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Does bilingualism help trilingualism in phonetic perception?*

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Hong, Seung-ah and Jongsup Jun. 2013. Does bilingualism help trilingualism in phonetic perception? *Linguistic Research* 30(1), 33-49. The purpose of this paper is to answer the question of whether bilingual speakers learn a third language more easily than monolinguals. For this, we narrowed down our research interest to Arabic-English bilingual speakers' perception of the phonetic contrasts in Korean. We have conducted the perception experiment in which native Arabic speakers are grouped into *monolinguals* and *late-bilinguals of English*, and are asked to discriminate a different speech sound among three Korean syllables. We cross-classified the subjects' responses in a multi-way frequency table defined by five categorical variables; i.e. *group* (monolingual vs. bilingual), *syllable structure* (V vs. *h*V), *target stimulus position* (initial vs. final), *contrast pairs of Korean vowels* (/a-ʌ/, /a-e/, /ʌ-ɨ/, /o-ʌ/, /u-o/, /u-ɨ/, /i-e/, /i-ɨ/), and *response* (correct vs. incorrect). The log-linear regression analysis indicates robust L1 transfer effects on L3, but we found no significant difference between monolingual and bilingual speakers. Considering the general interest in multi-lingualism among the public and people's vague belief that bilingualism may help trilingualism, the findings of this paper have significance not only for the field of second language acquisition, but for pedagogical purposes as well. **(Hankuk University of Foreign Studies)**

Keywords Arabic, Egyptian Arabic, discrimination, perception, bilingualism, trilingualism, log-linear regression

1. Introduction

Language learners hear speech sounds of a foreign language (L2) with reference to their first language (L1) phonology (Best & Strange 1992; Bohn & Best 2012; McAllister, Flege & Piske 2002). The speech perception system tends to restrict acoustic signals of L2 within the L1 inventory of phonetic segments, which prevents

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** First author *** Corresponding author learners from recognizing non-native contrasts. At the same time, there is a view that language learners become more sensitive to non-native contrasts of phonetic segments through their increasing experience of L2. Earlier studies indicate that late-bilinguals' perception or production of L2 segments can be improved through sufficient exposure to the target language (Flege, Bohn & Jang 1997; Levy & Strange 2008), and that the L2 experience may influence the L1 system as well (Brown & Gullberg 2008, Chang 2011, Pavelenko 2000). In short, the speech perception system of bilingual speakers is not the same as that of monolinguals.

An interesting question arises in this regard: *Do bilingual speakers learn a third language more easily than monolinguals?* In other words, does the knowledge of one foreign language (L2) help us perceive the phonetic contrasts of another foreign language (L3)? If we take *any* advantage of L2 in learning L3, which is more important between L1 and L2?

To answer these questions, we have carried out the perception experiment in which native Arabic speakers are grouped into *monolinguals* and *late-bilinguals of English*, and are asked to discriminate a different speech sound among three Korean syllables. Subjects' responses are cross-classified in a multi-way contingency table defined by five categorical variables; i.e. *group* (monolingual vs. bilingual), *syllable structure* (V vs. *h*V), *target stimulus position* (initial vs. final), *contrast pairs of Korean vowels* (/a-ʌ/, /a-e/, /ʌ-ɨ/, /o-ʌ/, /u-o/, /u-ɨ/, /i-e/, /i-ɨ/), and *response* (correct vs. incorrect). We tested various log-linear *models*, i.e. equations, that are expected to explain the complicated distribution of frequency counts. Results of the log-linear regression analysis indicate robust L1 transfer effects on L3, but we have found no significant difference between monolingual and bilingual speakers.

2. Earlier works on non-native segment perception

Scholars have proposed two representative models for the perception of L2 speech segments: Speech Learning Model (SLM) and Perceptual Assimilation Model (PAM). Both models explain the L2 speech perception in terms of the L1 speech system with slightly different focuses of interest. SLM aims to answer why certain L2 categories are acquired more successfully than others whereas PAM focuses on why certain L2 categories can be distinguished from other sounds easily.

According to SLM, the L2 segment acquisition is explained by the assimilation process between L1 and L2 segments (e.g., Bohn & Flege 1992, Flege 2003). Speakers acquire unfamiliar L2 sounds more successfully than familiar sounds because the L2 sounds that are phonetically close to L1 counterparts tend to be assimilated into existing L1 categories. For this reason, language learners find it difficult to distinguish familiar L2 sounds from existing L1 sounds.

On the other hand, unfamiliar L2 sounds are not assimilated into existing L1 categories, and are added to the speaker's mental inventory of speech segments. This suggests that the late-bilingual speakers of English in our study may have acquired certain English vowels that are not available in their native language, i.e. Egyptian Arabic. Seven English vowels (/ɪ/, /ɛ/, /æ/, /ɑ/, /ɔ/, /ʌ/, and /ʊ/) are not found in Egyptian Arabic, and these vowels may have been added to the bilingual subjects' vowel inventory. If this is the case, we can predict that monolingual and late-bilingual speakers in our study may perceive the Korean vowels differently.

PAM does not assume one-to-one correspondence between L1 and L2 sounds (e.g., Best, McRoberts & Goodell 2001; Best & Strange 1992; Best & Tyler 2007). Some L2 sounds may assimilate into a group of sounds in L1, whereas other L2 sounds may correspond to no L1 sound. Whether an L2 sound assimilates into a single L1 segment or not, some L2 sounds are discriminated more easily than others. This model does not make a direct prediction about the L3 segment perception, but it seems that speakers' experience of one foreign language may have altered their perceptual space, and that bilingual speakers will perform differently from monolinguals, but not so much differently as is predicted in SLM.

Besides SLM and PAM that emphasize the role of L1 in learning a second language, we find several studies that focus on the role of L2 on L3 acquisition (Hammarberg & Hammarberg 2005; Llama, Cardoso, & Collins 2010; Wrembel 2010, 2011). In general, L1 is more dominant than L2 (Llisterri & Poch 1987); but L2 can also play a significant role for L3 acquisition (Williams & Hammarberg 1998).

Observing the L2 transfer effect on L3, scholars have suggested that the status of L2, typological similarities between L2 and L3, the amount of L2 usage, etc. should be possible factors for the transfer effect. One non-trivial problem is that we do not know in what direction L1 and L2 interact with each other for the L3 acquisition. It can be the case that what seems to be the effect of L2 is *in fact* the effect of L1.

To investigate this issue, we must use an advanced statistical technique that controls for the effect of L1 and L2 simultaneously. In the rest of this paper, we present how we collected the data, and analyzed the complicated distribution of frequency counts by using log-linear models that control for the effects of L1 and L2 simultaneously.

3. Phonological differences: Arabic, English, and Korean

Three languages are involved in this study: Arabic, English, and Korean. Arabic is the native language of the participants, whereas English is the L2 which distinguishes the monolingual (GM) and bilingual (GB) subjects. Korean is the target language (L3) in the experiment.

Korean has a large-size vowel inventory (Maddieson 2011). Korean vowels used to have durational contrasts, but the duration no longer has the phonemic distinction these days (Park 1994). Likewise, some vowels lost their phonemic status historically: /e/ and /ɛ/ are merged into /E/ (Bae 2003, Shin 2000), and /ö/ and /ü/ are diphthongized as /we/ and /wi/ respectively. As a result, there are 7 monophthongs, /a/, /i/, /u/, /E/, /o/, /ʌ/, and /ɨ/ in the Korean vowel system. The English vowel system is richer than the Korean inventory. American English has 11 vowels: /i, ɪ, e, ɛ, æ, ɑ, ɔ, ʌ, o, ʊ, u/ (Clopper, Pisoni & de Jong 2005).

Unlike Korean or English, Arabic is known as a language with a limited number of vowels. In describing the Arabic language, we have to make a distinction between the colloquial variety and Modern Standard Arabic (MSA). While MSA consists of only corner vowels, the colloquial Arabic in Egypt has more vowels on its inventory since the diphthongs /ay/ and /aw/ in MSA have changed into long monophthongs /e:/ and /o:/ in Egyptian Arabic (EA) (Al-Ani 1970, Elgendy 1982, Newman & Verhoeven 2002, Norlin 1984). Long and short EA vowels show different spectra: short vowels are more central than their long counterparts while the short and long vowels in MSA differ only in terms of temporal properties (Al-ghamdi 1998, Elgendy 1982, Norlin 1984). As a result, EA has the following vowels in its inventory: short /a/, /i/, /u/, and long /a:/, /i:/, /u:/, /e:/, /o:/.

In Arabic phonology, CV is the most unmarked syllable structure while V is a common syllable in Korean and English.[1] In order to find out if the L1 syllable

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[1] Although we usually assume that the CV syllable subsumes V, V is not allowed in Arabic. In a

constraint is applied to non-native phonetic contrasts, we have constructed our stimuli in both V and CV conditions. Notice that the coarticulation involved in pronouncing V after C in the C-V syllable makes the temporal and spatial changes in the vowel. Since our goal is to assess the contrasts in vowels rather than the preceding consonants, we have used /h/ as the preceding consonant in the CV condition.[2] This is because the glottal fricative /h/ in Korean tends to assimilate itself to the following vowel, and hence it maintains only the manner of articulation features. Hence, /h/V can be interpreted as a devoiced V, which sounds like a weakened /ʔ/V syllable in Arabic. This is because the Arabic glottal stop makes the following vowel devoiced when it is weakened before a vowel.

4. Methods

We have used the ABX discrimination task in assessing the L2 influence on the perception of L3 phonetic contrasts. In this experiment, subjects are presented with a set of three stimuli, where one stimulus is a different sound from the other two. For instance, one stimulus set is composed of [a-e-e], where the subjects are supposed to pick out the initial [a] sound that is different from the other two.

4.1 Participants

11 native Arabic speakers participated in the experiment (Age range: 21-55; Mean age=35). All the participants are Egyptian Arabic speakers who have lived in Cairo during lifetime. They are divided into two groups based on their experience of learning English as a foreign language (L2). Six participants have no prior learning experience of English, and are categorized as monolingual Arabic speakers (GM; 4 males and 2 females). The other group (GB) is composed of five participants (2 males and 3 females) who have learned English as their L2. The English proficiency of GB subjects may vary, but the difference between GM and GB is clear since GM

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natural stream of speech, glottal stop /ʔ/ can be weakened, so the /ʔ/V would sound like V. Nevertheless, CV is the simplest syllable structure in Arabic.

[2] Syllable structures like /hV/ or /hVd/ are often employed in earlier studies for the vowel perception and production (i.e. Yang 1996).

subjects cannot understand even a simple English word while GB subjects are able to communicate in English with a native English speaker.[3] None of the subjects have reported any hearing problem.

4.2 Test material

In this experiment, we have used seven Korean vowels (/a, e, i, o, u, ʌ, ɨ/) in two syllable conditions (/V/ and /*h*V/) as target stimuli.[4] They are produced by a native Korean speaker who is a 29-year old female from Seoul. The vowels are produced three times, and the best sample for each category is selected as test material. The recording is digitized in 22.05 kHz sampling rate using the Praat software (Boersma & Weenick 2011). The duration and amplitude of the recording are normalized. See *Appendix* for the stimulus sets used in the experiment.

4.3 Procedure

The Korean vowels are paired on the basis of the degree of approximation in the vowel space. We have set up eight pairs in total: /a-ʌ/, /a-e/, /ʌ-ɨ/, /o-ʌ/, /u-o/, /u-ɨ/, /i-e/, and /i-ɨ/. For each pair, we have set up 4 trial types based on the position of the target stimulus (TSP) in the set: TSP-*initial* sets (ABB and BAA) and TSP-*final* sets (AAB and BBA). For example, such stimulus sets as /a-e-e/, /e-a-a/, /a-a-e/, and /e-e-a/ are built from the /a-e/ pair. The three vowels in a set are presented to each subject through the Praat software on a computer monitor. Four choice buttons are displayed on the monitor as ‘1’, ‘2’, ‘3’ and ‘Same’. If the subject judges all three sounds as ‘Same’, the ‘Same’ button should be clicked. Otherwise, they have to pick out the odd stimulus by clicking its number. In total, 234-sets of trials are presented to each subject: eight pairs of contrasts (/a-ʌ/, /a-e/, /ʌ-ɨ/, /o-ʌ/, /u-o/, /u-ɨ/, /i-e/, /i-ɨ/) are presented through four trial types (ABB, BAA, AAB, BBA) in two syllable contexts (/V/ and /*h*V/) with three times of iteration; on top of this, the control sets

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[3] GB subjects learned English at school whereas GM subjects had limited educational background. Also, GB subjects are placed in English-speaking environments in their daily lives while GM subjects have not had any chance of using English in their lives.

[4] /E/ is used to represent the merged category of /e/ and /ɛ/. However, the /E/ stimulus used in this study is closer to /e/ than /ɛ/, so it will be transcribed as /e/.

of seven vowels in two syllable contexts are added as dummies with three times of iteration.[5] The ISI (Inter-Stimuli Interval) is 1,500-msec[6]. Once the subject makes a decision, he/she is not allowed to modify the choice. On average, it takes about 45 minutes per participant to complete the whole session.

5. Results of the experiment: Variables and cross-tabulation

The results of the experiment are coded into five categorical variables in Table 1. The four independent variables and one dependent variable in this table cross-classify the 128 cells in Table 2.

Table 1. Variables for coding the data (Abbreviations in parentheses)

Variable		Values
Independent	(G)roup	GM / GB
	(S)yllable Structure	V / *h*V
	(T)arget-stimulus position	Initial / Final
	(C)ontrast Pair	/a-ʌ/, /a-e/, /ʌ-ɨ/, /o-ʌ/, /u-o/, /u-ɨ/, /i-e/, /i-ɨ/
Dependent	(R)esponse	Correct / Incorrect

Table 2. Cross-tabulation of the ABX discrimination test result

{S}	{T}	{C}	{G}				*Grand Total*
			GM		GB		
			Correct	Incorrect	Correct	Incorrect	
V	Initial	a-ʌ	26	10	19	11	66
		a-e	30	6	26	4	66
		ʌ-ɨ	32	4	27	3	66
		o-ʌ	33	3	28	2	66
		u-o	1	35	1	29	66
		u-ɨ	28	8	26	4	66
		i-e	34	2	28	2	66
		i-ɨ	16	20	23	7	66

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[5] These are dummy sets to see if the participants respond sincerely.

[6] Werker and Logan (1985) report that listeners without prior exposure to the target language rely on their phonemic level of perception that occurs in the 1,500-msec ISI condition. Since the present study aims to investigate the assimilation pattern of Korean vowels into Arabic vowel categories, we need the ISI which enables listeners to rely on the 'phonemic process'.

	Final	a-ʌ	33	3	24	6	66
		a-e	29	7	30	0	66
		ʌ-ɨ	34	2	30	0	66
		o-ʌ	35	1	30	0	66
		u-o	2	34	0	30	66
		u-ɨ	34	2	28	2	66
		i-e	34	2	26	4	66
		i-ɨ	24	12	23	7	66
*h*V	Initial	a-ʌ	26	10	22	8	66
		a-e	33	3	29	1	66
		ʌ-ɨ	32	4	27	3	66
		o-ʌ	34	2	28	2	66
		u-o	10	26	10	20	66
		u-ɨ	26	10	20	10	66
		i-e	33	3	29	1	66
		i-ɨ	30	6	28	2	66
	Final	a-ʌ	30	6	24	6	66
		a-e	36	0	29	1	66
		ʌ-ɨ	35	1	29	1	66
		o-ʌ	36	0	30	0	66
		u-o	19	17	18	12	66
		u-ɨ	31	5	27	3	66
		i-e	36	0	29	1	66
		i-ɨ	32	4	28	2	66
Grand Total			904	248	776	184	2112

A classical method for analyzing frequency data is to conduct the Chi-square test on a two-way contingency table. When we analyze a multi-way contingency table like Table 2, however, the Chi-square test does not work. We need a more advanced statistical tool that enables us to explain the complicated distribution of frequency counts in the cross-tabulation defined by more than three categorical variables.

6. Log-linear models for the cross-tabulation

6.1 Basics of the log-linear regression analysis

The log-linear regression is a model-building method that enables us to analyze a multi-way contingency table.[7] In the log-linear regression analysis, we begin with a hypothesis or a *model* where all the factors are fully involved as effect terms. Suppose we want to build a model with the four independent factors in Table 2. The full or *saturated* model includes all possible effect terms as shown in a mathematical equation in (1) which we abbreviate to {GSTC}.

(1) $$\begin{aligned} \mathrm{ln}F_{ijkl} = {} & \mu + \lambda_i G + \lambda_j S + \lambda_k T + \lambda_l C + \lambda_{ij} G{*}S + \lambda_{ik} G{*}T + \lambda_{il} G{*}C \\ & + \lambda_{jk} S{*}T + \lambda_{jl} S{*}C + \lambda_{kl} T{*}C + \lambda_{ijk} G{*}S{*}T + \lambda_{ijl} G{*}S{*}C \\ & + \lambda_{ikl} G{*}T{*}C + \lambda_{jkl} S{*}T{*}C + \lambda_{ijkl} G{*}S{*}T{*}C \end{aligned}$$

The saturated model in (1) is mathematically set up to explain all the frequency counts in the cross-tabulation perfectly. The second step of log-linear regression is to reduce some effect terms from the saturated model. For instance, the reduced models in (2) have fewer number of effect terms than the saturated model.

(2) a. {G}: $\mathrm{ln}F_i = \mu+\lambda_i G$
    b. {S}: $\mathrm{ln}F_j = \mu+\lambda_j S$
    c. {T}: $\mathrm{ln}F_k = \mu+\lambda_k T$
    d. {G}, {S}: $\mathrm{ln}F_{ij} = \mu+\lambda_i G+\lambda_j S$
    e. {GS}: $\mathrm{ln}F_{ij} = \mu+\lambda_i G+\lambda_j S+\lambda_{ij} GS$
    f. {GST}: $\mathrm{ln}F_{ijk} = \mu+\lambda_i G+\lambda_j S+ \lambda_k T+\lambda_{ij} GS+\lambda_{jk} ST+\lambda_{ik} GT+\lambda_{ijk} GST$

The purpose of log-linear regression is to find the simplest model that explains the entire data as nicely as the saturated model. Suppose one of the restricted models in (2) could explain the entire data as nicely as the saturated model. Clearly, we do not need such a complicated model as (1); rather, we have to conclude that the simpler or *economical* model is sufficient to explain the data.

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[7] For more information on log-linear regression, see Agresti (2007), Jun (2010), Kennedy (1992), Knoke and Burke (1980), and Li (2002).

For this, we run a likelihood Chi-square test on a reduced model using the formula in (3), where n_{ijkl} is the observed frequency of the *ijkl*-th cell, and μ_{ijkl} is the expected frequency of the same cell.

(3) $G^2 = 2\sum n_{ijkl} \ln \left(\frac{n_{ijkl}}{\mu_{ijkl}}\right)$

Because we look for a reduced model that predicts more or less the same frequency distribution as the saturated model, we want the Sig. value of the test to be greater than the critical α=.05. In other words, we do not want the reduced model to be significantly different from the saturated model. This way, we test numerous reduced models, and find the most economical or *parsimonious* model that explains the data as nicely as the saturated model with fewest possible effect terms.

6.2 Hierarchical model-building for Table 2

Table 3 presents representative log-linear models for Table 2. Instead of the classical log-linear regression, we performed the *logit* log-linear regression analysis by including the response factor (R) as a dependent variable. In the *logit* version of the log-linear regression analysis, all the effect terms in the equation interact with the dependent variable, and hence we can tell whether a particular effect term *significantly* influences the response factor (R) or not.[8]

Table 3. Hierarchical model building

#	Model	G^2	df	p
1	{GSTC}	0	0	.
2	{GST}, {GSC}, {GTC}, {STC}	11.688	7	0.111
3	{GST}, {GTC}, {STC}	14.931	14	0.383
4	{GST}, {GSC}, {GTC}	17.155	14	0.248
5	{GST}, {GSC}, {STC}	17.270	14	0.242
6	{GSC}, {GTC}, {STC}	11.691	8	0.166
7	{GTC}, {STC}, {GS}	14.988	15	0.452
8	{GST}, {GTC}, {SC}	21.176	21	0.448
9	{GST}, {STC}, {GC}	21.419	21	0.434

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[8] The interaction of R with each effect term is omitted for convenience in Table 3 and below.

10	{GST}, {GSC}, {TC}	23.404	21	0.323
11	{GSC}, {GTC}, {ST}	17.235	15	0.305
12	{GSC}, {STC}, {GT}	17.270	15	0.303
13	{GTC}, {STC}	15.005	16	0.524
14	{GSC}, {GTC}	17.259	16	0.369
15	{GST}, {GSC}	30.213	28	0.353
16	{GSC}, {STC}	17.742	16	0.339
17	{GST}, {STC}	32.753	28	0.245
18	{GTC}, {SC}	21.334	24	0.619
19	{STC}, {GC}	21.917	24	0.584
20	{STC}, {GT}	33.055	30	0.320
21	{STC}, {GS}	33.121	30	0.317
22	{STC}, {G}	33.411	31	0.351
23	{STC}	36.295	32	0.275
24	{GC}, {GS}, {SC}, {T}	35.440	38	0.588
25	{SC}, {ST}, {TC}, {G}	39.382	38	0.408
26	{GC}, {ST}, {SC}	34.707	38	0.623
27	{GT}, {GC}, {SC}	35.070	38	0.606
28	{GT}, {ST}, {SC}	45.951	44	0.391
29	{GS}, {GT}, {SC}	46.482	44	0.370
30	{ST}, {SC}, {TC}	42.257	39	0.332
31	{GC}, {SC}, {T}	35.450	39	0.633
32	{SC}, {TC}, {G}	39.539	39	0.446
33	{SC}, {ST}, {G}	46.330	45	0.417
34	{GS}, {SC}, {T}	46.841	45	0.397
35	{SC}, {TC}	42.415	40	0.367
36	{SC}, {G}, {T}	47.140	46	0.426
37	{SC}, {T}	50.011	47	0.355

In the log-linear regression analysis, we usually test hundreds of models, but Table 3 shows only the models that fit the data as nicely as the saturated model. Since the goal of the log-linear regression is to find the model that explains the data as nicely as the saturated model with minimum number of variables, we choose the model #37 in Table 3 as the most parsimonious log-linear equation as shown in (4).

(4) {SC}, {T}: $\ln F_{jkl} = \mu + \lambda_j S + \lambda_k T + \lambda_l C + \lambda_{jl} SC$

According to (4), EA speakers discriminate Korean vowels as a function of the *target stimulus position* (→ effect of {T}), and of the interaction between *syllable structure* and *vowel contrasts* (→ effect of {SC}). In other words, the complicated frequency distribution in Table 2 is nicely explained by the very simple log-linear equation in (4).

7. Discussion

In the log-linear equation in (4), the effect of {G} is entirely left out. This implies that the experience of learning English as L2 does not help EA speakers perceive the Korean vowel contrasts. In other words, the late-bilinguals have no advantage for the L3 segment perception compared with mono-lingual speakers. This is a surprising result since several earlier studies have reported the influence of L2 on the L3 acquisition (Hammarberg & Hammarberg 2005; Llama, Cardoso, & Collins 2010; Wrembel 2010, 2011). One possible reason for this is that our GB subjects do not have a sufficient command of the English language, so they cannot exploit the L2 phonology as a source for the L3 segment perception. Alternatively, the difference between English and Korean vowel systems may hinder GB subjects from utilizing the L2 phonology for L3 perception.

Next, the log-linear equation in (4) clearly shows that the target stimulus position (T) significantly contributes to the frequency distribution in Table 2. The effect of {T} is illustrated by a two-way contingency table defined by T and R, as in Table 4.

Table 4. Cross-tabulation for T and R

	Correct	Incorrect	*Grand Total*
Initial	795	261	1056
Final	885	171	1056
Grand Total	1680	432	2112

Table 4 shows how correct responses are distributed with reference to the target stimulus position. In general, EA speakers tend to correctly discriminate Korean vowels when the target stimulus is located at the end of the stimulus set (as in AAB or BBA condition). This tendency can be attributed to the well-known *recency effect* in cognitive psychology; that is, subjects remember the latest, i.e. recent, stimulus best due to the limited capacity of the memory buffer.

Finally, the log-linear equation in (4) shows that there is a significant interaction effect between S*C and R. Table 5 illustrates this point.

Table 5. Cross-tabulation for S*C and R

	V		*h*V		*Grand Total*
	Correct	Incorrect	Correct	Incorrect	
a-ʌ	102	30	102	30	264
a-e	115	17	127	5	264
ʌ-ɨ	123	9	123	9	264
o-ʌ	126	6	128	4	264
u-o	4	128	57	75	264
u-ɨ	116	16	104	28	264
i-e	122	10	127	5	264
i-ɨ	86	46	118	14	264
Grand Total	794	262	886	170	2112

Overall, EA speakers correctly discriminate the L3 segment contrasts. It is also noteworthy that EA speakers do not discriminate the /u/-/o/ contrast well. In particular, our subjects find it difficult to discriminate the /u/-/o/ contrast in the V condition compared with the result from the *h*V condition. This is explained by the fact that CV is the unmarked syllable structure in Arabic. This strongly suggests that EA speakers are influenced by the L1 phonology rather than by the L2 phonology.

8. Conclusion

Does bilingualism help trilingualism? We cannot answer this question by studying a narrow domain of grammar, namely acoustic phonetics. Then, does bilingualism help trilingualism *in phonetic perception*? This question is certainly narrowed down a bit more to acoustic phonetics, but we still cannot answer this question satisfactorily by studying only some possible interactions among Arabic, English, and Korean. For this reason, we have to be careful in interpreting the results of our study. The present study shows that Arabic-English bilingualism does not help the perception of Korean segment contrasts. We could not find expected L2 effects on the L3 perception in the study that involves Arabic, English, and Korean.

Many people want to believe that it will be easier to learn a third language when we already know a second language. Our finding, however, indicates that the question is not so simple as one may wish to believe. We have observed quite robust L1 transfer effects on the L3 perception consistent with the previous findings in the literature. Considering the general interest in multi-lingualism among the public, the findings of this paper have significance not only for the field of second language acquisition, but for pedagogical purposes as well. This is why our present finding calls for a more detailed study of both the L1 and the L2 transfer effects in various cross-linguistic settings.

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Appendix

Stimulus sets used in the discrimination task

		ABB	BAA	AAB	BBA
V	a-ʌ	a-ʌ-ʌ	ʌ-a-a	a-a-ʌ	ʌ-ʌ-a
	a-e	a-e-e	e-a-a	a-a-e	e-e-a
	ʌ-ɨ	ʌ-ɨ-ɨ	ɨ-ʌ-ʌ	ʌ-ʌ-ɨ	ɨ-ɨ-ʌ
	o-ʌ	o-ʌ-ʌ	ʌ-o-o	o-o-ʌ	ʌ-ʌ-o
	u-o	u-o-o	o-u-u	u-u-o	o-o-u
	u-ɨ	u-ɨ-ɨ	ɨ-u-u	u-u-ɨ	ɨ-ɨ-u
	i-e	i-e-e	e-i-i	i-i-e	e-e-i
	i-ɨ	i-ɨ-ɨ	ɨ-i-i	i-i-ɨ	ɨ-i-i
*h*V	a-ʌ	ha-hʌ-hʌ	hʌ-ha-ha	ha-ha-hʌ	hʌ-hʌ-ha
	a-e	ha-he-he	he-ha-ha	ha-ha-he	he-he-ha
	ʌ-ɨ	hʌ-hɨ-hɨ	hɨ-hʌ-hʌ	hʌ-hʌ-hɨ	hɨ-hɨ-hʌ
	o-ʌ	ho-hʌ-hʌ	hʌ-ho-ho	ho-ho-hʌ	hʌ-hʌ-ho
	u-o	hu-ho-ho	ho-hu-hu	hu-hu-ho	ho-ho-hu
	u-ɨ	hu-hɨ-hɨ	hɨ-hu-hu	hu-hu-hɨ	hɨ-hɨ-hu
	i-e	hi-he-he	he-hi-hi	hi-hi-he	he-he-hi
	i-ɨ	hi-hɨ-hɨ	hɨ-hi-hi	hi-hi-hɨ	hɨ-hi-hi
Control sets					
V	a-a	a-a-a	*h*V	a-a	ha-ha-ha
	e-e	e-e-e		e-e	he-he-he
	i-i	i-i-i		i-i	hi-hi-hi
	o-o	o-o-o		o-o	ho-ho-ho
	u-u	u-u-u		u-u	hu-hu-hu
	ʌ-ʌ	ʌ-ʌ-ʌ		ʌ-ʌ	hʌ-hʌ-hʌ
	ɨ-ɨ	ɨ-ɨ-ɨ		ɨ-ɨ	hɨ-hɨ-hɨ

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