Interference for 'new' versus 'similar' vowels in Korean speakers of English

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Abstract

This paper tests Flege's (1987) Speech Learning Model and Bohn and Flege's (in press) hypothesis about the 'deflected' realization rule of a 'similar' L2 vowel. It is shown that Korean-English bilinguals' production of new English vowels, /I, U/, conforms to Flege's prediction. However, their production of similar English vowels, /i, u, U/, conformed to neither Flege's model nor to Bohn and Flege's hypothesis. We especially examined the interference between Korean and English high vowels, /i, I, U, u/, and /U/ based on 8 Korean-English bilinguals with different years of residnece in the States, 4 English monolinguals and 3 Korean monolinguals. Formant values of English vowels produced by Korean-English bilinguals with different years of residence in America were compared with those of English monolinguals. For the vowel /i/, Flege's notion of 'similar' L2 vowels needs be redefined to distinguish similar and identical vowels. He may need either some continuous measures or more systematic criteria to categorize whether a phone in L2 is new or similar to phones in L1.

Introduction

Languages differ in their ways of phonetic realization as well as their phonemic inventories. Weinreich (1953) states that learners of a second language (henceforth L2) tend to identify L2 phones in terms of their native language (henceforth L1) categories and, as a result, use articulatory patterns established during L1 acquisition to produce those L2 phones. Therefore, it is easily noticeable whether an utterance is produced by a native speaker or not.

In general, the degree to which a new phonetic category in L2 is established is proportional to the degree of experience in the L2 and the age at which L2 is acquired (Williams, 1980). Other factors also seem to play a role, such as the degree of similarity between L1 and L2. For example, Flege's (1987) Speech Learning Model showed that equivalence classification prevents adult L2 learners from establishing a phonetic category for 'similar' L2 phones, as opposed to 'new' phones. A 'new' phone is defined as an L2 phone which has no counterpart in L1 and therefore differs acoustically from all phones found in L1. A 'similar' L2 phone, on the other hand, is defined as an L2 phone which is realized in an acoustically different manner from an easily identifiable counterpart in L1. Flege (1987) found that the production of French /y/, a 'new' phone, by English speakers who were highly experienced in French was more authentic than that of French /u/, a 'similar' phone, which was close to their English /u/. That is, after long exposure and practice, adults could eventually produce an L2 vowel authentically if it were a 'new' vowel, but could not produce it authentically if it were a 'similar' vowel.

This speech model was refined somewhat when Bohn and Flege (in press) found that German-English bilinguals' production of a 'new' English vowel /æ/

affected the production of a 'similar' English vowel /ɛ/, as long as a category for the new vowel /æ/ had *not* been established. That is, the production of the new English vowel /æ/ by the less experienced German-English bilinguals was closer to the English norm than that by the more experienced bilinguals. It was claimed that the realization rules used to produce a 'similar' L2 vowel are "deflected" by the neighboring 'new' vowel, for which L2 learners had not yet established a phonetic category. Therefore, according to the refined model, if a 'similar' vowel and a 'new' vowel are neighboring vowels, the more experienced bilinguals would produce the 'new' L2 phone more authentically than the 'similar' phone due to the equivalence classification but the less experienced bilinguals would produce the 'similar' phone more authentically due to the 'deflected' realization rule until the neighboring 'new' phone is acquired.

This paper tests Flege's Speech Learning Model and the refined version of it, using Korean and English data. We especially examined the interference between Korean and English high vowels, /i, ɪ, ʊ, u/, and /ʌ/. Formant values of English vowels produced by Korean-English bilinguals with different years of residence in America were compared with those of English monolinguals.

A pilot study was conducted to decide what are 'new' and what are 'similar' vowels between Korean and English high vowels and /ʌ/. Formant values of /i/ and /u/ were overlapping very much between Korean and English, with English /u/ having somewhat higher F1 and F2 values than Korean /u/. On the other hand, English lax vowels /ɪ, ʊ/ showed separate vowel spaces from Korean high vowels /i, ɨ, u/, even though the edges of each vowel space were overlapped; In the F1 dimension, English /ɪ, ʊ/ have higher F1 values than those for Korean high vowels, and in the F2 dimension, English /ɪ/ is in between Korean /i/ and /ɨ/ while that of English /ʊ/ is in between Korean /ɨ/ and /u/. These results were also found in Jun (1990). Based on formant values, we categorized English /i/ and /u/ as 'similar' vowels and English /ɪ, ʊ/ as 'new' vowels to Korean bilinguals.

The pilot study also showed that Korean and English /ʌ/ have mean formant values which differ more than those of English /i/ and /ɪ/; Korean /ʌ/ tends to have lower F1 values and higher F2 values than English /ʌ/. We also found individual variations for the formant values of /ʌ/ among English monolinguals. One speaker showed formant values for a very high back vowel which are closer to those of Korean /ʌ/, while the other showed formant values for a more central vowel. However, since the monolinguals who participated in our present experiment produced values similar to the formant values for English /ʌ/ observed in Peterson and Barney (1952): F1: 640 Hz, F2: 1190 Hz for 33 male speaker, which have been assumed to be the standard values, we did not consider the possible individual deviation for /ʌ/ in our discussion. Even though /ʌ/ in both languages differs acoustically, Korean learners of English tend to recognize English /ʌ/ as Korean /ʌ/ since there is no other unrounded close-to-mid vowel in Korean. Therefore, we categorized English /ʌ/ as a 'similar' vowel together with English /i/ and /u/ but English /ɪ, ʊ/ as 'new' vowels to Koreans. Figure 1 shows a schematic vowel space for each language based on data from our pilot study and Jun (1990). The same tendency was also found in the present experiment.

In Flege (1987), an intermediate value for VOT norms in L1 and L2 was observed for experienced L2 speakers. He suggested that the phonetic category may be restructured or modified as experienced L2 speakers judge the L2 and L1 phone to be equivalent. Therefore, to examine the effect of L2 on L1, we compared formant values of Korean vowels produced by Korean-English bilinguals with those of Korean monolinguals. The vowel space for each bilingual was examined

to see whether, and if so how, acquiring or recognizing a new vowel influences the production of other vowels.

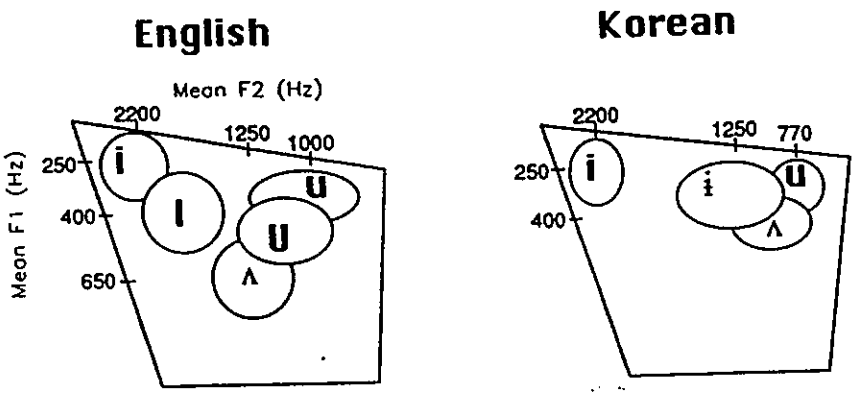

Figure 1. Schematic vowel spaces for English /i, I, u, U, ʌ/ and Korean /i, ɨ, u, ʌ/, based on data from Jun (1990).

The results support Flege's model to some extent in that more experienced Korean-English bilinguals produced 'new' English vowels more authentically than 'similar' English vowels. However, another aspect of the results contradicts the predictions of both Flege's (1987) original hypothesis and Bohn and Flege's (in press) refinement of it, namely that less experienced Korean-English bilinguals produce 'similar' English vowels better, i.e., closer to the English norm and distinct from Korean counterpart, than more experienced bilinguals do.

Method

Subjects

Eight Korean-English bilingual speakers with different durations of residence in the U.S.A. participated in the experiment. Four of them resided in the U.S. from 1.2 to 5.3 years and their average age was 29 (Less Advanced Group). The other four resided in the U.S. from 26 to 31 years and their average age was 56 (Advanced Group). The years of residence (YrR in a table) for each speaker is shown in Table 1.

Table 1. Years of Residence (YrR) for Advanced (subj.1-4) and Less Advanced(subj 5-8) group.

Levels	Advanced				Less Advanced			
Subjects	1	2	3	4	5	6	7	8
YrR	31	30	28	26	5.3	3.3	1.3	1.2

All of the subjects came to the U.S. in their late twenties to attend graduate school and have practiced spoken English since that time. All of the members of the less advanced group had been in Columbus since they came to this country and have been graduate students in various areas of humanities. Members of the advanced group had been in Columbus an average of 10 years prior to the experiment, and they all studied Chemistry or Chemical Engineering. Among those

in the advanced group, only subject 2 is married to an American. Except for him, all the bilinguals speak English at work or school but Korean at home. All of them speak the same dialect of Korean, i.e., Seoul Korean. As norms for each language, productions of each language were collected from four monolingual English speakers and three monolingual Korean speakers. Three monolingual English speakers are from Ohio and one from Oklahoma. Two monolingual Korean speakers are from Seoul area and one from Kwangju Chonnam, but the dialects have no difference in the quality of vowels studied in this experiment.

Material

Words with each target vowel, English /i, ɪ, u, ʊ, ʌ/ and Korean /i, ɨ, u, ʌ/, in four different preceding contexts, bilabial, alveolar, velar and glottal, were selected. Four words with /a/ in the same context were selected as foils. Each word was repeated 10 times and randomized. There were 240 English words total (5 vowels * 4 contexts * 10 repetitions) and 200 Korean words total (4 vowels * 4 contexts * 10 repetitions). The word lists for both languages are given in Table 2. Some of Korean forms are nonsense words (abbreviated as 'NM') but are all pronounceable syllables.

Table 2

Korean test data			
pi 'rain'	ti NM	ki 'a flag'	hi NM
pɨ NM	tɨ NM	kɨ 'that'	hɨ NM
pu 'richness'	tu 'two'	ku 'nine'	hu 'after'
pəl 'punishment'	tət 'a trap'	kəp 'a scare'	hət 'vain'
Korean foil data			
pal 'a foot'	tal 'a moon'	kat 'a hat'	hap 'a sum'

English test data			
bead	tea	key	heed
bid	tip	kid	hid
book,	took	could	hood
booed	two	coo	who'd
but	dug	cut	hut
English foil data			
pot	dot	cot	hot

Recording

Recording was made in a pseudo-anachoic chamber for all English monolinguals and subjects 1 and 7. For others, a portable cassette recorder (SONY Walkman, model WM D6C) was used to record their readings in a quiet room of a house or an office. Each monolingual speaker read the appropriate word list and bilingual speakers read both word lists. For the bilinguals, the order of language was counterbalanced between subjects: half of each group read English first, and the other half Korean first. To prime the bilinguals' productions of each language, the first author explained the procedures in the relevant language just before recording the corpus for that language. In addition to this, each subject was asked to read an English passage (a paragraph from either Lawrence's novel, "Rocking

Horse Winner", or Fry's (195?) article) aloud just before reading the English corpus. One month later, recordings were made again for an accent judgment test. The bilinguals read five sentences excerpted from *The Lantern* (the Ohio State University student newspaper) and a tape is made by editing the recordings; for each sentence, the order of readings for each speaker was randomized and rerecorded with a two second pause between each speaker and a four second pause between each sentence. The five sentences are given in the Appendix.

Accent Judgements

The degree of accent in English of the bilinguals was rated by 15 native English speakers who listened to the tape and rated them, based on their general impression, on a scale of 1 to 10, where 1 was 'native-like' (or 'no foreign accent') and 10 was 'very strong foreign accent'. The score of the degree of accent was correlated with the years of experience.

Formant Measurements

Each of the test words was digitized and a vowel with some portions of surrounding consonants was extracted using a waveform editing program. The formant values of the vowel were measured around a center of the vowel showing a steady formant value using an LPC formant tracker with 14 coefficients, 200 window size and 100 window step.

Results

The F1 and F2 values of similar and new vowels in both languages were compared in their absolute values and in relation to other vowels within a vowel space for each bilingual. Then, a correlation between the accent judgment score and years of residence for each bilingual is shown.

Comparison for similar vowels

The results show that the formant values of /i/ were more than similar between English and Korean. This was also found in Jun (1990)[1] and in our pilot study. Formant values for /i, u, ʌ/ in both languages by monolinguals and Korean bilinguals are shown in Figure 2.[2] In figure 2, the leftmost column within each graph represents mean formant values for each monolingual group and two horizontal lines in the middle of each graph indicate the value of the leftmost column, i.e. the means of each vowel in each language.

As shown in Fig. 1(a), since the formant values of /i/ in both languages are almost identical, we cannot test Flege's (1987) Speech Learning Model which is about 'new' vs. 'similar' vowel. Mean formant values are represented with one standard error in both directions. The results for another similar vowel, /u/, showed inconsistency with the hypothesis that the production of similar vowels is roughly the same for all bilinguals regardless of L2 experience. This is shown in Fig.1 (b). That is, less experienced bilingual subjects produced /u/ with more distinction in the two languages than the more experienced subjects did, i.e, they

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[1] Jun(1990) found that the labial positions for /i/ were not significantly different in English and Korean.

[2] Since we did not normalize speaker variation, a relative, rather than the absolute, formant value was compared between two languages in relation to that of monolinguals.

produced English /u/ lower and fronter (higher F1 and F2) than Korean /u/, thus closer to the English norm.

Lastly, monolinguals' production of the supposedly similar vowel, /ʌ/, shows that formant values are quite different for each language. However, as seen in Fig. 2 (c), almost all bilinguals produced this vowel with similar formant values for each language. Moreover, most of the formant values fall between norms for each language. This may indicate bidirectional interference.

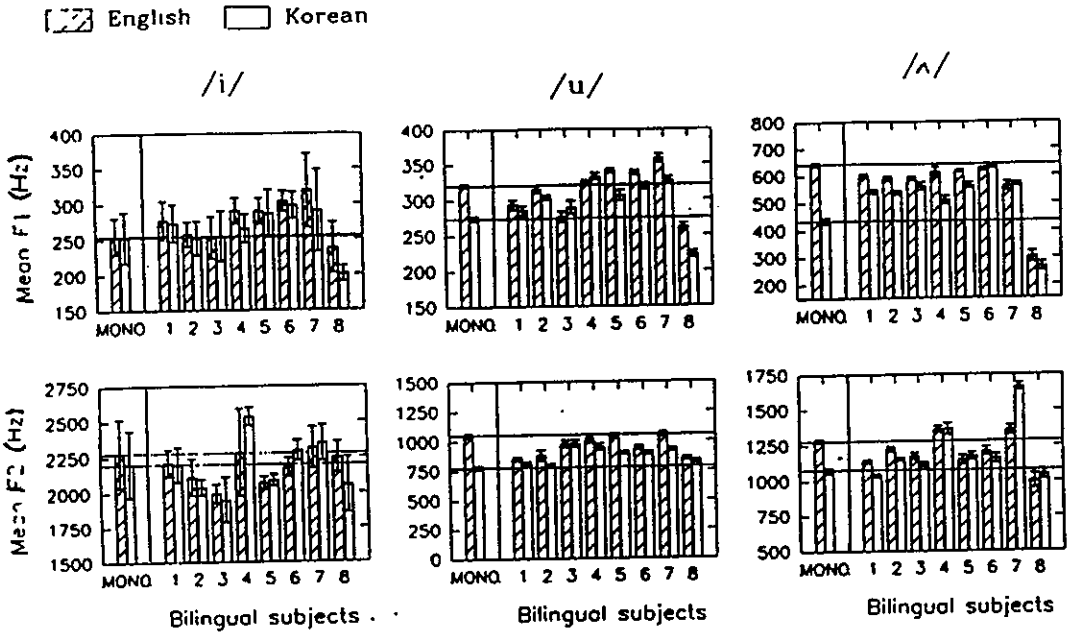

Figure 2. Mean formant values of English and Korean (a) /i/, (b) /u/, and (c) /ʌ/ by English and Korean monolinguals (MONO) and eight Korean bilinguals. SD is shown around the mean.

Comparison for new vowels

Since the important aspect of /ɪ/ and /ʊ/ is less the absolute formant value than the relationship to the tense counterpart, a relative formant values of /i/ versus /ɪ/ or /u/ versus /ʊ/ for each subject were compared with the monolinguals' norms. That is, to see whether bilinguals acquired the 'new' vowels, /ɪ, ʊ/, or not, the relative formant values between tense /i, u/ and lax /ɪ, ʊ/ counterparts are shown in Figure 3. Shaded portion and the white portion of the first bar graph (MONO) represent formant values of English monolinguals' tense and lax vowels, while the other bar graphs represent values of tense/lax vowels by Korean-English bilinguals.

Figure 3 (a) and (b) show that the differences in F1 and F2 values between tense and lax vowels by subjects with the most experience are very close to those by the English monolinguals, while these differences are very small for the subjects with less experience. However, some less experienced subjects, subject 7 and 6 (1.3 and 3.4 years of residence, respectively) showed a clear F2 distinction between /i/ and /ɪ/ only (Figure 3 (a)). At the same time, subject 4 (26 years of residence) does not seem to show any sign of acquiring the 'new' vowels with small difference in formant values between tense and lax vowels. This seems to indicate that years of residence does not correlate well with the degree of acquisition

of a new vowel. This discrepancy will be discussed more in the next section where we correlate the years of residence with the degree of accent in general.

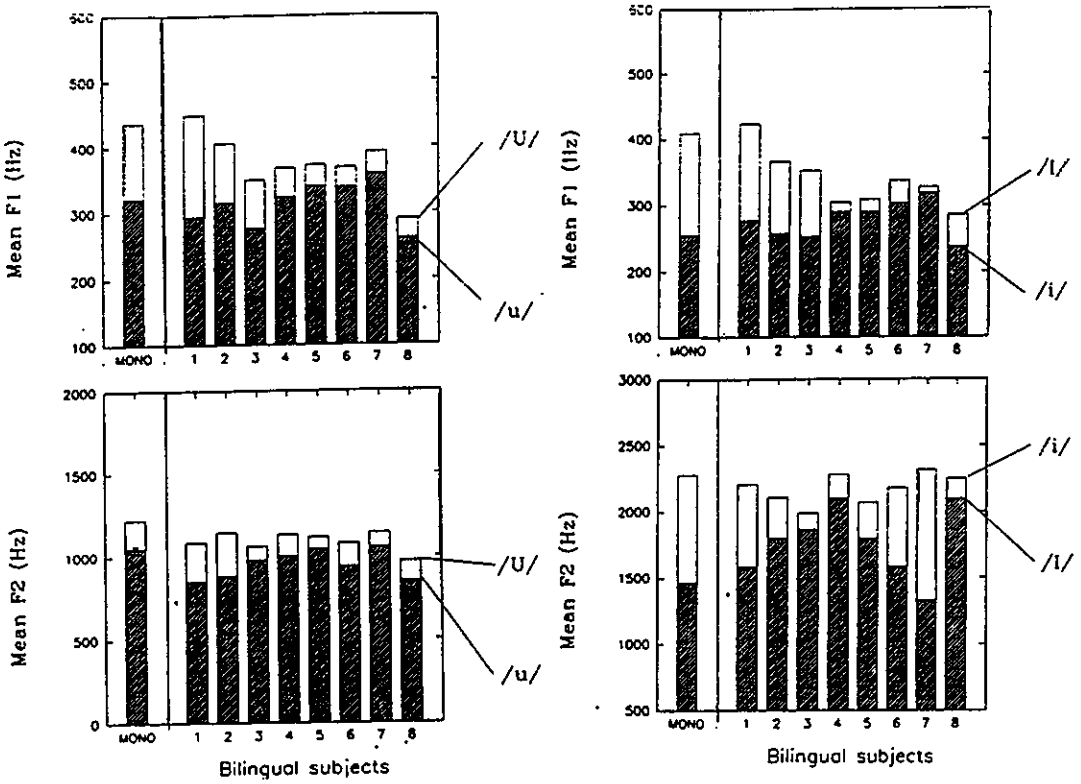

Figure 3. Mean F1 and F2 values of (a) English /i/ and /I/ (b) English /u/ and /U/ by monolinguals of English and Korean and by eight Korean-English bilinguals

Except for these 3 subjects, the general pattern seems to support Flege's Speech Learning Model. That is, L2 learners with more experience will produce a new L2 phone more authentically, while those with less experience will substitute the L1 phone which is acoustically and/or articulatorily close to the new L2 phone for the new L2 phone.

Since it looks as though the less experienced bilinguals produce 'similar' vowels better (meaning closer to the English norm and distinguishing from Korean counterpart) than the more experienced bilinguals but 'new' vowels worse than the more experienced bilinguals, we examined the vowel space for each bilingual to see whether, and if so how, acquiring or recognizing a new vowel influences the production of other neighboring vowels.

Vowel Space for each subject

When we look at each bilingual's vowel spaces for each language, three types of vowel spaces were observed. The first type shows a separate space for each vowel within each language, especially between English /i/ and /I/ or /u/ and /U/, showing that the new L2 vowels are acquired. It also has overlapping spaces for similar vowels between languages. This type of vowel space is shown by subject 1

and 2 and possibly by subject 3. We will refer to this group as the 'separate-vowel-space' group. Figure 4 shows the vowel spaces for subject 1 and 2.

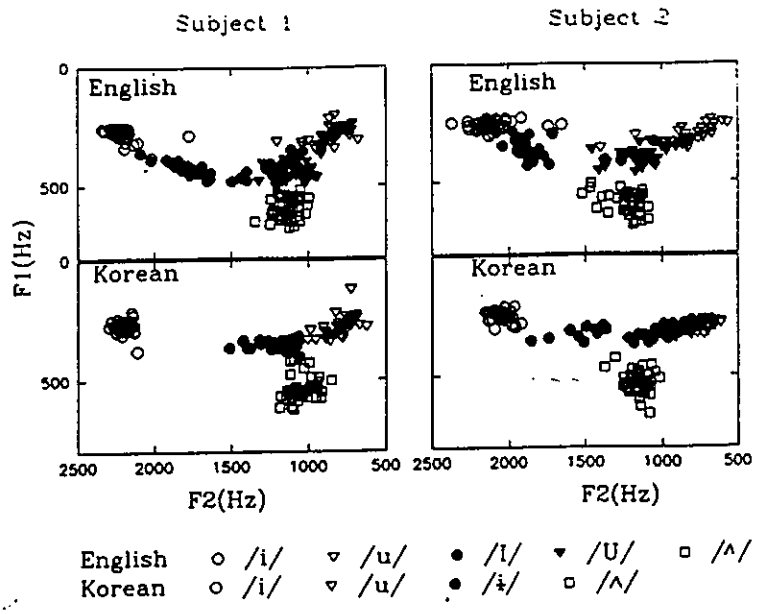

Figure 4. Vowel space of English and Korean high vowels and /ʌ/ by subject 1 and 2

As seen in Figure 4, these subjects acquired the new English vowels and produced the similar English vowels less authentically. This conforms to the predictions by Flege's model.

The second type is the opposite of the first type. The vowel space for English tense (i.e. 'similar') and lax (i.e. 'new') vowels are completely overlapping and the spaces covered by both vowels are the same as the space of Korean /i/ or /u/. This type of vowel space tells us that Korean /i/ and /u/ are substituted for English /i, ɪ/ and /u, ʊ/, respectively. This type is what we can expect from the bilinguals with little experience in L2. We will refer to this group as the 'overlapping-vowel-space' group. Two subjects, subject 5 and 6 showed this type of vowel spaces even though they have been in the States for at least four years. Figure 5 shows their vowel spaces.

The third type shows a stage inbetween the first and the second type. As in the second type, it has overlapping spaces for English tense and lax vowels covering spaces for both vowels. However, unlike the second type, the space for English /i/ is lower and more back (i.e., more central) than the norm and thus close to the space for /ɪ/ of the English norm. Also, the space for English /u/ is lower and fronter (i.e., more central) than the norm and thus close to the space for /ʊ/ of the English norm. This type of vowel space is shown by the rest of bilinguals with some variations. These bilinguals may be in the process of acquiring new English vowels, and we will refer to this group as the 'intermediate' group. The vowel spaces of subjects 4 and 7 represent this type of vowel space and are shown in Figure 6. The vowel space also indicates that there is interference from English to Korean; Korean /i/ or /u/ has more variation in F2 values than the Korean norms.

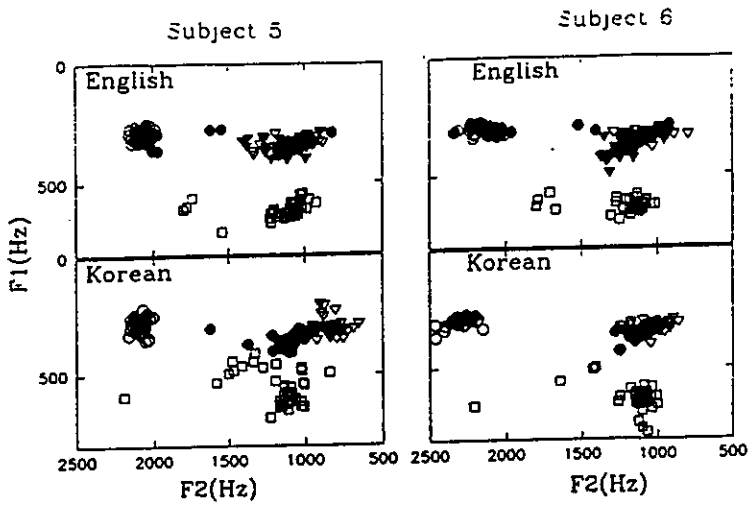

Figure 5. Vowel space of English and Korean high vowels and /ʌ/ by subject 5 and 6

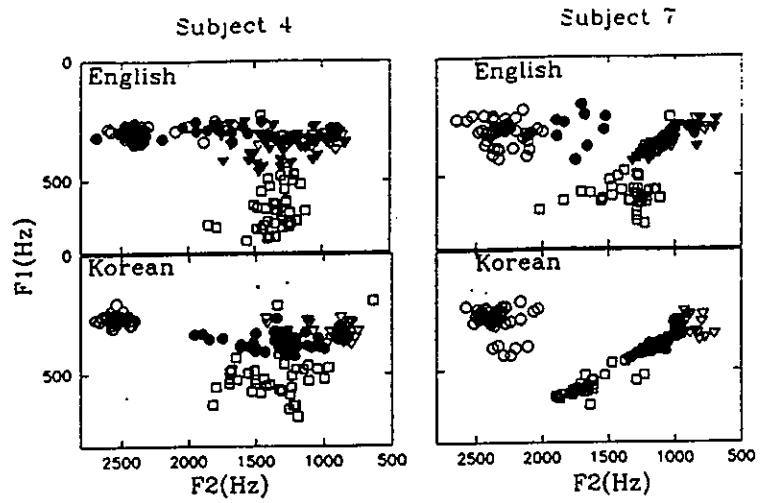

Figure 6. Vowel space of English and Korean high vowels and /ʌ/ by subject 4 and 7

Since some of the bilinguals with fewer years of residence show signs of acquiring a new vowel while some of the bilinguals with longer years of residence show no signs of acquiring a new vowel, it seems that the years of residence alone is not a good criterion for dividing bilinguals into two groups. Accent judgement scores given to each bilingual were compared in terms of the degree of acquisition of the new vowel. The following section shows the results of the correlation between years of residence and accent judgement scores.

The correlation between years of residence and accent scores

Accent scores for each subject were correlated with the years of residence. The resulting correlation was very low, r =0.1323. This seems to be due to the low score (i.e. more accented) for experienced speakers 3 and 4 and the high score (less accented) for less experienced speakers 7 and 8.

Accent judgement scores for each bilingual are out of 750 (5 sentences * 15 judges * 10 points). The following table shows this.

Table 3. Accent judgement scores for each bilinguals with their years of residence.

Subject	1	2	3	4	5	6	7	8
YrR	31	30	28	26	5.3	3.3	1.3	1.2
Scores	468	456	271	314	267	342	465	362

Subject 1 and 2 got high scores and it seems that they acquired the new vowels, while subject 4 and 5, who got low scores, do not seem to acquire any new vowel. However, for other subjects, these accent scores do not seem to be reflected very well in the degree of acquisition of the new English vowels. That is, subject 3 got a very low score considering his long years of residence but he seems to have almost acquired the new vowel. On the other hand, subjects 7 and 8 got very high scores (2nd and 4th out of 8 bilinguals) with less than 2 years of residence. However, neither of them have completely acquired the new English vowels as has been shown in Figure 3. Maybe they have a better intonation pattern, timing or better pronunciation of consonants. This may possibly be due to their majoring in linguistics, and thus being more aware of their pronunciation of English. Subjects 3 and 4 may sound more accented because of their slow rate of reading and voice quality. In our opinion, these subjects were more fluent speakers in a conversation than most less experienced speakers. But their slow rate of reading passages sounded more accented and less confident in English.

Therefore, the accent judgement score as well as the years of residence cannot be used as an indicater of how good a bilingual's pronunciation of a specific sound is. There could be many other possible parameters which can affect a bilingual's L2 pronunciation: 1) How old he was when he was first exposed to much English, 2) From whom the person learned L2 initially, 3) How concerned he is with his pronunciation, i.e. how much attention he pays to his own pronunciation, and how important he thinks his or other's pronunciation of L2 sounds is, 4) How much he knows about the pronunciation rules in L2, 5) What his social status and social environment are, and how this affects his exposure to formal and colloquial L2, 6) How fast or slow he reads or speaks, and (7) individual differences in mimicking skills, etc.

Discussion

Productions of new English vowels, /ɪ/ and /ʊ/, by Korean bilinguals were consistent with Flege's hypothesis: the 'separate-vowel-space' group produced them authentically while less experienced ones did not. However, productions of similar English vowels, /i/, /u/, and /ʌ/, showed characteristics which were not predictable from Flege's model. First, productions of a similar English vowel, /u/, were not consistent with the hypothesis: the 'intermediate' group produced /u/ more authentically than the 'separate-vowel-space' group. The 'intermediate' group bilinguals showed a category merge effect between the similar, /u/, and the new vowel, /ʊ/, thus, making the similar vowel /u/ much closer to the English norm than to the Korean /u/, while making no clear distinction between English /u/ and /ʊ/. This may happen because they recognize the new L2 vowel but have not quite acquired it yet.

On the other hand, the 'separate-vowel-space' group showed formant values of English /u/ very close to those of their Korean /u/. This may be due to their acquisition of the new English vowel, /ʊ/. That is, they may try to avoid invading the vowel space for the newly acquired L2 phone.

A similar tendency was shown for the other 'similar' vowel /i/. Even though formant values of /i/ in both languages are almost identical, the the 'intermediate' group bilinguals produced English /i/ closer to English /ɪ/, thus making a distinction from Korean /i/. On the other hand, the 'separate-vowel-space' group produced English /i/ close to Korean /i/, thus making no distinction from Korean /i/ but clear distinction from English /ɪ/.

A similar reversed phonomenon is also shown in Bohn and Flege (in press) where inexperienced Germans produced /ɛ/ with durations that were English-like, whereas the experienced Germans produced /ɛ/ with shorter durations than both the native English and the inexperienced German group. They claimed that this phenomenon was attributed to the influence of new neighboring L2 phones on similar L2 phones only for the less experienced bilinguals, and that the realization rules used to produce a similar L2 vowel are "deflected" by the neighboring new vowel, for which L2 learners had not yet established a phonetic category.

This deflection by the neighboring new vowels for less experienced bilinguals doesn't work for our data since only the 'intermediate' group, not the 'overlapping-vowel-space' group showed this so-called 'deflection' phenomenon. This reversed phenomena can be explained better if we consider the vowel dispersion theory proposed by Liljiencrants and Lindblom (1973), Lindblom (1975, 1979) and Maddieson (1977). By the dispersion theory, each vowel in a language is maximally dispersed. So, if there are more vowels in the same height or backness dimension, there will be less variation for each vowel and the vowels will be evenly dispersed in the same dimension.

The same principle would work for the vowel space of an individual. That is, if someone acquired a new L2 vowel (as in the case for the 'separate-vowel-space' group), he or she might try not to invade the new vowel's space when producing a vowel adjacent to the new L2 vowel. However, if there is no established space for a new L2 vowel, nor is there any recognition for the acoustic difference of the new vowel (as in the case for the 'overlapping-vowel-space' group), the new vowel and a vowel adjacent to the new vowel can both be produced in the same space which is originally for the vowel adjacent to the new vowel. And finally, if one recognizes the acoustic difference of the new vowel and at least tries to produce the new vowel (as in the case for the 'intermediate' group), one might overshoot the target (i.e. neighboring 'similar') vowel, thus, close to the new vowel, and creating a merge effect.

Therefore, the fact that the 'intermediate' but not the 'overlapping-vowel-space' group produced 'similar' phones better than the 'separate-vowel-space' group might suggest that bilinguals are reorganizing their vowel space and the degree of reorganization depends on the degree of bilingualism. Bohn and Flege's explanation that the realization rule for the similar vowel is 'deflected' due to the new neighboring vowel as far as the new L2 vowel is acquired does not work for the results of our experiment since the 'overlapping-vowel-space' group did not show any better performance as far as the new L2 vowel is concerned. Rather, they substituted their L1 for the new L2 phone as in the case of the 'separate-vowel-space' group.

And finally, bilinguals did not produce the 'similar' vowel /ʌ/ close to the norm of any language. Rather, they produced /ʌ/ in both languages with formant values intermediate to the two languages; although, the norms of each language differed significantly. The less experienced bilinguals did not show any deflection phenomena, as predicted by Bohn and Flege (in press). We assume that this may be because there is no vowel space established for a neighboring 'new' vowel. This seems to indicate bidirectional interference.

Conclusion

This paper tested Flege's (1987) Speech Learning Model and Bohn and Flege's (in press) hypothesis about the 'deflected' realization rule of a 'similar' L2 vowel. It is shown that Korean-English bilinguals' production of new English vowels, /ɪ, ʊ/, conforms to Flege's prediction. However, their production of similar English vowels, /i, u, ʌ/, conformed to neither Flege's model nor to Bohn and Flege's hypothesis.

For the vowel /i/, Flege's notion of 'similar' L2 vowels needs be redefined to distinguish similar and identical vowels. He may need either some continuous measures or more systematic criteria to categorize whether a phone in L2 is new or similar to phones in L1.

For the vowels /u/ and /ʌ/, contrary to Flege's model, English /u/ was produced closer to the English norm by the 'intermediate' group bilinguals than by the 'separate-vowel-space' group. This reversed phenomenon was claimed by Bohn and Flege to be due to the 'deflected' realization rule of a 'similar' vowel next to a 'new' vowel until the acquisition of the new L2 vowel. But their hypothesis cannot explain the fact that the 'overlapping-vowel-space' Korean-English bilinguals did not produce English /u/ better than other bilingual groups. Rather, this could be explained better if we consider the combined vowel space for the two languages for each individual and apply the dispersion theory. Consideration of the vowel space can explain both why the reversed phenomenon was found also for English /i/, an almost identical vowel, and why the phenomenon was not found for English /ʌ/. The vowel space observed for English /ʌ/ by bilinguals also indicates that there is bidirectional interference.

Finally, we found that the years of residence in L2 is very poorly correlated with the accent judgement score of each bilingual and that, for adult learners, the accent judgement score as well as the length of residence in L2 was not a good indicator by itself of how good the production of a specific L2 phone is.

Appendix

1. If you are currently enrolled and do not receive instructions in the mail, by May 16, contact your college office immediately.
2. A Franklin County grand jury found that grades on state bar exams were fixed for nine people in 1986.
3. Your letter to Aunt Ruth may be scattered physically all over the disk.
4. A number of these students took jobs just to pay for the big event.
5. At present we have an extremely limited number of positions for this summer because of the mandated budget cuts.

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