Pronunciation proficiency in the first and second languages of Korean–English bilinguals

GRACE H. YENI-KOMSHIAN
University of Maryland

JAMES E. FLEGE and SERENA LIU
University of Alabama

This study examined pronunciation proficiency in both the first (Korean) and second (English) languages of bilinguals. The participants were adult immigrants whose age of arrival in the USA ranged from 1–23 years. English and Korean sentences were rated by native listeners to obtain measures of pronunciation proficiency. English pronunciation of participants with ages of arrival of 1–5 years was close to monolinguals, heavier accents were noted as ages of arrival increased from 6 to 23 years. Korean pronunciation of participants with ages of arrival of 1–7 years was distinctly accented, while those with ages of arrival of 12–23 years were rated the same as monolinguals. Participants with ages of arrival of 1–9 years pronounced English better than Korean, whereas the reverse was true for ages of arrival of 12–23 years. Overall, the results were more consistent with the view that deviations from native pronunciation result from interactions between the languages of bilinguals rather than with the view of a maturationally defined critical period for language learning.

Studies which have examined the effect of age of learning on the pronunciation of a second language (L2) have largely ignored the issue of how bilinguals pronounce their first language (L1). The two studies that report on L1 pronunciation are based on self-ratings (Flege, Munro and MacKay, 1995; Weber-Fox and Neville, 1996). Both of these studies show that those learning L2 before ages 10 or 11 rate themselves relatively better in pronouncing their L2 than their L1, and older L2 learners rate themselves better in L1 than L2. To the best of our knowledge, no previous study has carried out comparable levels of analyses of pronunciation proficiency, in both the L1 and L2 of bilinguals, within a developmental framework where age of L2 learning is a major factor.

The bilinguals tested in the present study were native Koreans who emigrated to the USA at different ages and who learned English as a second language. They were evenly stratified according to their age of arrival (AOA) in the USA, which was used as an index of age of L2 learning. Among the tasks administered to this group of bilinguals were speech production tests, to assess pronunciation in L1 and L2, and an English grammaticality judgement test (GJT) to assess morphosyntax in L2. The results of an examination of AOA effects on L2 pronunciation and L2 morphosyntax in this group of participants were recently published (Flege, Yeni-Komshian and Liu, 1999). The findings showed a strong AOA effect on L2 pronunciation, revealing an inverse relationship between AOA and pronunciation proficiency. In contrast, for morphosyntax, the effect of AOA became non-significant when variables confounded with it were controlled. The results showed that performance on the GJT was affected by the number of years of schooling in the USA and amount of English used by the bilinguals. These findings reveal that increased years of schooling in the USA and L2 use enabled them to acquire aspects of English grammar at native-like levels, but that pronunciation was largely determined by age of L2 learning (i.e., AOA). Working with the same group of bilinguals, the present study evaluated AOA effects on overall pronunciation proficiency in L1 and L2. The aims of the present study are to determine if native L1 pronunciation is retained when an L2 is acquired, to examine age effects on L2 pronunciation learning, to compare the relative balance between L1 and L2 pronunciation proficiency, and to examine background factors.
that may contribute to different patterns of L1/L2 proficiencies.¹

The design of the present study has age of L2 learning (AOA) as a primary factor. The findings are then relevant to the critical period hypothesis (CPH). The CPH posits that humans are optimally suited for learning one or more languages during a critical period, estimated by Lenneberg (1967) to be between age two and puberty, and that past this critical period, there is a major decline in language learning ability. Penfield and Roberts (1959) were among the first to write about children's special abilities in learning languages. They state that "before the age of nine to twelve, a child is a specialist in learning to speak. At that age he can learn two or three languages as easily as one" (p. 235). Lenneberg (1967) advanced the CPH for first language acquisition by presenting neurological arguments (e.g., the course of neuronal maturation in the human cortex, the onset of hemispheric lateralization for language function, loss of neural plasticity at puberty, recovery of language following brain injury) to estimate the beginning and end of the critical period (CP). Although subsequent research has not supported some of these arguments (Krashen, 1973; Dennis and Whitaker, 1976, regarding the onset of hemispheric lateralization; and Kaye, Grady, Haxby, Moore and Friedland, 1990; Karbe, Thiel, Weber-Luxenburger, Herholz, Kessler and Wolf-Dieter, 1998, regarding the loss of plasticity at puberty), the notion that there is an optimal or sensitive period for language learning is intriguing and continues to attract researchers interested in L1 and L2 acquisition.

Interest in the CPH has generated a large body of empirical research aptly described by Bialystok and Miller (1999) as extraordinarily heterogeneous. These studies have employed different methodologies, subject groups, tasks, and language areas. There have been attempts to identify the required characteristics of critical periods in development (Colombo, 1982; Bornstein, 1989) and extensive discussions in favor of or against the CPH in the context of L2 acquisition (e.g., Birdsong, 1999). There have also been attempts to define the conditions necessary for its support or rejection in second language acquisition (e.g., Long, 1990; Harley and Wang, 1997; Bialystok and Hakuta, 1999; Bialystok and Miller, 1999).

Advocates of the CPH use age of learning as the primary index of the individual's neural maturational state and do not emphasize the effects of experiential factors that co-vary with age. The evidence they require for supporting the CPH in L2 learning is for younger learners to have native-like pronunciation and for older learners to deviate from native pronunciation. In fact, many studies of L2 pronunciation show an age of learning effect that favors early L2 learners (Asher and Garcia, 1969; Fathman, 1975; Oyama, 1976; Tahta, Wood and Lowenthal, 1981; Patkowski, 1990, 1994; Flege, Munro and MacKay, 1995; see research reviewed in Scovel, 1988; Long, 1990, and Harley and Wang, 1997). There are, however, studies reporting on cases of late L2 learners (age 12 and older) who were rated by a majority of native listeners to have attained native-like proficiency (Toup, Boustagui, Tigi and MoseIle, 1994; Bongaerts, van Summeren, Planken and Schils, 1997; Bongaerts, 1999). There are problems with using age of L2 learning as the index of the neural-maturational state of the individual because it is confounded with a host of experiential variables that may also have an impact on language learning. For example, many studies on the effects of age on L2 learning, including the present study, are conducted with immigrants to the USA or Canada. In these studies, age of L2 learning, as indexed by AOA, is confounded with variables that may affect achievement in L1 and L2, such as years of schooling in the native and/or the host countries, or length of residence in the host country. Thus an age effect, as exhibited by a negative correlation between AOA and L2 proficiency, may not support or refute the CPH or any other theoretical position (Flege, 1987a, 1998, 1999; Bialystok and Hakuta, 1999). It is important to note that the often demonstrated negative correlation between age of L2 learning and level of attainment is a finding accepted by all. The problem has to do with the interpretation of an age of L2 learning effect.

One solution to the problem of interpreting age of L2 learning effects was recently proposed by Bialystok and Miller (1999). They delineated three types of evidence that are needed to support the CPH. The first has to do with demonstrating a discontinuous function in relation to variations in age of L2 learning. The argument is that if age-related changes are gradual and linear then they are attributable to cognitive changes and not necessarily to a biologically defined critical period. The shape of an age-related function that is attributable to a critical period should be nonlinear, reflecting higher proficiency levels during the critical period (birth to puberty) and a marked reduction in proficiency at the end of the period (Bialystok and Hakuta, 1999). The second type of evidence proposed by Bialystok and

Miller (1999), is that younger L2 learners (those in the critical period) should perform at the same level as monolingual speakers. We expand this point to include the expectation that L2 learners, who are past the critical period, should have a detectable accent.2

The question of what would constitute support for the CPH from L1 pronunciation must also be raised. The logical answer has to be that the critical period applies to L1 as well as L2, especially for pronunciation, since it is normally acquired at home and does not rely heavily on formal schooling. This means that L1 pronunciation of all bilinguals should be native-like. The observation of an accent in the L1 would not disprove the existence of a critical period for L2 learning. It would, however, strongly suggest that conditions other than the critical period govern pronunciation proficiency in bilinguals.

To summarize, the evidence needed to support the CPH from L2 pronunciation consists of a significant age of learning effect reflecting a nonlinear function that marks the age range of optimal L2 learning during the critical period, native-like pronunciation in early L2 learners, and accented pronunciation in late L2 learners. The evidence needed to support the CPH from L1 pronunciation is that bilinguals should not differ from monolinguals.

There are some researchers who do not adopt the CPH. In general, they view L2 learning as a process that may be influenced by the nature of the interaction and/or interference between the L1 and L2 of bilinguals, and not by the age of L2 learning alone. In studying language learning and performance in bilinguals, they examine the effects of factors such as the level of L1 development prior to L2 learning (Oyama, 1979), code switching (Grosjean, 1998), the bidirectional L1–L2 influences (Flege, 1995, 1998, 1999), and differences in L1 and L2 linguistic structures (Bialystok and Hakuta, 1994; Bialystok, 1997). This general position which emphasizes the interaction or interference between L1 and L2 will be referred to as the interaction or interference hypothesis (IH). We will examine predictions derived from the general IH position that differ from the CPH predictions described above.

One prediction is that bilinguals will generally differ from monolinguals of the target L2 because they have learned an L1 previously and cannot learn the L2 as “a second first language” (Grosjean, 1982, 1989, 1998). This means that bilinguals, regardless of age of L2 learning, are not expected to pronounce their L2 in the same way as monolinguals. A second prediction is tied to the outcome of the frequent code switching engaged in by bilinguals (Grosjean, 1989, 1998). Code switching is thought to result in bidirectional L1–L2 influences which contribute to pronunciation in L1 and L2 that deviates from monolingual pronunciation. Studies of voicing characteristics of word initial stop consonants produced by bilinguals in L1 and L2 (Caramazza, Yeni-Komshian, Zurif and Carbone, 1973; Flege, 1987b) have shown that production in L2 is influenced by L1. Interestingly, in the Flege (1987b) study, L1 productions were also influenced by L2, but this was not the case in the Caramazza et al. (1973) study, where only L1 perception was influenced by L2. These findings show that under certain conditions the L1 can be affected by the L2, and provide some support for the idea of mutual influence of L1 on L2.

Flege and his colleagues have developed a speech learning model (SLM) that is used to generate specific predictions regarding the attainment of segmental pronunciation of vowels and consonants in the L2 (Flege, 1995). A basic assumption of the SLM is that the phonic elements of the L1 and L2 are related to one another at the level of position-sensitive allophones, and these phonic elements exist in a common L1–L2 phonological space. This means that the phonologies of L1 and L2 are in contact and may mutually influence each other. According to the SLM, foreign accents may arise because of the decreased likelihood with increasing age that new phonetic categories will be established for L2 sounds that do not have an exact phonetic counterpart in the L1. (Phonetic categories are long-term memory representations of language-specific speech sounds.) Difficulties in forming new phonetic categories with increasing age provide an explanation for why early learners are better than late learners in pronouncing L2 speech sounds. This would be an accent in the L2 that is influenced by the phonology of L1. There are other L2 learning situations, however, where pronunciation in the L1 may be influenced by the phonology of the L2. To elaborate on this last point, we need to describe two mechanisms, proposed by the SLM, that operate to influence segmental production and perception in L1 and L2.

The first mechanism is category assimilation. This mechanism is hypothesized to operate when category formation for an L2 sound is blocked by the presence of a similar, but nonidentical, sound in the L1 inventory. The L2 learner may assimilate the pho-
nentic properties of the L2 sound into an existing L1 phonetic category, and thereby modify the original L1 phonetic category to accommodate the merged phonetic properties of the L1 and L2 sounds. An L1 phonetic category that changes as a result of the mechanism of assimilation will be used to produce and perceive corresponding L1 and L2 sounds, and will reflect the phonetic properties of each to some degree. The outcome would be pronunciation that differs from monolinguals in either language, which was also predicted by Grosjean (1989, 1998).

The second mechanism, category dissimilation, may operate when new phonetic categories for L2 sounds are formed. As stated earlier, with increasing age of L2 learning, the likelihood that new phonetic categories will be established for L2 sounds is decreased, and the L2 is pronounced with an accent. It is also the case that formation of a new phonetic category may affect the pronunciation of L1, especially in early L2 learners who manage to establish new phonetic categories that accurately represent L2 sounds. In this case, the properties of L1 and L2 phonetic elements may be restructured in order to maintain phonetic contrast among and between the elements of the common L1–L2 phonological space (Flege, 1995, 1999).

Thus, the mechanisms of assimilation and dissimilation may result in changes in the way phonetic segments are pronounced by bilinguals in their L1 and L2. Unfortunately, the SLM does not, at present, provide a metric for evaluating the extent to which the two proposed mechanisms will affect overall proficiency in pronunciation. However, if the SLM is correct, then increased phonetic learning in L2 should result in more segmental changes in L1. Applied to the present study, the model would suggest that there should be an inverse relationship between L1 and L2 pronunciation proficiency. That is, as L2 pronunciation proficiency increases, proficiency in L1 may decrease, and vice versa. In addition, if L1 is lost or attenuated through disuse (Grosjean 1982; Romaine, 1995) then pronunciation in the L2 may be enhanced because the attenuated L1 will have a weaker influence on the L2 (Flege, 1999). In these cases, L2 will be pronounced better than L1.

To summarize, predictions from the general IH position would be that the L1 and L2 pronunciation of bilinguals will not be the same as monolinguals of either language, that bilinguals will show an inverse relationship between their L1 and L2 pronunciation proficiencies, and that most bilinguals will pronounce one language better than the other.

The results of this study will be presented in five sections. In the first section, bilinguals will be com-
Table I. Group descriptions and labels. The average age and standard deviation of age at testing (T/Age), length of residence, highest educational achievement in the USA, and highest educational achievement in Korea

<table>
<thead>
<tr>
<th>Group Description</th>
<th>Label</th>
<th>T/Age</th>
<th>LOR</th>
<th>HAU</th>
<th>HAK</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOA 1-3</td>
<td>KB3</td>
<td>22.7 (2.4)</td>
<td>20.0 (2.3)</td>
<td>15.6 (0.6)</td>
<td>none</td>
</tr>
<tr>
<td>AOA 4-5</td>
<td>KB5</td>
<td>21.2 (2.5)</td>
<td>16.4 (2.7)</td>
<td>14.8 (1.7)</td>
<td>none</td>
</tr>
<tr>
<td>AOA 6-7</td>
<td>KB7</td>
<td>23.6 (3.2)</td>
<td>16.9 (3.2)</td>
<td>15.9 (1.4)</td>
<td>0.5 (0.7)</td>
</tr>
<tr>
<td>AOA 8-9</td>
<td>KB9</td>
<td>23.5 (2.9)</td>
<td>15.0 (3.2)</td>
<td>15.8 (1.4)</td>
<td>2.3 (0.9)</td>
</tr>
<tr>
<td>AOA 10-11</td>
<td>KB11</td>
<td>24.2 (4.7)</td>
<td>13.5 (4.7)</td>
<td>15.5 (1.5)</td>
<td>4.4 (0.8)</td>
</tr>
<tr>
<td>AOA 12-13</td>
<td>KB13</td>
<td>24.1 (3.1)</td>
<td>11.7 (3.2)</td>
<td>15.4 (1.1)</td>
<td>6.2 (0.9)</td>
</tr>
<tr>
<td>AOA 14-15</td>
<td>KB15</td>
<td>27.2 (5.5)</td>
<td>12.5 (5.4)</td>
<td>15.6 (1.6)</td>
<td>8.1 (0.7)</td>
</tr>
<tr>
<td>AOA 16-17</td>
<td>KB17</td>
<td>29.1 (4.3)</td>
<td>12.5 (4.2)</td>
<td>15.7 (1.6)</td>
<td>10.0 (0.9)</td>
</tr>
<tr>
<td>AOA 18-19</td>
<td>KB19</td>
<td>32.1 (5.0)</td>
<td>13.7 (5.1)</td>
<td>16.5 (2.0)</td>
<td>11.6 (1.0)</td>
</tr>
<tr>
<td>AOA 20-23</td>
<td>KB21</td>
<td>34.5 (4.7)</td>
<td>13.5 (4.5)</td>
<td>15.5 (4.0)</td>
<td>13.4 (1.9)</td>
</tr>
<tr>
<td>English monolinguals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Korean monolinguals</td>
<td></td>
<td>20.3 (2.3)</td>
<td></td>
<td></td>
<td>13.8 (1.6)</td>
</tr>
</tbody>
</table>

AOA = age of arrival in the USA, in years; LOR = length of residence in the USA, in years; HAU = highest educational achievement in the USA, the number corresponds to the level attained; HAK = highest educational achievement in Korea, in number of years; KB = Korean bilingual; EM = English monolingual; KM = Korean monolingual.

The average age across the 12 groups was between 20 and 34 years. Group differences due to age were significant \( F(11,276) = 25.73, p < .0001 \), and the differences formed three subsets of groups: KB3–5 and KM \( (M = 21) \); KB7–13 \( (M = 24) \); and KB15–21, and EM \( (M = 30) \). The average length of residence (LOR) in the USA for the KB groups was 15 years (range 12–20) and the group differences were significant \( F(9,230) = 157.36, p < .0001 \), revealing longer LORs for those who came to the USA at an early age (KB3–7) than those who came later. There were no LOR differences in the KB9–21 groups. The correlation between AOA and LOR was significant, \( r(238) = -.42, p < .0001 \).

The last two columns in Table I deal with the participants’ educational experience. The variable HAU, highest educational achievement in the USA, corresponds to the highest level of schooling completed in the USA (e.g., high school was coded as 12). The average HAU was 15 years (Junior) and there were no significant group differences. The variable HAK, highest educational achievement in Korea represents the actual number of years of schooling in Korea. The main effect in this analysis was highly significant \( F(10, 253) = 680.46, p < .0001 \). The participants in the KB3–5 groups had no schooling in Korea. For the rest of the KB groups, there was a linear increase in the number of years of schooling in Korea closely paralleling group differences in AOA. The correlation between AOA and HAK was highly significant, \( r(238) = .97, p < .0001 \).

To summarize the information provided in Table 1, at the time of testing the participants were 26 years old \( (SD = 6) \), the KBs had an LOR of 15 years \( (SD = 5) \), and almost all were university students. Those who emigrated at a younger age also tended to be younger at the time of testing, resided longer in the USA, and had fewer years of schooling in Korea than those who emigrated at a relatively older age.

The 48 participants in the KB3–5 groups (AOA 1–5) reported that they were introduced to English when they were about five years old when they first went to American schools. The participants in the KB7–11 groups (AOA 6–11) also began to learn English in the USA. The participants in the older five KB groups (AOA 12–23), were introduced to English in Korea in the first year of middle school, when they were about 12–13 years of age. The Korean school system requires students to take six years of English in High School and at least one course in English at the college level. Throughout, the emphasis is on developing skills in grammar, reading and writing rather than in speaking. The participants (AOA 12–23) reported that their English teachers were native Koreans who spoke accented English.
General procedure

All KB participants were tested individually in a quiet room in a single one-and-a-half-hour session. They and the English monolinguals (EM) were tested at the University of Maryland (except for 45 KBs who were tested in a nearby Korean church). The Korean monolinguals (KM) were tested in Seoul, Korea. The KB participants were tested by Korean–English bilingual testers and the monolinguals were tested by monolingual native speakers in their languages.

The test session began with a hearing screening test followed by an interview in which participants responded to questions concerning their schooling and language experience in Korea and in the USA. Using a five-point scale, they then rated their own abilities in their two languages, responded to a language use questionnaire, and to a set of questions regarding their motivation to learn their two languages. Following this, they participated in speech production tests designed to elicit words and sentences in English and Korean. Instructions were taped in the relevant language for each of the speech production tasks. Finally, the English-speaking participants took a grammaticality judgement test (GJT) in English. The monolinguals participated in all the tests that were appropriate to their respective languages. As indicated above, the present study is based on pronunciation ratings of sentences produced in English (L2) and in Korean (L1).

Sentence elicitation The English and Korean tests were very similar in format. Two adult male native speakers, one from each language, read the test sentences that were used to generate the test tapes. Twenty-four English and 14 Korean sentences were elicited. Given the wide range of AOA, it was anticipated that the participants would differ in their L1 and L2 proficiency levels. Thus, the task had to be suitable for a wide range of abilities. To make the task as simple as possible, a delayed sentence repetition task was used because not all of the KB participants were equally fluent in reading English and Korean. They were also provided with the text of the sentences while they listened to the taped presentation for additional support. Each sentence was elicited twice in succession, the first time following a short (1.2 sec.) delay, and the second time after a longer (4.0 sec.) delay. The participants were instructed to wait for a signal (a tone) before repeating each sentence. The test stimuli were played through a Marantz tape recorder connected to a loud speaker. The responses were tape recorded using a dynamic unidirectional Shure microphone and a Marantz audio recorder.

Preparation of the test material Prior to the final selection of the English and Korean sentences two preliminary studies were carried out to determine if there were differences due to individual sentences or delay times. In each study, 5 native listeners rated all the English or Korean sentences produced by 12 speakers consisting of 8 KBs and 4 monolinguals in each language. The KBs were selected randomly from AOA groups that were likely to produce accented speech in each language. The ratings were analyzed using a three-way ANOVA in which speaker groups, sentences, and delay times were variables. The results were the same in both studies; a significant group effect indicating better pronunciation for the monolinguals than the KBs. The results also showed no significant differences due to sentences or delays, nor were any of the interactions significant. This indicated that there were no significant differences due to specific sentences or delay times.

Five sentences from each language were selected to develop the pronunciation rating tests. Care was taken to make the English and Korean tests as equivalent as possible. To that end, the sentences selected from each language were equivalent in terms of model production time (the average duration of the English sentences was 1,916 ms, for the Korean sentences it was 2,006 ms) and were the sentences repeated after the longer delay period (in a few instances the other sentence was used because of extraneous noise or laughter). Appendix A contains the English and the Korean sentences used in the pronunciation rating tests.

The sentences were digitized at 22.0 kHz with 16-bit amplitude resolution, using a commercially available program (Cool Edit). A specialized software system developed at the University of Alabama in Birmingham was then used to present the sentences and collect the ratings. All test sentences were normalized for peak intensity. Each test run consisted of one sentence produced by 264 speakers (240 KBs and 24 monolinguals) that appeared in three different randomizations.

Listeners Ten monolingual native listeners (seven females and three males) from each language group (English, Korean) judged the pronunciation of the sentences. The average age of the American listeners was 30 and for the Korean listeners it was 24 years. All listeners were college-educated and were not phonetically trained. The English listeners were originally from the Mid-Atlantic States and had lived there for an average of 23 years before moving to Birmingham, Alabama, where the English pronunciation ratings were carried out.

It would have been preferable to carry out the
Korean pronunciation tests in Seoul, Korea, but this was not feasible. The best option available to us was to engage Koreans who had recently come to the USA from Seoul; they had lived in the USA for an average of 1.4 years (range = 0.33–4 years). All of the Korean listeners had completed college in Korea and none was fluent in English. Only two of the listeners were university students, the rest were enrolled in a special English program designed for students whose English is very limited. Of necessity, all instructions were in Korean and testing was carried out at the University of Maryland.

**Pronunciation ratings** The procedure used to obtain pronunciation proficiency ratings for English and Korean was similar. The listener faced a computer screen with a nine-point scale displayed on it. They were instructed to select a number on the rating scale that best reflected their judgement regarding how each sentence was pronounced. The endpoint labels of the English scale were: “no accent” (number 9) and “very strong accent” (number 1); and the endpoints of the Korean scale were: “very good pronunciation” (number 9) and “very poor pronunciation” (number 1). Literal translations of endpoints were not used, because the word “accent” also means “dialect” in Korean. The listeners were informed that the vast majority of speakers spoke the Seoul dialect and that there were a few who spoke other dialects. The written and oral instructions emphasized the point that their task was to judge pronunciation in terms of any native speaker of Korean and not to judge the sentences on the basis of regional dialects.

All the listeners were instructed, and also trained in practice trials, to use the whole scale in making their judgements. Listeners were tested individually in five sessions, over five days. One sentence was rated in each session, which lasted for about one and a half hours. The order in which the sentences were rated was counterbalanced.

**Initial analyses**

**The multifaceted composition of AOA** Analyses of the language background variables showed that AOA was significantly correlated with a number of the background variables. Three of the background variables correlated very highly with AOA. One of the variables is the age at which the participants reported they could first speak English comfortably (AOSEC). This confirms our original expectation that AOA would be an index of the age of L2 learning. The other two variables are: number of years of schooling in Korea (HAK) and number of years of schooling in the USA (YSU). This last variable included years of special instruction in English as well as years in regular schools. The inter-correlations among these four variables are shown in Table 2 and range from a high of .97 for AOA and HAK, to a low of .89, for AOSEC and YSU. The positive correlations among AOA, AOSEC and HAK reveal that years spent in Korean schools (HAK) is directly related to AOA and AOSEC. The negative correlations between YSU and the other three variables reflect the other side of the same coin. Thus, AOA is not simply an index of how old the participants were when they came to the USA and felt comfortable speaking English. It is also an index of the number of years of schooling in Korea, which is negatively related to the number of years of schooling in the USA.

Part of the reason for the high level of inter-correlations among these variables is that all the KB participants came directly to the USA from Korea, were attending school prior to leaving Korea and entered American schools upon their arrival in the USA. This linkage may be specific to bilinguals recruited from university campuses; however, similar findings have been reported for other bilingual populations (e.g., Bahrick, Hall, Goggin, Bahrick and Berger, 1994; Flege et al. 1995).

The correlations between the English and Korean pronunciation outcome measures with the four back-
ground variables (AOA, AOSEC, HAK, YSU) are shown at the bottom of Table 2. All the correlations are highly significant, but the correlations with AOA are slightly higher, and for this reason AOA was used as the representative single index to report the findings. Because of the high correlations between these variables and AOA, they were not used as co-variates in the analysis of the data.

**English and Korean pronunciation rating scores** Each speaker's pronunciation was rated a total of 150 times per language (ten listeners, five sentences, three repetitions). The average of the correlations of the ten listeners' ratings per language group was very high [English $M = .96 (.02)$; Korean $M = .93 (.02)$]. Similarly, the average of the correlations of the five sentences was also very high [English $M = .91 (.01)$; Korean $M = .90 (.02)$]. These high correlations provided the justification for computing an average score to represent English pronunciation and another average for Korean pronunciation, which were then used as the dependent variables in subsequent analyses. The ANOVAs were therefore by subjects but not by items.

**Results**

**Bilinguals compared with monolinguals**

A parallel set of analyses was applied to L1 and L2 pronunciation scores. In this section, we compare the KB participants' pronunciation in English and in Korean to monolingual speakers in each language.

**English** The English pronunciation scores of the 10 KB and the EM groups were entered in a two-way ANOVA with groups (11 levels) and gender treated as between-subjects variables. Gender was included as a factor because of general interest, and should differences exist they tend to favor females (Bates, Dale and Thal, 1995). The ANOVA results showed significant group [F (10, 242) = 105.65, $p < .0001$] and gender [F (1, 242) = 12.96, $p < .0004$] effects. The interaction was not significant. The gender effect revealed that females had higher scores (better pronunciation) than males. This latter finding is similar to some L2 studies (Asher and Garcia, 1969; Tahta et al., 1981) and somewhat different from Flege et al. (1995), who reported an interaction indicating an advantage for the females in the younger AOA groups and an advantage for males in the older AOA groups.

Multiple group comparisons (Newman-Keuls) revealed that the EM group obtained significantly higher pronunciation scores than all the KB groups. That is, none of the bilingual groups were rated at the same level as the monolingual group. The pronunciation scores of the ten KB groups drop with increasing AOA and tend to cluster into several groups. The participants in the youngest two KB groups (AOA 1–5) had higher pronunciation scores (closer to native-like) than the next two KB groups (AOA 6–9); they, in turn, were better than the next two KB groups (AOA 10–13). The last set of four KB groups (AOA 14–23) did not differ from each other and had significantly lower pronunciation scores than all other groups.

The pronunciation scores of the 240 KB and 24 ME participants are plotted as a function of AOA for 240 Korean–English bilinguals and pronunciation scores for 24 English monolinguals (filled circles, top left). The fitted curve is the third order polynomial function between AOA and pronunciation.

**Figure 1.** English pronunciation scores as a function of AOA for 240 Korean–English bilinguals and pronunciation scores for 24 English monolinguals (filled circles, top left). The fitted curve is the third order polynomial function between AOA and pronunciation.

The linear correlation between AOA and pronunciation scores accounted for 73% of the variance. These scores were entered into a polynomial regression analysis to determine whether the relationship between AOA and English pronunciation is better expressed in higher order terms. The analysis showed that there was a significant improvement ($p < .0001$) at the third order (cubic) polynomial over the first and second order, accounting for an additional 2% of the variance. The results of this analysis are shown in Figure 1.

A different criterion was used in the Flege et al. (1999) study to estimate the number of participants who performed in a “native-like” fashion in English pronunciation.
the variance (75%). The curve in Figure 1 displays the shape of the third order function between AOA and English pronunciation. The nonlinearity appears to be at the beginning (AOA 1–5) and at the end (AOA 14–23) of the AOA distribution.

A second polynomial regression analysis of the English pronunciation scores was carried out which included four variables as co-variates. These variables were selected because they may theoretically influence pronunciation. The variables are: amount of reported use of English, amount of reported use of Korean (See Appendix B), length of residence in the USA (LOR), and the total number of years spent in schools (Korea plus USA). This analysis indicated significant effects due to amount of English use ($p < .04$), amount of Korean use ($p < .009$), and total years of schooling ($p < .04$); however, LOR was not significant. These findings indicate that, in addition to the effect of AOA, increased use of English and more years of schooling contributed positively to English pronunciation, while increased use of Korean had the opposite effect, and LOR had no effect. The third order function in this co-variance analysis was significant ($p < .004$), explaining an additional 2% of the variance (77%).

To summarize, the bilinguals who had emigrated to the USA at a very young age (AOA 1–5 years) had relatively high pronunciation rating scores in English, but as a group they were distinguishable from monolingual speakers. With increasing AOA (6–13), there was a steady reduction in English pronunciation scores, indicating heavier foreign accents. The rate at which accents became stronger was diminished for those whose AOA was more than about 14 years. In addition to AOA effects, frequent use of English and more years of schooling were associated with increased proficiency in English pronunciation, and increased use of Korean tended to lower it; however, length of residence in the host country had no effect.

**Korean** The Korean pronunciation scores from the 10 KB and the KM groups were analyzed in the same way. The only significant ANOVA effect was for groups [$F (10, 242) = 63.98, p < .0001$]. Multiple group comparisons showed that the 11 groups formed 3 partially overlapping clusters. The lowest pronunciation ratings (poorest Korean pronunciation) were given to the participants in the three youngest KB groups (AOA 1–7); their scores were significantly lower than all other groups. At the older end of the AOA range, the results showed that four KB groups (KB13, KB15, KB19, and KB21) had pronunciation scores that were not significantly different from the KM group. The scores of the remaining three groups (KB9, KB11 and KB17) were lower than the KM group. This analysis showed that only bilinguals whose AOA was greater than 12 years (except for KB17) were judged to pronounce Korean (L1) at a level that did not differ from the ratings given to monolingual Koreans.

Figure 2 is a plot of the Korean pronunciation scores of the 240 KB and 24 KM participants as a function of AOA. The scores of the KM participants are shown at the top right (filled circles) of the figure. There were 118 KB participants (49%) who received pronunciation ratings that were within the range of the scores of the Korean monolinguals. As can be seen in Figure 2 these individuals covered a wide range of AOAs.

The linear correlation between AOA and Korean pronunciation accounted for 54% of the variance. Polynomial regression analyses were carried out to examine the relationship between AOA and Korean pronunciation scores. This analysis showed a significant ($p < .0001$) second order (quadratic) function. The variance explained with the second order function was increased by 9%, up to 63%. The curve in Figure 2 shows the shape of the second-order function between AOA and Korean pronunciation. The nonlinearity reflects the slowness in acceleration of the curve starting at about an AOA of 12 years and continuing up to the KM participants.

A second polynomial regression analysis, using the four background variables (English use, Korean use, years of schooling, and LOR) as co-variates, was carried out. The results of this analysis indicated...
that, in addition to AOA, increased use of Korean contributed positively \( (p < .02) \) to Korean pronunciation proficiency. The contributions of English use, LOR, and years of schooling were not significant. This analysis showed a significant second order function \( (p < .0001) \) and the variance explained was increased by two percent up to 65%.

To summarize, the Korean pronunciation of the majority of immigrants who came to the USA at age 12 or later was rated at the same level as Korean monolinguals residing in Seoul. The younger immigrants (AOA 1–11) were rated significantly lower than monolinguals and the lowest scores were mostly for those whose AOA ranged from 1 to 7 years. Increased use of Korean contributed significantly to improved pronunciation; however, the amount of English use, the number of years spent in schools, and years of residence in the host country had no effect on Korean pronunciation.

AOA and the four background variables used as co-variates had different effects on English and Korean pronunciation proficiency. These variables accounted for 77% of the variance in English and 65% of the variance in Korean pronunciation scores. Pronunciation functions with AOA were nonlinear for both English and Korean. As a group, the younger L2 learners did not attain native-like proficiency in L2 and were poor in pronouncing L1. Most of the 17 individuals whose English pronunciation scores were in the same range as the English monolinguals had low pronunciation scores in Korean. Only two individuals (AOA 5 and AOA 8) had L1 and L2 pronunciation scores that were within the range of the monolinguals in the two languages.

Pronunciation proficiency differences in the bilinguals' two languages

This analysis sought to compare the KB participants' pronunciation in their two languages without reference to the monolingual groups. To allow for direct comparison, the two sets of pronunciation scores were transformed to z-scores. Figure 3 displays the average pronunciation scores of the 10 KB groups for English and Korean. The correlation between English and Korean pronunciation scores was negative \( (r (238) = -.65, p < .001) \), indicating that for most KB participants L1 and L2 pronunciation scores were inversely related.

A two-way (groups x language) ANOVA was carried out to compare pronunciation proficiency in English and Korean using the z-scores. There was a significant group effect \( [F (9, 230) = 5.96, p < .0001] \) and the language by group interaction was highly significant \( [F (9,230) = 125.58, p < .0001] \). The interaction was examined by simple main effects analysis. It revealed that the English pronunciation scores were significantly higher than the Korean scores for the youngest four KB groups (AOA 1–9). In contrast, the Korean pronunciation scores were higher than English scores for the oldest five KB groups (AOA 12–23). The only group which did not show a significant difference in English and Korean pronunciation was the KB11 group (AOA 10–11); however, their scores in English and Korean pronunciation were only slightly above average.

An effort was made to find out if Korean pronunciation was better for those who had reported taking Korean lessons in the USA. The background information, provided by the participants, indicated that a certain proportion of early-arriving KBs (KB3–11; AOA 1–11) were sent to church schools or tutors to study Korean. The participants' average age was 13 years \( (SD = 5) \) when they received training in Korean, and the average duration of training was 26 months \( (SD = 20) \). The correlation between the participants' Korean pronunciation scores and months of training was only significant for the participants in the KB3 (AOA 1–3) group \( [r (20) = .57, p < .01] \). (The correlation between months of training in Korean and English pronunciation scores was not significant.) These results suggest that time spent studying Korean is associated with improvement in Korean pronunciation only among those who came to the USA at a very young age (AOA 1–3). This finding should be viewed as a suggestion that needs to be examined further since it is correlational in nature and may be reflecting the effects of other factors (e.g., the difference between families that arranged for Korean lessons and those who did not) that were not assessed in the present study.

In summary, in nine out of ten KB groups, pronunciation was better in either L1 or L2 and it was equal only in the KB11 group (AOA 10–11).
There was a negative relationship between L1 and L2 pronunciation scores. For KB3–9 (AOA 1–9), English pronunciation scores were better than Korean; for the older KB groups (AOA 12–23), Korean pronunciation was better than English. Pronunciation scores for KB11 were equal and slightly above average in both languages.

**Differences between “early” and “late” L2 Learners**

For this sample of 240 KBs, half of the participants were 11 years or younger when they came to the USA and the other half were 12 years or older. This divides the KB participants into two equal groups of “early” and “late” L2 learners. The two groups also differed in at least two other ways: the country where they began to learn English and the pronunciation proficiency of their English teachers. Although the effects of these differences are not separable, the correlations between AOA and L2 pronunciation for the early and late learners were calculated to see if the magnitudes of the two correlations differ in the direction proposed by Johnson and Newport (1989) in support of the CPH (see also Patkowski, 1990, 1994). They argued for a significant linear correlation between age of L2 learning and achievement for the early learners and a nonsignificant relationship with age for the late learners. The results showed that the correlations between AOA and English (L2) pronunciation scores were significant for both early L2 \( r(118) = -.63, p < .0001 \) and late L2 learners \( r(118) = -.51, p < .0001 \). Furthermore, the difference in the magnitude of the correlations for the early and late learners was not significant \( z = 1.43 \), suggesting that the two correlations were of comparable magnitude. The result of the early L2 learners, but not the late learners, supports the prediction.

The same analysis was carried out with Korean (L1) pronunciation. The results revealed a significant correlation between AOA and pronunciation for the early learners \( r(118) = .68, p < .0001 \) but not for the late learners. This might be in part due to the relatively small variation in the Korean pronunciation scores of the late L2 learners. The CPH for L1 predicted native-like L1 pronunciation for all participants (i.e., no significant correlation between AOA and L1). Thus, the non-significant correlation of the late learners supports the CPH, but the results for the early learners do not support the CPH.

Another set of correlations between L1 and L2 pronunciation for early and late learners was carried out to examine further the inverse relationship between L1 and L2 reported earlier (see Figure 3). For the early learners, the correlation between L1 and L2 pronunciation scores was significant \( r(118) = -.47, p < .0001 \), revealing an inverse relationship. On the other hand, the correlation between L1 and L2 for the late learners was not significant. These results suggest that the predicted inverse relationship between L1 and L2 (Flege, 1995) is limited to early L2 learners and is not supported by the late L2 learners.

**Patterns of relative pronunciation proficiency in L1 and L2**

In this section the KB participants were assigned to one of four groups on the basis of their relative proficiency in L1 and L2 pronunciation. The four groups were then compared on background factors such as AOA, LOR, education, language use, attitude, and motivation.

Figure 4 is a scattergram of English and Korean (y-axis) pronunciation scores (z-scores) for 240 Korean-English bilinguals. The dark lines in the figure correspond to the average score for each language.

-43%) consisted of participants who scored below the mean in English and below the mean in Korean; for the older KB groups (AOA 12–23), the group with the largest number of cases \( n = 104; 43\% \) consisted of participants who scored below the mean in English and above the mean in Korean pronunciation (top left); they will be referred to as the E−K+ group. The next group in terms of size \( n = 83; 35\% \) had the opposite pattern, they were above the mean in English and below the mean in Korean (bottom right); they will be referred to as the E+K−
group. Next in size was the group (n = 37; 15%) that scored above the mean in both English and Korean (top right); they will be referred as the E+K+ group. A small number of participants (n = 16; 7%) scored below the mean in both languages; they will be referred as the E-K- group.

The average pronunciation scores in English and Korean for these four groups are shown in Table 3. The four groups were compared to examine if those who were above or below the mean were equivalent. This analysis indicated that group E+K- scored significantly higher than group E+K+ in English pronunciation and significantly lower than group E-K- in Korean pronunciation. The other comparisons were not significant. As can be seen in Table 3, group E+K- had the highest English and the lowest Korean pronunciation scores compared to the other three groups.

The four groups were first compared on five background variables. These were AOA and the three variables highly correlated with it (AOSEC, HAK, and YSU), and LOR. Each variable was analyzed separately in a one-way ANOVA followed by multiple group comparisons (Newman-Keuls). The group means on these five variables are shown in Table 4. The results showed that three out of the four groups differed significantly on AOA. Each group was significantly different from every other group. Predictably, the AOA of group E-K- was the highest (they are the older immigrants) while the AOA of group E+K- was the lowest (the younger immigrants). The other two groups, E-K- and E+K+, had intermediate but significantly different AOAs.

The exact same pattern of group differences seen for AOA was also seen for (AOSEC) the age at which the participants reported speaking English easily and for (HAK) the number of years of schooling in Korea. A reverse order of group differences was seen for (YSU), the number of years of schooling in the USA. In this case, group E+K- had the highest number of years of schooling in the USA followed by group E+K+, and the least number of years were reported by groups E-K- and E-K+. For LOR, the results showed that three out of the four groups had about the same number of years (14 years) of residency in the USA, while the LOR for participants in the E+K- group was 17 years.

In summary, the participants whose English pronunciation was the best and whose Korean pronunciation was the worst (E+K-) had a distinct pattern. They were about six years old when they came to the USA, were about seven years old when they first felt comfortable speaking English, had hardly any schooling in Korea but did have about 15 years of schooling in the USA, and had resided in the USA for about 17 years. In comparison, the background variable scores for the E+K+ group were not as extreme as the E+K- group. They (E+K+) were about 11 years old when they emigrated, 12 years old when they felt comfortable speaking English, and had five years of schooling in Korea and 12 years of schooling in the USA. In contrast, the participants whose English pronunciation was below average and Korean pronunciation was above average (E-K+) showed the reverse pattern to that seen in the E+K- group. They were about 17 years old when they came to the USA, were about 19 years old when they first began to speak English comfortably, and had completed 10 years of schooling in Korea and seven years of schooling in the USA.

The profile of group E-K- is not easy to explain. Their below average performance in English pronunciation can be explained as a reflection of their being late L2 learners (AOA = 14; AOSEC = 17). This is supported by the fact that the two groups that were above average in English pronunciation (E+K- and E+K+) were younger (AOA 6 and 11) than group E-K- when they came to the USA. Possible reasons for their low scores in Korean pronunciation, however, are not readily evident. It cannot be in the domain of AOA because members of the E+K+ group came to the USA at a younger age and consequently had fewer years of schooling in Korea than those in the E-K- group. The only other explanation left is the possibility that some members of the E-K- group were not good language learners, in any language. The only evidence to support this suggestion is that, as a group, the

---

Table 3. The average English and Korean pronunciation scores (z-scores) and standard deviations in the four groups representing different patterns of relative L1 and L2 proficiencies

<table>
<thead>
<tr>
<th></th>
<th>E-K+</th>
<th>E+K-</th>
<th>E+K+</th>
<th>E-K-</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>104</td>
<td>83</td>
<td>37</td>
<td>16</td>
</tr>
<tr>
<td>English</td>
<td>-0.90 (.49)</td>
<td>1.02 (.40)</td>
<td>0.55 (.41)</td>
<td>-.77 (.52)</td>
</tr>
<tr>
<td>Korean</td>
<td>0.73 (.39)</td>
<td>-1.12 (.66)</td>
<td>0.65 (.37)</td>
<td>-.43 (.60)</td>
</tr>
</tbody>
</table>

E+ = above average in English pronunciation; E- = below average in English pronunciation; K+ = above average in Korean pronunciation; K- = below average in Korean pronunciation.

*p < .0001

---

5 The same five variables were analyzed again for groups E+K- and E+K+ (English pronunciation as a co-variate) and for groups E+K- and E-K- (Korean pronunciation as a co-variate), because of differences between group E+K- and the other two groups. This analysis did not produce any changes in the pattern of group differences.
Table 4. The average and standard deviation of background variables in the four groups representing different patterns of relative L1 and L2 proficiencies

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1) E-K+ (n=104)</th>
<th>(2) E+K- (n=83)</th>
<th>(3) E+K+ (n=37)</th>
<th>(4) E-K- (n=16)</th>
<th>F(3,236)</th>
<th>Pattern of group differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOA</td>
<td>16.94 (3.49)</td>
<td>5.89 (3.53)</td>
<td>11.10 (3.35)</td>
<td>14.25 (4.77)</td>
<td>179.23*</td>
<td>(1)&gt;(4)&gt;(3)&gt;(2)</td>
</tr>
<tr>
<td>AOSEC</td>
<td>19.14 (2.53)</td>
<td>7.43 (2.17)</td>
<td>12.10 (3.31)</td>
<td>16.81 (5.24)</td>
<td>165.32*</td>
<td>(1)&gt;(4)&gt;(3)&gt;(2)</td>
</tr>
<tr>
<td>HAK</td>
<td>9.73 (1.23)</td>
<td>0.66 (2.81)</td>
<td>4.57 (3.02)</td>
<td>7.44 (4.16)</td>
<td>184.16*</td>
<td>(1)&gt;(4)&gt;(3)&gt;(2)</td>
</tr>
<tr>
<td>YSU</td>
<td>6.67 (2.74)</td>
<td>14.87 (1.79)</td>
<td>11.57 (3.02)</td>
<td>8.13 (4.33)</td>
<td>154.44*</td>
<td>(2)&gt;(3)&gt;(4)&gt;(1)</td>
</tr>
<tr>
<td>LOR</td>
<td>12.72 (4.51)</td>
<td>17.28 (3.60)</td>
<td>13.95 (4.15)</td>
<td>13.81 (4.18)</td>
<td>19.21*</td>
<td>(2)&gt;(3)&gt;(4)&gt;(1)</td>
</tr>
</tbody>
</table>

* p < .0001

E+ = above average in English pronunciation; E- = below average in English pronunciation; K+ = above average in Korean pronunciation; K- = below average in Korean pronunciation.

In general, LOR in the host country did not have a strong effect on L2 pronunciation proficiency. The probable explanation is that the participants had a minimum LOR of eight years (M = 15), and increased LOR beyond this period did not have much of an effect. LOR may have contributed positively to the English pronunciation scores of the E+K- group, but for this group other factors, an AOA of 6 years and 15 years of schooling in the USA, also contributed positively to increased proficiency in English pronunciation.

It was of interest to examine if factors related to language use, attitudes, and motivation would add to the pattern of differences among the groups. For this analysis, we used the self-ratings of participants concerning their language use in English (Enguse) and in Korean (Koruse). The participants also responded to questions in which they were asked to judge the importance of learning English (Elearn), of learning Korean (Klearn), and to rate their motivation to learn English (Meng). Appendix B contains the items used to construct these five variables (Enguse, Koruse, Elearn, Klearn, and Meng). The group means are shown in Table 5.

For this analysis, the effects due to AOA and LOR were removed statistically by computing one-way ANCOVAs, with AOA and LOR used as covariates. The results showed a significant main effect for Enguse \[ F(3,234) = 4.48, p < .004 \] and the multiple group comparisons indicated that participants in group E+K- reported using English more frequently than all the other groups. The other three groups did not differ significantly from each other on this variable. The group differences in Koruse were also significant \[ F(3,234) = 7.87, p < .0001 \] revealing that group E+K- reported using Korean less fre-
quently than the other three groups. This second analysis also showed that the other three groups reported using Korean at comparable levels except for significantly higher Korean use in group E-K+ than group E+K+.

The same ANCOVA analysis was applied to the remaining three variables (Elearn, Klearn, and Meng) and the results showed no significant group differences. Thus, for these three variables, the apparent differences in group means, seen in Table 5, are accounted for by differences in AOA and LOR.

To summarize, the major finding of this analysis is that, when the effects of AOA and LOR were controlled statistically, the group with the highest English and lowest Korean pronunciation scores (E+K-) was also the group that used English more frequently and Korean less frequently than the other three groups. The results also suggest that frequent use of Korean is associated with above average Korean and below average English pronunciation which was seen in the E-K+ group. The group with above average scores in both languages (E+K+) used both languages equally frequently, but at levels that were lower in English than group E+K- and lower in Korean than in group E-K+.

**Listeners' pronunciation ratings versus self-ratings**

In this section, information regarding the correspondence between native listeners' ratings of pronunciation and participants' self-report are provided. Participants used a five-point scale to rate their own ability to pronounce English and Korean. The correlation between the listeners' ratings and the participants' self-ratings were significant for English \(r(238) = .75, p < .0001\) and for Korean \(r(238) = .71, p < .001\), revealing a moderately strong correspondence between these two measures. This information is of interest to researchers who have done similar work or who have analyzed data based on self-report (e.g., Hakuta and D'Andrea, 1992; Bialystok and Hakuta, 1999).

**Discussion**

**The critical period hypothesis**

As stated earlier, evidence in support of the CPH from L2 pronunciation consists of native-like proficiency in early L2 learners, a significant age of learning effect that is demonstrated by a nonlinear function reflecting increased levels of pronunciation proficiency during the critical period, and accented pronunciation in the late learners. The evidence needed in support of the CPH from L1 pronunciation is native-like proficiency regardless of the age of L2 learning.

**Pronunciation proficiency in L2**

The group results do not support the prediction of native-like pronunciation for early L2 learners because none of the KB groups, including the youngest KB group (AOA 1–5), was rated native-like in L2 pronunciation. Individual results provide partial support for this prediction since the 17 individuals whose pronunciation was rated within the range of the monolinguals had AOAs of 1–8 years.

The results showed a significant age-of-L2-learning effect in which the very young L2 learners had a mild accent, and with increasing AOAs there was a concomitant reduction in pronunciation proficiency. Although the pronunciation by AOA function was nonlinear, the shape of the function did not correspond with the predictions from the CPH. The nonlinear third order function had two relatively shallow portions of the curve at AOA 1–5 and AOA 14–23. For the participants in KB7–13 (AOA 6–13), who were mostly in the critical period when they began to learn their L2, the function was strongly linear, revealing a constant drop in pronunciation proficiency with increasing AOA. Support for the CPH would have required the initial shallow portion of the curve to extend up to about an AOA of 11 years. The results obtained met this requirement for the AOA range of 1–5 years. However, the probable reason for the flat curve at AOA 1–5 is the fact that these participants began to learn English at about the age of 5 years. Thus, these results offer partial support for the CPH which comes mainly from the performance of the late L2 learners (AOA 14–23) who were rated as having a strong accent in their L2.

The L2 pronunciation results do not correspond fully with earlier studies that have reported native-like pronunciation in participants who began learning their L2 prior to the age 6 or 7 (e.g., studies reviewed by Long, 1990). Methodological differences between this study and earlier studies may account for some of the differences. Although it is important to note that none of participants (AOA 1–19, LOR 5–7) in the Asher and Garcia (1969) study, were rated as native speakers.

It may be the case that when pronunciation is examined in the precise manner that was carried out in the present study, a mild accent will be detected even in very early L2 learners. For example, one published study (Flege, Frieda and Nozawa, 1997) reported findings that are similar to ours. In this study, English (L2) pronunciation of early L2 learners (AOA 2.6–9.6) of monolinguals was rated by native English listeners. The pronunciation ratings...
of the two groups were significantly different. In the Flege et al., (1995) study, although the group results showed no significant differences between early L2 learners (AOAs up to 7) and monolinguals, one of the listeners differentiated the pronunciation of even the youngest L2 learners from the monolingual speakers. Detection of accented L2 pronunciation in early L2 learners was also reported in two other studies (Guion, Flege and Loftin, forthcoming; Piske, Flege and MacKay, 1999). Finally, we had occasion to replicate our own findings in the course of conducting another study with some of the speakers included in the present study. English sentences produced by 24 KBs (AOA 2–9) and the 24 English monolinguals were rated by a different group of 10 native English listeners. The results showed significant differences in pronunciation between the KBs and monolinguals. This replication of the results indicates that the findings of the present study are genuine and not specific to the original group of English listeners.

Pronunciation proficiency in L1 The findings of this study indicate that native-like pronunciation in the L1 was seen in 49% of the bilinguals, most of whom were late L2 learners (AOA 12–23). Only 21% of the early L2 learners (AOA 1–11) were rated the same as monolinguals. Thus, support for the CPH from L1 is partial; it comes from individuals who were late L2 learners and from a minority of early L2 learners. The low level of proficiency in L1 among the early L2 learners substantiates the findings, based on self-report, of earlier studies (Flege et al. 1995; Weber-Fox and Neville, 1996).

Our L1 pronunciation findings are in accord with the findings of two recent developmental studies, carried out with children of immigrants who learned English as an L2 (Jia and Aaronson, 1999; Kohnert, Bates and Hernandez, 1999). The language areas assessed in L1 and L2 in these studies were lexical-semantic (Kohnert et al., 1999) and morphosyntactic (Jia and Aaronson, 1999). Both studies show that children undergo a switch in language dominance during the course of acquiring English as an L2. Viewed developmentally, the findings reveal that young L2 learners (age of L2 learning less than 8–10 years) begin by exhibiting dominance in their L1 and then switch from L1 dominance to L2 dominance with increasing experience in English. Thus by the end of the developmental phase, the early L2 learners become dominant in L2 and not in L1. The accuracy by AOA functions, in the Jia and Aaronson (1999) study, for L1 and L2 are quite similar to the results reported in Figure 3. Early L2 learners (up to about age 9 years) had higher scores in English (L2) than Chinese (L1), while the older immigrants had higher scores in Chinese. In their “Adominant language switch and maintenance hypothesis,” Jia and Aaronson (1999) suggest that the L2 learning process is quite different for early and late learners because each group experiences a different language learning environment. They present evidence to show that young L2 learners are exposed to a richer English (L2) environment than older learners, while older L2 learners experience a richer Chinese (L1) environment. This rich experience in English that the young L2 learners engage in, accompanied by an L1 that may not have been well-established or may even have been attenuated (Oyama, 1979; Grosjean, 1982; Romaine, 1995), may account for the switch in the dominant language of young immigrants learning English as an L2. It may very well be that the same switch from L1 to L2 dominance takes place in the area of pronunciation. Such a shift in dominance is not an outcome that is predicted by the CPH. Rather, this finding appears to be related to the effects of the different linguistic and social environments experienced by the early and late L2 learners.

Predictions from the CPH would lead us to expect that learning to pronounce any number of languages during the critical period would result in pronunciation that is indistinguishable from that of monolinguals. The results do not support this prediction because the KB3–11 (AOA 1–11) groups were rated significantly differently from monolinguals in both their L1 and their L2. Only two participants (AOA 5 and AOA 8), had L1 and L2 pronunciation scores that were within the range of the scores given to monolinguals. This amounts to less than 1% of the 240 KB participants, which clearly marks them as exceptions rather than the rule.

The interference andlor interaction hypothesis

The evidence needed to support the IH position is that bilinguals should differ from monolinguals: they should show an inverse relationship between L1 and L2 proficiency, and most bilinguals should pronounce one language better than the other. Some, but not all, of these predictions were supported by the findings of this study. For example, the prediction that bilinguals will not pronounce their languages as two monolinguals (Grosjean, 1989) was upheld. Two findings support this conclusion. First, all KB groups received significantly lower L2 pronunciation scores than the monolinguals. Second, the group that was above average in both L1 and L2 (E+K+) did not attain high pronunciation rating scores in either language.

The prediction of an inverse relationship between
This section contains remarks regarding factors that did not show this effect. We interpret the findings of predicted inverse relationship, but the late learners language significantly better than the other were monolinguals, and of bilinguals pronouncing one predictions of bilinguals not being the same as two learners were not supported. On the other hand, IH pronunciation in L2 as well as in L1 for the early L2 learners who had a strong accent in their L2 and were native-medium groups) were significantly better in pronouncing one of their languages over the other.

In conclusion, the findings offer partial support to predictions derived from the CPH and IH positions. Support for the CPH came from the late L2 learners who had a strong accent in their L2 and were native-like in their L1. However, predictions of native-like pronunciation in L2 as well as in L1 for the early L2 learners were not supported. On the other hand, IH predictions of bilinguals not being the same as two monolinguals, and of bilinguals pronouncing one language significantly better than the other were upheld. However, the IH prediction of an inverse relationship between L1 and L2 proficiency was partially supported. The early learners showed the predicted inverse relationship, but the late learners did not show this effect. We interpret the findings of this study to be more consistent with the IH than the CPH predictions.

Factors that may contribute to increased proficiency in L1 and L2 pronunciation

This section contains remarks regarding factors that may contribute to different patterns of pronunciation proficiencies in L1 and L2. The findings show that native-like L1 pronunciation is not automatically retained by young immigrants who move to the USA and learn English as an L2. In general, those who were 12 years old when they departed from their L1 environment retained native pronunciation proficiency in their first language. Those who emigrated between the ages of 8–11 were fairly proficient, but as a group their pronunciation scores were lower than the monolinguals. Studies of first language acquisition have shown that in normally developing children, complete mastery of phonology, productive control of most of syntactic structures, and early literacy are achieved by about age eight (Smit, Hand, Freilinger, Berenthal and Bird, 1990; Snow, Burns and Griffin, 1998). It appears that this amount of first language experience at home and at school may be necessary for maintenance of L1 pronunciation in a host country where the L2 is the prestige language and is spoken in most contexts outside the home. The participants who emigrated to the USA prior to age eight either had very rudimentary schooling in Korea (AOA 6–7) or none at all (AOA 1–5). Some had special training in Korean, but this appears to have been of benefit only for the youngest immigrants (AOA 1–3).

The bilinguals in the E+K+ group, those who were above average in both L1 and L2 pronunciation proficiency, were individuals who were on average 11 years old when they emigrated to the USA. They learned Korean in their native country and then soon after their arrival in the USA they began to learn English. Their experience was advantageous as far as pronunciation is concerned, they were old enough to retain their L1 and young enough to attain a fairly high level of proficiency in their L2. The above average performance in L1 and L2 pronunciation of this group is consistent with the findings from a bilingual sentence-interpretation study by Liu, Bates and Li (1992). In their study they report that the bilingual group that performed very much like monolinguals in each of their two languages had AOAs between 6 and 10 years. The study had other groups, with AOAs that were earlier or later than 6–10, that did not perform as well as this relatively late-arriving group.

The KBs who were 12 to 23 years old upon immigration to the USA were first introduced to English by accented speakers who may have taught them accented English. The younger they were when they came to the USA, the easier it may have been for them to unlearn nonnative styles of pronunciation. Their pronunciation in Korean was as proficient as monolinguals, and their high level of proficiency did not change as a result of residency in the USA for an average of 15 years. A large scale study of bilingual Hispanic immigrants to the USA has also reported that older immigrants retain their L1 over many years of residency in the host country (Bahrick, Hall, Goggin, Bahrick and Berger, 1994).

It appears then that, for immigrants living in the Mid-Atlantic States of the USA, learning the two languages sequentially is associated with good English and Korean pronunciation. The group that attained above average proficiency in both L1 and L2 learned Korean first and at about the ages of 8 to 9 years began to learn English. The findings also indicate that improved L1 and L2 pronunciation is related to frequent use of both languages and increased years of schooling in the USA. This improvement in pronunciation, however, did not reach native-like levels for the vast majority of the partici-
pants, including the early L2 learners. On the other hand, increased use of English and more years of schooling in the USA, in the same groups of bilinguals, was associated with native-like proficiency in English morphosyntax (Flege et al., 1999).

The recommendation for sequential bilingualism does not negate the possibility of success for concurrent bilingualism in environments that provide linguistic support for both languages. The point made is that linguistic support in most places in the USA is predominantly for English. The findings of this study apply to immigrants who live in locations where English is clearly the dominant language and where the need for using languages other than English is not part of the routine of everyday life. It could very well be that in other environments, where the need to function in two or more languages is clearly evident, different patterns of L1 and L2 attainment will be seen.

References


is not two monolinguals in one person. *Brain and Language* 36, 3–15.


Appendix A

English sentences:
1. Ron set a thick rug in the sun.
2. Joe will feed the pup who sat by you.
3. Fit the ring to the water tap.
4. You should thank Sam for the food.
5. It is fun to play chess with a rook.

Korean sentences, rendered in the Yale system of romanization (Martin, 1992) and [English translations]:
1. ttenakan chinkwulul sayngkak. hamyen selepta. [When I think about my friend, who has gone, I am sad.]
2. nay ttal.un nay sok.ul manh.i ssek.yessta. [My daughter worries me terribly.]
3. lanceyli kakeyeyun coh.un os.i tumulta. [At the lingerie shop, good clothing is scarce.]
4. sewuleysenun thayksilul thakika elyepta. [In Seoul, getting a taxi is difficult.]
5. hwaka nan sensayngnim.un haksaynguy ttakwilul ttay-yepta. [The angry teacher slapped the student’s face.]

Appendix B

Contents of language use, attitude, and motivation variables.

I. Language use

There were seven English-use and nine Korean-use items. Participants responded to the items by using a 5-point scale (1 = never, 5 = always). Five of the items were the same in the two languages; there were two items for English use only and four items for Korean use only. The variable Enguse is based on the average of the seven English items and Koruse is based on the average of the nine Korean items. The following is the listing of these items.

Enguse and Koruse items
1. At home I speak English (Korean).
2. At work and/or at school, I speak English (Korean).
3. At parties and with friends, I speak English (Korean).
4. Overall, in the past five years, I have been speaking English (Korean).
5. I watch English- (Korean-) language movies and/or videos.

II. Importance of learning English and Korean

Items used for the degree of judged importance for the learning English (Elearn) and Korean (Klearn) variables. A five-point scale was used (5 = agree, 1 = disagree). Each variable is based on the average of the four items listed below:
1. It is important to speak English (Korean) grammatically.
2. I enjoy learning new words and new ways of saying things in English (Korean).
3. It is important to pronounce English (Korean).
4. I want to improve my pronunciation of English (Korean).

III. Motivation for learning English

Items used in the motivation to learn English (Meng) variable. A five-point scale was used (5 = agree, 1 = disagree). The variable is based on the average of the five items listed below.
1. I believe that speaking English will help me get a good job.
2. I try to have as many American friends as possible.
3. I believe that Americans will respect me more if I use correct English grammar and vocabulary.
4. I believe that Americans will respect me more if I pronounce English well.
5. I believe that English is important for my success at work/school.

Received May 11, 1999 Revision accepted May 3, 2000