THE ROLE OF VOWEL CONTRAST IN LANGUAGE-SPECIFIC PATTERNS OF VOWEL-TO-VOWEL COARTICULATION: EVIDENCE FROM KOREAN AND JAPANESE

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ABSTRACT

The purpose of the present paper is to test the role of vowel contrast in V-to-V coarticulation. Specifically, V-to-V anticipatory and carryover coarticulations in Korean and Japanese were examined in terms of F1 and F2 in crowded vs. non-crowded regions of the vowel space. The results showed that vowel contrast does not directly contribute to the language-specific coarticulation pattern between these two languages, which is at odds with Manuel & Krakow (1984), and Manuel (1987), but in good agreement with Bradlow (1995).

Keywords: V-to-V coarticulation, Japanese, Korean, vowel contrast

1. INTRODUCTION

Vowel contrast is widely believed to be crucial to the cross-linguistic differences in vowel-to-vowel (V-to-V) coarticulation. Generally languages with a relatively crowded vowel space show weaker V-to-V coarticulatory effects, because speakers try to maintain distinctions among segments, and thus they are sensitive to the acoustic differentiation of the vowels of their language [1, 2, 3, 4]. For example, Manuel and Krakow [1] conducted a comparative study of V-to-V coarticulation in two Bantu Languages, Shona and Swahili, with the typical five vowel systems, and English with a more crowded vowel space. English as well as Shona and Swahili showed coarticulatory effects from the first vowel to the following vowel, but the magnitude of the effects was considerably smaller in English than in Shona and Swahili.

Manuel [2] further argues that speakers are actually sensitive to specific regions of the vowel space, not to the overall crowdedness of that space. In her studies, Manuel compares the anticipatory coarticulations of Shona and Ndebele, which have five vowels, to those of Sotho, which has seven vowels. The vowel spaces in these three languages were equally crowded with four vowels (/i, e, o, u/), but the low and mid vowel regions of Sotho was more crowded with 3 vowels than those of Shona and Ndebele (with only /a/). Given that the vowel /ɛ/ intervenes between /e/ and /a/ in Sotho, it was expected that /e/ and /a/ were less susceptible to anticipatory coarticulation in Sotho than in the other two languages, and these expectations were generally borne out.

Bradlow [5], however, showed that there was no positive correlation between the inventory size and 'tightness of within-category clustering,' the degree of within-category spread. When she examined the effect of inventory size on the acoustic realization of vowels in English and Spanish, she expected that in a language with many vowel phonemes such as English, phonetic variants for a certain vowel category are more tightly clustered than the language with less vowel phonemes such as Spanish, to minimize the potential for confusion between neighboring categories. However, it was shown that there was no difference in the tightness of within-category clustering between these two languages. These results suggest that vowel contrast might not be directly linked to the amount or pattern of coarticulation.

In light of the controversial claims and experimental evidence discussed above, the present study was undertaken to assess the role of vowel contrast in cross-linguistic patterns of V-to-V coarticulation. Specifically it attempted to show how Korean and Japanese, whose vowels differ in number and in their distribution in the acoustic space, differ in the exhibition of coarticulatory effects in V-to-V context. Korean is widely known to have 8 vowel phonemes as in /i, e, ɛ, ɪ, u, o, ɨ, a/, while Japanese has only five (/i, e, a, o, u/).

2. METHOD

The materials for the acoustic study were non-words with a structure of V_1CV_2, where V_1 and V_2 = [i, e, o, a]. These four vowels were found in both languages with slight acoustic differences. The C

in V_1CV_2 was a bilabial stop, [b]. With these constraints, eight distinct contexts were examined as follows:

			anticipatory		carryover	
			V1	V2	V1	V2
(1)	F1	crowded	a	i	i	a
		non-crowded	e	i	i	e
	F2	crowded	i	o	o	i
		non-crowded	a	o	o	a

Stimuli were divided into two categories: vowels in a crowded area of the vowel space and those in a non-crowded area, for each formant condition (F1 and F2), and type of coarticulation (anticipatory and carryover). Each word was recorded in a frame sentence, Korean '[seonsaengnimi___saraŋhæjo]' and Japanese '[seenseiga___sωkinano]' ("The teacher loves __").

Korean has mid front vowels /e/ and /ɛ/ between /i/ and /a/ (a 'crowded' region), while in Japanese only /e/ falls between these two vowels. However, between /i/ and /e/ (a 'non-crowded' region), there is no intervening vowel in either language. Thus we hypothesized that the coarticulatory raising of /a/ due to /i/ in the F1 dimension would be less strong for Japanese than for Korean, but such differences in coarticulatory pattern would not occur between /e/ and /i/. Likewise, for the F2 dimension, the coarticulatory backing of /i/ due to /o/ would be less strong for Korean than for Japanese for the same reason, but there would be no such coarticulatory differences between /a/ and /o/. This hypothesis was based on the fact that in the F2 dimension, Korean has /ω/ between /i/ and /o/, but Japanese has no intervening vowel. On the other hand, between /a/ and /o/, there is no intervening vowel in either language.

For a more precise cross-linguistic comparison, normalized F1 and F2 values were obtained, and formant frequencies were converted to the mel scale. The stimuli were presented in native language orthography, Hangeul for Korean speakers, and Katakana for Japanese speakers, the latter of which made the Japanese speakers considered the test words as non-words. Eight male native speakers each of Korean and Japanese read and recorded 5 repetitions of the randomized lists of 8 test words in a sound-attenuated room.[1] Based on the fact that the average duration of vowels between the two languages was not the same, the formant values of the vowels in the first or second syllable were measured at two different points of the vowel, namely, 5 ms before the vowel offset ('pseudo-vowel offset'), and at the steady state of the vowel of the first syllable for the case of anticipatory articulation; the same formant values were measured at 5 ms after the vowel onset ('pseudo-vowel onset'), and at the steady state of the vowel of the second syllable for the case of carryover coarticulation. The acoustic analysis was mainly based on the formant measurements taken from LPC autocorrelation formant tracks which were checked against the formants observed in wideband spectrograms, but manual correction was also done in some dubious cases.

3. RESULTS

3.1 F1

The following figures display the averaged F1 values at the vowel onset/offset and midpoint were presented for anticipatory, crowded region (Figure 1), anticipatory, non-crowded region (Figure 2), carryover, crowded region (Figure 3), and carryover, non-crowded region (Figure 4).

The vowel /i/ has a low F1, while /a/ and /e/ have relatively high F1's and thus the coarticulatory effect of the adjacent vowel /i/ on the target vowel /a/ or /e/ would be shown as a lower F1. We expected that Japanese speakers would show greater difference in F1 than Koreans between /i/ and /a/, a crowded vowel space, but not in /i/ and /e/, a non-crowded vowel space. The results in Figure 1 through Figure 4 did not fall in the expected direction. A visual comparison of the F1 values indicates that speakers of both languages showed considerable coarticulatory effects in most cases. However, a one-way ANOVA for each language at two different points shows that there were no significant main effects of coarticulation, except for one sporadic result for Korean at midpoint for anticipatory effect of /i/ to /e/.

Figure 1: Anticipatory effects on V1 /a/ midpoint and offset when the V2 is /i/ vs. /a/ (reference)

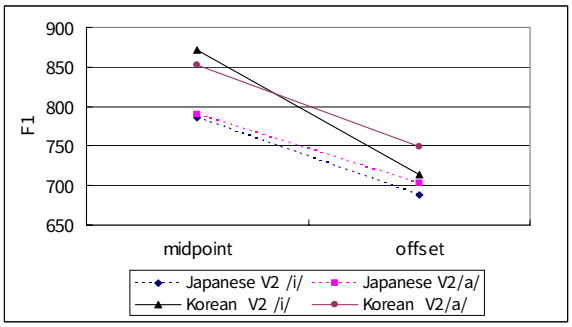


Figure 2: Anticipatory effects on V1 /e/ midpoint and offset when the V2 is /i/ vs. /e/ (reference)

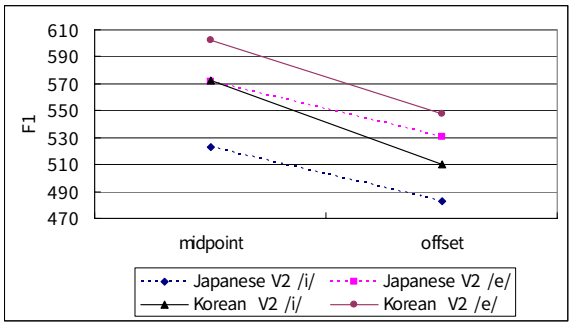


Figure 3: Carryover effects on V2 /a/ midpoint and offset when the V1 is /i/ vs. /a/ (reference)

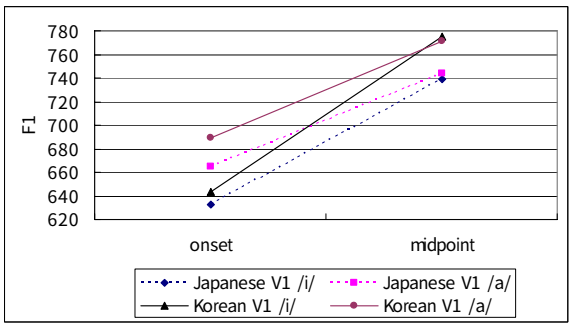
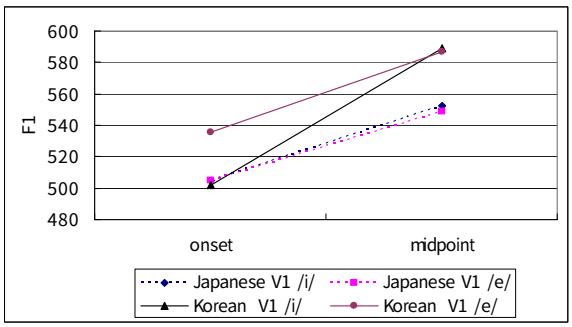


Figure 4: Carryover effects on V2 /e/ midpoint and offset when the V1 is /i/ vs. /e/ (reference)



3.2 F2

The following are the averaged F2 values at the vowel onset/offset and midpoint for anticipatory, crowded region (Figure 5), anticipatory, non-crowded region (Figure 6), carryover, crowded region (Figure 7), and carryover, non-crowded region (Figure 8). The vowel /o/ has a low F2, while /a/ and /i/ have relatively high F2's and thus the coarticulatory effect of the adjacent vowel /o/ on the target vowel /a/ or /i/ should result in a lower F2. We expected that Japanese speakers would show greater difference in F2 than Korean in a crowded vowel space, but not in a non-crowded vowel space. The results in Figure 5 through Figure 8 did not show such expected coarticulatory patterns. The results from a one-way ANOVA for each language at two different points are shown in Table 1: overall Korean speakers showed greater coarticulation than Japanese speakers; furthermore, there was no systematic pattern between the results from the crowded and those from the non-crowded vowel space.

It was expected that there would be more coarticulatory effects in the context where Korean, but not Japanese, had an intervening vowel between the two target vowels; however, Table 1 did not show such a pattern (Compare the grey area and the area with * marks).

Figure 5: Anticipatory effects on V1 /o/ midpoint and offset when the V2 is /o/ vs. /i/ (reference)

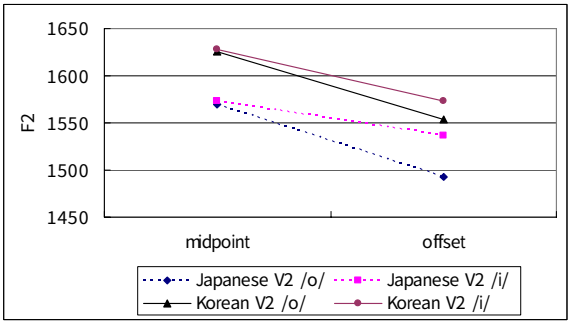


Figure 6: Anticipatory effects on V1 /a/ midpoint and offset when the V2 is /o/ vs. /a/ (reference)

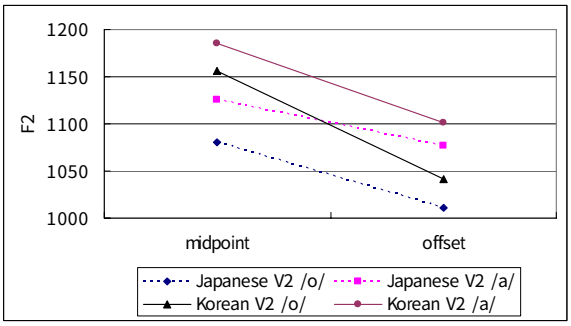


Figure 7: Carryover effects on V2 /o/ midpoint and offset when the V1 is /o/ vs. /i/ (reference)

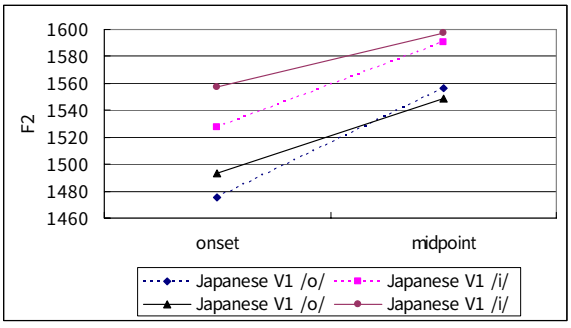


Figure 8: Carryover effects on V2 /a/ midpoint and offset when the V1 is /o/ vs. /a/ (reference)

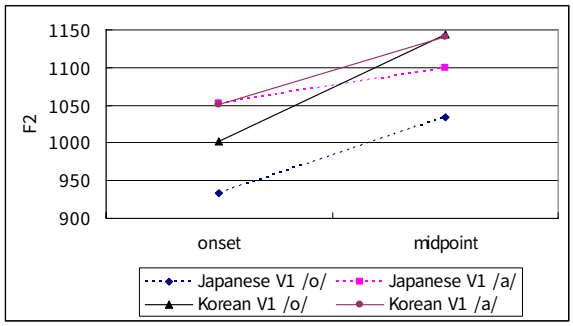


Table 1. Statistical results for F2 (* for significant coarticulatory effects; the grey area are for cases statistically significant effects were expected)

		Japanese		Korean	
		O	Mid.	O.	Mid.
A.	/o/->/i/				
	/o/->/a/			*	
C.	/o/->/i/			*	*
	/o/->/a/	*	*	*	

(A=anticipatory coarticulation, C=carryover coarticulation, O=onset/offset, Mid.=midpoint)

4. DISCUSSION

The results of the present study showed that there is considerable V-to-V coarticulation for both Korean and Japanese, but its exact amount and the pattern did not fall in the expected fashion. First, there were no cross-linguistic coarticulatory differences between Korean and Japanese, even though these two languages show difference in overall crowdedness of the vowel space. Even though it was expected that Japanese (with fewer vowel phonemes) would allow more coarticulation without loss of vowel contrast than Korean does, there was no such correlation between the overall vowel crowdedness and the coarticulatory effects. Furthermore and more importantly, neither language's coarticulatory patterns were sensitive to the specific regions of vowel space. Even in cases between /a/ and /i/, and /a/ and /o/ where Korean exhibited more vowel crowding than Japanese, the magnitude of the coarticulatory effects in Korean was not smaller than that of Japanese.

The results of the present study clearly show that vowel contrast is not directly linked to cross-linguistic differences in coarticulatory patterns, refuting the previous claims by [1], [2], and [3]. These results, however, are in good agreement with [5], which showed that the range and degree of within-category variance for vowels are not dependent on the size of the vowel inventory, even though the location of vowel categories in the acoustic vowel space is determined in part by a language-specific, base-of-articulation property. Specifically, vowels in English (with many vowel phonemes) were spread apart to the same degree as vowels in Spanish (with fewer vowel phonemes). The data of [5] are noteworthy in that English and Spanish have a larger difference in inventory size than the languages used in previous analyses such as [1] and [2]. Based on the data of [5], the possible argument, if any, would be refuted that the number of vowels, 8 (Korean) vs. 5 (Japanese), is not large enough to cause such cross-linguistic coarticulatory differences.

As Manuel [6] pointed out, the role of vowel contrast might be more likely to set an outer limit on coariculation, but not to fully explain the effects. The extent and pattern of coarticulation are generally sensitive to the system of phonological vowel contrast in a specific language; however, this does not necessarily mean that the contrast could fully explain the coarticulation patterns. Manuel's claim was based on inter-speaker differences in coarticulation; however, many other factors could be responsible for such coarticulatory effects. Further studies controlling for a wide range of factors are required before drawing any conclusion on the source of language-specific coarticulatory patterns.

5. REFERENCES

[1] Manuel, S., Krakow, R. 1984. Universal and language particular aspects of vowel-to-vowel coarticulation. *Haskins Laboratories Status reports on Speech Research*, SR-77/78, 69-78.

[2] Manuel, S. 1987. *Acoustic and Perceptual Consequences of Vowel-to-Vowel Coarticulation in Three Bantu Languages*, Ph.D. dissertation, Yale University.

[3] Beddor, P., Harnsberger, J., Lindemann, S. 2002. Language-specific patterns of vowel-to-vowel coarticulation: Acoustic structures and their perceptual correlates. *Journal of Phonetics* 30, 591-627.

[4] Magen, H. 1984. Vowel-to-vowel coarticulation in English and Japanese. *J. Acoust. Soc. Am.* 45, 1217-1233.

[5] Bradlow, A. 1995. A comparative acoustic study of English and Spanish vowels, *J. Acoust. Soc. Am.* 97(3), 1916-1924.

[6] Manuel, S. 1999. Cross-language studies: relating language-particular coarticulation patterns to other language-particular facts. In Hardcastle, W., Hewlett, N. (eds), *Coarticulation: Theory, Data, and Techniques*. Cambridge, UK: Cambridge University Press, 179-198.

[1] For Japanese stimuli, the first syllable had a high pitch accent, and the second syllable had a low pitch accent.