

Native- and Second-Language Interaction in Early and Late Bilinguals: The Effect of Cross-Language Similarity

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ABSTRACT

The present study examined the interaction between bilinguals' native (L1) and second (L2) languages as a function of the perceived similarity between L1 and L2 segments. Two hypotheses were proposed. The first hypothesis was that segments that are "similar" in the L1 and L2 would influence each other (and would thus "interact") to a greater extent than those that are "dissimilar" in the L1 and L2. The second hypothesis was that the extent to which similar and dissimilar L1 and L2 segments interact would also depend upon bilinguals' age at the time of L2 learning. Results provided support for both of these hypotheses. The findings of the present study thus provide insights into the dynamic and often complex nature of the interaction between L1 and L2 phonetic systems.

1 INTRODUCTION

How do a bilingual's two phonetic systems interact? Research in bilingual speech learning has suggested that this interaction (which manifests itself as a bi-directional influence of a bilingual's two languages) may depend upon several factors. One factor—perceived cross-language similarity—is related to how perceptually similar segments are across a bilingual's two languages. Some researchers have shown that, at least in bilinguals who acquire a second language (L2) after the native language (L1) has been acquired, the extent to which the perception and production of L2 segments are "colored" (and are thus influenced) by the L1 can depend upon how closely L2 segments are perceptually identified with those in the L1 [1, 2]. In other words, L2 segmental perception and production are more susceptible to the influence of perceptually similar rather than dissimilar L1 segments.

Less understood is the influence of L2 segments on L1 perception and production. To date, only a handful of studies have investigated L2 influences on a bilingual's L1 [3, 4, 5], and no study has determined the extent to which these influences depend upon the similarity between L1 and L2 segments. One of these studies [3] examined the degree of foreign accent in Quechua and Spanish sentences spoken by Quechua-Spanish bilinguals. The degree of accent in the bilinguals' L2 (Spanish) production increased as a function of L1 (Quechua) use, but remained unchanged in their L1

production as a function of L2 use. In other words, there was an asymmetry in how the bilinguals' L1 and L2 interacted: There was an effect of the L1 on the L2 but no effect of the L2 on the L1.

Another factor that also determines whether and to what extent a bilingual's L1 and L2 interact is a bilingual's age at the time of L2 learning (or "age" for short) [1,2,6]. That is, the L1-L2 interaction may differ in early and late bilinguals (those who acquire an L2 in childhood and adulthood, respectively). One study [5], for example, found that early Italian-English bilinguals produced perceptually similar Italian and English voiced stops (/b, d, g/) with long-lag (English-like) voice-onset times (VOTs) whereas late bilinguals produced them with short-lag (Italian-like) VOTs. Thus, late bilinguals may have altered their L1 segmental representations (or categories) to accommodate similar L2 segments whereas early bilinguals may have done the opposite, creating merged L2-based categories to perceive and produce similar L1 and L2 segments. Although revealing about interaction between early and late bilinguals' L1 and L2, this study examined only highly similar L1 and L2 segments. It is possible that the extent and direction of L1-L2 interaction may differ for similar vs. dissimilar segments.

In other words, would early and late bilinguals demonstrate different patterns of the L1-L2 interaction depending upon how similar L1 and L2 segments are? That is, do both age and cross-language similarity determine how bilinguals organize their phonetic system(s)? This study addressed these questions by examining to what extent the L1-L2 interaction depends on the L1-L2 segments' similarity.

In particular, it was predicted that (1) for both early and late bilinguals the extent of the L1-L2 interaction would be greater for similar than dissimilar L1 and L2 segments, and (2) L2 influences upon bilinguals' L1 segmental production would differ for early and late bilinguals. Two experiments were conducted to test these hypotheses. Experiment 1 determined the degree of perceived similarity between 8 English (L2) and 10 Korean (L1) vowel segments. Experiment 2 examined the extent to which the production of English and Korean vowel segments by Korean-English bilinguals (who differed in age and amount of U.S. residence) depended on these segments' perceived similarity.

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2 EXPERIMENT 1

Experiment 1 determined the degree of similarity between 8 English (/i/, /ɪ/, /u/, /ʊ/, /ɑ/, /Δ/, /æ/, /ɛ/) and 10 Korean (/i/, /o/, /ɨ/, /y/, /æ/, /ɛ/, /e/, /Δ/, /a/, /u/) vowel segments (or “vowels” for short). Participants were 10 child (mean age: 8.8; range: 7-9 years) and 10 adult (mean age: 22.7; range: 20-23 years) native Korean speakers who had resided in the U.S. for about 1 year.

2.1 METHOD

The English vowels, recorded by 3 male monolingual English speakers, were randomly presented 144 times (24 tokens × 3 talkers × 2 repetitions) in 24 monosyllabic words (Table 1). First, participants heard an English token and selected which of the 10 vowels of standard Korean (represented orthographically in Hangeul on a computer monitor) to which the English vowel in the token was most similar. Then, participants heard the same English token again and rated the degree of similarity between the English vowel they heard and the Korean vowel they chose on a 7-point scale (where 1=“vowels sounded very dissimilar”; 7=“vowels sounded very similar”).

/i/	/ɪ/	/ɛ/	/æ/	/ʊ/	/u/	/Δ/	/ɑ/
beat	bit	bet	bat	boot	book	but	bought
neat	knit	net	gnat	nike	nook	nut	not
heed	hid	head	had	who'd	hood	hut	hot

Table 1: English stimuli used in Experiment 1.

Vowel-identification responses were analyzed by determining how many times each participant classified each English vowel with its modal (most frequent) Korean response alternative. Similarity-rating responses were analyzed by computing a participant's mean similarity rating between each English vowel and its modal Korean response alternative. (The findings presented below are based on analyses of vowel identification; analyses of similarity ratings did not reveal any child-adult differences in ratings of the similarity between English and Korean vowels.)

2.2 RESULTS

Results indicated that both children (C) and adults (A) selected the same Korean vowel as the modal response alternative in their classification of each English vowel (Table 2, vowels are ordered by degree of similarity to their modal Korean response alternatives).

English	Korean	Proportion of Identification	
/i/	/i/	A: .92	C: .79
/u/	/u/	A: .83	C: .61
/ɑ/	/a/	A: .73	C: .66
/ɪ/	/i/	A: .68	C: .58
/æ/	/ɛ/	A: .67	C: .44
/ʊ/	/u/	A: .61	C: .39
/ɛ/	/ɛ/	A: .57	C: .39
/Δ/	/Δ/	A: .51	C: .42

Table 2: Mean proportion of identification of each English vowel with its modal Korean response alternative.

In addition, the English (E) and Korean (K) vowels fell into 3 types of cross-language perceptual relationships. The first type were vowels that were perceived on a *one-to-one* basis (one English vowel identified with one Korean vowel: E /ɑ/-K /a/; E /Δ/-K /Δ/). These vowels were similar across the two languages. The second type were vowels that were perceived on a *two-to-two* basis (two English vowels identified with two Korean vowels: E /æ/, /ɛ/-K /ɛ/, /e/). These vowels were dissimilar. Finally, the third type were vowels that were perceived on a *two-to-one* basis (two English vowels identified with one Korean vowel: E /i/, /ɪ/-K /i/; E /u/, /ʊ/-K /u/). These vowel pairs were confusable across the two languages, with one English vowel being similar to, and the other more dissimilar from, the Korean vowel. These findings provided the basis for examining the extent to which L1-L2 interaction is determined by the perceptual similarity between L1 and L2 segments.

3 EXPERIMENT 2

Experiment 2 examined whether early and late Korean-English bilinguals' production of English vowels and Korean vowels depended upon the perceived similarity between these vowels.

3.1 METHOD

The stimuli for this experiment consisted of 8 English vowels (/i/, /ɪ/, /ɛ/, /æ/, /u/, /ʊ/, /Δ/, /ɑ/) in 24 monosyllabic words. These were the same English vowels used in Experiment 1 (Table 3).

/i/	/ɪ/	/ɛ/	/æ/	/u/	/ʊ/	/Δ/	/ɑ/
beat	bit	pet	bat	boot	book	but	pot
bead	big	bed	bad	booed	good	bug	pod
heed	hid	head	had	hoop	hood	hut	hot

Table 3: English stimuli used in Experiment 2.

In addition, the participants also produced 7 Korean vowels (/i/, /ɨ/, /ɛ/, /e/, /u/, /Δ/, /a/) in 14 mono- and bi-syllabic words (Table 4). These vowels were chosen because, of the 10 Korean vowels in Experiment 1, they were perceived to be the most similar to English vowels.

/i/	/a/	/u/	/Δ/	/ɛ/	/e/	/ɨ/
bhang	bap	bukchae	pasot	paygay	pekgom	dungday
hita	hakyu	huksek	hakgan	hayum	hebit	huksek

Table 4: Korean stimuli used in Experiment 2.

Participants were 40 native Korean speakers who had been exposed to English in the U.S. as children (early bilinguals; n=20; mean age: 9; range: 6-13 years) or as adults (late bilinguals; n=20; mean age: 23; range: 15-30). Of these bilinguals, half had resided in the U.S. for 1 year (mean: .7; range: .1-1.5 years), and half for 7 years (mean: 7.4; range: 4-15 years). The 4 groups (n=10) will be referred to as the Early+1 (1=“1 year of U.S. residence”), Early+7 (7=“7 years of U.S. residence”), Late+1, and Late+7 groups.

A picture-naming task elicited English and Korean words. Participants were first familiarized with picture names and

were then asked to spontaneously name the pictures as they were presented in separate language blocks in 3 random iterations. Each participant's spontaneous productions of the words were then submitted to an acoustic analysis.

3.2 ACOUSTIC MEASUREMENTS

Acoustic analyses of the bilinguals' L1 and L2 production were performed to obtain a measure of the L1-L2 interaction at the segmental level. The English and Korean vowels were analyzed by measuring F0, F1, F2 in two locations in each token, onset of voicing and vowel midpoint. These measurements, converted to Bark scale (B) to normalize for gender and age differences in vowel height, were transformed to two values: B1-B0, an estimate of vowel height, and B2-B1, an estimate of vowel position in the front-back dimension [7]. (Only the values obtained from the vowel midpoint were submitted to statistical analyses.)

It was predicted (1) that L2 (English) influences upon L1 (Korean) production would be greater for the early than late bilinguals, and (2) that L1 and L2 segments would interact to a greater extent when these segments are similar rather than dissimilar across the two languages. Thus, there should be more L1-L2 segmental influences on production for L1-L2 vowel pairs perceived on a *one-to-one* basis (similar vowels) than for L1-L2 vowel pairs perceived on a *two-to-two* basis (dissimilar vowels) or for L1-L2 vowel pairs perceived on a *two-to-one* basis (confusable vowels).

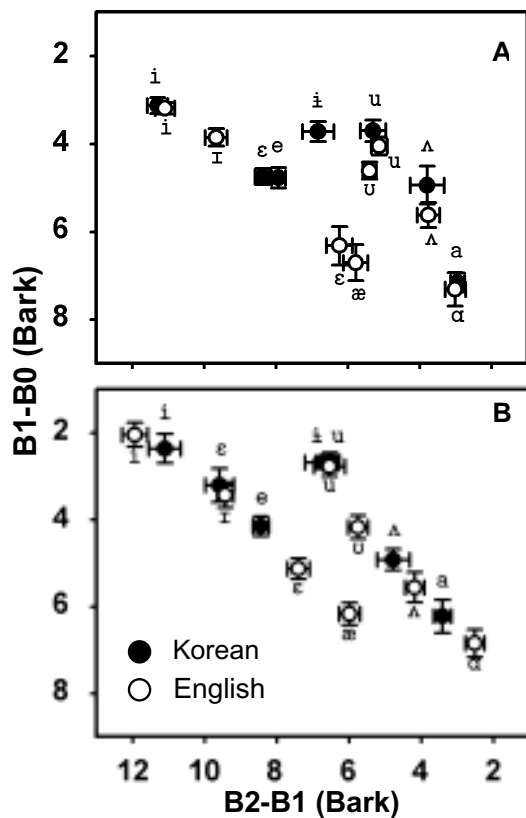


Figure 1: Mean acoustic values of English and Korean vowels produced by Early+1 (A) and Early+7 (B) groups.

3.3 RESULTS

Comparisons of the B1-B0 and B2-B1 values between the Early+1 and Early+7 groups yielded the following results. First, for a vowel pair perceived on a *two-to-one* basis (E /ɪ/-K /i/) and two vowel pairs perceived on a *one-to-one* basis (E /ɑ/-K /a/, E /Δ/-K /Δ/), the Early+1 and Early+7 groups' B values did not differ in English or Korean. Second, for 2 other vowel pairs perceived on a *two-to-one* basis (E /i/-K /i/, E /u/-K /u/), the Early+1 and Early+7 groups' B values differed for English /i/ and for both English /u/ and Korean /u/. The Early+7 group produced English /i/, /u/ and Korean /u/ with lower F1 values (i.e., higher in the vowel space) than the Early+1 group did. Finally, for the vowel pairs perceived on a *two-to-two* basis (E /æ/-K /ɛ/, E /ɛ/-K /ɛ/) and an additional vowel pair (E /ʊ/-K /ɨ/), the Early+1 and Early+7 groups' B values differed in Korean but not in English. The Early+7 group produced the Korean /ɨ/ and /ɛ/ with lower F1 values (i.e., higher in the vowel space) than the Early+1 group did, suggesting that these two Korean vowels became more similar to English vowels.

Overall, these findings revealed a bi-directional influence of the L1 and L2 upon the early bilinguals' L1 and L2 production. (See Figure 1. Korean vowel symbols are represented above the vowel; English vowel symbols are represented below the vowel. Brackets enclose two standard errors of the mean.)

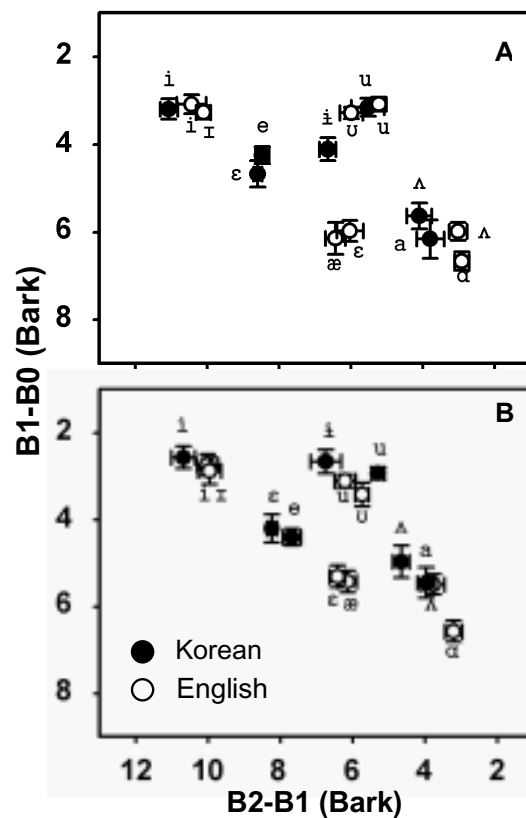


Figure 2: Mean acoustic values of English and Korean vowels produced by Late+1 (A) and Late+7 (B) groups.

Analyses of the B1-B0 and B2-B1 values between the Late+1 and Late+7 groups yielded the following results. For all vowels examined, the Late+1 and Late+7 groups' B values did not differ in English or Korean. These findings revealed a unidirectional influence of the L1 upon the late bilinguals' L2 production (Figure 2).

Acoustic analyses of early and late bilinguals' production of L1 and L2 segments confirmed our hypotheses. First, the extent to which L1 and L2 segments interacted importantly depended upon the bilinguals' age at the time of L2 learning. That is, bi-directional influences upon L1 and L2 segmental production occurred more in early than late bilinguals. Second, the extent to which L1 and L2 segments interacted depended on how perceptually similar those segments were. Thus, the segments perceived as being relatively similar (E /ɑ/–K /a/) or dissimilar (E /æ/–K /ɛ/) across the bilinguals' L1 and L2 were *more* likely to influence each other (or have acoustic values that were “colored” by proximitous L2/L1 segments).

4 DISCUSSION

This study examined the influence of cross-language similarity on the likelihood that bilinguals' productions of L1 and L2 segments would “color” or influence each other. In addition, this study examined whether this influence would depend upon bilinguals' age at the time of L2 learning. The findings of this study indicated that, for both early and late bilinguals, the bilinguals' L1 (Korean) influenced their L2 (English) production when L1 and L2 segments were similar across the two languages (English /ɑ/–Korean /a/, English /Δ/–Korean /Δ/). The direction of the cross-language influence was reversed when L1 and L2 segments were dissimilar (English /æ/, /ɛ/–Korean /e/, /ɛ/): For these vowels, only early bilinguals' L2 (English) influenced their L1 (Korean) production. In other words, the extent of the L1-L2 interaction was greater for the early than late bilinguals. When L1 and L2 segments were confusable (i.e., segments that were members of segment pairs perceived on a *two-to-one* basis: English /ɪ/–Korean /i/; English /u/–Korean /u/), the L1 (Korean) influenced only the late but not early bilinguals' L2 (English) production.

These findings shed light on the nature of L1 and L2 speech learning. In particular, early bilinguals' two phonetic systems may be more likely to interact, being more influenced by the L1. This may suggest that their L1 segmental representations (categories) are more flexible than those of late bilinguals [2]. Early bilinguals may thus be more likely than late bilinguals to develop new categories for L2 segments. Late bilinguals, however, seem to rely on merged L1-based segmental categories and use them to process both L1 and L2 segments. The findings of the present study overall provide evidence for the complex interaction between bilinguals' L1 and L2 and invite further investigation into the nature of early and late bilinguals' phonetic system(s).

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