CROSS-LANGUAGE DIFFERENCES IN OVERLAP AND ASSIMILATION PATTERNS IN KOREAN AND RUSSIAN

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ABSTRACT

This paper investigates cross-linguistic differences in gestural overlap in consonant clusters and discusses how different patterns of overlap may interact with language-specific place assimilation patterns. We examine Russian and Korean stop-stop sequences within and across words, produced at two speaking rates. Significant differences in degrees of overlap emerge between the two languages for both prosodic conditions. We discuss to what extent language-specific differences in overlap can be linked to the language-specific propensity for articulatory place assimilation.

Keywords: overlap, assimilation, Russian, Korean

1. INTRODUCTION

An increasing number of studies show that gestural overlap patterns between consonant clusters can differ considerably across languages. Gibbon, Hardcastle & Nikolaidis [7] collected electropalatography data from speakers of six languages (English, Catalan, Italian, French, German, and Swedish) producing stop-lateral clusters of the type /VklV/. They found systematic differences across the languages in the timing of the tongue dorsum and tongue tip gestures of /k/ and /l/, with the greatest overlap shown by Catalan speakers and to the smallest overlap shown by Swedish speakers. Zsiga [16] conducted an acoustic study of overlap in stop-stop (e.g., /p#k/, /p#t/) clusters in English and Russian. The two groups of speakers showed marked differences in the timing of the consonant gestures: English speakers exhibited less frequent C1 releases and smaller C1-C2 closure ratios than Russian speakers, indicative of greater overlap in English than in Russian. Similar cross-language differences in degrees of overlap were obtained by Yanagawa [15] in an articulatory (EMMA) investigation of stop clusters in English, German, and Cantonese, with Cantonese exhibiting considerably higher degree of overlap than German.

It has been proposed that language-particular differences in gestural overlap in the articulation are directly or indirectly related to patterns of place assimilation in consonant clusters [2, 5, 13], yet little work has been done that explicitly relates our increasing understanding of cross-linguistic differences in degree of overlap to cross-linguistic differences in assimilation patterns. A relationship between degree of overlap and consonant assimilation is not unexpected, since overlap has the potential of obscuring C1 perceptually (greater in some clusters than in others). This in turn may lead to perceived assimilations or reductions [5].

In the present paper we investigate cross-linguistic differences in the degree of articulatory overlap in consonant clusters and discuss the potential interaction between degree of overlap and consonant assimilation. Specifically, we are comparing degrees of overlap in stop clusters (sequences) in two languages: an assimilating language, Korean, and a non-assimilating language, Russian. Korean is known to optionally assimilate C1 to the place of articulation of C2 in coronal-initial clusters (e.g. /tk/ → [kk], /tp/ → [pp]) and in labial-dorsal clusters (e.g. /pk/ → [kk]), whereby assimilation seems to be largely categorical in nature with few tokens showing gradient reduction of C1, different from what has been reported in some studies for English [e.g., 14]. Dorsal-initial clusters (e.g. /kp/ and /kt/) and labial-coronal clusters (e.g. /pt/) are unaffected by assimilation [9, 10]. Russian, on the other hand, exhibits no place assimilation in any of these clusters [1, 8].

If a correlation between overlap and assimilation or deletion does exist, we may expect that languages with a relatively high degree of overlap are more prone to place assimilation or deletion than languages with relatively little overlap. Similarly, we may expect that languages exhibiting gradient/categorical assimilation or deletion would also show overall high degrees of overlap (as measured in consonant sequences unaffected by assimilation). At the same time,

languages that do not exhibit such assimilation or deletion at all are expected to show overall lower degrees of overlap in the same sequences.

Our prediction is thus that the assimilating language, Korean, should show overall greater canonical overlap in consonant sequences compared to the non-assimilating language, Russian. For both languages, we examine the production of /kp/, /kt/, and /pt/ sequences (unaffected by place assimilation in Korean) within words and across word boundaries, as well as in normal and fast speech rate conditions.

2. METHOD

We collected acoustic and articulatory data using a magnetometry system (EMMA). Kinematic data were sampled at 500Hz and smoothed by a low-pass filter of 15Hz, the acoustic signal was sampled at 20kHz. Standard calibration and post-processing procedures were applied. Receiver coils tracking articulator movement were attached to upper and lower lip, jaw, tongue tip (TT), anterior and posterior tongue body (TD).

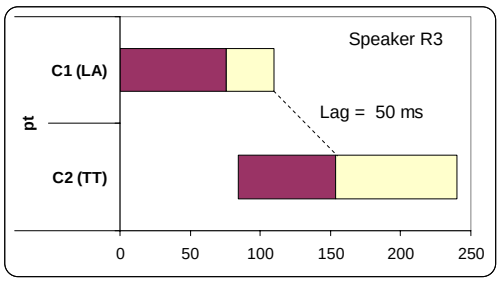
2.1. Subjects and Stimuli

We recorded data from three native speakers of Russian (further referred to as R1, R2, and R3) and three native speakers of Seoul Korean (K1, K2, and K3). Data collection was part of two bigger independent studies, thus the design differs slightly for the two languages. The stimuli in both languages contained the stop-stop clusters /kp/, /kt/ and /pt/ in two prosodic conditions: word-medially and across word boundary. The Russian test items – *bra[k p]adaja, bra[k t]omnogo, gra[p t]omnogo, blo[kp]ost, o[kt]ava, and la[pt]a* – were presented in the carrier phrase "eto ____ opjat'" ('This is ___ again'). Five repetitions of each target word or phrase were collected. The Korean test items – *a[k p']alamyənsə, a[k t']ahesə, ha[p t']aŋkimyən-sə, a[kp']ali, a[kt']am, and ha[pt']aŋ* – were presented in the carrier phrase /neka ____ lanɨn malɨl tɨlәpoassta/ ('I have heard of___') for K1 and (to shorten the carrier phrase) "neka ____ lako tɨlәssə" ('I heard it as ___') for subjects K2 and K3. Nine repetitions of each target word or phrase were collected. Only the first five of these were analyzed, to be consistent with the Russian data. Two speaking rate conditions were employed for both groups of speakers; subjects were instructed to read the sentences at a normal, comfortable rate or quickly. For Russian speakers, fast speech data were collected only for phrases, not for words. Due to technical problems, only normal speech data were collected for R3.

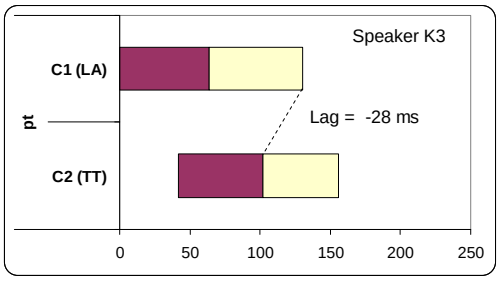
2.2. Analysis

The target sequences in the kinematic data were semi-automatically labeled for three articulatory landmarks: the beginning of the closing movement, the achievement of the target, and the release from the target. The landmarks were identified algorithmically on the basis of a velocity threshold. For /p/ measurements, the time series for Lip Aperture (LA) was computed as the Euclidian distance between the upper lip and lower lip receiver coil. (For R1, /p/ measurements were based on the lower lip raising only, due to malfunctioning of the upper lip receiver coil). For /k/ and /t/ measurements, TD and TT vertical displacement signals were used respectively.

Figure 1: Sample tokens of word-internal /pt/ clusters in Russian (a) and Korean (b), illustrating positive and negative Plateau Lag (in ms). For each gesture, the first interval represents the movement towards the target, the second interval represents the plateau (closure).



a.



b.

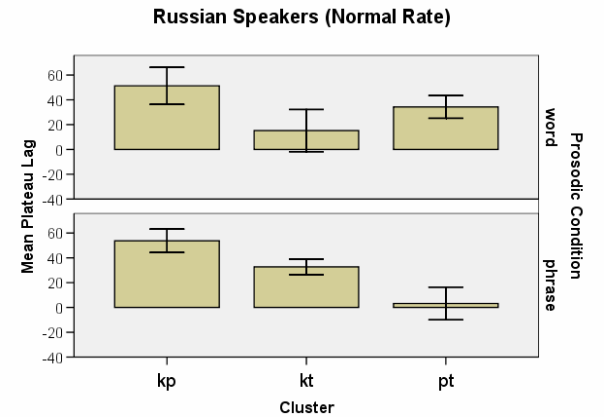
Degree of overlap was assessed by measuring Plateau Lag (PL), which was calculated as the time between the release of C1 and the achievement of target for C2 (cf. Fig. 1). Small numbers of PL indicate a higher degree of overlap, while large numbers indicate a smaller degree of overlap. A negative number indicates that the target of C2 is

attained earlier than the release of C1. This overlap measure was used since it is related to whether C1 is audibly released or not, an apparently important difference between the two languages. This measure is also similar to Zsiga's % released [16].

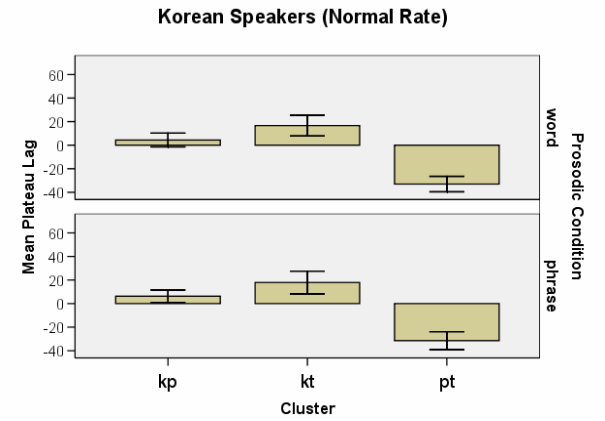
3. RESULTS

Looking at the normal speaking rate only, for which both prosodic conditions were collected for both languages, the Russian speakers showed greater plateau lag (less overlap) than Korean speakers (cf. Fig. 2). On average this difference was about 35 ms. Lag values for Russian speakers were mostly positive, indicating that C1 was consistently released prior to the achievement of C2. Lag values for Korean speakers were either positive or negative, depending on the cluster. Positive values were overall lower compared to Russian. We conducted an ANOVA with the between-factor Language and within-factors Cluster Type (/kp/, /kt/, and /pt/) and Prosodic Condition (word and phrase). The results confirmed a significant main effect of Language [F(1,4)=24.578, p=.008]. There was also an effect of Cluster Type [F(2,8)=12.587, p=.003]. The clusters where C1 had a more posterior constriction location compared to C2 (back-to-front: /kp/, /kt/) showed greater lag than the cluster where C1 was more anterior than C2 (front-to-back: /pt/). There was a significant Cluster Type x Language interaction [F(2,8)=5.386, p=.033] pointing to the lack of /kt/ vs. /pt/ difference for Russian (cf. Fig. 2a). There was no effect of Prosodic Condition or any interactions.

Figure 2: Plateau Lag (ms) for Russian (a) and Korean (b) speakers by prosodic condition and cluster for the normal speaking rate.



a.



b.

Mean plateau lag (PL) values as a function of speaking rate are shown in Table 1. The data indicate a near-lack of a rate effect: Overall, there were no clear lag differences between the normal and fast rate conditions. A notable exception is R1, whose lag values were almost 20 ms smaller in fast rate than in slow rate. For both rates, the Korean speakers displayed greater overlap than the Russian speakers. Rate differences were more clearly manifested in closure duration (plateau duration, PD) for C1 and C2 (cf. Table 2). PD was on average 22% (Korean) to 25% (Russian) shorter in the fast condition than in the normal condition. Due to the missing fast data for R3, rate effects were not evaluated statistically.

Table 1: Mean PL (ms) by language and rate.

PL (ms)	Korean		Russian	
speaker	normal	fast	normal	fast
1	-10.42	-8.48	26.76	7.33
2	1.70	4.87	24.09	22.40
3	7.21	8.52	41.43	n/a
Total	-4.81	-0.09	29.43	14.87

Table 2: Mean PD (ms) by language and rate.

		Korean		Russian	
speaker	PD (ms)	normal	fast	normal	fast
1	C1	35.40	25.35	20.84	15.60
	C2	55.42	35.93	67.00	50.67
2	C1	56.04	45.02	31.29	22.27
	C2	40.86	34.47	69.09	52.67
3	C1	26.67	22.99	29.23	n/a
	C2	43.22	33.61	75.23	n/a
	Total C1	38.88	32.31	26.86	18.93
	Total C2	50.09	34.79	69.84	51.67

4. DISCUSSION AND CONCLUSION

The cluster type effect emerged as significant for both languages: back-to-front clusters /kp/ and /kt/

were less overlapped than the front-to-back cluster /pt/ (with the exception of /kt/ in Russian words). Such an effect has previously been reported for other languages, such as English, Georgian, and French [3, 6, 11]. It has been argued that this effect can be causally linked to recoverability constraints: high degrees of overlap in stop-stop clusters can obscure the place of C1 to a greater extent when C1 is posterior relative to C2 (in back-to-front clusters) [6]. Presumably, these perceptual factors influence language-particular grammatical constraints on inter-gestural coordination [16], resulting in different timing patterns for front-to-back and back-to-front clusters. It has also been proposed that there may be an alternative, physiological explanation for the cluster type effect [11]. In the case of /kt/ the tongue tip movement towards the target is constrained by another lingual articulation (the tongue dorsum gesture), resulting in some separation between the two closures. In the case of /pt/, however, the tongue tip is unconstrained by the lip gesture and is free to achieve the target during the C1 closure. Yet it is not clear how physiological factors can account for the lesser degree of overlap in /kp/ (where the lip gesture is also free to achieve its target prior to the C2 release), as well as for the observed cross-linguistic differences in overlap.

The near-lack of a rate effect on degree of overlap in both languages is a less expected result, given some previous findings of gestural sliding in fast rate in English [4, 12]. It is possible that such gestural sliding is 'blocked' in Russian, which requires coda stops to be audibly released (cf. [16]). Similarly, a requirement for audibly unreleased coda stops in Korean [10] may constrain the degree of variation in gestural sliding due to speaking rate. Both languages showed a marked rate effect on C1 and C2 closure duration, in line with previous findings for English [4, 12].

Robust between-language differences emerged in our study for all cluster types, both prosodic conditions as well as both speaking rates. This supports our initial hypothesis that the degree of overlap may be related to the propensity of a language to assimilate in consonant clusters. (However, possible effects of other processes, such as 'post-obstruent tensification' in Korean [10] cannot be discounted). Gestural overlap and place assimilation of consonants have long been viewed as a major source of sound change, since overlap can lead to the perceptual hiding of gestures. If languages differ significantly in the degree of overlap of consonant clusters and this interacts with the assimilatory patterns found in a given language, it should be asked how these findings can be related to the hypothesis that perceptual hiding through overlap is a contributing factor to sound change. This question has to remain purely speculative at this point, and future research will have to investigate the interaction of language specific patterns of overlap and assimilation over a larger sample of languages.

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