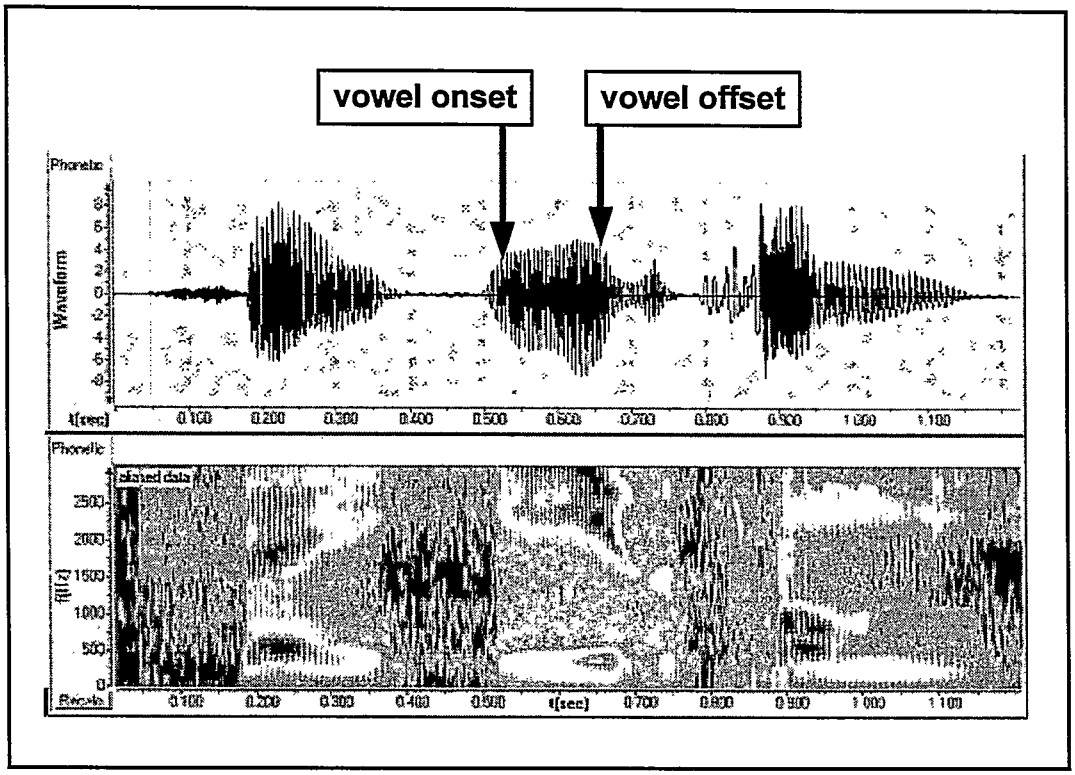

Figure 4.2 Illustration of waveform and spectrogram display: duration is the distance between vowel onset and offset

In the case where the vowel onset and offset indicated in the waveform and spectrogram differ, indicators in the waveform were given priority. For example, frequently the vowel offset indicated in that waveform can end before the offset in the spectrogram because of the post-voicing. F1 and F2 formant frequencies were measured, using both spectrographic and spectral analysis. Vowel steady state was taken to be the

middle one-third portion of the total vowel duration (between point 1 and point 2 in Figure 4.3). The left cursor was placed at the one-third point of the vowel, and the right cursor was placed at the two-third point of the vowel.[11] From here, the formant values in the spectrogram were measured. F1 and F2 were identified by placing the cursor on each of the first highest and the second highest amplitude points of the spectral display (a and b in Figure 4.3). For /e/ in diphthongs, the middle one-third portion of the first half of vowel duration was taken.

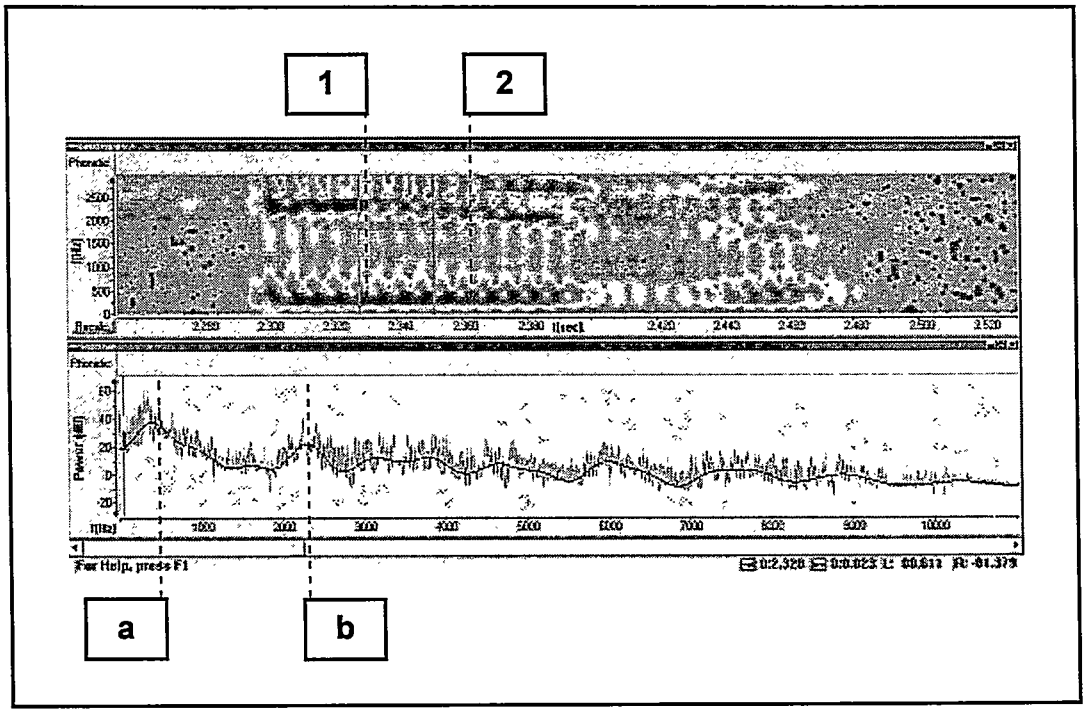

Figure 4.3 Illustration of partial spectrogram (upper) and spectrum (lower)

[11] Speech Analyzer does not allow one to measure a single point. Instead, it composes a spectral display that represents average values across the duration that is to be selected.

In the spectrogram, the dark bands show the formants, the lowest band being F1 and the second one being F2, etc. When we measure the F1 and F2 values in the spectrum, these values correspond to the frequency of the darkest part of the band. Data points were then typed into SPSS (Statistical Package for the Social Sciences) 10.0 for analysis.

4.4 Statistical Analysis

To determine the relationship between the Korean and English production of Korean speakers and non-linguistic factors, such as combined GROUP, AGE, AOA, LOR and MOTI, the bivariate correlation and multi-factor ANOVA (one-way analysis of variance) were performed. Here, for the independent variables of correlation test, numeric variables were used. On the other hand, to perform the ANOVA, the categorized GROUP, AGE, AOA, LOR and MOTI were submitted.[12] ANOVA and correlation test are utilized to see whether or not there is a difference between the result of the test in which the independent variable is a set of discrete categories, and the result of the test in which the independent variables are continuous variables.

Using Correlation, specially Pearsons Correlation Coefficients, one can measure the simple bivariate correlation between variables. In this study, the dependent variables were F1, F2, duration and voicing effect of Korean and English vowels of native Korean speakers; the independent variables were numeric non-linguistic factors, such as year of birth (i.e., 1960, 1973, 1980, etc.), age first moved to the United States (i.e., age 9, age 15, age 20, age 30, etc.), length of residence (i.e., 1.5 years, 3 years, 4.2

[12] For an excellent overview of how to select a statistical analysis appropriate to various kinds of language studies, see Brown (1988), pp 186-187.

years, 8 years, etc.) and so forth. With Pearsons Correlation test, SPSS generates an "r" score that indicates the bivariate correlation between pairs of variables. Here, r rages from –1 to +1, with –1 indicating a perfect negative correlation, with +1 indicating a perfect positive correlation and 0 indicating no correlation. The closer r is to –1 or to+1 the stronger the negative or positive relation between to variable respectively.

For categorical non-linguistic factors, ANOVA tests were used. ANOVA test compares the differences of means for two or more groups, such as AOA-1 (less than age 11), AOA-2 (between the ages of 11 and 17) and AOA-3 (age 18 and above) for a particular behavior of production of Korean or English. The result of ANOVA test shows whether of not there are significant differences among groups in a particular outcome. In this study, multi-factor ANOVA was performed using "Generalized Linear Model" function of SPSS. Here, multi-factor ANOVA is used when the means of more than 2 groups are compared. The experiments of this study are typical objects of Repeated Measures multi-factor ANOVA statistics, in that the data of this experiment include the repetitions of the subjects. Hence, if one conducts only a one-way ANOVA, there is a possibility of statistical error because the premise of a Non-repeated ANOVA design is that each cell is filled with a different subject. Here, as independent variables, categorical variables were used, and as dependent variables, numerical. As independent variables, the ten GROUPS and the grouped AGE, AOA, LOR and motivation were used. Here, such categorized non-linguistic variables and Korean (3 levels) and English (5 levels) vowels were "fixed factors." The repetition (3 levels) should be "random factors." F1, F2, duration, the distance of the highest vowel and lowest vowel and

voicing effect of Korean and English are treated as dependent variables. P–values are appraised at a $p<0.05$ level. If such a multi-factor ANOVA test showed there is a significant difference among the different groups (if the significance level was $p<0.05$), one-way ANOVA tests (the significance level was $p<0.05$) and *post-hoc* tests were conducted to learn more specific information that about what specific groups significantly different. In this study, two *post-hoc* tests, Bonferroni and Tukey's HSD (Honestly Significant Difference) were employed. Here, the Bonferroni test adjusts for experiment-wise error by dividing the alpha values by the total number of tests performed, while Tukey's HSD allows the research to make pair-wise comparisons of means after a significant F-value has been observed in an ANOVA.

CHAPTER 5

KOREAN VOWEL PRODUCTION OF NATIVE KOREAN SPEAKERS

5.0 Introduction

One of the pressing goals of this study is to investigate the characteristics of Korean vowel production of native speakers of Korean. This chapter provides the results and analysis of the Korean production of native Korean speakers and answers the research questions raised in chapter 1. Those questions are as follows: (1) How do native Korean speakers produce Korean vowels in terms of features, including the vowel qualities, the number of vowel categories, the acoustic space occupied, duration and the degree of voicing-dependent effect of vowel duration? (2) How do AGE, AOA and LOR affect L1 pronunciation? And (3) How is the Korean production of native Korean speakers in this study, as well as the production of Korean speakers in other studies, similar and different?

Section 5.1 addresses research question (1) and (2) by presenting the Korean production of the subjects in this study and analyzes the production based on the phonetic or phonological linguistic features, including F1, F2, duration, the distance between /i/ and /ɛ/, the distance between /e/ and /ɛ/ and the degree of the voicing-dependent effect of vowel duration. As we shall see, earlier AOA, longer LOR and AGE affect some aspects of the L1 production. Section 5.2 compares these results to

the results of previous studies as per research question (3) and then discusses some of the similarities and differences; in the end, the comparison of previous work supports the finding of the study presented in this dissertation.

5.1 Korean Production of the Subjects

This section presents the Korean production of the subjects who participated in this study. As discussed in chapter 4, the dependent variables under consideration here are F1, F2 and duration of each vowel token, as well as other derived measurements, such as the number of front vowels occupying the acoustic space and the effects of consonant voicing. These dependent variables are analyzed in two ways. Section 5.1.1 presents the results of the statistical analysis based on using the 10 subject groups (GROUPS) as the independent variable. Section 5.1.2 presents the results of a similar set of statistical procedures, but in this case, the independent variables are the separate social factors of age (AGE), age of arrival (AOA), and length of residence (LOR). By conducting two sets of related analyses, one can compensate for the relative strengths and weakness inherent in each. Using GROUP as the independent variable (section 5.1.1) allows us to capture partial effects, but prevents us from generalizing the possible influence of each social factor taken individually; on the other hand, an analysis that employs each social variable separately (section 5.1.2) allows us to discern the influence of each individual factor more easily (but can not capture partial effects).

5.1.1 The Production of Korean Front Vowels as Produced by Ten Subject Groups

In this section, F1, F2 and the duration of three Korean front vowels, ㅇㅣ /i/, ㅇㅔ /e/ and ㅇㅐ /ɛ/, as produced by male Korean-speaking subjects who are categorized into ten groups (See chapter 4), are presented. The mean values and standard deviations of F1, F2 and duration, as produced by different groups, are represented in Table 5.1.

Table 5.1 The average vowel formants (Hz) and duration (ms) of the Korean vowels /i e ɛ/, which are based on all /hVd/, /bVd/ and /bVt/ tokens. Group standard deviations appear in parentheses

- /i/

GROUP	F1 in Hz	F2 in Hz	Duration in ms
1	255 (57)	2211 (173)	114 (109)
2	288 (21)	2029 (181)	47 (18)
3	283 (40)	2115 (190)	65 (29)
4	297 (25)	2272 (103)	64 (24)
5	293 (32)	2150 (178)	48 (20)
6	292 (26)	2083 (177)	70 (42)
7	287 (27)	2094 (167)	56 (23)
8	293 (22)	2048 (162)	35 (13)
9	288 (17)	2100 (119)	37 (12)
10	291 (22)	2088 (142)	43 (15)

Table 5.1 - *Continued*

- /e/

GROUP	F1 in Hz	F2 in Hz	Duration in ms
1	515 (80)	1741 (143)	137 (101)
2	483 (147)	1729 (109)	65 (19)
3	531 (109)	1817 (116)	82 (29)
4	523 (178)	1899 (168)	104 (38)
5	484 (93)	1836 (135)	71 (21)
6	496 (104)	1818 (138)	102 (54)
7	470 (97)	1815 (132)	84 (34)
8	489 (86)	1777 (97)	53 (17)
9	526 (98)	1818 (83)	55 (18)
10	491 (98)	1811 (105)	55 (18)

- /ɛ/

GROUP	F1 in Hz	F2 in Hz	Duration in ms
1	528 (73)	1745 (155)	129 (96)
2	524 (136)	1734 (102)	66 (18)
3	569 (82)	1794 (115)	84 (29)
4	509 (161)	1789 (100)	106 (26)
5	503 (84)	1840 (155)	69 (20)
6	507 (97)	1817 (125)	92 (52)
7	485 (106)	1804 (123)	80 (32)
8	514 (90)	1780 (132)	53 (17)
9	516 (99)	1778 (96)	52 (16)
10	498 (89)	1820 (110)	54 (20)

To determine if there are significant differences among variables, a multi-factor ANOVA was conducted. Here, the GROUP and vowel phoneme were treated as independent factors, and each F1 and F2 values and duration were treated as dependent factors. The repetition was treated as a random factor (Table 5.2).

Table 5.2 Summary of the result of the multi-factor ANOVA test for F1, F2 and duration of Korean vowels. The bold font marks those factors and interactions with a p-value less than 0.05

- Dependent Variable: F1:

F1	df	F	p
Group (1-10)	10	6.750	**.000**
Vowel (/i e ɛ/)	2	823.456	**.000**
Repetition (2-4)	2	.674	.550
(Group) x (Vowel)	20	5.511	**.000**
(Group) x (Repetition)	20	1.664	.084
(Vowel) x (Repetition)	4	2.416	.051[13]
(Group) x (Vowel) x (Repetition)	40	.462	.998

[13] The p-value of 0.051 associated with this particular interaction might be suggestive of statistical significance, but leaves us wondering as to how such significance might be interpreted. It is perhaps the case that with each subsequent repetition, subjects tended to vary their value of F1 for each of the target vowels in different ways. One might imagine, for example, more consistency in the production of /i/ and less for the mid-low front vowels.

Table 5.2 - *Continued*

- Dependent Variable: F2

F2	df	F	p
Group (1-10)	10	12.916	**.000**
Vowel (/i e ɛ/)	2	4585.207	**.000**
Repetition (2-4)	2	3.944	.091
(Group) x (Vowel)	20	7.928	**.000**
(Group) x (Repetition)	20	1.507	.132
(Vowel) x (Repetition)	4	.265	.900
(Group) x (Vowel) x (Repetition)	40	.448	.999

- Dependent Variable: Duration

Duration	df	F	p
Group (1-10)	10	107.907	**.000**
Vowel (/i e ɛ/)	2	105.573	**.000**
Repetition (2-4)	2	1.369	.312
(Group) x (Vowel)	20	3.889	**.000**
(Group) x (Repetition)	20	2.987	**.001**[14]
(Vowel) x (Repetition)	4	1.646	.162
(Group) x (Vowel) x (Repetition)	40	.208	1.000

[14] The significance of this interaction between Group and Repetition suggests that the subjects in this study reacted differently to the methodological requirement to repeat the test sentences multiple times. A review of the data in Table 5.1 reveals that the standard deviations for vowel duration for Group 1 are noticeably larger than those of the other groups. Given that the subjects in Group 1 are the most likely to have the "least fluent" Korean language skills, it is perhaps not surprising that they were the most influenced by the requirement for multiple repetitions. This methodological issue merits further inquiry, particularly as it pertains to the often complex relationship between an immigrant's purported L1 and his/her degree of fluency.

The results of this multi-factor ANOVA test show that of the all three dependent variables, F1, F2, and duration, GROUP plays a significant role in explaining the variation. The Group by Vowel interaction also shows the significance; it means that the effect of GROUP varies, depending on the vowels.

5.1.1.1 The GROUP Effect Depending on Vowels

In order to obtain more specific information, three additional sets of one-way ANOVA tests were conducted (statistically significant at the 0.05 level) on the three Korean front vowels. Since the results of ANOVA show that there are significant differences among GROUPS ($p<0.01$), the Bonferroni *post-hoc* test was conducted to see how the F1, F2 and duration are correlated to the GROUP.

The results show that not all the subjects manifest an identical quality of Korean vowels. The subjects who arrived in the U.S. before age 11 (GROUP-1) typically manifest a lower F1 and a higher F2 values for /i/, and longer durations for all three vowels, while the subjects who live in Korea manifest a higher F1 and a lower F2 values for /i/ and shorter durations for all vowels. A summary of the *post-hoc* tests as follows.

- ㅇ| /i/ :

The mean F1 of /i/ produced by GROUP-1 (subjects who arrived in the U.S. before age 11 and have lived more than 8 years) is significantly lower than those in other groups. As for F2, the values of GROUP-1 and GROUP-4 (i.e., the subject whose LOR is more than 5 years) are significantly higher than the values of GROUP-6, GROUP-7, GROUP-8 and GROUP-10 (i.e., the subjects whose LOR is less than 5

years) and GROUP-2: the value of GROUP-5 is significantly higher than GROUP-2 and GROUP-10. In terms of duration, the duration of GROUP-1 is significantly longer than the duration of other groups: the durations of groups, GROUP-8, GROUP-9 and GROUP-10 (subjects who live in Korea) and GROUP-5 are significantly shorter than the durations of GROUP-3 and GROUP-6: and the durations of GROUP-4 and GROUP-7 are significantly different from that of GROUP-10. However, there are no durational differences among GROUP-5, GROUP-8, GROUP-9 and GROUP-10.

- ㅔ /e/

Among all 10 of the subject groups, there are no statistical significant differences among the mean values of F1 or F2 of /e/. On the other hand, the mean duration of the subjects who arrived in the U.S. before age 11 (GROUP-1) is significantly longer than those of other groups: the durations of GROUP-8, GROUP-9 and GROUP-10 (subjects who live in Korea) and GROUP-5 are significantly shorter than those of GROUP-4 and GROUP-6: and the duration of GROUP-3 is significantly different from those of GROUP-8, GROUP-9 and GROUP-10. However, there are no durational differences among GROUP-5, GROUP-8, GROUP-9 and GROUP-10.

- ㅐ /ɛ/

With regard to the vowel formants, the F1 of GROUP-3 (i.e., the subjects whose LOR is more than 8 years) is significantly higher than those of GROUP-5, GROUP-6, GROUP-7, GROUP-8 and GROUP-10 (i.e., the subjects whose LOR is shorter than 5 years). In terms of F2, the groups that produced lower F2 values are GROUP-1 and GROUP-2 (i.e., the subjects who arrived in the U.S. before age 17 and have lived there

longer than 5 years) and the group that produced a significantly higher F2 value than those of other groups is GROUP-5. The duration of GROUP-1 is significantly longer than the durations of other groups, and the durations of GROUP-4 and GROUP-6 are significantly longer than those of GROUP-8, GROUP-9 and GROUP-10 (subjects who live in Korea) and GROUP-5: and the durations of GROUP-3 and GROUP-7 are significantly longer than those of GROUP-8, GROUP-9 and GROUP-10. GROUP-5 is significantly longer than GROUP-10. There are no durational differences among GROUP-8, GROUP-9 and GROUP-10.

5.1.1.2 The Number of Vowel Categories

In order to investigate the number of vowel categories produced by native Korean speakers, ten additional sets of one-way ANOVA tests were conducted for the ten GROUPS. Since the result of ANOVA shows that there are significant differences among vowels, *post-hoc* tests were conducted to see the number of Korean front vowel categories produced by each GROUP.

- *F1*

Since the result of the ANOVA test shows that there is a significant difference in the F1 values of each vowel, two *post-hoc* tests, Bonferroni and Tukey HSD Process were employed. The results of the *post-hoc* tests shows that in most groups, the F1 values of Korean front vowels are divided into two groups: high vowel /i/ and low

vowels /e ɛ/. Only in GROUP-7 and GROUP-8 are the F1 values divided into three groups.

- *F2*

Since the result of the ANOVA test shows that there is a significant difference in the F2 values of each vowel, once again, the two *post-hoc* tests were employed. The results of the *post-hoc* tests show that in all groups, the F2 values of Korean front vowels are divided into two groups: more front vowel /i/ and less front vowels /e/ and /ɛ/.

The F1 and F2 of each vowel are plotted on an F1 x F2 chart to show the position of the vowels in the acoustic phonetic vowel space.[15] Figure 5.1 and Figure 5.2 are examples of Korean production of native Korean speakers (GROUP-1 and GROUP-10). Here, it is visually noticeable that Korean speakers fail to distinguish Korean /e/ and /ɛ/.

[15] In this study, for the F1 x F2 charts, linear scales were used rather than logarithmic scales because the ranges of the sales of F1 (between 500 Hz to 1000 Hz) and F2 (between 1000 Hz to 3000 Hz) were relatively narrow. Use of logarithmic scales reduces our ability to see differences along the F2 axis. Moreover, the statistical evaluation should be given more weight, since they test significance no matter how close or distance in the linear or logarithmic scale the values may appear.

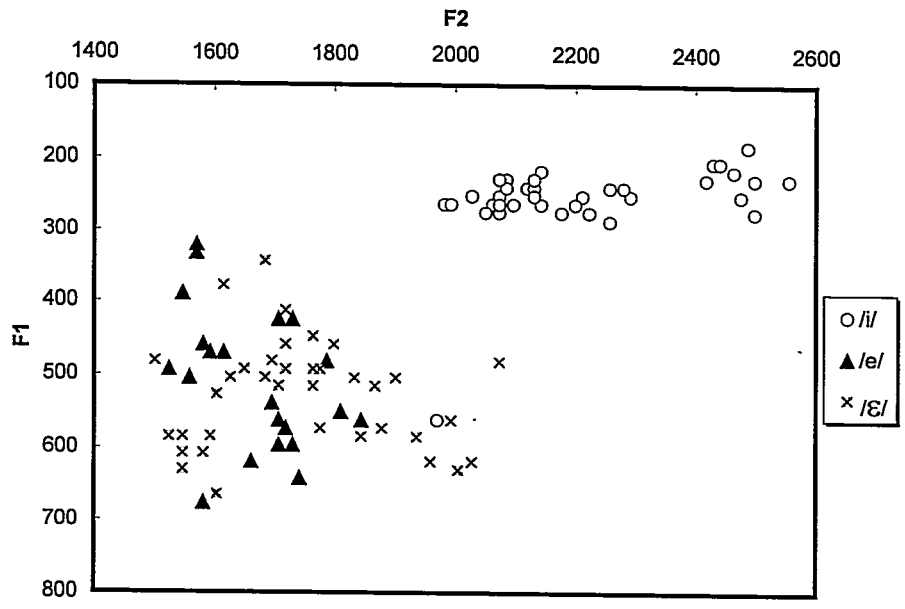

Figure 5.1 The production of Korean front vowels /i e ɛ/ of GROUP-1

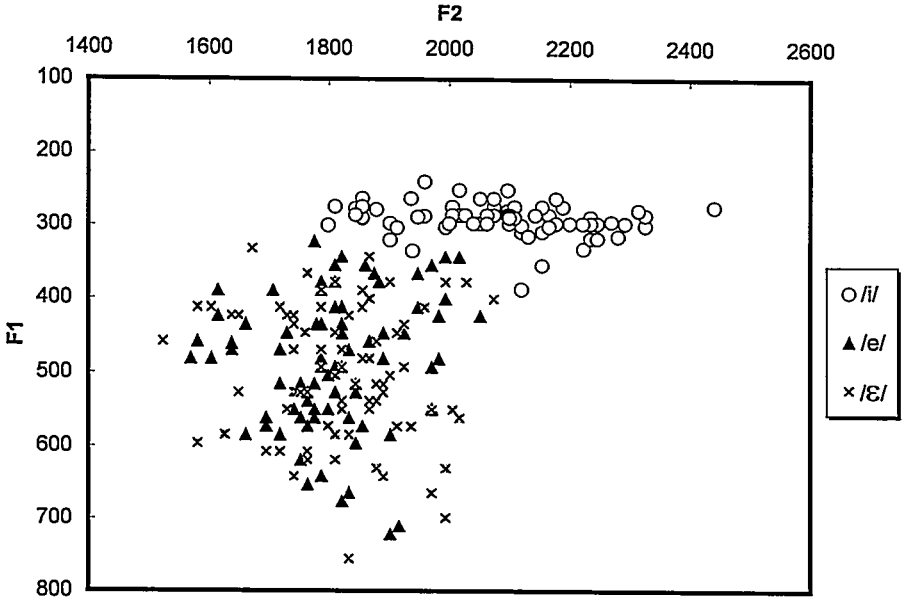

Figure 5.2 The production of Korean front vowels /i e ɛ/ of GROUP-10

- *Duration*

The result of the *post-hoc* test shows that in most groups, the F2 values of Korean front vowels are divided into 2 groups: shorter vowel /i/ and longer vowels /e ɛ/. On the other hand, in GROUP-1 (the subjects who arrived in the U.S. before age 11), the durations of Korean front vowels /i e ɛ/ are similar to each other.

5.1.1.3 The Acoustic Space Occupied by the Front Vowels

The distance between the vowels ㅇㅣ/i/ and ㅇㅐ/ɛ/ was calculated as follows:

F1 of ㅇㅐ/ɛ/ - F1 ㅇㅣ/i/ = a

F2 of ㅇㅐ/ɛ/ - F2 ㅇㅣ/i/ = b

The distance between /i/ and /ɛ/ = $\sqrt{(a^2 + b^2)}$

The mean distances, as produced by each group, are presented in Table 5.3.

Table 5.3 The mean distance between /i/~/ɛ/, as produced by each group

GROUP	Mean (Hz)	Std. Deviation
1	545	136
2	400	172
3	453	149
4	544	216
5	402	126
6	373	123
7	372	131
8	380	180
9	399	123
10	396	225

The ANOVA test reveals that there are significant differences among groups ($p<0.01$). Subsequent Bonferroni *post-hoc* test shows that the distances of GROUP-1 and GROUP-4 are significantly longer than the distances of other groups. On the other hand, there are no significant differences among other groups. These values will be compared to the distance of native English speakers in chapter 6. Then, they will be compared to the highest and lowest English vowels, as produced by native Korean speakers in chapter 7.

In addition to the distance between the highest vowel /i/ and the lowest vowel /ɛ/, the distance between the lowest front vowels /e/ and /ɛ/ was calculated. However,

the ANOVA test reveals that there are no significant differences among the groups ($p>.05$).

5.1.1.4 Comparison of the Production in Different Contexts /bVd/ and /bVt/ tokens

How is the duration of vowels affected by the pre-vowel consonant or post-vowel consonants? We turn to Table 5.4 and Figure 5.3, which show the mean durational ratio of vowels in b-V-d to vowels in b-V-t, as produced by ten GROUPS.

Table 5.4 The mean durational ratio (%) of vowels in b-V-d to vowels in b-V-t, as produced by different GROUPS

GROUP	Mean (%)	Std. Deviation
1	79	26
2	84	45
3	72	26
4	74	18
5	83	31
6	79	23
7	89	57
8	78	30
9	74	30
10	83	31

The ANOVA test indicates that in terms of the ratio there is a difference among the groups ($p<.05$). The *post-hoc* test reports that the ratio of GROUP-3 is significantly lower than that of GROUP-7.

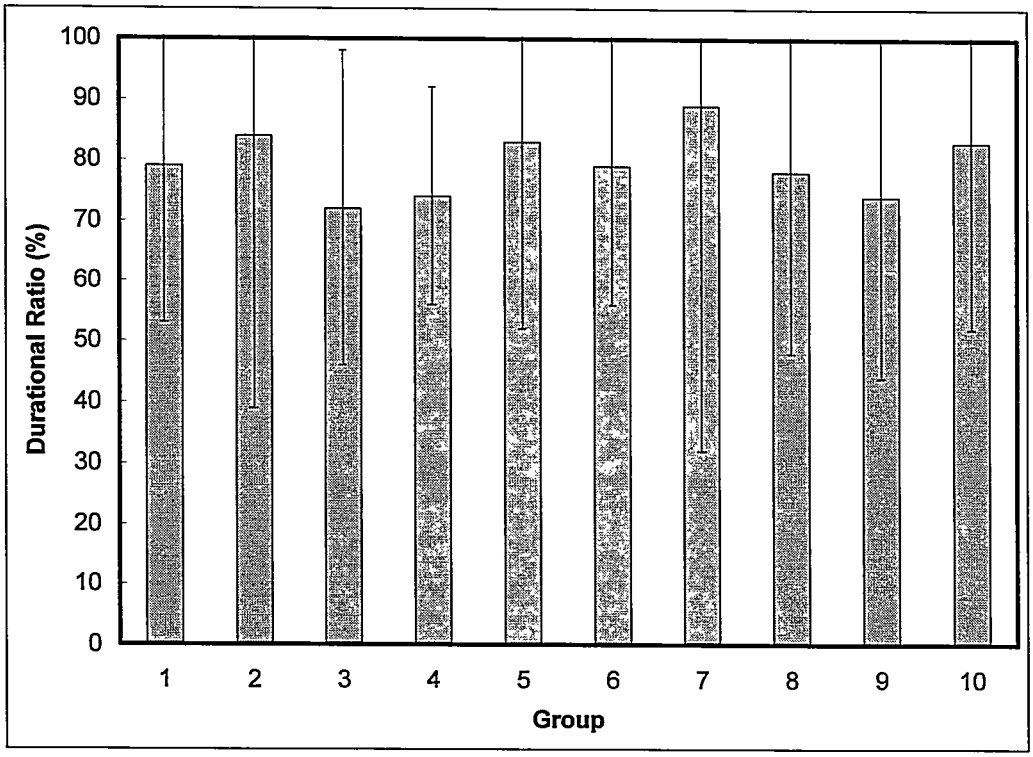

Figure 5.3 The mean durational ratio (%) of vowels in b-V-d to vowels in b-V-t, as produced by different GROUPS

In summary, section 5.1.1 shows that the subjects who arrived in the U.S. before age 11 (GROUP-1) produce the /i/ with lower F1 values and higher F2 values and produce /ɛ/ with lower F2 values, while the groups who live in Korea produce the /i/ with higher F1 values and lower F2 values. In addition, the longer vowel duration and longer distance between /i/ and /ɛ/ are associated with the group who arrived in the U.S.

before age 11. In terms of the number of front vowels, most subjects produce only two front vowels.

5.1.2 The Effect of Non-Linguistic Factors on L1 Pronunciation

To determine the effect each linguistic factor may have on L1 pronunciation, the correlation test and multi-factor ANOVA were performed. On the one hand, numeric variables were employed for the independent variables of the correlation test. On the other hand, to perform the multi-factor ANOVA, the categorized AGE, AOA and LOR were submitted as independent variables.

5.1.2.1 Correlation Test

Table 5.5 illustrates how each of the non-linguistic factors correlated with English pronunciation. All correlation coefficients and probability statistics were determined using Pearsons Correlation coefficients.

Table 5.5 Summary of the correlation test

		AGE	AOA	LOR
F1	r	.022	-.033	.082*
	p	.281	.179	.001
F2	r	.051*	-.013	.060*
	p	.012	.608	.014
Duration	r	.120*	-.087*	.143*
	p	.000	.000	.000
/i/~/ɛ/ distance	r	.051	-.117*	.259*
	p	.150	.006	.000
Voicing Effect	r	-.020	.040	-.099*
	p	.571	.355	.021
/e/~/ɛ/ distance	r	.134*	.120*	.043
	p	.000	.005	.316

* $p<0.05$ level (two-tailed)

The output of the correlation test shows that there is a weak correlation between duration and AGE (r=.120); distance between Korean /e/ and /ɛ/ and AGE (r=.134); distance between Korean /i/ and /ɛ/ and AOA (r= -.117); distance between Korean /e/ and /ɛ/ and AOA (r=.120); the duration and LOR (r=.143); and distance between Korean /i/ and /ɛ/ of the subjects and their LOR (r=.259). On the other hand, in other places, there exists either a very weak correlation or none at all.

5.1.2.2 Multi-factor ANOVA Procedure

This section focuses on the Korean pronunciation of native Korean speakers and categorized non-linguistic factors. Table 5.6 summarizes the mean vowel formants (Hz), duration (ms), the distance between Korean vowels /i/ and /ɛ/ (Hz), the distance between Korean vowels /e/ and /ɛ/ (Hz) and the voicing effect (%), as produced by different AGE, AOA, and LOR groups.

Table 5.6 The mean (and s.d.) vowel formants (Hz), duration, distance between Korean vowels /i/ and /ɛ/, the distance between /e/ and /ɛ/ and the voicing effect, as produced by different AGE, AOA and LOR groups

AGE		**1**	**2**	**3**	**4**
F1 (Hz)	i	278 (19)	289 (29)	285 (37)	283 (37)
	e	440 (79)	493 (102)	521 (105)	470 (129)
	ɛ	483 (85)	509 (100)	528 (100)	565 (90)
F2 (Hz)	i	2092 (186)	2091 (219)	2126 (177)	2120 (195)
	e	1737 (68)	1814 (116)	1794 (137)	1852 (125)
	ɛ	1722 (73)	1807 (127)	1788 (129)	1806 (128)
Duration (ms)	i	52 (12)	53 (42)	52 (24)	73 (26)
	e	76 (22)	73 (45)	80 (31)	89 (28)
	ɛ	73 (19)	71 (43)	77 (27)	92 (26)
/i/ ~ /æ/ (Hz)		441 (142)	396 (168)	442 (155)	445 (129)
/ɛ/~ /æ/ (Hz)		125 (71)	118 (95)	113 (81)	171 (127)
Voicing Effect (%)		80 (26)	79 (32)	82 (43)	71 (16)

Table 5.6 - *Continued*

AOA		1	2	3
F1 (Hz)	i	258 (52)	278 (25)	289 (33)
	e	508 (84)	529 (141)	492 (108)
	ɛ	526 (89)	555 (123)	514 (102)
F2 (Hz)	i	2186 (171)	2158 (192)	2117 (173)
	e	1771 (147)	1832 (129)	1817 (131)
	ɛ	1764 (148)	1822 (129)	1804 (128)
Duration (ms)	i	106 (99)	56 (26)	58 (28)
	e	133 (91)	74 (29)	83 (34)
	ɛ	128 (87)	74 (27)	80 (32)
/i/ ~ /æ/ (Hz)		509 (163)	455 (153)	412 (146)
/ɛ/~ /æ/ (Hz)		90 (59)	128 (97)	127 (98)
Voicing Effect (%)		75 (24)	77 (36)	81 (37)

Table 5.6 - *Continued*

LOR		1	2	3	4	5
F1 (Hz)	i	291 (21)	289 (27)	294 (31)	291 (22)	273 (43)
	e	497 (93)	476 (98)	484 (97)	476 (149)	533 (106)
	ɛ	509 (91)	491 (105)	500 (88)	512 (139)	560 (6)
F2 (Hz)	i	2048 (252)	2095 (162)	2128 (175)	2119 (173)	2152 (184)
	e	1796 (98)	1813 (124)	1815 (145)	1815 (136)	1816 (9)
	ɛ	1792 (119)	1806 (117)	1817 (153)	1788 (106)	1794 (127)
Duration (ms)	i	38 (14)	54 (22)	56 (31)	51 (2)	75 (56)
	e	54 (17)	83 (32)	81 (39)	78 (31)	96 (55)
	ɛ	53 (18)	78 (31)	77 (37)	80 (28)	95 (52)
/i/ ~ /æ/ (Hz)		389 (184)	374 (133)	405 (133)	423 (180)	477 (148)
/ɛ/~ /æ/ (Hz)		111 (91)	116 (92)	120 (94)	151 (113)	123 (92)
Voicing Effect (%)		79 (30)	87 (53)	82 (28)	77 (33)	74 (25)

The results of the multi-factor ANOVA procedure reveal that AGE plays a prominent role in F1, duration and the distance between /e/ and /ɛ/. Likewise, AOA plays a significant role in F1, F2, duration and the distance of Korean vowels /i/ and /ɛ/,

while LOR's role is evident in F1, F2, duration and the distance between /i/ and /ɛ/. Here, the results were considered statistically significant at the 0.05 level. To obtain more information, additional series of ANOVAs (statistically significant at the 0.05 level) for each of the target vowels were conducted treating each non-linguistic factors as the primary independent variable.

- AGE

In terms of the AGE, we can see older subjects produce higher F1 values of /ɛ/, a longer vowel duration and a longer distance between /e/ and /ɛ/ than do younger subjects. In detail, the results of the Bonferroni *post-hoc* test reveal that AGE is a dominant factor in the following outcomes:

1) F1

Regarding /i/, the mean values of F1 of all AGE groups are similar ($p=0.78$). On the other hand, for /e/, the mean F1 of the subjects whose ages are 31 to 40 (AGE-3) is significantly higher than other groups while F1 of those under 21 (AGE-1) is significantly lower than those 31 to 40 (AGE-3) ($p<0.01$). As for /ɛ/, the mean F1 value of subjects over 40 (AGE-4) is significantly higher than the values of those under 30 (AGE-1 and AGE-2) ($p<0.01$).

2) Duration:

For /i/ (($p<0.01$) and /ɛ/ ($p<0.01$), the subjects whose age is over 40 (AGE-4) produce significantly longer vowel durations than those 21 to 30 (AGE-2). On the other hand, there is no significant difference for vowel /e/ ($p=0.11$).

3) Distance between /e/ and /ɛ/

In terms of the distance between /e/ and /ɛ/, the subjects whose ages are over 40 (AGE-4) produce significantly longer distances than those 21 to 40 (AGE-2 and AGE-3) ($p<0.01$). In Figure 5.4, the distances between /e/~/ɛ/ of different groups are represented by plotting F1 against F2. Here, the distance produced by AGE-4 is much longer than those of other groups.

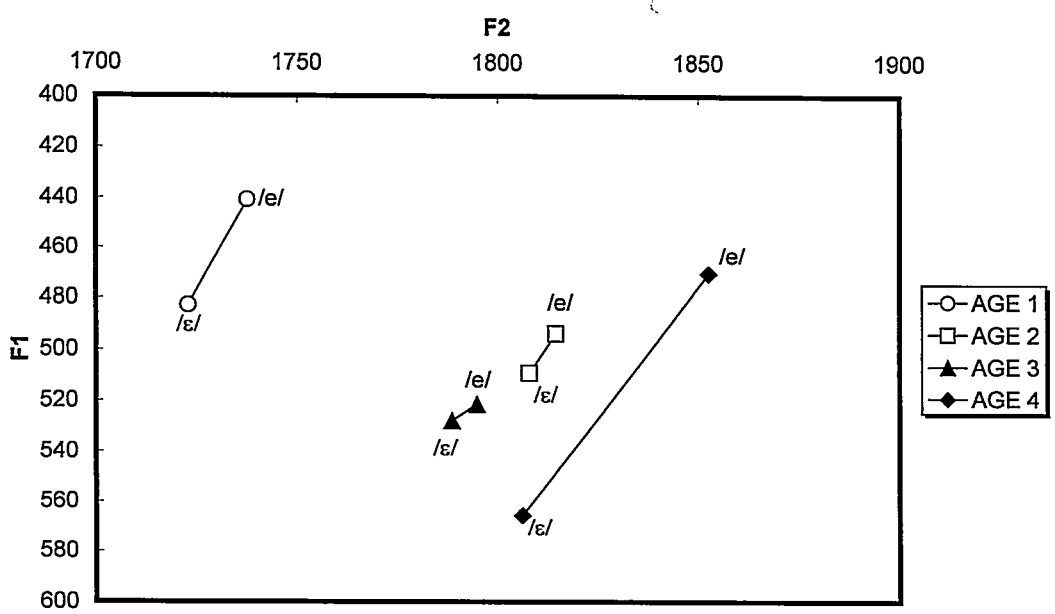

Figure 5.4 The distances between /e/~/ɛ/, as produced by different AGE groups

Such a result confirms Hong's (1991) claim, that, while the older generations tend to distinguish /e/ and /ɛ/, the younger generations do not distinguish these two vowels.

- AOA (age of arrival)

In terms of the AOA, demonstrated in the results are the following findings: Subjects whose AOA is younger produce a lower F1 value of /i/, higher F1 values of /e/ and /ɛ/, a longer vowel duration and a longer distance between /i/ and /ɛ/ than do the subjects whose AOA is higher. In detail, the results of Bonferroni *post-hoc* tests show that AOA plays a significant role in the following behaviors:

1) F1

For /i/, the mean value of F1 of the subjects who arrived in the U.S. less than age 11 (AOA-1) is significantly lower than the other subjects ($p<0.01$). On the other hand, there are no significant differences between the subjects who arrived between the ages of 11 and 17 (AOA-2) and those arrived after age 18 (AOA-3). For /e/ and /ɛ/, there are significant differences in F1 (p of /e/ =0.36; p of /ɛ/=0.13). The mean F1 value of AOA-2 is significantly higher than those of AOA-3.

2) Duration

For vowels /i/ ($p<0.01$), /e/ ($p<0.01$) and /ɛ/ ($p<0.01$), the subjects who arrived in the U.S. before age 11 (AOA-1) produce significantly longer vowel durations than other groups. On the other hand, there is no difference between the subjects who arrived between the ages of 11 and 17 (AOA-2) and those arrived after age 18 (AOA-3).

3) Distance between /i/ and /ɛ/

In terms of the distance between /i/ and /ɛ/, the subjects who arrived in the U.S. less than age 11 (AOA-1) produces a significantly longer distance than in other groups

($p<0.01$). In Figure 5.5, the distances between /i/~/ɛ/ of different groups are represented in an F1 by F2 plot. Here, mean distance produced by AOA-1 is longest.

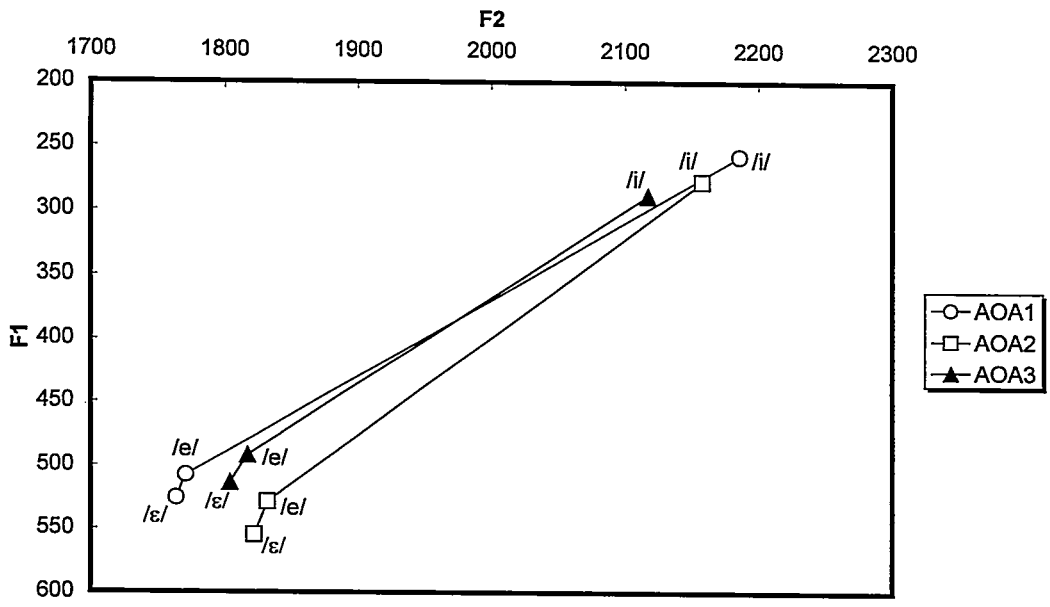

Figure 5.5 The distances between /i/~/ɛ/ produced by different AOA groups

- LOR (length of residence)

The results of Bonferroni *post-hoc* tests show that subjects whose LOR is longer typically manifest a lower F1 value and a higher F2 value of /i/, higher F1 values of /e/ and /ɛ/, a longer vowel duration and longer distance between /i/ and /ɛ/ than do the subjects whose LOR is shorter. In detail, the results show that LOR has a dominant role in the following behaviors:

1) F1

For /i/, the mean value of F1 of the subjects who have lived in the U.S. more than 8 years (LOR-5) is significantly lower than those of other groups ($p<0.01$). On the other hand, there are no significant differences among the subjects who live in Korea (LOR-1), who live in the U.S. for 1 month to 1 year (LOR-2), 1- 5 years (LOR-3) and 5 to 8 years (LOR-4). For /e/ ($p<0.01$) and /ɛ/ ($p<0.01$), the F1 of LOR-5 is significantly higher than other groups.

2) F2

For /i/, the mean value of F2 of the subjects who live in Korea (LOR-1) is significantly lower than those who have lived in the U.S. more than 1 year (LOR-3, LOR-4 and LOR 5), while the values of the subjects who have lived in the U.S. more than 8 years (LOR-5) are significantly higher than those who have lived in the U.S. less than 1 year (LOR-1 and LOR-2) ($p<0.01$). On the other hand, there are no significant F2 differences in vowel /e/ ($p=0.38$) and /ɛ/ ($p=0.29$).

3) Duration:

For vowels /i/ ($p<0.01$), /e/ ($p<0.01$) and /ɛ/ ($p<0.01$), the subjects who have lived in the U.S. more than 8 years (LOR-5) produces a significantly longer vowel duration than other groups, while the subjects who live in Korea produces a significantly shorter duration than other groups. On the other hand, there are no significant differences among LOR-3, LOR-4 and LOR-5 groups.

4) Distance between /i/ and /ɛ/

In terms of the distance between /i/ and /ɛ/, the subjects who have lived in the U.S. more than 8 years (LOR-5) produces a significantly longer distance than other groups ($p<0.01$). In Figure 5.6, the distances between /i/and /ɛ/ of different groups are represented in the F1 by F2 plot and it shows that the distance produced by LOR-5 is the longest.

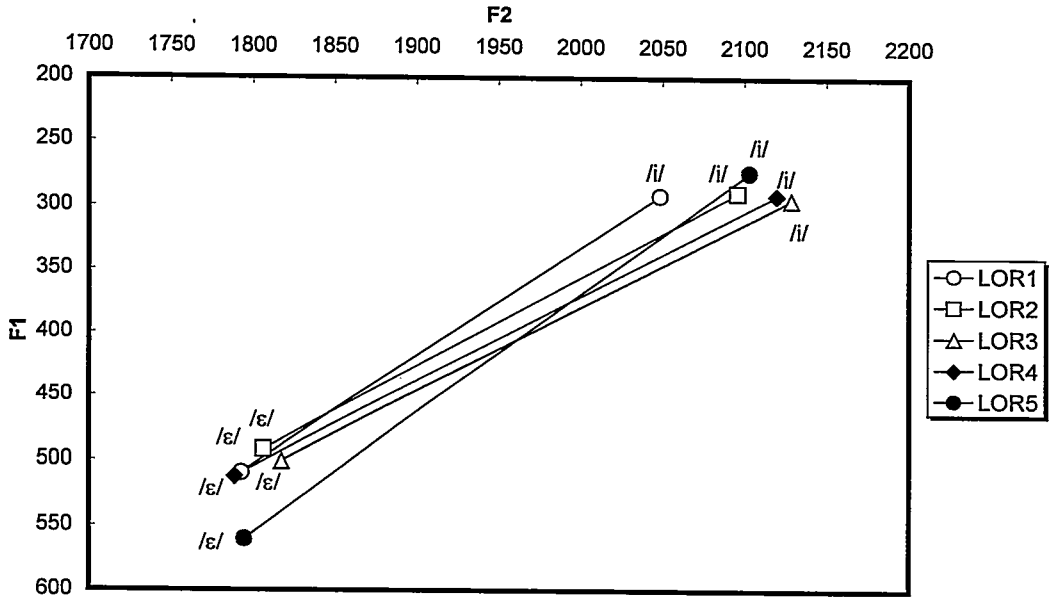

Figure 5.6 The distances between /i/~/ɛ/ produced by different LOR groups

In summary, section 5.1.2 reveals that Korean productions vary, depending on subjects' AGE, AOA and LOR. For instance, the subjects whose age is older, AOA is younger and LOR is longer produce /i/ vowels with lower F1 values or higher F2 values and produce /ɛ/ with higher F1 values or lower F2 values. In addition, subjects whose

AOA is younger or LOR is longer produce a longer duration or a longer distance between /i/ and /ɛ/. We can argue that the longer distance between /e/ and /ɛ/ is associated with the subjects whose AGE is older.

5.2 Comparison to Other Studies

This section compares the various features of Korean vowel production, as produced by the subjects in this study, to the results of previous studies. Section 5.2.1 addresses some of the previous studies, in particular those which have focused on vowel quality. It compares them to the results of this study. While the acoustic space occupied by Korean front vowels is discussed in section 5.2.2, the inherent vowel duration and the lengthening effects are discussed in section 5.2.3.

5.2.1 Vowel Qualities

When we discuss the vowel formants, we should not overlook that the values of vowel formants are affected by the background of the subjects and experimental differences. Hence, the backgrounds of the subjects and the methods of other studies should be considered. A few studies have investigated English vowels as produced by native Korean speakers. However, not all of these studies provided any information on the subject, including the gender of the subjects, likely a factor that significantly affects formant vales. Among the studies that measure the formants of English vowels as produced by native Korean speakers, in this chapter, the formants of four studies that targeted male speakers are compared to the formants of this study.

A pioneer in the field, Han (1963) examined the production of eleven Korean vowels by three native Korean males and one native Korean female. The subjects' ages ranged from 23 to 32. Although they were all born in the vicinity of Seoul, two of them had lived in the United States for two years, one had lived in the United States for one year, and the other had lived in the United States for eight years. To observe the qualities of Korean vowels, the target vowels were embedded in words, then the F1 and F2 vowel formants of eleven vowels were measured and plotted F1 by F2 to compare the acoustic space. The results, including F1 and F2 vowel qualities, are presented in Table 5.7. Even though Han's measurements are relatively less specific than recent studies, since recently a variety of acoustic instruments have been developed, this study is meaningful in that it contributes to the studies of Korean phonetics as the forerunner.

Kahng (1990) measured the Korean vowel production of eight male Korean speakers. In terms of age, he selected four age cohorts: the twenties, thirties, forties and fifties. Each subject was born and raised in Seoul and spoke a Seoul dialect. The subjects were more selective with their occupation, as their occupations were either professors or broadcasting anchors. For spectrographic analysis, the ILS (Interactive Laboratory System) S/W of the computer Sun 3/80 at KAIST (Korean Advanced Institute of Science and Technology) was used. The mean formants of Korean vowels /i e ɛ/ measured in the study are shown in Table 5.7.

Lee (1998) also compared the formants of Korean vowels produced by Korean speakers using Linear Predictive Coding (LPC) analysis. The subjects of his study consisted of three males and three females. They were all university students, spoke

standard Korean and were in their twenties. The target vowels were eight Korean vowels: /이 에 애 아 어 오 우 으/ (/i e ɛ a ʌ o u ɨ/), and were embedded in two environments: isolated vowels, which are pronounced by themselves, and carrier vowels, which are pronounced in given sentences: 이것은 '이'라고 합니다 [iketun 'i'rako hapnita] 'It is called 'i'.' Among the eight vowels, the mean F1 and F2 values of /i e ɛ/, as produced by the male subjects participating in this study, is shown in table 5.7.

This study would be incomplete if we failed to mention Yang's (1996) contribution. Yang measured the quality (F1, F2, F3 and F0) of Korean vowels, as produced by ten Korean males and ten Korean females. All subjects were university students, born and educated in Seoul and speak of standard Korean. The target Korean vowels occurred in a /h__da/ context. The subjects were asked to produce each word at a normal speed and as naturally as possible. The average F1 and F2 values of /i e ɛ/ produced by the male speakers are shown in Table 5.7.

Table 5.7 The F1 and F2 formants (Hz) of Korean vowels /i e ɛ/ of the aforementioned studies

F1

	/i/ (Hz)	/e/ (Hz)	/ɛ/ (Hz)
Han	334	506	604
Kahng	274	439	503
Lee	269	456	476
Yang	343	570	634

F2

	/i/ (Hz)	/e/ (Hz)	/ɛ/ (Hz)
Han	2031	1834	1825
Kahng	2202	1977	1867
Lee	2176	1894	1883
Yang	2517	2173	2067

Based on the above results, we can observe that the F1 and F2 values of Yang's study (1996) are different from those of other studies, in that the F1 values of /e/ and /ɛ/ are higher than the mean values of other studies and the F2 values of all vowels are higher than those of other groups. The reason for such a difference may be explained by the target subjects: the subjects who participated in Yang's study were Koreans who lived in United States, whereas the subjects who participated in other studies were Koreans who lived in Korea.

5.2.2 The Acoustic Space Occupied by the Front Vowels

Even though most previous studies have focused on only the measurement of F1 and F2, the present study has taken into consideration worthy behaviors: the distance between /i/ and /ɛ/ and the distance between /e/ and /ɛ/. The mean F1 and F2 of each vowel in the above studies are plotted on an F1 x F2 chart to show the position of the vowels in the acoustic phonetic vowel space (Figure 5.7). Here, the distances between /i/ and /ɛ/ and that of /e/ and /ɛ/ are observed.

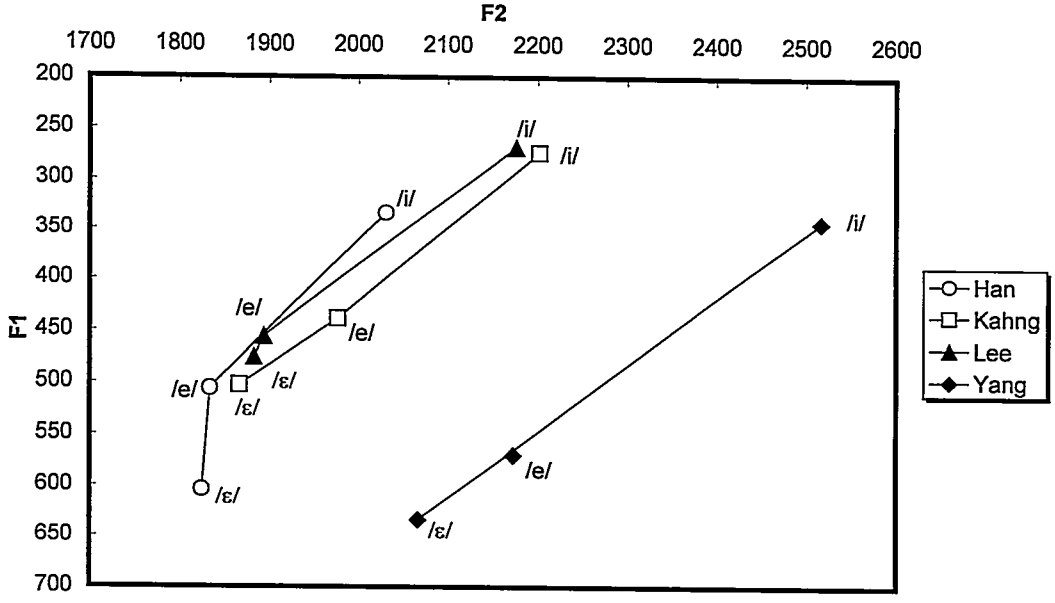

Figure 5.7 The distance between /i/~/ɛ/ and /e/~/ɛ/ of aforementioned studies

In addition, the distances between /i/ and /ɛ/ and distances between /e/ and /ɛ/ are calculated (Table 5.8).

Table 5.8 The distances between /i/~/ɛ/ and /e/~/ɛ/

	Distance between /i/~/ɛ/ (Hz)	Distance between /e/~/ɛ/ (Hz)
Han	339	98
Kahng	405	127
Lee	358	22
Yang	535	123

Based on these calculations, we notice that the distance between /i/ and /ɛ/ produced by the subjects of Yang's study is longer than those of Han, Kahng and Lee's studies. As mentioned above, the major difference between the methodology of Yang's study and other studies is that Yang's subject were people who had been in the United States for more than 3 years, whereas the subjects of other studies had lived only in Korea.

When we compare the methodology of the above studies to the result of the present study, we see that the number of subjects in the present study greatly exceeds the number of those in the other studies. Herein, 91 male Korean speakers participated. They ranged in age from 18 to 50 and spoke standard Korean. While some of them lived in Korea, some have lived in the United States with various lengths of residence. When we compare the results of the aforementioned studies to those of the present study, the Korean production of the subjects whose AOA is earlier and LOR is longer

(GROUP-1, GROUP-2, GROUP-3 and GROUP-4) appears to be similar to that of Yang's study, whereas the Korean production of the subjects who live in Korea (GROUP-8, GROUP-9 and GROUP-10) appears to be similar to Han, Kahng and Lee's studies (Compare Table 5.3 with Table 5.8). For example, the distances between /i/ and /ɛ/ produced by GROUP-1, GROUP-2, GROUP-3 and GROUP-4 are between 400 Hz to 545 Hz, while those of GROUP-8, GROUP-9 and GROUP-10 are 380 Hz to 399 Hz. Thus, we can draw the inference that LOR also affects the production of L1, despite the general belief that L2 affects the L1 of only those people who arrive in the L2 environment when they are young.

5.2.3 Duration Related Issues

According to Yang (1996), the mean duration of Korean vowels is 86 msec. The mean duration produced by the subjects who participated in the present study is similar to the vowel duration of Yang's study. On the other hand, the duration of GROUP-1, who arrived in the United States before 11 years, produces a significantly longer duration than that of the Koreans in Yang's study.

According to the present study, in terms of the ratio of bVd and bVt, the ANOVA did not reveal any significant group differences. Here, the mean ratio of all groups is 79%. Such a result shows that the vowel duration ratio is similar to that reported by Chen (1970): 78%.

5.3 Conclusion

The Korean production of native Korean speakers, according to GROUPS, which are divided into the combination of non-linguistic factors (AOA, LOR and MOTI), was analyzed. Moreover, to understand the effects of each non-linguistic factor, the Korean production was analyzed with AGE, AOA and LOR, separately. The following is the summary of results based on both aforementioned types of analysis. Such a summary answers the research questions raised in the introduction section of chapter 5.

(1) How do native Korean speakers produce Korean vowels in terms of features, including the vowel qualities, the number of vowel categories, the acoustic space occupied, duration, and the degree of voicing-dependent effect of vowel duration?

(2) How do AGE, AOA and LOR affect L1 pronunciation?

The work conducted in this study confirms the previous claim that Korean front vowels tend to be divided into two groups: /i/ and /e ɛ/. Furthermore, this study reveals that not all the subjects manifested an identical L1 vowel production. Rather, the productions are related to non-linguistic factors. For example, the people who arrived in the U.S. before age 11 and have lived here more than 8 years tend to produce Korean /i/ in a higher or more fronted position than others. The people who arrived in the U.S. before age 11 or have lived here more than 5 years produce a longer distance between the highest and lowest front vowels and a longer inherent vowel duration than others. These results suggest that LOR, as well as AOA, in the L2 environment might affect the

L1 production. In addition, the older subjects produce significantly longer vowel durations and longer distances between /e/ and /ɛ/ then others. This result confirms the general belief that an /e/ and /ɛ/ merger is occurring, especially in younger generations.

3) How is the Korean production of native Korean speakers in this study, as well as the production of Korean speakers in other studies, similar and different?

The comparison of several previous studies to the present study shows that, even though the absolute F1 and F2 values produced by Korean speakers in each study are different, the distance between /i/ and /ɛ/, duration and the degree of voicing effect are similar. In addition, it is noted that the results of previous studies that target the people who live in Korea are similar to each other and similar to the result of the subjects who live in Korea in the present study. On the other hand, such results differ from the result of the study that target the subjects who live in the U.S. and differ from the result of the subjects whose LOR is long in this study. These findings support the claim of the present study that, as well as the AOA, LOR also might affect some behaviors of Korean production by Korean speakers.

CHAPTER 6

ENGLISH VOWEL PRODUCTION OF NATIVE KOREAN SPEAKERS

6.0 Introduction

A chief goal of this study is to investigate the characteristics of English vowel production of native speakers of Korean. This chapter provides the results and analysis of the English production of those speakers. In preparation, the following questions were raised: (1) How do native Korean speakers produce English vowels, in terms of such features including vowel qualities, number of vowel categories, acoustic space occupied by vowels, vowel duration and degree of voicing-dependent effect of vowel duration? (2) How do AGE, AOA, LOR and MOTI affect L2 pronunciation? (3) How is the English production of native Korean speakers in this study similar and different from that of Korean speakers in other studies? What factors are responsible for these similarities and differences? And (4) How does the production of English by native speakers of Korean differ from that of native speakers of English?

Section 6.1 addresses research question (1) and (2) by presenting the English production of the subjects in this study and analyzes the production based on the phonetic or phonological linguistic features, including F1, F2, duration, the distance between /i/ and /ɛ/, the distance between /e/ and /ɛ/ and the degree of the voicing-dependent effect of vowel duration. As we shall see, earlier AOA, longer LOR and

higher degree of motivation affect some aspects of the L2 production. Section 6.2 compares these results to the results of previous studies as per research question (3) and then discusses some of the similarities and differences; in the end, the comparison of previous work supports the finding of the study presented in this dissertation. Section 6.3 then compares such results to the production of native English speakers based on previous studies and next Section 7.1 discusses how the Korean production of native Korean speakers and the English production of native English speakers differ.

6.1 English Production of the Subjects in This Study

This section presents the result of the English production of the subjects who participated in the present study. The statistical method of data analysis used in this chapter is quite similar to the one used for the analysis of the Korean production of native Korean speakers in chapter 5. Section 6.1.1 shows the mean F1, F2, duration of English vowels, the number of vowel categories and the acoustic space occupied by the English front vowels and the degree of voicing effect, as produced by different GROUPS. Section 6.1.2 discusses how each AGE, AOA, LOR or MOTI affects L2.

6.1.1 The Production of English Front Vowels, as Produced by Each Subject Group

This section presents the characteristics of the production of five English front vowels /i ɪ e ɛ æ/, as produced by male Korean-speaking subjects categorized as ten groups (chapter 4). The mean values and standard deviation of F1, F2 and vowel duration produced by different groups are represented in Table 6.1.

Table 6.1 The average vowel formants (Hz) and duration (ms) of the English vowels /i ɪ e ɛ æ/ that are based on all /hVd/, /bVd/ and /bVt/ tokens. Group standard deviations appear in parentheses.

- /i/

GROUP	F1 in Hz	F2 in Hz	Duration in ms
1	246 (21)	2357 (78)	167 (53)
2	262 (20)	2117 (171)	97 (31)
3	285 (50)	2232 (195)	155 (49)
4	294 (40)	2385 (61)	140 (30)
5	301 (48)	2275 (184)	132 (41)
6	282 (34)	2212 (131)	123 (37)
7	301 (39)	2154 (155)	110 (46)
8	330 (40)	2138 (182)	83 (33)
9	334 (61)	2126 (161)	74 (17)
10	332 (44)	2192 (154)	94 (41)

- /ɪ/

GROUP	F1 in Hz	F2 in Hz	Duration in ms
1	369 (58)	1875 (130)	126 (31)
2	276 (40)	2065 (150)	83 (18)
3	301 (47)	2189 (198)	121 (39)
4	298 (26)	2365 (75)	114 (37)
5	305 (46)	2255 (176)	110 (31)
6	290 (48)	2172 (102)	93 (29)
7	288 (34)	2158 (142)	95 (36)
8	330 (45)	2106 (156)	72 (24)
9	328 (35)	2159 (147)	72 (18)
10	335 (37)	2151 (253)	87 (52)

Table 6.1 - *Continued*

- /e/

GROUP	F1 in Hz	F2 in Hz	Duration in ms
1	434 (73)	1986 (135)	194 (59)
2	360 (59)	1958 (153)	153 (33)
3	445 (84)	2033 (186)	199 (47)
4	369 (52)	2141 (236)	188 (49)
5	451 (88)	2082 (183)	169 (31)
6	442 (95)	1984 (164)	163 (28)
7	425 (98)	2001 (185)	168 (46)
8	439 (77)	1953 (162)	99 (43)
9	445 (84)	1937 (152)	92 (38)
10	433 (75)	2046 (177)	96 (34)

- /ɛ/

GROUP	F1 in Hz	F2 in Hz	Duration in ms
1	551 (53)	1736 (123)	149 (38)
2	560 (103)	1706 (90)	106 (31)
3	596 (84)	1824 (139)	156 (49)
4	555 (123)	1878 (98)	132 (37)
5	539 (92)	1893 (165)	134 (37)
6	539 (114)	1815 (130)	124 (26)
7	515 (106)	1851 (168)	124 (39)
8	499 (84)	1774 (116)	92 (27)
9	516 (92)	1773 (94)	87 (19)
10	499 (112)	1868 (155)	99 (35)

Table 6.1 - *Continued*

- /æ/

GROUP	F1 in Hz	F2 in Hz	Duration in ms
1	680 (53)	1657 (95)	190 (53)
2	574 (106)	1722 (96)	113 (29)
3	623 (64)	1838 (133)	162 (49)
4	570 (108)	1868 (86)	150 (33)
5	558 (79)	1881 (146)	134 (38)
6	561 (114)	1826 (90)	131 (29)
7	523 (107)	1856 (149)	121 (36)
8	516 (99)	1768 (112)	95 (29)
9	516 (71)	1749 (106)	88 (23)
10	504 (94)	1865 (143)	99 (32)

To determine if there are significant differences among variables, the multi-factor ANOVA was conducted for the GROUP and the kind of vowels as independent factors, and each mean F1 and F2 values and duration as dependent factors. The repetition was treated as a random factor (Table 6.2).

Table 6.2 Summary of the result of the multi-factor ANOVA test for F1, F2 and the duration of English vowels. The bold font marks those factors and interactions with a p-value less than 0.05

Dependent Variable: F1

Source	df	F	Sig.
Group	10	28.380	**.000**
Vowel	4	3311.450	**.000**
Repetition	2	.578	.584
(Group) x (Vowel)	40	32.095	**.000**
(Group) x (Repetition)	20	1.128	.339
(Vowel) x (Repetition)	8	.769	.631
(Group) x (Vowel) x (Repetition)	80	.425	1.000

Dependent Variable: F2

Source	df	F	Sig.
Group	10	73.173	**.000**
Vowel	4	7868.520	**.000**
Repetition	2	1.484	.282
(Group) x (Vowel)	40	20.935	**.000**
(Group) x (Repetition)	20	1.805	**.034**
(Vowel) x (Repetition)	8	.199	.991
(Group) x (Vowel) x (Repetition)	80	.275	1.000

Table 6.2 – *Continued*

Dependent Variable: DURATION

Source	df	F	Sig.
Group	10	239.002	**.000**
Vowel	4	570.635	**.000**
Repetition	2	4.714	**.022**
(Group) x (Vowel)	40	26.844	**.000**
(Group) x (Repetition)	20	3.852	**.000**
(Vowel) x (Repetition)	8	.612	.768
(Group) x (Vowel) x (Repetition)	80	.205	1.000

The results of the multi-factor ANOVA test show that for each of the three dependent variables, F1, F2, and duration, both GROUP and the kind of vowels play a significant role in explaining the variation. The Group by Vowel or Group by Repetition interaction also shows that the effect of GROUP varies, depending on the kind of vowels or repetition.

6.1.1.1 The GROUP Effect Depending on Vowels

In order to obtain more specific information, five additional sets of the one-way ANOVA tests (the significance level was $p<0.05$) were conducted on the five English front vowels. Since the results of the ANOVA show that there are significant differences among GROUPS ($p<0.01$), Bonferroni *post-hoc* tests were conducted to see how F1, F2 and duration differ according to GROUP.

The result shows that the values of F1 and F2 and the duration produced by the subjects who arrived in the U.S. before age 11 (GROUP-1) and the subjects who lived in Korea (GROUP-10) are different from the production of other subjects in the opposite direction. The subjects whose AOA is younger and LOR is longer typically manifest lower F1 value of /i/, higher F1 value and lower F2 value of /æ/ and longer duration. The more detailed findings of the *post-hoc* tests are as follows:

- /i/

The mean F1 value of /i/ produced by the subjects who arrived in the U.S. before age 11 (GROUP-1) is significantly lower than those in other groups and the F1 value of GROUP-2 is significantly lower than those of the subjects who live in Korea (GROUP-8, GROUP-9 and GROUP-10). On the contrary, the mean F1 values of the subjects who live in Korea (GROUP-8, GROUP-9 and GROUP-10) are significantly higher than those of other groups. In terms of F2, the values of GROUP-2, GROUP-9 and GROUP-10 are significantly lower than those of other groups. On the other hand, the F2 values of GROUP-1 and GROUP-4 are a significantly higher than other groups. In terms of duration, the durations of GROUP-1 and GROUP-3 (i.e., the subjects whose LOR is longer than 8 years) are significantly longer than the durations of other groups, while the durations of the subjects who live in Korea (GROUP-8, GROUP-9 and GROUP-10) are significantly shorter than other groups.

- /ɪ/

The mean F1 value of /ɪ/ produced by the subjects who arrived in the U.S. before age 11 (GROUP-1) is significantly higher than other groups, while F2 of GROUP-1 is significantly lower than other groups. The durations of GROUP-1 and GROUP-3 (i.e., the subjects whose LOR is more than 8 years) are significantly longer than other groups, while the durations of the subjects who live in Korea (GROUP-8, GROUP-9 and GROUP-10) are significantly shorter than those of other groups.

- /e/

The mean F1 values produced by GROUP-2 and GROUP-4 are significantly lower than other groups. For F2, the values of GROUP-4 and GROUP-5 are significantly higher than some groups, including GROUP-8 and GROUP-9. The durations of GROUP-1 and GROUP-3 (i.e., the subjects whose LOR is more than 8 years) are significantly longer than the duration of GROUP-8, GROUP-9 and GROUP-10 (i.e., the subjects who live in Korea).

- /ɛ/

The F1 of GROUP-3 is significantly higher than GROUP-5, GROUP-6, GROUP-7, GROUP-8, GROUP-9 and GROUP-10 (i.e., the subjects whose LOR is less than 5 years). In terms of F2, GROUP-1 and GROUP-2 (i.e., the subjects who arrived in the U.S. before age 17) produce lower values than other groups, while GROUP-4 and GROUP-5 produce higher values than other groups. The durations of GROUP-1 and GROUP-3 (i.e., the subjects whose LOR is more than 8 years) are significantly longer

than other groups. The durations of GROUP-8, GROUP-9 and GROUP-10 (i.e., the subjects who live in Korea) are significantly shorter than other groups.

- /æ/

The mean F1 value of the subjects who arrived in the U.S. before age 11 (GROUP-1) is significantly higher than the values of other groups; the value of GROUP-3 is significantly higher than GROUP-5, GROUP-6, GROUP-7, GROUP-8, GROUP-9 and GROUP-10 (i.e., the subjects whose LOR is less than 5 years). The values of GROUP-4, GROUP-5, GROUP-6 and GROUP-7 (i.e., the subjects who live in the U.S. for 1 month to 8 years) are significantly higher than those of GROUP-8, GROUP-9 and GROUP-10 (the subjects who live in Korea). In terms of F2, GROUP-1 and GROUP-2 (i.e., the subjects who arrived in the U.S. before age 17) produce lower values than other groups, while GROUP-4 and GROUP-5 produce higher values than other groups. The duration of GROUP-1 is significantly longer than those of other groups. The duration of GROUP-3 is significantly longer than those of GROUP-5, GROUP-6, GROUP-7, GROUP-8, GROUP-9 and GROUP-10 (i.e., the subjects whose LOR is less than 5 years) and GROUP-2.

6.1.1.2 The Number of Vowel Categories

In order to investigate the number of English front vowels, additional one-way ANOVA tests were conducted for the ten GROUPS. Since the result of the ANOVA shows that there are significant differences among the groups ($p<0.01$), *post-hoc* tests were conducted.

- ***F1***

Since the result of the one-way ANOVA test shows that there are significant differences in the F1 values of each vowel, two *post-hoc* tests, Bonferroni and Tukey HSD Procedure, were employed. The results of the *post-hoc* tests show that in GROUP-1 (the subjects who arrived in the U.S. before age 11), the F1 values of English front vowels are divided into five groups. In GROUP-3, the English front vowels are divided into four groups: /i ɪ/, /e/, /ɛ/ and /æ/. In GROUP-4, GROUP-5, GROUP-6, GROUP-7, GROUP-8, GROUP-9 and GROUP-10 (i.e., the subjects whose LOR is less than 8 years) and GROUP-2, the vowels are divided into three groups: high vowel /i ɪ/, mid vowels /e/ and low vowel /ɛ æ/. Except for GROUP-1, consisting of those who came to the U.S. before age 11 and had lived in the U.S. for more than 8 years and whose degree of motivation is above average, the F1 values of /i/ and /ɪ/ are not much different from all the groups. In addition, /e/ and /æ/ do not show a significant difference in most groups except for GROUP-1 and GROUP-3 (i.e., the subjects whose LOR is more than 8 years). Here, in terms of /e/, it cannot be ignored that the reason that Korean speakers pronounce the /e/ vowel distinctly with /ɛ/ or /æ/ may be that the /e/ vowel is produced as a diphthong and affected by the following /i/ vowel.

- ***F2***

The result of the *post-hoc* test shows that the F2 value of the English front vowels produced by the subjects who arrived in the U.S. before age 11 (GROUP-1) are divided into five groups. In other groups, these vowels are divided into three groups: high vowels /i ɪ/, mid vowels /e/ and low vowels /ɛ æ/. As for F2, except for GROUP-1,

the values of /i/ and /ɪ/, as well as /ɛ/ and /æ/, do not show a significant difference in all groups.

The mean F1 and F2 of each vowel, as produced by each GROUP, are plotted on an F1 x F2 chart to show the position of the vowels in the acoustic phonetic vowel space. Figure 6.1 and Figure 6.2 are examples of the English production of native Korean speakers (GROUP-1 and GROUP-10). Here, it is visually noticeable that the subjects in GROUP-1 who arrived in the U.S. before age 11 and whose LOR is longer than 8 years distinguish /i/ from /ɪ/ and /ɛ/ from /æ/, whereas the subjects in GROUP-10 who live in Korea fail to distinguish these vowels.

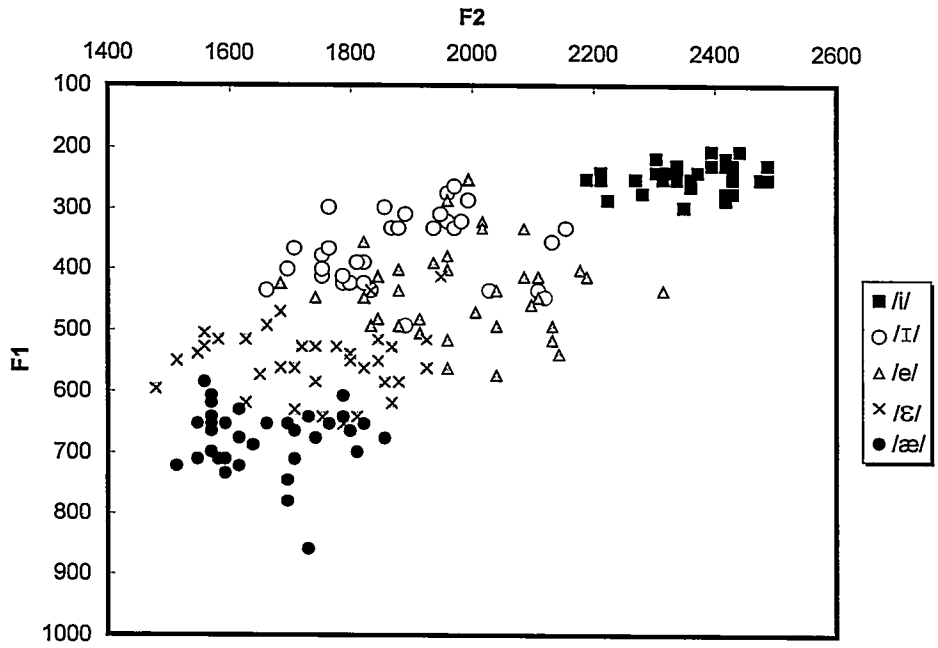

Figure 6.1 The production of English front vowels of GROUP-1

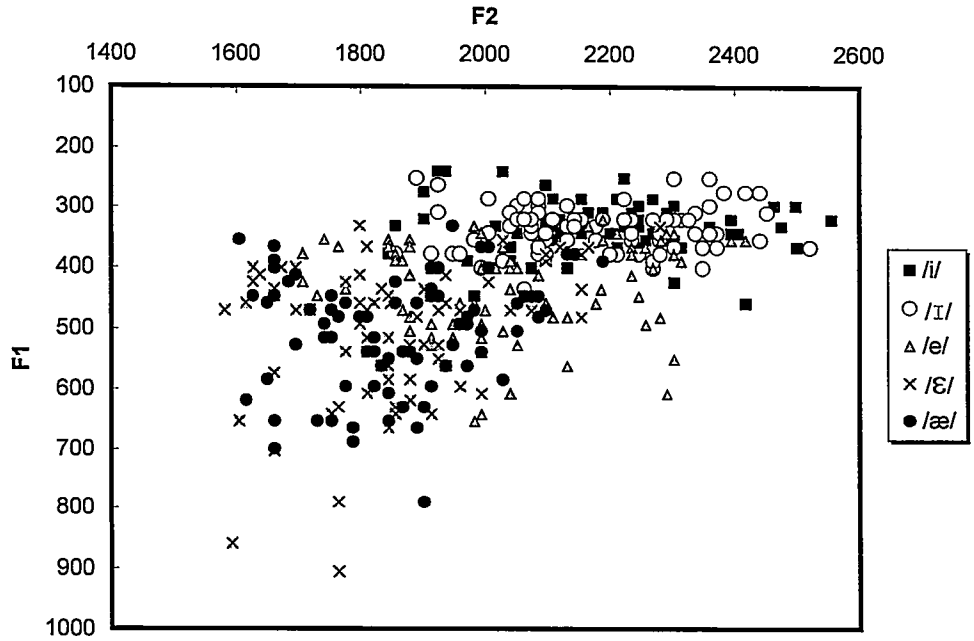

Figure 6.2 The production of English front vowels of GROUP-10

6.1.1.3 The Acoustic Space Occupied by the Front Vowels

The distance between the highest front vowel /i/ and lowest front vowel /æ/ was shown in section 5.1.1.3. The values of the mean and standard deviation of the distance, as produced by ten groups, are presented in Table 6.3. The ANOVA test was conducted and the result reveals that there are significant differences among groups ($p<0.01$). Subsequent Bonferroni *post-hoc* test shows that the distance of the subjects who arrived in the U.S. before age 11 (GROUP-1) is significantly longer than other groups; the distances of GROUP-3 and GROUP-4 (i.e., the subjects who arrived in the U.S. after age 18 and have lived there for more than 5 years) are significantly longer than GROUP-7, GROUP-8, GROUP-9 and GROUP-10 (i.e., the subjects whose LOR is less than 1 year). That is, longer distance is associated with subjects whose AOA is younger and LOR is longer.

Table 6.3. The mean and standard deviation of the distance between /i/~/æ/, as produced by ten groups

Groups	Mean (Hz)	Std. Deviation
1	825	106
2	511	162
3	533	159
4	591	117
5	486	133
6	495	125
7	390	146
8	424	177
9	410	148
10	383	141

These values will be compared to the distance of native English speakers in section 6.3.

In addition to the distance between the highest vowel /i/ and the lowest vowel /æ/, the distance between the lowest front vowels /ɛ/ and /æ/ was calculated. The means and standard deviations of the distances, as produced by ten groups, are presented in Table 6.4. The ANOVA test reveals that there are significant differences among groups ($p<0.01$). Subsequent Bonferroni *post-hoc* test shows that the distance produced by the subjects in GROUP-1 who arrived in the U.S. before age 11 is significantly longer than those of other groups. On the other hand, there are no differences among other groups.

Table 6.4 The mean and standard deviation between the distances between /ɛ/~/æ/, as produced by ten groups

GROUP	Mean (Hz)	Std. Deviation
1	168	74
2	125	92
3	106	81
4	92	71
5	105	64
6	111	85
7	107	77
8	97	69
9	117	88
10	93	77

6.1.1.4 Vowel Duration

Table 6.5 and Figure 6.3 show the mean duration of five English front vowels, as produced by the ten groups of subjects.

Table 6.5 The mean durations of five English front vowels as produced by ten groups

GROUP	Mean (ms)	Std. Deviation
1	165	54
2	110	37
3	159	53
4	145	44
5	136	41
6	127	37
7	123	48
8	88	33
9	83	25
10	95	39

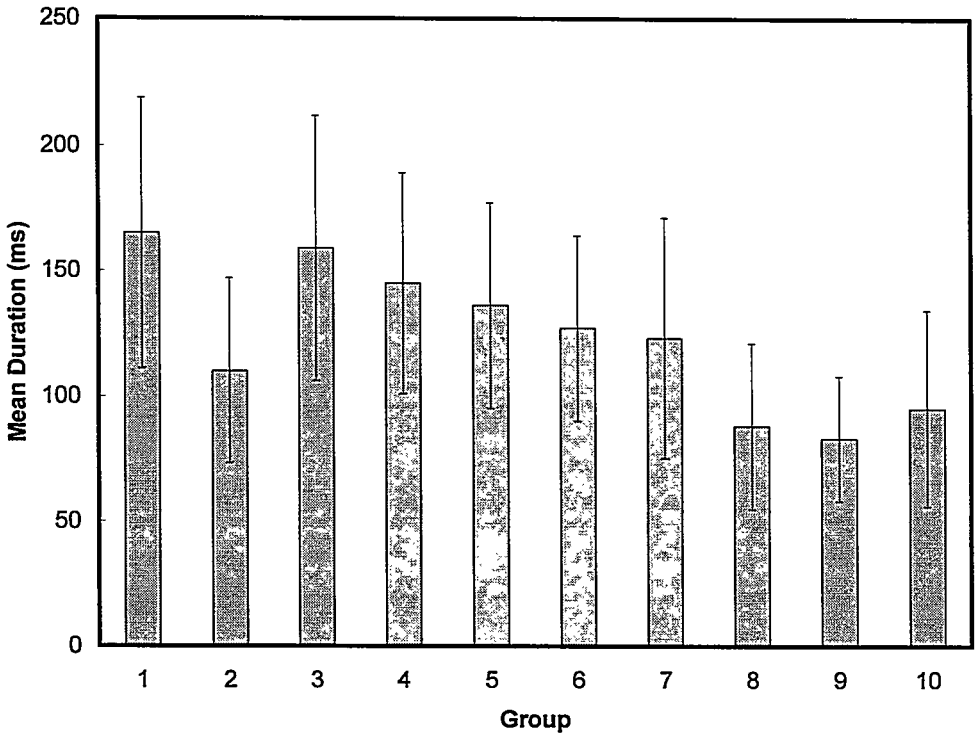

Figure 6.3 The mean durations of five English front vowels as produced by each group

The result of the ANOVA test shows that there is a significant durational difference among groups ($p<0.01$). The durations of GROUP-1 and GROUP-3 (i.e., the subjects whose LOR is more than 8 years) are significantly longer than those of other groups, while the durations of GROUP-8, GROUP-9 and GROUP-10 (the subjects who live in Korea) are significantly shorter than those of other groups. There are significant differences among other groups also. For example, the duration of GROUP-4 is significantly longer than those of GROUP-6, GROUP-7, GROUP-8, GROUP-9 and GROUP-10 (i.e., the subjects whose LOR is less than 5 years). That is, a longer vowel duration is associated with subjects whose AOA is earlier and LOR is longer.

In addition, there are significant differences in the duration of each vowel ($p<0.01$). Once again, a *post-hoc* test was employed. The result of the *post-hoc* test shows that in GROUP-1 (the subjects who arrived in the U.S. before age 11), the durations of /ɪ/ and /ɛ/ vowels are significantly shorter than other vowels. GROUP-2 (the subjects who arrived in the U.S. between ages 11 to 17) produces vowels /i/ and /ɪ/ with a shorter duration than other vowels, while it produces the /e/ vowel with a significantly longer duration than other vowels. GROUP-3, GROUP-4, GROUP-5, GROUP-6 and GROUP-7 (i.e., the subjects who arrived in the U.S. after 18 years and have lived for more than 1 month to 1 year) produce /ɪ/ with a significantly shorter duration than that of other vowels, while it produces the /e/ vowel with a significantly longer duration. GROUP-8 and GROUP-9 produces /i/ and /ɪ/ vowels with significantly shorter durations than other vowels. On the other hand, GROUP-10 produces all the vowels with a similar vowel duration.

6.1.1.5 The Lengthening Effects Based on the Voicing of a Following Consonant

The durational ratios of vowels in the pre-voiceless context to vowels in the pre-voiced context were measured. Table 6.6 illustrates the vowel durational ratios for each GROUP.

Table 6.6 The mean durational ratio (%) of vowels in b-V-d to vowels in b-V-t, as produced by different GROUPS

GROUP	Mean (%)	Std. Deviation
1	71	14
2	74	14
3	75	22
4	84	14
5	79	19
6	81	17
7	86	30
8	83	25
9	92	29
10	82	24

To yield more specific information, an ANOVA test was conducted. The test revealed that there is a statistically significant relationship between a subject's GROUP and the durational ratio ($p<0.01$). The *post-hoc* tests show that the ratios of GROUP-1, GROUP-2 and GROUP-3 (i.e., the subjects who arrived in the U.S. before age 17 or whose LOR is more than 5 years) are significantly lower than the values of GROUP-7, GROUP-8, GROUP-9 and GROUP-10 (i.e., whose LOR is shorter than 1 year). That is, lower ratios are associated with subjects whose AOA is lower and LOR is longer (Figure 6.4).

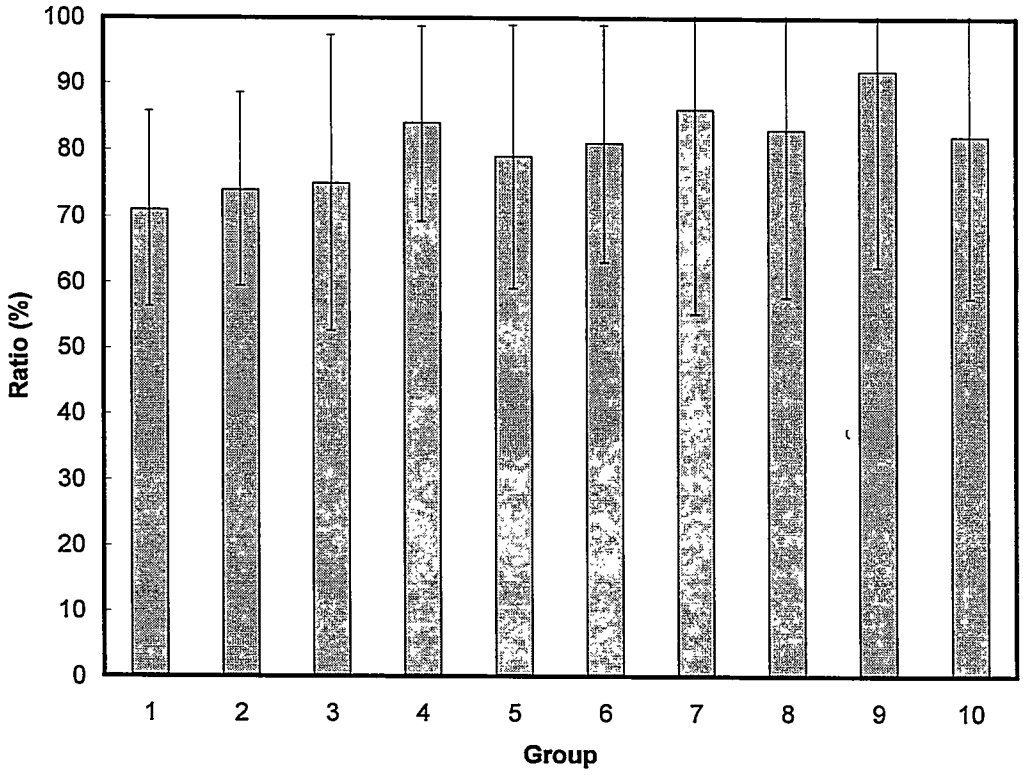

Figure 6.4. Durational ratios (%) of vowels in the prevoiceless context to vowel in the prevoiced context

6.1.2 The Effect of Each Non-linguistic Factor on L1 Pronunciation

To determine the effect of separate non-linguistic factors, such as AGE, AOA, LOR and MOTI, which may affect the L1 pronunciation, the correlation test and multi-factor ANOVA test were performed. For the correlation test, the independent variables were numeric variables of non-linguistic factors. On the other hand, to perform the ANOVA test, the values were categorized as shown in Chapter 4.

6.1.2.1 Correlation Test

This section focuses on the relationship between the English production of native Korean speakers and numeric independent variables, such as year of birth, age arrived in the U.S., length of residence and the score of the degree of motivation. This section also investigates the relationship between the English production of native Koreans and independent factors related to motivation, such as degree of the instrumental motivation and integrated motivation and the amount of time of listening to and speaking English.

Table 6.7 shows how each of the non-linguistic factors correlate with English pronunciation. All correlation coefficients and probability statistics were determined using Pearson Correlation Coefficients. The outputs of the correlation test show a pattern of relationships between some features of the English production of the subjects and AGE, AOA and LOR. On the contrary, there is less of a relationship between English production and MOTI. For example, in terms of the duration of vowels, the r-value of AGE and LOR are 0.237 and 0.215, respectively; these values indicate a weak-positive relationship between the duration and AGE and the duration and LOR. In terms of the distance between /i/ and /æ/, the r-value of AOA and LOR are 0.362 and 0.408, respectively; these values indicate that there are relatively weak to moderate relationships between the distance between the highest and lowest front vowels and AOA and the distance between the highest and lowest front vowels and LOR. In this situation, the correlation is significant because the p-values are all less than 0.01.

Table 6.7 Summary of the correlation test on English production and non-linguistic factors, AGE, AOA, LOR and MOTI

		AGE	AOA	LOR	MOTI
F1	r	.006	.077*	.101*	.002
	p	.685	.000	.000	.897
F2	r	.093*	.122*	.039*	.007
	p	.000	.000	.042	.635
Duration	r	.237*	.027	.215*	.061*
	p	.000	.152	.000	.000
/i/ ~ /æ/ distance	r	.018	.362*	.408*	.007
	p	.619	.000	.000	.837
/ɛ/ ~ /æ/ distance	r	.045	.140*	.029	.047
	p	.315	.031	.652	.295
Voicing effect	r	.066	.236*	.134*	.043
	p	.016	.000	.000	.115

* $p<0.05$ level (two-tailed).

In terms of the motivation, as mentioned in section 4.1.2, the degree of the motivation is based on four self-analysis questions to measure the strength of concern, strength of effort, degree of instrumental motivation and the degree of integrated motivation. Seventy three percent of the subjects rate the same score for the degree of instrumental and integrated motivations. Fifteen percent of the subjects rate higher for instrumental motivation than for integrated motivation, while twelve percent of the

people rate higher for integrated motivation. Table 6.8 shows that the relationship between the dependent variables and integrated motivation or the dependent variables and instrument motivation is either very weak or non-existent. Even though Gardner and Lambert (1972) claim that integrative motivation is associated more with L2 learning, the present study cannot agree with them: no differences between the integrated and instrumental motivation were found. With regard to the time spent listening to and speaking English, there is a significant relationship between these factors and duration and the distance between /i/ and /æ/: the r-value of listening to and speaking are 0.335 and 0.373, respectively. In terms of the distance between /i/ and /æ/, the r-value of the time spent listening to and speaking English are 0.382, and 0.318, respectively. These values indicate a weak to moderately positive relationship between duration and the distance between /i/ and /æ/ and the time spent listening to and speaking English.

Table 6.8 Summary of the correlation test on English production and non-linguistic factors, MOTI (average), instrumental motivation, integrated motivation and time spent listening to and speaking English

		MOTI			Listening	Speaking
		average	**instrumental**	**integrated**		
F1	r	.002	-.020	-.020	.069*	.040*
	p	.897	.206	.200	.000	.011
F2	r	.007	.019	.013	.029	.007
	p	.635	.231	.410	.068	.661
Duration	r	.061*	.075*	.044*	.373*	.335*
	p	.000	.000	.006	.000	.000
/i/ ~ /æ/ distance	r	.007	.065	.045	.318*	.381*
	p	.837	.064	.208	.000	.000
/ɛ/ ~ /æ/ distance	r	.005	-.021	.015	-.164*	-.146*
	p	.867	.444	.588	.000	.000
Voicing effect	r	.047	.067	.073	.023	-.016
	p	.295	.138	.107	.614	.723

* $p<0.05$ level (two-tailed).

6.1.2.2 Multi-factor ANOVA Procedure

This section focuses on the English pronunciation of native Korean speakers and categorized non-linguistic factors. Table 6.9 summarizes the mean vowel formants (Hz), duration (ms), distance of Korean vowels /i/ and /ɛ/ (Hz), distance of /ɛ/ and /æ/ (Hz) and voicing effect, as produced by different AGE, AOA, LOR and MOTI groups.

Table 6.9 The production (mean) of the English vowels, as produced by different AGE, AOA, LOR and MOTI groups. Group standard deviations appear in parentheses.

AGE		**1**	**2**	**3**	**4**
F1 (Hz)	i	284 (42)	309 (50)	283 (41)	299 (57)
	ɪ	337 (62)	318 (51)	307 (46)	298 (47)
	e	385 (64)	439 (86)	424 (81)	442 (90)
	ɛ	483 (95)	529 (101)	558 (92)	552 (101)
	æ	561 (129)	545 (103)	589 (96)	570 (59)
F2 (Hz)	i	2253 (65)	2184 (186)	2269 (175)	2237 (225)
	ɪ	2051 (229)	2143 (190)	2175 (194)	2253 (215)
	e	1972 (137)	2004 (174)	2048 (200)	2012 (227)
	ɛ	1725 (134)	1825 (151)	1819 (140)	1840 (156)
	æ	1731 (134)	1820 (140)	1811 (130)	1849 (155)
Duration (ms)	i	111 (35)	108 (48)	133 (46)	149 (52)
	ɪ	92 (19)	92 (40)	105 (35)	125 (36)
	e	149 (34)	140 (59)	176 (49)	198 (56)
	ɛ	115 (27)	114 (42)	135 (39)	158 (54)
	æ	122 (29)	117 (46)	146 (43)	156 (53)
/i/ ~ /æ/	(Hz)	602 (172)	450 (179)	565 (184)	493 (182)
/ɛ/~ /æ/	(Hz)	98 (67)	106 (76)	100 (79)	115 (75)
Voicing Effect	(%)	71 (16)	80 (25)	81 (19)	80 (24)

Table 6.9 - *Continued*

AOA		1	2	3
F1 (Hz)	i	243 (21)	269 (32)	293 (44)
	ɪ	369 (61)	323 (71)	296 (42)
	e	430 (75)	402 (83)	435 (90)
	ɛ	559 (57)	592 (87)	547 (102)
	æ	680 (49)	623 (85)	565 (97)
F2 (Hz)	i	2342 (77)	2250 (292)	2231 (172)
	ɪ	1870 (121)	2079 (251)	2210 (165)
	e	1995 (160)	2044 (188)	2035 (192)
	ɛ	1754 (126)	1753 (117)	1850 (157)
	æ	1681 (100)	1767 (110)	1851 (139)
Duration (ms)	i	174 (52)	113 (37)	132 (47)
	ɪ	133 (39)	91 (23)	107 (36)
	e	202 (59)	167 (38)	180 (46)
	ɛ	158 (47)	123 (41)	137 (41)
	æ	195 (55)	129 (38)	140 (43)
/i/ ~ /æ/ (Hz)		795 (115)	616 (225)	484 (159)
/ɛ/~ /æ/ (Hz)		160 (83)	114 (85)	105 (75)
Voicing Effect (%)		68 (15)	76 (17)	80 (23)

Table 6.9 - *Continued*

LOR		1	2	3	4	5
F1 (Hz)	i	331 (46)	299 (38)	297 (45)	280 (34)	271 (45)
	ɪ	331 (40)	288 (35)	301 (46)	293 (46)	325 (63)
	e	439 (78)	428 (96)	443 (90)	380 (69)	441 (81)
	ɛ	503 (95)	522 (105)	535 (99)	546 (103)	592 (75)
	æ	512 (92)	532 (104)	555 (93)	562 (97)	644 (60)
F2 (Hz)	i	2152 (171)	2180 (164)	2253 (165)	2295 (255)	2258 (179)
	ɪ	2131 (191)	2180 (147)	2227 (155)	2232 (239)	2085 (219)
	e	1978 (170)	2025 (188)	2050 (183)	2035 (224)	2023 (182)
	ɛ	1802 (132)	1875 (170)	1847 (169)	1805 (120)	1795 (133)
	æ	1794 (130)	1875 (148)	1844 (144)	1808 (113)	1788 (135)
Duration (ms)	i	84 (34)	114 (49)	130 (39)	122 (40)	154 (49)
	ɪ	76 (35)	97 (37)	105 (32)	95 (29)	121 (38)
	e	97 (39)	176 (53)	170 (33)	167 (45)	195 (48)
	ɛ	93 (29)	127 (41)	131 (33)	127 (41)	152 (47)
	æ	95 (29)	127 (43)	134 (35)	134 (38)	166 (51)
/i/ ~ /æ/ (Hz)		409 (162)	401 (145)	503 (140)	573 (226)	613 (181)
/ɛ/~ /æ/ (Hz)		100 (76)	107 (79)	107 (72)	101 (77)	120 (83)
Voicing Effect (%)		85 (26)	84 (30)	80 (18)	75 (16)	75 (20)

Table 6.9 - *Continued*

MOTI		1	2	3
F1 (Hz)	i	305 (44)	313 (62)	297 (48)
	ɪ	317 (53)	324 (46)	310 (50)
	e	428 (82)	435 (81)	435 (87)
	ɛ	521 (108)	528 (89)	545 (97)
	æ	536 (104)	539 (89)	572 (101)
F2 (Hz)	i	2231 (193)	2171 (145)	2215 (189)
	ɪ	2175 (222)	2139 (159)	2151 (192)
	e	2036 (182)	1960 (172)	2016 (182)
	ɛ	1847 (149)	1776 (120)	1819 (151)
	æ	1846 (127)	1754 (119)	1817 (144)
Duration (ms)	i	106 (47)	107 (50)	124 (49)
	ɪ	87 (41)	94 (41)	102 (36)
	e	137 (57)	139 (69)	163 (56)
	ɛ	113 (41)	116 (48)	128 (43)
	æ	116 (44)	121 (53)	134 (47)
/i/ ~ /æ/ (Hz)		466 (183)	477 (186)	499 (189)
/ɛ/~ /æ/ (Hz)		97 (78)	111 (83)	110 (77)
Voicing Effect (%)		81 (23)	84 (26)	79 (23)

The results of the multi-factor ANOVA procedure reveal that AGE plays a significant role for F1 ($p=0.03$), F2 ($p<0.01$), duration ($p<0.01$) and the distance between highest vowel and lowest vowel ($p<0.01$). AOA plays a significant role in the F1 ($p<0.01$), the F2 ($p<0.01$), the duration ($p<0.01$), the distance between highest vowel and lowest vowel ($p<0.01$), the distance between /ɛ/~/æ/ ($p<0.01$) and the voicing effect ($p<0.01$). LOR plays a significant role in the F1 ($p<0.01$), F2 ($p<0.01$), the duration ($p<0.01$), the distance between highest vowel and lowest vowel ($p<0.01$) and the voicing effect ($p<0.01$). On the other hand, MOTI plays a significant role only in duration.

To obtain more information, additional series of the ANOVA and *post-hoc* tests for each of the target vowels, treating each non-linguistic factor as the primary independent variable, were conducted.

- **AGE**

With regard to AGE, the *post-hoc* tests show that the older subjects produce /ɪ/ with lower F1 value and higher F2 value, /ɛ/ and /æ/ with higher F2 values, and all English front vowels with longer durations. In detail, the results show that AGE plays a significant role, as follows:

1) F1:

For /ɪ/, the mean values of F1 of each AGE group are significantly different, in that the F1 of the subjects who are younger than age 30 (AGE-1 and AGE-2) are significantly higher than those of the subjects who are older than age 30 (AGE-3 and

AGE-4). There are no significant differences between AGE-1 and AGE-2 or AGE–3 and AGE–4. For tense /i/ and /e/, the F1 values of AGE-2 is significantly higher than the values of AGE–3. For /ɛ/, the F1 values of AGE-1 (the subjects who are younger than age 20) produce significantly lower values than the values of other groups. On the other hand, the values of /æ/ are similar among other groups.

2) F2

For lax /ɪ/, the F2 value of AGE–1 (the subjects who are younger than age 20) is significantly lower than the values of AGE-3 and AGE-4 (the subjects who are older than age 30); the value of AGE–2 is significantly lower than that of AGE-4. For tense /i/ and /e/, there are no significant differences among other groups. For the F2 values of /ɛ/, the value of AGE-1 is significantly lower than AGE-3 and AGE-4. For /æ/, as produced by AGE-1, the value is significantly lower than those values of other groups.

3) Duration

For lax /ɪ/, the duration of AGE–4 (the subjects who are older than age 40) is significantly longer than those of other groups. On the other hand, there is no significant difference among other groups. For /i e æ/, the durations of AGE–1 and AGE–2 (the subjects who are younger than age 30) are shorter than the duration of AGE–3 and AGE–4 (the subjects who are older than age 30). The durations of /ɛ/ of AGE-1 and AGE-2 are significantly shorter than the duration of AGE-3 and AGE-4 and that of AGE-4 is significantly longer than other groups.

4) Distance between /i/ and /æ/

The distances of AGE–1 and AGE-3 are significantly longer than that of AGE-2 group.

- **AOA (age of arrival)**

With regard to AOA, subjects who arrived in the U.S. earlier produce a higher F1 and lower F2 values of /ɪ/ and /æ/, a lower F1 and a higher F2 of /i/, a longer duration, a longer distance between /i/ and /æ/ and a longer distance between /ɛ/ and /æ/. The more detailed summary of results of ANOVAs and the *post-hoc* test are as follows:

1) F1:

For /ɪ/ and /æ/, the mean values of F1 of each AOA group are significantly different, in that the F1 of the subjects who arrived in the U.S. before age 11 (AOA-1) is significantly higher than other groups and that of the subjects who arrived in the U.S. after age 18 (AOA-3) is significantly lower than that of other groups. For /i/, the F1 value of AOA-1 (the subjects who arrived in the U.S. before age 11) is significantly lower than other groups, while that of AOA-3 (the subjects who arrived in the U.S. after age 18) is significantly higher than other groups. On the other hand, for /e/, there are no significant differences among AOA groups. In addition, for /ɛ/, the subjects who arrived in the U.S. between the aged of 11 and 17 (AOA-2) produce significantly higher F1 values than those of the subjects who arrived in the U.S. after age 18 (AOA-3).

2) F2

For /ɪ/ and /æ/, the mean values of F2 of each AOA group are significantly different, in that the F1 values of the subjects who arrived in the U.S. before age 11 (AOA-1) are significantly lower than other groups and those of the subjects who arrived in the U.S. after age 18 (AOA-3) are significantly higher than those of other groups. For /i/, the F2 value of AOA-1 is significantly higher than other groups. AOA-3 produces a significantly higher F2 for /ɛ/. On the other hand, for /e/, there are no significant differences among AOA groups.

3) Duration

For all vowels, /i ɪ e ɛ æ/, the durations of the subjects who arrived in the U.S. before age 11 (AOA-1) are significantly longer than those of other groups.

4) Distance between /i/ and /æ/

The mean distance of the subjects who arrive in the U.S. between the ages of 11 and 17 (AOA-2) is significantly longer than that of the subjects who arrived in the U.S. after age 18 (AOA-3) and significantly shorter than that of the subjects who arrived in the U.S. before age 11 (AOA-1). Such a finding can be visually confirmed in Figure 6.5.

5) Distance between /ɛ/ and /æ/

The mean distance of the subjects who arrived in the U.S. before age11 (AOA-1) is significantly longer than other groups. In Figure 6.5, the distances between /ɛ/~/æ/,

as produced by different groups are represented in an F1 by F2 plot. Here, one can notice that the mean distance of the AOA-1 is much longer that those of other groups.

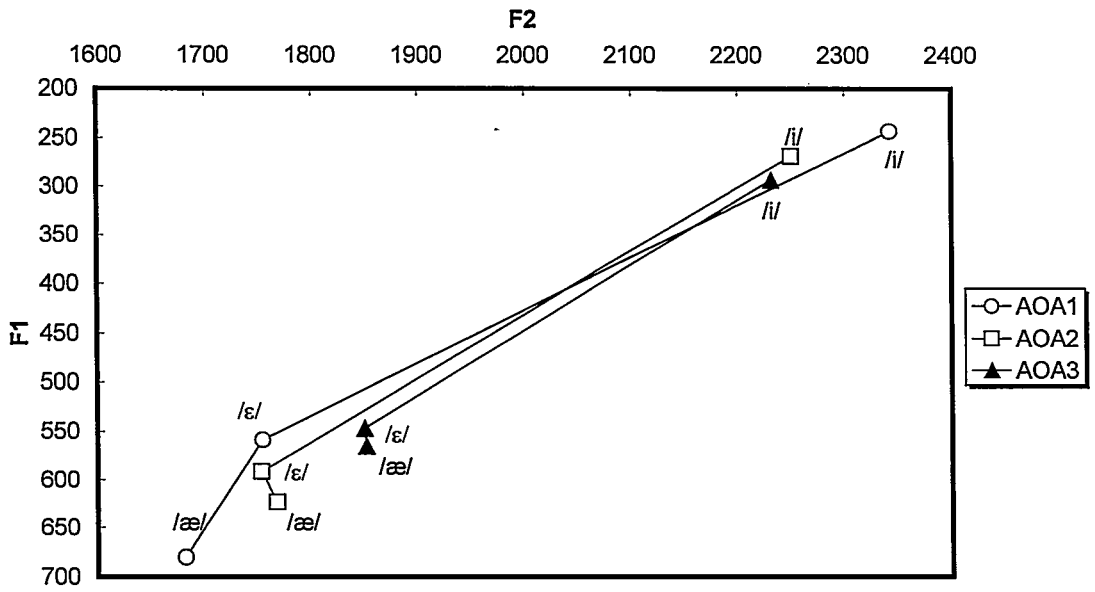

Figure 6.5 The distances between /i/~/æ/, as produced by different AOA groups

6) Voicing effect

The mean ratio of b-V-t to b-V-d of the subjects who arrived in the U.S. before age 11 (AOA-1) is significantly lower than that of other groups. It means that AOA-1 produces more voicing dependent effects than other groups.

- **LOR (length of residence)**

In terms of the LOR, the subjects whose LOR is longer produce lower F1 and higher F2 values for /i/, higher F2 values for /ɛ/ and /æ/, a longer duration, a longer distance between /i/ and /æ/ and a higher degree of voicing effect. The more detailed results of the ANOVAs and the *post-hoc* test are as follows:

1) F1:

For /ɪ/, the subjects who live in Korea (LOR-1) and the subjects whose LOR is longer than 8 years (LOR-5) produce significantly higher values than other groups. For /i/, LOR-5 produces significantly lower F1 values than LOR-1 (LOR=0), LOR-2 (LOR= 1 month to 1 year) and LOR 3 (LOR=1 to 5 years); the F1 value of LOR-4 (LOR=5 to 8 years) is significantly higher than those of LOR-1 and LOR-2, while LOR-1 produces a significantly lower F1 value than those of other groups. The F1 of /e/ produced by LOR-4 is significantly lower than those of other groups. The F1 values of /ɛ/ and /æ/ vowels produced by LOR-1 are significantly lower than those of LOR-3, LOR-4 and LOR-5, while those produced by LOR-5 are significantly higher than those of other groups. On the other hand, there are no significant differences among the groups, LOR-2, LOR-3 and LOR-4.

2) F2

For /ɪ/, the subjects whose LOR is longer then 8 years (LOR-5) produce significantly lower F2 values than LOR-2 (LOR= 1 month to1 year), LOR-3 (LOR=1 to 5 years) and LOR-4 (LOR=5 to 8 years), while LOR-3 and LOR-4 produce higher F2

values than the subjects who live in Korea (LOR-1). For /i/, the groups LOR-1 and LOR-2 produce a significantly lower F2 than those of other groups. For /e/, the F2 value of LOR-3 is higher than that of LOR-1.

3) Duration

For /ɪ e ɛ æ/, the subjects who live in Korea (LOR-1) produce significantly shorter durations than those of other groups, and the subjects whose LOR is longer than 8 years (LOR-5) produce significantly longer durations than other groups. For /i/, the duration of LOR-1 is significantly shorter than those of other groups; the duration of LOR-2 (LOR=1 month to 1 year) is significantly longer than LOR-1, while significantly shorter than those of LOR-3 (LOR=1 to 5 years), LOR-4 (LOR=5 to 8 years) and LOR-5 (LOR= more than 8 years). The duration of LOR-5 is significantly longer than those of all other groups. On the other hand, there is no difference between LOR-1 and LOR-2 or LOR-4 and LOR-5.

4) Distance between /i/ and /æ/

The distances of the subjects whose LOR is longer then 5 years (LOR-4 and LOR-5) are significantly longer than those of other groups, while the distances of the subjects whose LOR is shorter than 1 year (LOR-1 and LOR-2) are significantly shorter than those of other groups. In Figure 6.6, the distances of different LOR groups are represented in an F1 by F2 plot. Here, one can notice that the distances are positively associated with the LOR.

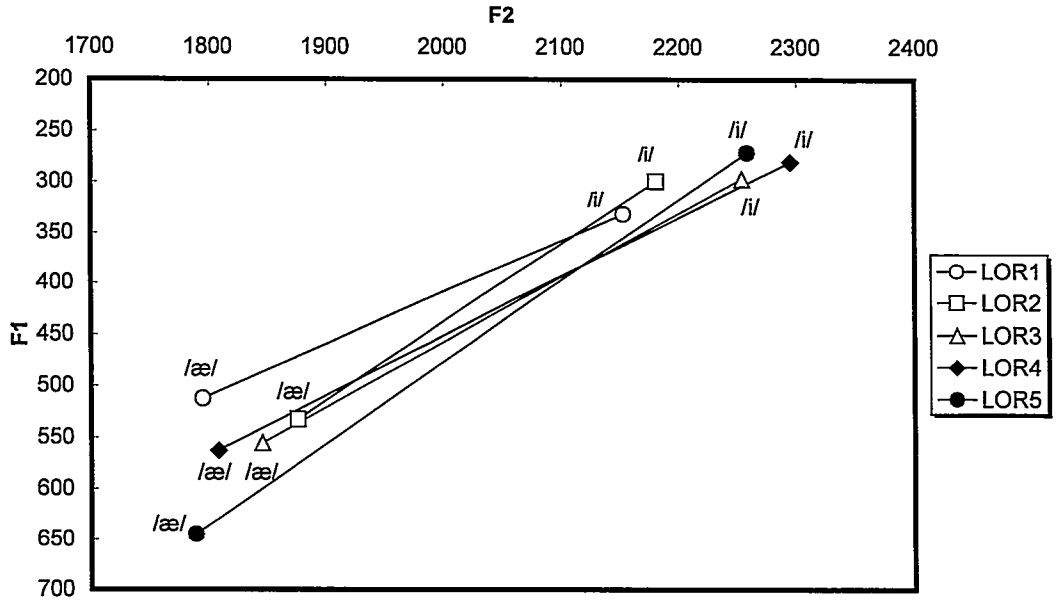

Figure 6.6 The distance between /i/~/æ/, as produced by different LOR groups

5) Voicing effect

The ratios of b-V-t to b-V-d of the subjects whose LOR is shorter than 1 year (LOR-1 and LOR-2) are significantly higher than those of the subjects whose LOR is longer than 5 years (LOR-4 and LOR-5). This result means that the LOR-1 and LOR-2 produce less lengthening effect based on the voicing of following consonants.

- **MOTI**

Motivation plays a significant role only for duration. For all English vowels, the duration produced by the subjects whose motivation is higher (MOTI-3) is significantly longer than the subjects whose motivation is lower (MOTI-1).

6.2 Comparison of the English Production of Korean Speakers in Other Studies

This section compares the production of English vowel production of subjects in this study, to the result of previous studies. Section 6.2.1 focuses on the under-differentiation phenomenon of the front vowels. Section 6.2.2 discusses the previous studies which focused on the vowel qualities and compares them to the result of this study. Discussed next is the acoustic space occupied by the English front vowels spoken by native Korean speakers. Lastly, the production of English vowel duration and the lengthening effects are addressed in section 6.2.3.

6.2.1 Under-differentiation of the Front Vowels

In terms of the production of English vowels as produced by Korean speakers, the phenomenon that raises the most interest from researchers is under-differentiation of English front vowels. Researchers have claimed that Koreans quite often cannot distinguish English /i/ from /ɪ/ (Kim 1994; Flege, Bohn & Jang 1997) and /ɛ/ from /æ/ (Ingram and Park 1997; Flege, Bohn & Jang 1997). For instance, Kim (1994) investigated 30 male and female Korean speakers of English on the production of the /i/ and /ɪ/ vowels. The subjects' exposure to English in the United States had begun at varying ages, ranging from birth to 25. She divided the subjects into five groups

according to AOA: 1-3, 4-7, 8-11, 12-15 and older than 16. The chronological age of the subjects ranged from 17 to 42, while their LOR ranged from 8 to 21 years. The result of this study shows that the Koreans whose AOA is older than 16 years old cannot distinguish the vowel formants of English /i/ from /ɪ/, in that they produced the /ɪ/ vowel with the /i/-like vowel formants. Korean speakers distinguish these two vowels based only on vowel duration. Flege, Bohn & Jang (1997) targeted twenty Korean speakers whose LOR varied. The subjects were divided into two groups: an experienced group (Mean= 7.3 years) and an inexperienced group (Mean = 0.7 years). All subjects had arrived in the United States when they were adults. Among their findings was that Korean speakers could not distinguish the formants of English /i/ from /ɪ/ and /ɛ/ from /æ/ even though the subjects were experienced learners. During the same year, Ingram and Park (1997) examined the English vowel production of three groups of Koreans: an inexperienced group, consisting of five college students in their twenties and residents of Australia for less than 12 months; an experienced group consisting of four males and one female in their thirties, residents of Australia for more than five years, all teachers of Korean; the last group was comprised of four Korean males, in their fifties and who could not speak English. Consistent with other findings, the result showed that most Korean speakers cannot distinguish English vowels /ɛ/ and /æ/.

The common points of the aforementioned studies are that Koreans who arrived in the U.S. when they are adults cannot distinguish /i/ from /ɪ/ or /ɛ/ from /æ/ even though they have lived in the U.S. for a considerable length of time. The present study

also confirms the claim of previous studies. Among ten groups, except for GROUP-1 who arrived in the U.S. before age 11, other groups fail to distinguish English /i/ from /ɪ/ and /ɛ/ from /æ/. Hence, it can be concluded that the Koreans who arrived in the U.S. after age 11 cannot distinguish /i/ from /ɪ/ or /ɛ/ from /æ/, despite an LOR of many years.

6.2.2 The Acoustic Space Occupied by the Front Vowels

Until now, there are but a few studies that have observed the qualities of English vowels, as produced by native Korean speakers, using acoustic measurement. Among these few studies, three of them, Koo (2000), Hwang (2001) and Kim (2003) are discussed in this section. In 2000, Koo measured the production of English vowels of native Korean male speakers who were born and raised in Seoul. They had all majored in English education. The target vowels were ten English monosyllabic words. These words were embedded in the sentence: "It's _____." Similarly, Hwang (2001) measured the F1 and F2 formants of English vowels spoken by three Korean high school students and five college students. In addition, Kim (2003) examined the production of English front vowels by twenty Korean males living in Seoul. The subjects were college students whose ages ranged from 19 to 25. They were all born and educated in Seoul, and none had ever lived in an English speaking country. The target English vowels were in three contexts: h(V)d, b(V)d, and b(V)t. These words were embedded in the carrier sentence: "Say _____ for me."

Table 6.10 compares the F1 and F2 formants of Korean vowels /i ɪ e ɛ æ/ of the aforementioned studies. These values are plotted in Figure 6.7. Based on this information, we can accept that, even though the absolute values of F1 and F2 of three

of the studies are a little bit different (e.g., F1 values of /i/ produced by the subjects in Koo and Hwang are 311 Hz and 399 Hz, respectively), the acoustic space occupied by the front vowels does not differ greatly.

Table 6.10 The F1 and F2 formants of Korean vowels /i ɪ e ɛ æ/ in Koo, Hwang and Kim's studies

	Koo		**Hwang**		**Kim**	
	F1 (Hz)	F2 (Hz)	F1 (Hz)	F2 (Hz)	F1 (Hz)	F2 (Hz)
/i/	311	2127	396	2608	333	2122
/ɪ/	325	2093	412	2598	339	2124
/e/					441	1961
/ɛ/	594	1758	650	2198	508	1802
/æ/	589	1742	681	2141	511	1796

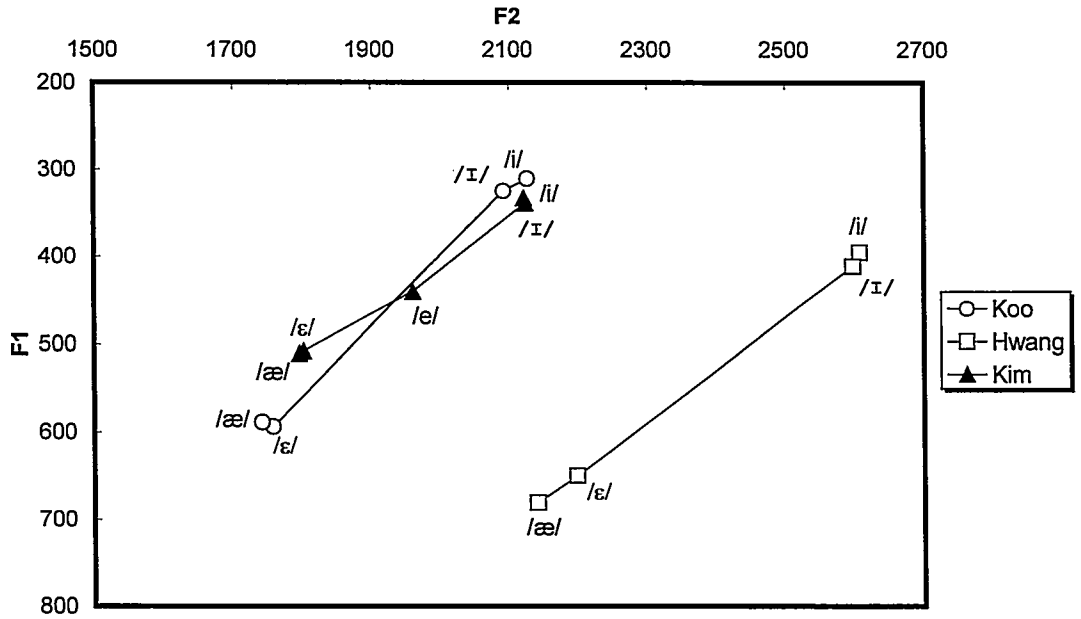

Figure 6.7 The F1 and F2 formants of Korean vowels /i ɪ e ɛ æ/ in Koo, Hwang and Kim's studies

In addition, the distance between /i/~/æ/ and the distances between /ɛ/~/æ/ in these studies were calculated and shown in Table 6.11.

Table 6.11 The distance between /i/~/æ/ and the distance between /ɛ/~/æ/

	Distance between /i/~/ɛ/ (Hz)	Distance between /ɛ/~/æ/ (Hz)
Koo	474	167
Hwang	547	64
Kim	371	6

When the results of previous studies and present studies are compared the distance, as noted in the above studies, is clearly similar to those of GROUP-7 (the distance is 390Hz), GROUP-8 (the distance is 424Hz), GROUP-9 (the distance is 410Hz) and GROUP-10 (the distance is 383Hz), while it shows a significant difference among those in other groups, especially GROUP-1 (the distance is 825Hz). One reason may be that all subjects in the above studies, and GROUP-7, GROUP-8, GROUP-9 and GROUP-10 in the present study, are Koreans who either live in Korea or whose LOR is relatively short.

6.2.3 Duration Related Issues

In terms of the voicing-dependent vowel duration, Kim (1994) measured the English vowel productions of native Korean speakers who came to the U.S. at various ages and have lived in the U.S. for more than eight years. The target vowels, /i u a/ were in the words that begin with /b k s h/ and ended with a voiceless or voiced stop. In her study, she noticed that Koreans produce vowels preceding a voiced stop with longer durations than vowels preceding a voiceless stop, much as native English speakers do. In the present study, the voicing effects produced by the subjects whose AOA is earlier than 11 or LOR is longer than 5 years (GROUP-1, GROUP-2, GROUP-3 and GROUP-4) differ greatly from those produced by the subjects whose LOR is less than 1 year (GROUP-7, GROUP-8, GROUP-9 and GROUP-10). The ratios produced by the subjects whose AOA is earlier than 11 or LOR is longer than 5 years (GROUP-1, GROUP-2, GROUP-3 and GROUP-4) are similar to those produced by the subjects of Kim's study. On the other hand, the ratios produced by the subjects whose AOA is

earlier than 11 or LOR is longer than 5 years (GROUP-7, GROUP-8, GROUP-9 and GROUP-10) are greater (less voicing effect) than the values produced by the subjects of Kim's study.

6.3 Comparison of English Vowels, as Produced by Korean Speakers and Native English Speakers

This section compares the phonological and phonetic characteristics of English vowels as produced by native Koreans who participated in the present study and native English speakers of previous studies. Section 6.3.1 focuses on vowel qualities, the acoustic space occupied by the English front vowels and the number of vowel categories. The inherent vowel duration and the lengthening effects are discussed in section 6.3.2.

6.3.1 The Acoustic Space Occupied by the Front Vowels

The studies that observe the qualities of English vowels, as produced by native English speakers using acoustic measurement, conducted much earlier than those studies of English vowels produced by native Korean speakers. In the early 1950s, Peterson and Barney (1952) measured the vowel formants of American men and women. Here, the formant values of vowels /i ɪ ɛ æ/, as produced by male speakers, are shown in Table 6.12. It also shows the results of Ladefoged (1982), Olive et al. (1993) and Yang (1996) that investigate the qualities of English vowels, as produced by native English speakers.

When the vowel qualities for the five target vowels are plotted in an F1 by F2 space (Figure 6.8), it is evident that, even though the values of F1 and F2 of the

aforementioned three studies are slightly different, the distances occupied by the front vowels are similar to each other.

Table 6.12 The English production of native English speakers

	Peterson & Barney		**Ladefoged**		**Yang**		**Olive et al.**	
	F1 (Hz)	F2 (Hz)	F1 (Hz)	F2 (Hz)	F1 (Hz)	F2 (Hz)	F1 (Hz)	F2 (Hz)
/i/	270	2290	280	2250	286	2317	280	2250
/ɪ/	390	1990	400	1920	409	2012	400	2900
/ɛ/	530	1840	550	1770	531	1900	550	1700
/æ/	660	1720	690	1660	687	1743	700	1650

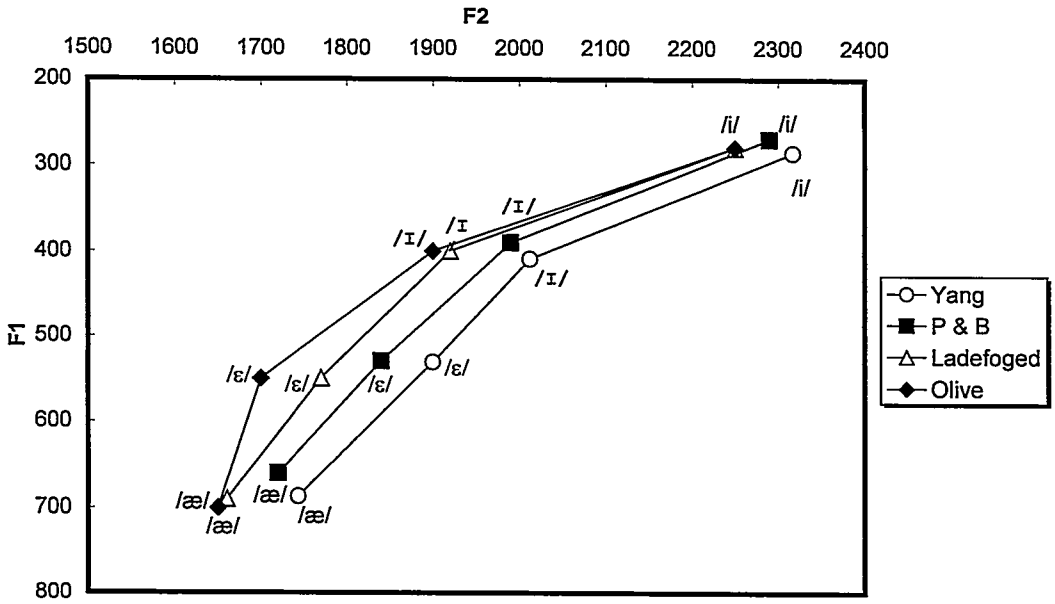

Figure 6.8 The distances between/i/~/æ/ and /ɛ/~/æ/ of four studies of English

Such distances are calculated for the comparison to those values of subjects in the present study.

Table 6.13 The distances between /i/~/ɛ/ and /e/~/ɛ/,
as produced by native English speakers

	Distance of /i/~/ɛ/ (Hz)	Distance of /e/~/ɛ/ (Hz)
Peterson & Barney	690	176
Ladefoged	718	178
Yang	700	221
Olive et al.	732	158

While the F1 and F2 values and the distance, as noted in the aforementioned studies, are similar to those of the subject who arrived in the U.S. before age 11 (GROUP-1), it shows a greater significant difference in other subjects, especially in the subjects whose LOR is less than 1 year (GROUP-7, GROUP-8, GROUP-9 and GROUP-10).

6.3.2 Vowel Duration Related Issues

Peterson and Lehiste (1960) measured the intrinsic duration of English vowels and found that the duration of /i ɪ e ɛ æ/ are 240 ms, 180 ms, 270 ms, 200 ms and 330 ms, respectively. Bohn and Flege (1990) also showed that the mean vowel durations of English /i/ is 131 ms, /ɪ/ is 108 ms, /ɛ/ is 116 ms and /æ/ is 182 ms, respectively. When such results are compared to those of the present study, it is evident that the durations produced by the native Korean speakers are systemically shorter than their counterparts, as produced by native English speakers. The duration differences between Korean and native English speakers are greater in GROUP-7, GROUP-8, GROUP-9 and GROUP-10, whose AOA is older than age 16 and LOR is lower than other groups. On the other hand, the duration of English vowels produced by the subject in GROUP-1, whose AOA is earlier than age 11 is similar to that of native English speakers.

Referring to the Peterson and Lehiste (1960) and Bohn and Flege (1990) data, we notice that native English speakers produce a longer duration for vowel /æ/ than /i/ and /ɛ/ vowels. However, in the present study, except for the subjects who arrive in the U.S. before age 11 (GROUP-1), the Korean speakers typically do not distinguish such vowels in terms of duration.

In terms of the lengthening effects based on the voicing of the following consonant, Kim (1994) shows the durational ratios of vowels in the pre-voiceless context to vowels in the pre-voiced context of native English speakers and Koreans. According to her results, the ratio of native English speakers is 74.63 % in the carrier-sentence form. There are no significant differences from the ratio of native Korean speakers. Kim could not find any significant differences among all the different Korean AOA groups and the native English groups. In the present study, the durational ratio of the subjects who arrived in the U.S. before age 11 (GROUP-1) is similar to the ratio of native English speakers shown in Kim's study. The subject whose LOR is longer than 5 years (GROUP- 2, GROUP- 3 and GROUP- 4) also does not show any great differences either in the ratio of native English speakers in Kim's study or in GROUP-1 in the present study. Considering that the subjects of Kim's (1994) study are people whose LOR is more than 8 years and the LOR of GROUP-1, GROUP- 2, GROUP- 3 and GROUP- 4 in this study is more than 5 years, we can assert that the results of these two studies are identical. On the other hand, in the present study, given that the durational ratios produced by the subject whose LOR is less than 1 year (GROUP-7, GROUP-8, GROUP-9 and GROUP-10) are shorter than those produced by native English speakers, we can conclude that Korean speakers whose LOR is short or non-existent cannot produce a native-like voicing effect, while the Koreans whose LOR is relatively longer (more than 5 or 8 years), can produce a native-like voicing effect regardless of their AOA.

6.4 Summary

This chapter analyzed the English production of native Korean speakers according to GROUPS, which is divided into the combination of non-linguistic factors (AOA x LOR x MOTI). In addition, to understand the effects of the each non-linguistic factor, the English production was analyzed according to AGE, AOA, LOR and MOTI, separately. The results based on both these two analyses are considered for the general results and the conclusion of the present study. Next, these results were compared to the data of native English speakers that were shown in previous studies (Peterson & Lehiste 1960; Ladefoged 1982; Bohn and Flege 1990; Olive et al 1993; Kim 1994; Yang 1996). Following is a summary of the findings, which answers the research questions (1), (2), (4) and (3) raised in the introduction section of chapter 6.

(1) How do native Korean speakers produce English vowels, in terms of such features, including qualities, number of vowel categories, acoustic space occupied by vowels, duration and degree of voicing-dependent effect of vowel duration?

(2) How do AGE, AOA, LOR and MOTI affect L1 pronunciation?

(4) How does the production of English by native speakers of Korean differ from that of native speakers of English?

The results reveal that the effect of AOA is clear in conjunction with a certain period of experience with the L2. For example, the result shows that most subjects fail to distinguish English /i/ from /ɪ/ or /ɛ/ from /æ/, resulting in the reduction of the number of vowel categories in that the subjects produce only three front vowels. Only

the people who arrive in U.S. before age 11 can produce 5 front vowels in the same manner as native English speakers do. On the other hand, this study reveals that a longer LOR also results in improvement of even with a late AOA. For example, not only those with an early AOA, but also those people with a longer LOR produce closer qualities of /i ɪ æ/ as those of native English speakers. In addition, people with a longer LOR produce a longer distance between /i/ and /æ/, longer vowel duration and more voicing dependent effect of vowel duration than those produced by people with shorter LOR. Such results imply that L2 pronunciation might be improved even though they might not able to reach the production of those with early AOA or native English speakers. Certain features, such as the vowel duration, AGE and MOTI, also affect the production, in that older AGE and higher MOTI produced longer vowel durations than others even though they are still much shorter than that of native English speakers.

(3) How is the English production of native Korean speakers in this study similar and different from that of Korean speakers in other studies? What factors are responsible for these similarities and differences?

The present study confirms the previous studies' claim that Koreans who arrived in the United States when they are adults cannot distinguish /i/ from /ɪ/ or /ɛ/ from /æ/ even though they have lived in the U.S. for a long time. In terms of the vowel qualities and the distances between the /i/~/æ/ and /ɛ/~/æ/, the production of the subjects in previous studies are similar to the production of the subject whose LOR is less than 2 years in the present study while different from that of subjects whose AOA is earlier than age 11 or LOR is longer. The reason is proposed that most of the aforementioned

previous studies target the subjects who never lived in the U.S. In terms of the voicing effect, the result of the previous study that targets Koreans who lived in the U.S. for more than 8 years is that Koreans produce vowels preceding a voiced stop with longer durations than vowels preceding a voiceless stop, as native English speakers do. On the other hand, the present study shows that only the subjects whose AOA is earlier than age 11 and the LOR is longer produce native-like voicing effect, while the subjects whose LOR is less than 1 year cannot.

The analyses in this study show that the non-linguistic factors, especially AOA and LOR of the subject, affect the results of the L2 production. Hence, more prudence in selecting and describing the target subjects is suggested, if not warranted.

CHAPTER 7

ISSUES RELATED TO L1 INTERFERENCE

7.0 Introduction

To forward the goal of understanding how the Korean language influences the English pronunciation of native Korean speakers, this chapter discusses the following questions based on the results and discussions in chapters 5 and 6:

(1) In which features of English pronunciation does Korean interference occur?

(2) How do non-linguistic factors affect the degree of Korean interference in English pronunciation?

(3) What is the pattern of acquisition of English pronunciation of native Korean speakers; that is, what aspects of interference remain the longest and which disappear more quickly?

(4) Do individual differences in the number of Korean vowel categories affect the production of the number of English vowel categories?

Section 7.1 focuses on those features that Koreans have difficulty producing with native-like pronunciation, emphasizing how these features are affected by Korean interference. In section 7.2, the degree of interference is investigated by comparing the ratios of features of Korean and English in different groups. Section 7.3 discusses the sequence of English pronunciation acquisition of native Korean speakers. Section 7.4

compares the personal Korean vowel inventory to the English vowel inventory, focusing on the number of vowel categories.

7.1 Korean Interference

When we consider Koreans' difficulty in English vowel production (chapter 6) based on the characteristics of their Korean vowel production (chapter 5), we find that the subjects who participated in this study show the following difficulties: (1) under-differentiation of English /i/~/ɪ/ and /ɛ/~/æ/; (2) differences in F1 and F2 values of some English vowels from those of native English speakers; (3) non-English distance between the highest and lowest front vowels; and (4) difficulty providing native-like inherent vowel duration and the degree of lengthening effects based on the voicing of a following consonant.

7.1.1 Under-differentiation

Most Korean speakers in this study had difficulty in distinguishing English /i/ from /ɪ/ and /e/ from /æ/, resulting in a reduction on the English front vowel inventory. That is, they produced only three front vowels, while native English speakers produced five. When we consider that for most subjects, Korean front vowels are divided into only two groups (/i/ and /e ɛ/), the under-differentiation phenomenon can be interpreted as a matter of the L1 interference. This observation also confirms Weinreich's claim (1953) that under-differentiation of phonemes occurs when two sounds of L2 are not distinguished in L1.

However, when we consider Kim and Silva's 2003(a) study that investigated the production of Korean back vowels by English–speaking learners, it is questionable

whether or not the under-differentiation phenomenon of Korean speakers' English vowels is affected by only Korean interference. According to Kim and Silva, some beginning learners of Korean under-differentiate Korean back vowels, even though both Korean and English vowel inventories have /o u ʌ/. These findings lead them to conclude that native English speakers simplify the L2 vowel inventory and try to provide maximal differentiation. Such a phenomenon implies that some features may be affected by L1 interference while other features may be affected by some sort of language developmental sequence. Future research may provide the answer.

7.1.2 F1 and F2 Formants

In addition to the categorical differences mentioned in section 7.1.1, there are quantitative differences in the acoustic manifestations of the vowels that the two languages have in common: even between vowels that can be said to represent the "same" phonemic category (e.g., Korean /i/ and English /i/), they occupy somewhat different acoustic spaces. In this study, the quantitative differences among F1 or F2 values for some English front vowels produced by native English speakers and native Korean speakers were found. For example, when we compare the F2 values of English /i/ produced by the subjects of this study to those of native English speakers (Yang 1996), the speakers in this study, especially the subjects who live in Korea (GROUP-8, GROUP-9 and GROUP-10), produce much lower F2 values than native English speakers do. The mean F2 value /i/ produced by native English speakers is 2317 Hz, while the F2 values produced by GROUP-8, GROUP-9 and GROUP-10 are 2138 Hz, 2126 Hz and 2192 Hz, respectively. Based on the Korean speakers' Korean production,

it is not surprising that native Korean speakers have difficulty with the native-like English speech of F2 value of /i/. As the F2 values of Korean /i/ produced by GROUP-8, GROUP-9 and GROUP-10 are 2048 Hz, 2100 Hz and 2088 Hz, we can infer that the formant values of L1 affect those of L2. Such a result confirms Kim & Silva's (2003b) claim that the lower degree of fronting (lower F2 value) of /i/ produced by speakers whose LOR is less than 1 year can be attributed to the acoustic space of Korean rather than the /i/ of American English.

7.1.3 The Distance Between the Highest Front Vowel and Lowest Front Vowel

A notable difference among the English production of native English speakers and Korean speakers is the distance between the highest and lowest front vowels. Korean speakers produce a significantly shorter distance than that of native English speakers. This finding is consistent with previously reported phonetic work: second language learners tend to manifest an observable compromise between the two systems, while simultaneously, often overlay their L1 behaviors on their L2 production. In this study, when the distance between the highest and lowest front vowels is observed, two types of such interference were noticed.

- Compromise between L1 and L2 system

Except for the subjects who arrived in the U.S. before age 11, the distance between lowest and highest English front vowels of the Korean speaker is much shorter than that of native English speakers. On the other hand, in some groups, the distance between the highest and lowest front vowel of English by Korean speakers is longer than the distance between the highest and lowest front vowels of Korean by native

Korean speakers. That is, the distance of English front vowels, as produced by Korean speakers, compromises the distances of Korean of Korean speakers and English of English speakers. To illustrate, Figure 7.1 compares the distances of Korean and English front vowels of GROUP-7 to the distance of English vowels as produced by native English speakers (Yang 1996). When the distance is calculated, the mean distance of Korean produced by GROUP-7 is 373 Hz and the mean distance of English produced by the same subjects is 495 Hz. The distance of native speakers is much higher: 700 Hz (Yang 1996).

- *Overlay of L1 behavior on L2 production:*

Other groups show similar distances of Korean and English vowels as produced by the Korean speakers. For example, Figure 7.2 illustrates the acoustic space occupied by Korean and English vowels as produced by GROUP-10 and native English speakers. The distances of Korean and English vowels produced by GROUP-10 are similar and are much shorter than those of native English speakers. When the distance is calculated, the distance of Korean produced by GROUP-10 is 396 Hz and that of English produced by GROUP-10 is 383 Hz. These values are much shorter than those of a native speaker: 700 Hz (Yang 1996).

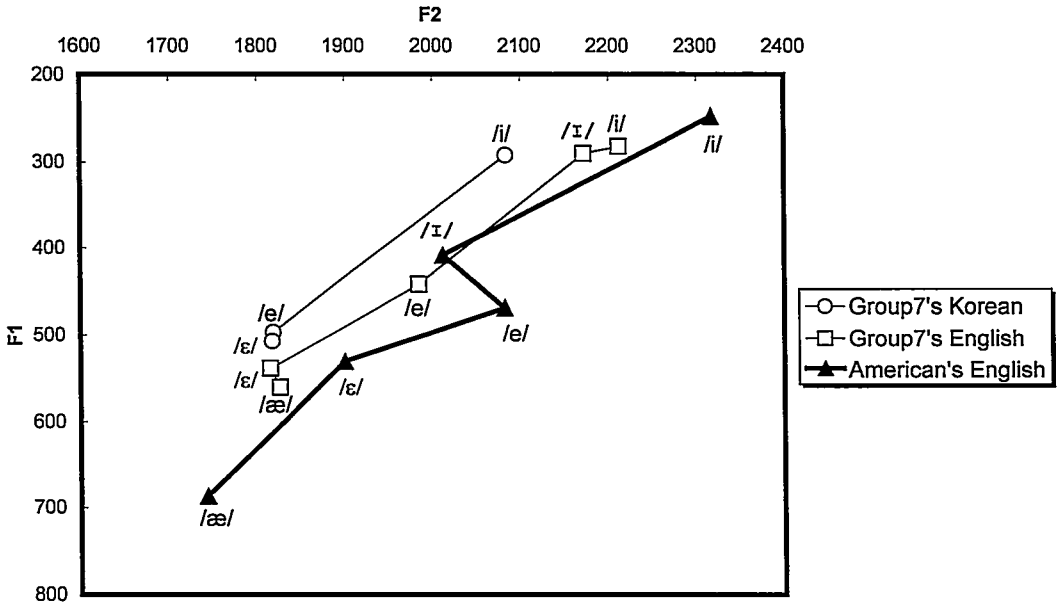

Figure 7.1 Comparison of the English production of native English speakers with Korean and English productions of GROUP-7

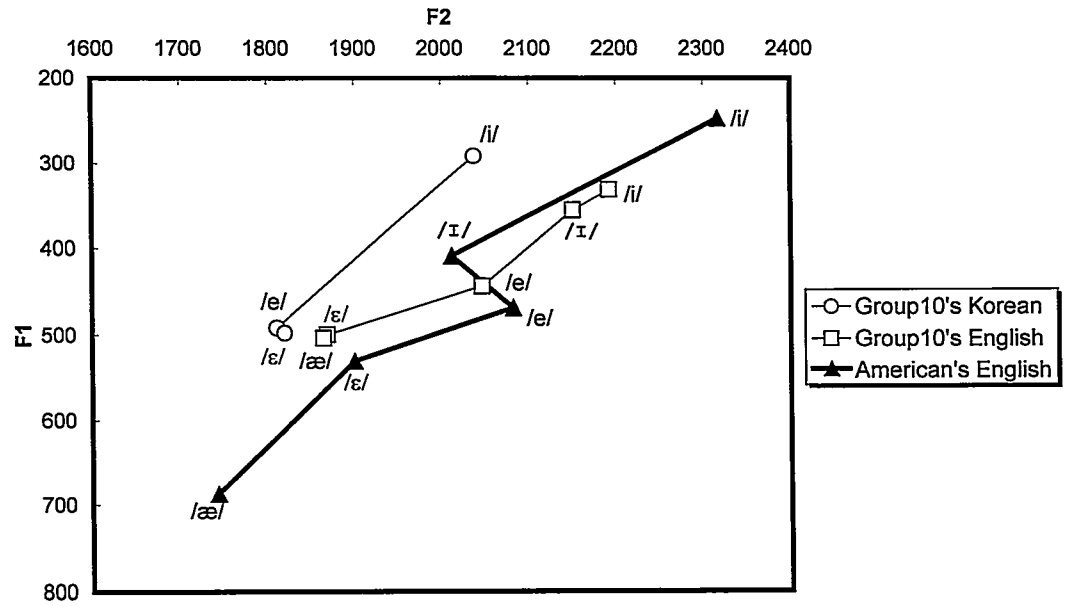

Figure 7.2 Comparison of the English production of native English speakers with Korean and English productions of GROUP-10.

7.1.4. The Inherent Duration and the Degree of Voicing Effect

The durations of Korean vowels are much shorter than their English counterparts, as produced by native English speakers. When comparing the duration of English produced by native Korean speakers to the duration of Korean and English produced by native speakers of each language (Peterson and Lehiste 1960), we notice that the mean duration of English vowels, as produced by native Korean speakers, is a compromise between the Korean speakers' durations of Korean and English speakers' duration of English (Table 7.1 and Figure 7.3). Therefore, we can infer that Korean interference appears to manifest itself in terms of inherent vowel duration.

Table 7.1 Comparison of the English vowel duration of native English speakers with that of GROUP-10

	Group 10's Korean (ms)	**Group 10's English (ms)**	**Americans' English (ms)**
/i/	43	87	240
/ɪ/		94	180
/e/	55	96	270
/ɛ/	54	99	200
/æ/		99	330

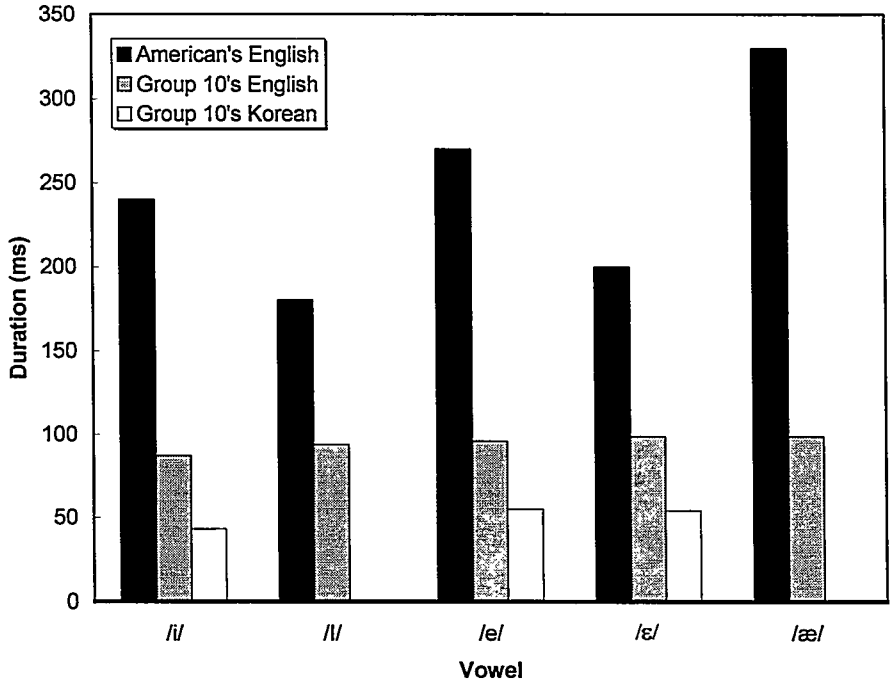

Figure 7.3 Comparison of the English vowel duration of native English speakers with that of GROUP-10

In terms of voicing effects, the mean ratios of b-V-d and b-V-t of English vowels produced by the subjects whose LOR is short or non-existent (GROUP-7, GROUP-8, GROUP-9 and GROUP-10) are higher than those of native English speakers. Such a result means that the subjects whose LOR is short or non-existent realize less of a voicing dependent effect. Considering that the voicing dependent effect of Korean vowels produced by the Korean speakers is lower than the voicing dependent effect of English by native English speakers, the lengthening effects based on the voicing of a following consonant can account for the Korean interference.

7.2 The Degree of Interference

As the data indicate, the degree of L1 interference seems to be different among the various groups of subjects. For instance, in section 7.1.4, the distances of the highest vowel and lowest English and Korean vowels produced by GROUP-10 are more similar to those produced by GROUP-7. This observation proposes that the degree of interference of GROUP-10 is higher than that of GROUP-7. Arguably, non-linguistic factors affect the degree of Korean interference. In support of this assertion, the ratios (X) of the distance between Korean vowels /i/ and /ɛ/ (X) to the distance between English vowels /i/ and /æ/ (Y) (R = X/Y) were calculated (Table 7.2). There are two reasons for selecting the distance between the highest and lowest English front vowels rather than other features (such as F1, F2, duration and voicing dependent effect). First, one of the most relevant findings in this study is the production of the distance between English vowels /i/~/æ/ by Korean speakers. Second, the effects of AOA and LOR are significant for this distance. In future studies, the ratios of Korean and English pronunciation in other linguistic behaviors, such as the ratios in F1, F2, duration, voicing effect, etc. can be investigated.

Table 7.2 The ratios (%) of the distances of Korean to those of English produced by ten GROUPS

GROUP	Mean (%)	Std. Deviation
1	66	.1625
6	77	.2637
2	86	.4564
5	86	.3251
4	89	.2987
3	93	.4919
8	97	.5556
7	110	.6005
9	121	.8580
10	123	1.2608

The ratios of the distance between Korean vowels /i/ and /ɛ/ to the distance between English vowels /i/ and /æ/ were submitted to ANOVA for examination of the effects of non-linguistic factors ($p<0.01$). The *post-hoc* test shows that the ratio of the distance of Korean to that of English produced by GROUP-1 is significantly lower than those of GROUP-7, GROUP-8, GROUP-9 and GROUP-10. The ratios of GROUP-2, GROUP-4, GROUP-5 and GROUP-6 also are significantly lower than those of GROUP-7, GROUP- 8 and GROUP-9. Therefore, we can conclude that the degrees of interference produced by the people whose LOR in the U.S. is less than 1 or who live in Korea are notably higher than those of people whose AOA is less than 11 or whose LOR is more than 1 year.

To determine the effects of separate non-linguistic factors (AGE, AOA, LOR and MOTI), ANOVA was conducted again. Table 7.3 shows the ratios of the distances between Korean vowels /i/ and /ɛ/ to English vowels /i/ and /æ/, as produced by different AGE, AOA, LOR and MOTI groups.

Table 7.3 The ratios (%) of the distances of Korean to those of English, as produced by different AGE, AOA, LOR and MOTI groups

AGE

	Mean (%)	**Std. Deviation**
1	76	.2261
2	101	.7231
3	84	.4013
4	105	.6260

AOA

	Mean (%)	**Std. Deviation**
1	63	.1929
2	84	.4481
3	93	.4993

Table 7.3 – *Continued*

LOR

	Mean (%)	Std. Deviation
1	110	.87
2	107	.58
3	83	.29
4	86	.62
5	85	.43

MOTI

	Mean (%)	Std. Deviation
1	98	.84
2	106	.82
3	93	.49

The results of the ANOVA procedure and *post hoc* test explains that AGE plays a significant role ($p<0.01$) in the ratio of Korean and English distances, in that AGE-2 and AGE-4 produce a significantly higher ratio than those of AGE-1 and AGE-3. AOA plays a significant role ($p<0.01$) in the ratio of Korean and English distances, in that AOA-1 produces a significantly lower ratio than those of other groups. This means that the AOA-1 group produces a lesser degree of interference than that of other groups. Similarly, LOR also plays a significant role ($p<0.01$) in the ratio of Korean and English distances, in that LOR-1 and LOR-2 produce a significantly higher ratio than the ratios of other groups. On the contrary, motivation does not play a significant role ($p=0.219$) in the ratio.

7.3 The Order of English Pronunciation Acquisition of Native Korean Speakers

This study shows that a higher degree of Korean interference appears to be associated with subjects whose AOA, LOR and MOTI are older, shorter and weaker, respectively. Such a degree of interference, however, tends to be reduced gradually. What, then, is the sequence of English pronunciation acquisition of English pronunciation? The answer to this question can be inferred from the English production data of the subjects.

The results of this study reveal that the most difficult features for Korean speakers is the distinction of English vowels /i/ from /ɪ/ and /ɛ/ from /æ/, in that only those Koreans whose AOA is younger than age 11 can distinguish these two vowels. The F1 and F2 of /i/ and /æ/ and the distance between the highest and lowest front vowels are also difficult to acquire, in that only those people whose AOA is younger than age 11 produce a native-like distance. However, there are significant differences among different LOR groups, which implies that the effect of Korean interference on the distance between /i/ and /æ/ can be reduced by an increase of LOR. However, as mentioned, regardless of one's increase in LOR, those subjects who arrived in the U.S. after age 11, do not reach native-like proficiency. Vowel durations by Korean speakers who live in Korea are much shorter than those of native English speakers. However, the duration increases in accordance with an increase of LOR, MOTI and AGE. That is, Korean interference in vowel duration varies depending on the subjects' AOA or LOR. Additionally, AGE and MOTI have an impact on vowel duration. However, only the duration produced by the subjects whose AOA is younger than age 11 approximates

native-like behavior. In this study, it has been determined that voicing effect is the most undemanding behavior for the subjects. Only those subjects whose LOR was relatively short (e.g., no longer than 3 years) did not consistently produce native-like voicing effects. More specific findings are as follows:

- /i/~/ɪ/ and /ɛ/~/æ/ distinctions:

Chapter 6, section 3 brought to our attention that native English speakers distinguish these vowels. In this study, however, only the Koreans whose AOA is younger than age 11 years (GROUP-1) distinguish /i/ from /ɪ/ and /ɛ/ from /æ/. In addition, when we calculated the distance between vowel /ɛ/ and /æ/, we found that the distance of subjects who arrive in the U.S. before age 11 (168Hz) is similar to that of native English speakers (221Hz, Yang 1996) and markedly higher than those of other groups. Yet distances of other groups are much shorter than those produced by native English speakers.

- The distance of the highest front vowel and lowest front vowel

In terms of the distance of the highest and lowest front vowels, the distance produced by the subjects who arrive in the U.S. before age 11 (GROUP-1) is similar to that of native English speakers and significantly longer than those of the other groups: Here, the value of GROUP-1 is 825 Hz, while that of native English speakers is 700 Hz (Yang 1996). On the contrary, the distances produced by the subjects whose LOR is less than 1 year (GROUP-7, GROUP-8, GROUP-9 and GROUP-10) are significantly shorter than those of other groups. Hence, we can conclude that the production of the

distance of the highest and lowest front vowels can be improved as a result of living in the U.S. Figure 7.4 compares the distance between the highest and lowest English vowels of native English speakers, as produced by GROUP-1 and GROUP-10.

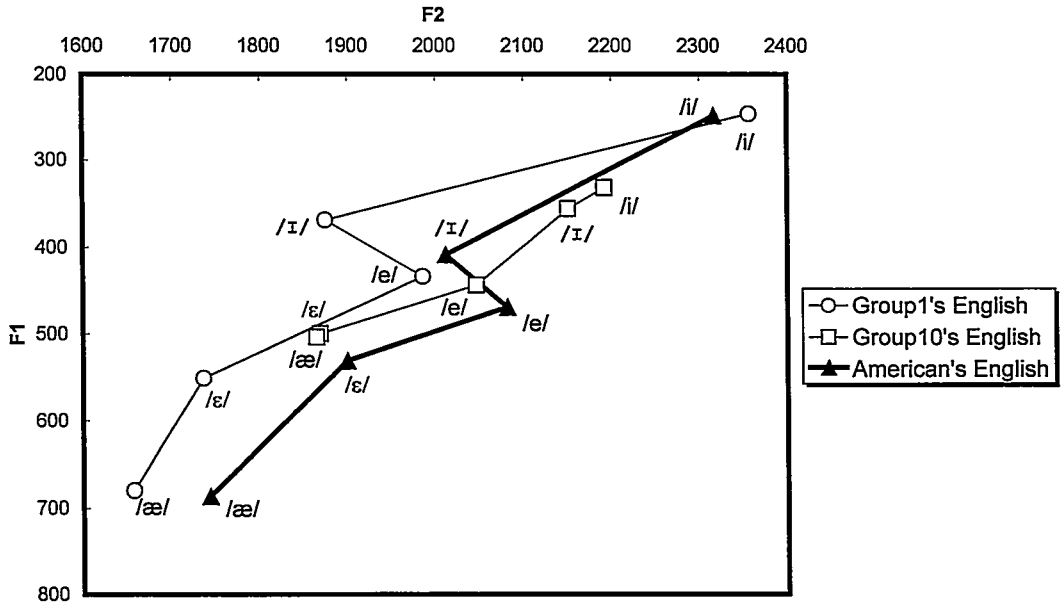

Figure 7.4 English production of native English speakers, as produced by GROUP-1 and GROUP-10

The results of the analysis for each of the non-linguistic factors (AGE, AOA, LOR and MOTI) serve to support the above finding. The degree of interference in distance of the highest and lowest vowels varies, depending on the subjects' AOA and LOR. For example, the distances are significantly different among subjects who arrive in the U.S. before age 11 (AOA-1), between ages 11 to 18 (AOA-2) and older than age

18 (AOA-3), with the distance of the subject who arrives in the U.S. before age 11 (AOA-1) the longest. In addition, the distances of the longer LOR groups (LOR-4 and LOR-5) are much longer than those of other groups, while those of the shorter LOR groups (LOR-1 and LOR-2) are significantly shorter than those of other groups.

- F1 and F2 of /i/ and /æ/

Most of the Korean speakers fail to produce native-like values of F1 and F2 of /i/ and /æ/. Only the subjects who arrived in U.S. before age 11 (GROUP-1) produces a native-like production. Here, when we consider that the F1 values of /i/ and /æ/, as produced by the subjects who live in Korea (GROUP-8, GROUP-9 and GROUP-10), are significantly different from those of other groups, and the values of the subjects who arrived in the U.S. before age 18 (GROUP-1 andGROUP-2) are significantly different from those of other groups, we can draw the following conclusion: the formant values of Korean speakers vary depending on subjects' AOA and LOR.

- The duration of vowel

Subjects who arrived in the U.S. before age 11 (GROUP-1), as well as the subjects who arrived in the U.S. after age 18 but have lived there for more than 8 years (GROUP-3), produce significantly longer vowel durations than the other groups, whereas the subjects who live in Korea (GROUP-8, GROUP-9 and GROUP-10) produce a considerably significantly shorter duration than the other groups. On the other hand, the results of the analysis for each of the non-linguistic factors show that

subjects in AGE-4, AOA-1, LOR-5 and MOTI-3 produce a significantly longer duration than the other groups. On the other hand, subjects in AGE-1, AGE-2 and LOR-1 produce a significantly shorter duration than the other groups, respectively. Hence, longer durations are associated with an older age, an earlier AOA, a longer LOR and a higher degree of motivation.

- The lengthening effect based on the voicing of a following vowel

In this study, the subjects who arrived in the U.S. before 18 or who have lived in the U.S. more than 5 years (GROUP-1, GROUP-2, GROUP-3 and GROUP-4) produce a similar degree of voicing effect to that of native English speakers. On the other hand, the voicing effects of the subjects whose LOR is less than 1 year (GROUP-7, GROUP-8, GROUP-9 and GROUP-10) are significantly lower than those of other groups. Thus, we might conclude production can gradually improve and can manifest the ultimate English voicing effect pattern.

7.4 The Relationship Between the Individual Korean Vowel Inventory and English Vowel Inventory

We cannot ignore that in spite of the fact that Koreans speak the same L1, there is a possibility that each speaker could have a different vowel inventory. For example, some Koreans have three front vowel inventories: /i/, /e/ and /ɛ/, while others have only two vowel inventories: /i/ and /e ɛ/. In addition, some Koreans' F1 or F2 values are higher than others, while others are lower than others; some people produce a longer duration than others and so forth. Which leads to the following question: Does the

individual difference in the number of Korean vowel categories affect English vowel pronunciation? To answer this question, the distances between Korean vowels /e/~/ɛ/ and English vowels /ɛ/~/æ/ are considered. Here, a bigger difference means more likelihood of 2 categories while a smaller distance means 1 category.

To identify the relationship between each speakers' Korean and English production, correlation tests were conducted for all subjects. However, the result of the correlation test shows that there is no significant relation between the individuals, distance between Korean vowels /e/ and /ɛ/ and English vowels, /ɛ/ and /æ/ ($r= 0.019$, $p=0.59$). In this case, the reason of this result may be interpreted as follows: (1) the differences in individual Korean vowel inventories among Koreans do not alter the production of the number of English vowel categories. Or (2) Even though there is a relationship between individual Korean vowel inventories and English vowel inventories, the relation vary depending to subjects' non-linguistic factors.

7.5 Conclusion

This chapter shows that the Korean interference affects some aspects of Korean speakers' English. Here, the degree of Korean interference appears to be associated with the non-linguistic factors of the subjects. Following is the summary of the findings in this chapter, answering the research questions raised in the introduction.

(1) In which features of English pronunciation does Korean interference occur?

The comparison of the vowel productions of Korean as produced by native Koreans, English by native Koreans and English by native English speakers suggests that the Korean speakers' difficulties in the production of English might be the effect of the interference of Korean. For example, Korean speakers produce a shorter distance between the highest and lowest English vowels, a shorter vowel duration and less voicing effect as a result of the influence of Korean. These phenomena are the results of Korean in that the distance between the highest and lowest Korean vowels is shorter than that of English, Korean vowels are systemically shorter than their English counterpart, and the voicing effect in Korean is lower than that of English.

(2) How do non-linguistic factors affect the degree of Korean interference in English pronunciation?

Korean interference is shown in two patterns: either Koreans overlay Korean (L1) behavior onto English (L2) production, or they compromise between Korean and English vowel systems. In this case, there is a tendency for beginner English learners whose AOA is later and LOR is shorter to overlay the L1 behavior on L2, while the more advanced learners compromise between L1 and L2.

When we measure the ratios of the distance between Korean vowels /i/~/ɛ/ to the distance between English vowels /i/~/æ/, the result shows that the subjects whose AOA is earlier and LOR is longer produce lower ratios, that is a lower interference degree.

(3) What is the pattern of acquisition of English pronunciation of native Korean speakers? In other words, for which features does the

interference remain the longest, and for to which features do interference effects disappear more quickly?

With regard to the sequences of L1 interference, the interference in some features (e.g., the voicing–dependent vowel duration) appears only in the early stage of L2 learning and disappears according to LOR or motivation. The interference in some features (e.g., the distinction of /i/ from /ɪ/ or /ɛ/ from /æ/) manifests itself more consistently even though the LOR is long and the degree of motivation is high. For these features, only an early AOA comes into play. The interference in other features (i.e., vowel duration and the distance between /i/~ /æ/) manifests itself consistently, but the degree of interference is reduced according to the difference of non-linguistic factors, such as an increase in LOR.

(4) Do individual differences in the number of Korean vowel categories affect the production of the number of English vowel categories?

Based on the assumption that some Koreans have 3 front vowel inventories: /i/, /ɛ/ and /æ/, while others have only two vowel inventories: /i/ and /ɛ æ/, the distance between Korean vowels /e/~/ɛ/ and English vowels /ɛ/~/æ/ are compared. The result of the correlation test shows that the differences in individual Korean vowel inventories among Koreans do not affect the production of the number of English vowel categories.

CHAPTER 8

CONCLUSION

8.0 Introduction

As mentioned in chapter 1, the goals of this study are two-fold: (1) to investigate the phonetic and phonological characteristics of Korean and English vowel production of native speakers of Korean; and (2) to analyze further L2 English data produced by subjects in terms of both L1 interference and non-linguistic factors.

The findings of the present study have implications in the domains of both theory and practice. Theoretically, this research has contributed to our understanding of the relationship between interference of native language and non-linguistic factors; with regard to practice, it provides direction for ways in which English instruction in Korea might be improved. Section 8.1 summarizes and discusses the significant findings of the results and based on these results, makes suggestions and recommendations that may be of use to those who conduct research on L1 or L2 acquisition. Section 8.2 draws on these results and suggests specific implications for the English educational system in Korea, including potentially beneficial pedagogical suggestions for Korean students and instructors. Finally, section 8.3 suggests some directions for future research.

8.1 Discussion of the Principal Findings and Theoretical Implications

8.1.1 Korean (L1) production

With regard to the Korean production of the subjects, this study concludes that not all subjects manifest an identical L1 vowel space: non-linguistic factors affect the speakers' L1. One finding is that Korean (L1) produced by Korean speakers might be affected by English (L2) if he/she arrives in the U.S. before age 11 or has lived in the U.S. for a long time (at least 5 years). The production of Korean front vowels by subjects who arrived in the United States before age 11 is different from the production of other subjects in several ways. For example, subjects who arrived in the U.S. before age 11 produced lower and higher F1 values for /i/, longer vowel durations, and longer distances between /i/ and /ɛ/ than other groups. Their Korean production is closer to the production of native-like English. Not only does a subject's age of arrival affect the vowel duration and acoustic space occupied by Korean vowels, but these features are also influenced by the subject's length of residence in the United States. Those subjects whose LOR is short or non-existent produce shorter vowel durations than other groups. The F1 of /ɛ/ of the subjects whose LOR is longer was significantly different from those of the subjects whose LOR is shorter. Moreover the subjects whose LOR is longer tend to produce a longer distance between the highest and lowest Korean front vowels. Hence, we might infer that if people live in an L2 environment for a long time, some features of their L1, such as vowel duration and the acoustic space occupied by vowels, can change in a way that sounds more L2-like. Indeed, when we compared the

Koreans' acoustic characteristics of Korean production of other studies (Han 1963; Kahng 1990; Yang 1996; Lee 1998), we noticed that the production produced by the Koreans who have lived in the United States for more than three years differs from the production by Koreans who have never lived in the United States. This finding is somewhat at odds with previous research, the majority of which suggests that LOR effects are not dominant (Flege et al. 1996).

Another finding of this study in terms of Korean production is that the older subjects produced a significantly longer vowel duration and a longer distance between /e/ and /ɛ/. Such a phenomenon suggests possible language change in Korea, in that the vowel duration of Korean is getting shorter and the distinction between /e/ and /ɛ/ is being reduced. Such results confirm the claim of previous Korean researchers younger Koreans do not distinguish Korean /e/ from /ɛ/ (Hong 1991; Lee 1998). These age differences in vowel duration and the distance between /e/ and /ɛ/ suggest more attention should be placed on to the possibility of a language change in Korea.

While some Korean language researchers have investigated the variance in Korean production in terms of social factors (e.g., dialect, age, social status, education), studies that investigate the effect of L2 on Korean are extremely rare. The results of the present study suggest that the effect of L2 on L1 should not be neglected in future Korean (L1) studies. Such research becomes increasingly more important as Korean speakers participate to a greater extent in the global community: with increasing exposure to English (and other foreign languages), it is possible that their Korean (L1)

pronunciation may change—at least in subtle ways. There are also implications for the nature of Korean-English relations in immigrant families living throughout the United States. What does the Korean of these Korean-American children sounds like? Future research may provide the answer.

8.1.2 English (L2) Production

With regard to the English production of the subjects, in addition to confirming the obvious—Korean speakers' difficulty in distinguishing English /i/~/ɪ/ and /ɛ/~/æ/—this study also examined many of the more specific phonological and phonetic features of the Korean speakers' English vowel pronunciation. Results from this study suggests that there are close relationships between L2 English production and non-linguistic factors, in that subjects who arrived in the U.S. earlier, who have lived in the U.S. longer and whose motivation is higher, typically manifest more native-like pronunciation. This study also shows that in terms of distinguishing English /i/~/ɪ/ and /ɛ/~/æ/, only an early age of arrival played a significant role. Except for the subjects who arrived in the U.S. before age 11, other subjects failed to distinguish these vowels, resulting in the reduction of the number of vowel categories. Such a result is similar those of other researchers who claim that adult Korean learners cannot distinguish English /i/ from /ɪ/ (Kim 1994; Flege, Bohn & Jang 1997) and /e/ from /æ/ (Ingram & Park 1997; Flege, Bohn & Jang 1997) even though they have lived in the United States for a long time. In addition, such a result supports the general belief that age of arrival in an L2 environment is the most important factor in L2 learning (Asher & Garcia 1969;

Fatham 1975; Suter 1976; Long 1990; Thomson 1991; Larsen-Freeman & Long 1991; Kim 1994; Flege et al. 1996).

On the other hand, for F1 and F2 values, the vowel duration, the distance between the highest and lowest vowels, and the degree of voicing, not only does age of arrival play a significant role, but also does length of residence. For example, /i ɪ æ/, as produced by the subjects who arrived in the U.S. earlier and those who have lived in the U.S. longer, resulted in a more native-like production. In terms of vowel duration, the distance between the highest and lowest vowels and the degree of voicing, subjects who arrived in the U.S. earlier and those who have lived in the U.S. longer typically manifest a longer vowel duration, a longer distance between the highest and lowest front vowels and more degree of voicing effect. Their production is more similar to that of native English speakers. Here, vowel duration is affected by chronological age, as well as motivation.

In addition, this study demonstrates that there are relationships among the ultimate L2 productive ability, specific language features and non-linguistic factors. For example, in terms of the acoustic space occupied by vowels and vowel duration, even though the production is improved by the increase of the length of residence or motivation, if a Korean arrives in the U.S. after age 11, he/she cannot produce native-like pronunciation. Hence, if researchers focus on a native-like production, they can assert that only age of arrival in the L2 environment plays a significant role, while researchers who focus on the improvement or the reduction of a foreign accent can

claim that other factors (such as length of residence, age or motivation) also affect the L2 production. On the other hand, the ability to achieve native-like voicing effects in English appears to be acquired relatively quickly by Korean speakers. Only those subjects whose length of residence in the U.S. was relatively short (e.g., no longer than 3 years) did not consistently produce native-like voicing effects. Such a finding supports the result of Kim's (1994) study that targeted Koreans whose length of residence was more than eight years. She shows that there is no influence in terms of age of arrival in the L2 environment effect, in that all subjects produce a similar degree of voicing effect to that of native English speakers.

This study suggests that these Korean speakers' difficulty in the production of English is the result of Korean interference. In terms of the types of interference, some Koreans overlay Korean behavior onto English production while others compromise between Korean and English vowel systems. With respect to the L1 interference, we can conclude the following:

- Korean interference in some features appears only in the early stage of L2 learning and then disappears.
- Interference in other features manifests itself more consistently, even though the subject's length of residence is long and the degree of motivation is high. For these features, only an early age of arrival plays a role.
- Interference in yet other features is manifested, but the degree of interference is gradually reduced; subjects never seem to achieve native-like proficiency.

The discovery of the above results may explain the contradictory results of the effect of length of residence or motivation in previous studies. For example, if research targets specific linguistic feature, such as the distinction of /i/~/ɪ/ or /ɛ/~/æ/, length of residence may not play a significant role. However, if the research addresses formant-based variables, the length of residence may play a significant role.

Moreover, this study suggests that there are differences even among the linguistic features in which the length of residence or other non-linguistic factors play a significant role. For example, some features improve with a minimal length of residence, e.g., one, two or three years, while for other features, the length of residence that required is relatively longer, e.g., more than five or eight years. Flege (1987) attempted to explain the difference of the length of residence effect within the differences of linguistic features between L1 and L2. He claimed that in terms of acquiring new vowels (i.e., those not present in L2), the length of residence plays a more significant role: advanced learners can produce new vowels better than beginning learners. On the other hand, in terms of L2 vowels that are similar to L1 vowels (i.e., those vowels that are said to be "shared" by the two languages), even advanced learners have difficulty producing native-sounding segments. They pronounce the target vowel in terms of an appropriate phonological category (broadly speaking), but they do not provide a native-like phonetic realization. One might further suggest that this situation is what makes for an L1 listener's perception of a "foreign accent."

This study suggests that to investigate the effect of interference and non-linguistic factors, the phonological and phonetic features of language must be more

carefully distinguished. Case in point is the claim that length of residence affects the production of L2 vowels. Obviously, this claim is too broad and general and it should be restated, such that: length of residence of more than 5 years affects the distance between the highest and the lowest front vowels. However, it cannot result in a native-like production. This claim now takes into account the complexity of length of residence and its impact on vowel production. Moreover, these findings suggest the importance of acoustic phonetic studies using instrumental methods that make it possible to detect very specific features of production, such as the degree of height (F1), fronting (F2), duration, and so forth.

In addition, this study suggests the need for additional study on the sequence of acquisition for L2 pronunciation. Though the sequence of L2 acquisition in grammar has been studied extensively, phonological or phonetic L2 acquisition has not received as much attention. According to Koo (1998), only the order of L1 acquisition has been studied; for example we know that L1 learners learn the /b d a/ sounds first, while the /f/ and /s/ sounds are difficult to acquire. However, this study suggests that detailed learning order in L2 pronunciation merits future research.

8.2 Implications on Teaching English in Korea

The results of the present study give rise to several implications regarding the English educational system in Korea, which may be useful to both English learners and instructors. Among possible suggestions for better English pronunciation acquisition, this chapter proposes four suggestions: a modification of the college English curriculum as a way of balancing theoretical and practical courses; an increase in authentic

speaking as provided by more native-English teachers; an offering of technology in instructional material; and an adjustment in ESL/EFL pedagogical practices.

Any modification of a college English curriculum requires a delicate balance between theory and practice. This study suggests an increase in courses that focus on more practical English teaching in conjunction with a theoretical background. Nowadays, the number of people who consider good English pronunciation to be a vital skill for global communication is growing. Evidence of this social shift is that according to statistics available on line at Aladdin.com (http://www.aladdin.co.kr), some best-selling books in English and language sections are the ones that provide special tips to improve English pronunciation. However, Korea colleges and universities still tend to overly focus on a theoretically-oriented English teaching curriculum, such as teaching English literature or history with an emphasis on improving reading skills. For example, at Yonsei University, English literature or history classes are more than 70 percent of the total available English courses. This may be one reason that Korean speakers have difficulty in English pronunciation as shown in the present study. Indeed, students need to learn more practical English, such as listening and conversation, with more practice on English pronunciation. When we consider that most of the English teachers in Korea are people who major in English and/or English education, students who major in English or English education should be provided more intensive courses that can teach practical skills, including pronunciation. One example of a highly effective course may be a course that teaches English

pronunciation combined with an acoustic phonetic study. For example, one of the findings of the present study is that the mean degree of height and fronting of English and Korean vowels differs, at least a little, even between vowels represented by the same phonetic symbol. If such a concept is taught in the phonetics class, the students can not only see but also understand the acoustic phonetic characteristics of Korean and English vowels. In this learning environment, noticing the difference between Korean and English will be achieved more easily and quickly.

The present study suggests that age of arrival and length of residence affect the English production of the Korean learner, which means that the L2 learners who are exposed to L2 input earlier and who are exposed to a larger amount produce a better L2. Hence, we can infer that greater use of authentic English will facilitate native-like production. When we consider that only a few learners are afforded the opportunity to visit an English speaking country to learn English, one possible way is to increase the use of authentic materials and native-English teachers in the ordinary English classes. It would be to the students' advantage if they were exposed to a range of English sounds spoken by native speakers and imitated those sounds, as well as the positions of the teacher's lips and tongue. For all the advantages of having native English teachers, there are, of course, disadvantages. According to Kang (2001), some native English teachers are less qualified to teach pronunciation because they do not have any linguistic or ESL background, so they may have difficulty correcting students' pronunciation and explaining different placement of the tongue and ways of articulation.

However, if we are more prudent in choosing native English teachers and place them in appropriate positions, balancing them with Korean (L1) speaking teachers, it may counteract any disadvantage thereby increasing pedagogical effectiveness.

Another suggestion for more effective English pronunciation teaching is to offer technology-based instructional material. As mentioned above, qualified native English teachers can assist in English pronunciation learning. However, actually to employ qualified English teachers is not as easy as it seems. In this situation, properly used technology instructional material can be a great resource, for it can assist in the teaching of native Korean (L1) teachers and learning of Korean students. For example, English teachers or learners can use the programs that can provide authentic sounds of native English speakers, next record Korean students' pronunciation, and then compare them to the pronunciation of native English speakers. In this study, to investigate the Korean and English production of native Korean speakers, Speech Analyzer Software was used. This software might also be able to be used as a teaching device. Students could record their pronunciation and then compare it to that of native English speakers. For example, when students learn the English vowel /æ/, students then read some words, including /æ/, and compare the vowel height, fronting, duration, and so forth with those of native English speakers.[16]

[16] Since the major purpose of Speech Analyzer Software is not teaching L2, it is not likely to be ideal for teaching English pronunciation. However, the use of programs or devices designed for pedagogy using a similar method can help the English pronunciation of Korean speakers.

Lastly, the adjustment of pedagogical practice to account for differences between English and Korean is suggested. Examples and suggestions are offered as follows:

- */i/ and /ɪ/ distinction*

This study has shown that Koreans fail to distinguish English /i/ and /ɪ/ even if their LOR has been lengthy but their arrival in the United Stated is after age 11. One possible reason for this phenomenon may be the instruction of English pronunciation in Korea. In Korea, teachers usually explain the difference between English /i/ and /ɪ/ in terms of only a durational difference. They do not, however, teach the phonological system of English, that English has the height and fronting distinction. Indeed, Kang (2001) investigated problems associated with the education of English pronunciation and found that even best selling books on English pronunciation have many mistakes on the description of the sounds. Among the books with incorrect vowel descriptions, Kang explained that some books do not mention the tense/lax distinction in English. In addition, many Koreans use a Korean/English dictionary, but even a dictionary has its limitations, as the differences are marked with only durational differences: e.g., *bead* is transcribed as [bi:d], while *bid* is transcribed as [bid] (*Essence English-Korean Dictionary* 1995). In order to improve the English front vowel pronunciation of native Korean speakers, it is necessary to teach the differences between English and Korean vowel inventories, as well as explain the differences among each pair of vowels. For example, teachers and books should teach that English /i/ is higher, more fronted and

longer than the English /ɪ/ vowel. In addition to such a phonetic description, showing pictures of typical lip and tongue positions of native English and having students imitate the lip and tongue positions will be helpful. Here, it would be to the students' advantage if they regularly spend time in front of a mirror to check the accuracy of the placement of the tongue or lips. In addition, accompanying listening exercises and activities that function to distinguish these two vowels is suggested in preparing the ESL student for accuracy. Such a comprehensive pedagogy will also serve to increase students' confidence.

- *Distinction and Pronunciation of /e/, /ɛ/* and /æ/

In terms of the vowel distinction, older Korean speakers tend to be more successful in distinguishing Korean 에 /e/ from 애 /ɛ/. Younger learners, however, tend to have much more difficulty differentiating these vowels. Hence, in the past, we might have been able to tell Koreans to exploit the difference between Korean 에 /e/ from 애 /ɛ/, so that they could better understand the English-like distinction of /e ɛ/ from /æ/. However, we cannot use this strategy any longer since younger Korean speakers no longer distinguish Korean 에 /e/ from 애 /ɛ/. Moreover, even though the Korean learners can distinguish English /ɛ/ from /æ/, this does not mean that they produce native-like /ɛ/ and /æ/ because these vowels are not exactly the same even though they are represented with the same phonemic symbols. Hence, incorporating some special pedagogical practice to teach these English vowels is necessary.

This study shows that the most problematic pronunciation among Koreans is English /æ/. The acoustic data indicate that the vowel height of English /æ/, as produced by native English speakers, is lower than that produced by native Korean speakers. Such a phenomenon indicates that native English speakers move their jaw downward more than native Korean speakers. Furthermore, it may be the result of Korean speakers' confusion between English /ɛ/ and /æ/ (Ingram and Park 1997; Flege, Bohn & Jang 1997), as mentioned above, and Korean interference since Korean does not have /æ/. Hence, ESL textbooks, in conjunction with instructors, should teach that there is a clear distinction between English /ɛ/ and /æ/, so that when Koreans pronounce English /æ/, they will have to move their jaw down, while opening their mouth wider. With repetitive jaw activities, the movement will become more natural, hence producing a vowel sound that resembles native-like quality. In addition, since the values of F2 of English /æ/ as produced by native English speakers are a lower than those of native Korean speakers, native Korean speakers have to practice, giving more constriction on the back of the tongue to produce a native-like pronunciation. The same instruction applies as in the case of the /i/ and /ɪ/ distinction: pictures of jaw and mouth positions of native English speakers, augmented with listening exercises to distinguish /ɛ/ and /æ/, will prove helpful with L2 pronunciation.

- *Vowel Duration and Lengthening Effect*

While English instructors in Korean have focused on the durational difference between English /i/ and /ɪ/, they do not teach that the inherent vowel duration of English

is systemically longer than the counterpart Korean vowels. However, it seems that one important reason for Korean speakers' foreign accent may be caused by the shorter duration of English vowels than the duration produced by native English speakers. Hence, English instructors should teach the inherent duration of English. Furthermore, students should know that American English /i/ and /e/ are phonetically realized as diphthongs.

With regard to the lengthening effects based on the voicing of following consonant, Korean speakers whose LOR is less than one year produce less of an effect than do native English speakers. In addition, since the effect of length of residence is significant in terms of the duration and the voicing-dependent vowel duration, we can infer that having students listen to authentic English pronunciation input will augment their English pronunciation.

8.3 Further Research

Even though this study has systematically investigated the relations of various phonological and phonetic features of Korean and English and various non-linguistic factors, more research is needed.

One such research area is the study of the interaction of one non-linguistic factor with the other non-linguistic factors. For example, in the present study, since the target subjects were all adults, all the subjects whose AOA was less than age 11 had more than 8 LOR years. Hence, the interaction effect, such as AOA x LOR or AGE x LOR, could not be observed. However, based on the assumption that the LOR effect

may be greater in a younger AOA group or younger AGE group, we can investigate how the LOR effect differs according to AOA group or AGE.

This field of research also needs to target other non-linguistic factors, such as gender, formal instruction, education degree and occupation to compare those results with the results of this study. For example, in a future study, if the data of both male and female subjects are collected, the gender differences in the L2 production and the interaction effect between gender and other non-linguistic factors will be learned. Since females are arguably more language-sensitive (Asher & Garcia 1969), we can infer a result that shows female superiority in L2 production; similarly, there is the possibility that the other non-linguistic effects are greater in females than males. In addition, since this study targets only the people who speak a Seoul dialect, another recommendation is to investigate other dialects of Korean and see how different dialects result in different productions of English.

Different linguistic factors also need to be examined. For example, one can target back vowels even though the present study targeted only front vowels. The production of vowels can be elicited from a different environment, such as isolated vowels, minimal pairs, natural conversation and so forth, while in the present study, the vowels were embedded in carrier sentences. In addition, other linguistic features related to vowel production can be studied. For example, the relation between stress and duration, the production of the vowel glide, vowel epenthesis and so forth are some other fields of study.

One interesting issue in this field is the relationship between perception and production. For example, can the Korean speakers who distinguish /i/ from /ɪ/ or /ɛ/ from /æ/ in perception pronounce these vowels in a native-like way? Conversely, can the Korean speakers who can pronounce /i ɪ ɛ æ/ with a native-like production, distinguish these vowels in perception? Hence, more advanced and elaborated perception study concerning more specific linguistic features and non-linguistic factors should be conducted.

Lastly, a future study focusing on the acquisition sequence of pronunciation would be worth pursuing. This current study is limited to only the production of English front vowels, as produced by Korean speakers, but further research is needed to target all vowels as produced by various language speakers and to see whether or not the acquisition sequence of vowel pronunciation is the same in all languages and all vowels. In addition, due to the scope of limitations, this study could not offer an explanation for how some features are more difficult to overcome while other features are easier to learn. However, if the scales of this study were enlarged, we may be able to explain some of these reasons.

APPENDIX A

BACKGROUND QUESTIONNAIRE

A.1 Original Questionnaire

* 성별 :남___ 여____

* 귀하가 태어나신 연도는? (예: 1973 년도) _____년도

* 귀하의 최종학력은? _____

* 귀하의 현재 직업은? ( )학생 ( )기타 _____

학생이시면, 전공은? _____

* 귀하의 아버지의 직업은? (혹은 어머니의 직업)

( )회사원 ( )공무원 ( )자영업 ( )전문직, 학생 ( )기타 _____

* 귀하의 아버지의 최종학력은? _____

* 귀하가 태어나신 지방은?

( )서울 및 경기도 ( ) 다른지방 : _____도

* 귀하는 어느지방에서 초등교육을 시작하셨습니까?

( )서울 및 경기도 ( ) 다른지방 : _____도 미국: _____주

* 귀하는 서울 및 경기도에 얼마나 사셨습니까?
_____년 (부터 까지)

* 귀하는 어느지방 방언을 사용하십니까?
(표준어를 사용하시는분은 서울경기지역에 표시하여주십시요.)

( )서울 및 경기도 ( ) 다른지방 : _____도

* 귀하의 아버지는 어느지방 방언을 사용하십니까?
(표준어를 사용하시는분은 서울경기지역에 표시하여주십시요.)

( )서울 및 경기도 ( ) 다른지방 : _____도

* 귀하의 어머니는 어느지방 방언을 사용하십니까?
(표준어를 사용하시는분은 서울경기지역에 표시하여주십시요.)

( )서울 및 경기도 ( ) 다른지방 : _____도

* 국어나 영어발음을 하는데에 어려움을주는 건강상의 문제가 있으십니까?
(예: 말더듬, 인후염, 등등)( )예 ( )아니요
있으시면 자세히: _____

* 영어를 처음 배우신 나이는? _____세

(중요)* 미국에 살았던 기간이 얼마나 되십니까?
_____년 (_____년____월 ~ 2003 년 __월)
(　　) 없음

(중요)* 귀하는 몇 살에 미국에 오셨습니까 (만나이)?

(　) 18 세 이전: _____세　　(　) 18 세 이후: _____세　(　)

* 평균적으로 하루에 몇 시간 정도 영어를 들으십니까? _____시간 _____분
방법_____

* 평균적으로 하루에 몇 시간 정도 미국인과 영어로 말하십니까? _____시간 _____분

* 혹시 영어가 모국어인 사람과 함께 사신적이 있으시다면 얼마 동안 사셨습니까? _____ 년
_____달

* 현재 영어회화 학원을 다니거나 다니신 경험이 있습나까? _____년동안_____시간/일주일

자세히_____　　강사:_____미국인 _____한국인

* 현재 영어 ' 발음교육' 을 받거나 혹은 받은 경험이 있습니까?
(　)예_____　　(　)아니요

* 귀하는 본인의 ' 국어' 발음이 얼마나 정확하다고 생각하십니까?

매우 정확하지않다　조금만 정확하다　보통이다　정확하다　매우 정확하다
◀(　)————(　)————(　)————(　)————(　)▶

* 귀하는 본인의 ' 영어' 발음이 얼마나 정확하다고 생각하십니까?

매우 정확하지않다　조금만 정확하다　보통이다　정확하다　매우 정확하다
◀(　)————(　)————(　)————(　)————(　)▶

* 귀하는 얼마나 영어발음에 신경을 쓰십니까?

매우 조금 쓴다　보통 이하 쓴다　보통이다　많이 쓴다　매우 많이 쓴다
◀(　)————(　)————(　)————(　)————(　)▶

* 귀하는 좋은 영어발음을 하기위해 얼마나 노력을 하십니까?

매우 조금 노력　보통 이하 노력　보통이다　많이 노력　매우 많이 노력
◀(　)————(　)————(　)————(　)————(　)▶

* 귀하는 정확한 영어발음이 직장을 갖기위해 또는 시험준비를 위해 중요하다고 생각하십니까?

전혀 중요하지않다 조금만 중요하다 보통이다 중요하다 매우 중요하다

◀-( )————( )————( )————( )————( )-▶

* 귀하는 정확한 영어발음이 직장을 갖기위함이 아닌 다른 목적으로 중요하다고 생각하십니까?

전혀 중요하지않다 조금만 중요하다 보통이다 중요하다 매우 중요하다

◀-( )————( )————( )————( )————( )-▶

A.2 English version of Questionnaire

* Sex: ____Male _____Female

* Year of birth: _____

* What is the highest level of school you have completed? _____

* What is your current occupation?

__ student __ other: _____

if you are a student, hat is your major?_____

* Father's occupation: _____

* Highest level of school father has completed: _____

* In which province were you born?

___ Seoul or Kyengki ___ Other Province _____

* In which province did you start public school?

___ Seoul or Kyengki ___ Other Province _____

* Experience living in the Seoul or Kyengki: _____years (from to)

* Your dialect : ___ Seoul or Kyengki ___ Other Province _____

* Father's dialect: ___ Seoul or Kyengki ___ Other Province _____

* Mother's dialect: ___ Seoul or Kyengki ___ Other Province _____

* Are you experiencing any current difficulties with your speech (e.g. dental problems, laryngitis, etc.)?

If 'yes,' explain briefly:

* Age at which you began English learning: _____

* Period of stay in the U.S.: _____ year(s) _____month(s) from to

( ) None

* Age at arrival in the U. S.:

( ) before 18: _____ ( ) after 18: _____

* In an average day, how many hours do you spend listening to English?

_____ hour(s) _____ minutes

* In an average day, how many hours do you spend speaking English?

_____ hour(s) _____ minutes

`* Experience living with native speakers of English:

( ) _____year(s) _____month(s) ( ) No

* Have you ever taken a English speaking class? __ yes __ no

If 'yes,' explain briefly:

* Pronunciation training:

( )Yes: _____ ( ) No

* How **clear** do you think your pronunciation of Korean is?

1	2	3	4	5
not at all	a little	average	clearer than average	very clear

* How **clear** do you think your pronunciation of English is?

1	2	3	4	5
not at all	a little	average	clearer than average	very clear

*How much **attention** do you pay to your pronunciation of English?

1	2	3	4	5
None at all	a little	average	more than average	a lot

*How much **effort** do you pay to your pronunciation of English?

1	2	3	4	5
None at all	a little	average	more than average	a lot

* How **important** do you think accurate English pronunciation is (in order to get a job or to take a examination)?

1	2	3	4	5
not at all	a little	average	somewhat important	Very important

* How **important** do you think accurate English pronunciation is (for other reasons. i.e. to integrate into the American society?

1	2	3	4	5
not at all	a little	average	somewhat important	very important

APPENDIX B

SPEECH SAMPLES

B.1 English Speech Samples

1. Say hid for me
2. Say heed for me
3. Say hayed for me
4. Say head for me
5. Say had for me
6. Say bid for me
7. Say bead for me
8. Say bayed for me
9. Say bed for me
10. Say bad for me
11. Say bit for me
12. Say beat for me
13. Say bait for me
14. Say bet for me
15. Say bat for me

B.2 Korean Speech Sample

16. 이건 히다라고 해요 'That's called hida'

17. 이건 헤다라고 해요 'That's called heyda'

18. 이건 해다라고 해요 'That's called hayda'

19. 이건 비다라고 해요 'That's called bida'

20. 이건 베다라고 해요 'That's called beyda'

21. 이건 배다라고 해요 'That's called bayda'

22. 이건 비타라고 해요 'That's called bita'

23. 이건 베타라고 해요 'That's called beyta'

24. 이건 배타라고 해요 'That's called bayta'

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BIOGRAPHICAL INFORMATION

Ji-Eun Kim received a Ph.D. in Linguistics at The University of Texas at Arlington in 2004. She received her B.A. in 1996 from Ewha Women's University in Korea and M.E.T. in Education specializing TESOL in 1999 from The University of Texas at Arlington. Her research interests are second language acquisition, Korean linguistics, TESOL (Teaching English to Speakers of Other Languages), Phonetics and Phonology and Sociolinguistics. Currently she is a professor at World Languages Division, Brookhaven College of the Dallas County Community College District, where she teaches Korean and ESOL.