Dialectal variability in Place and Manner of Korean affricates

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ABSTRACT

We examine dialect and age-related variability in the place and manner of Korean lenis affricates in speakers from Seoul and two less-studied Northern dialects. Place of articulation differed across dialects: while Seoul speakers produced affricates with a more posterior constriction (as compared to /s/), Northern speakers produced a more anterior constriction, comparable to /s/. Affricate manner of articulation was highly variable in all subgroups, ranging from "true" affricates (mostly seen in younger females from Seoul) to tokens virtually indistinguishable from fricatives. Acoustic correlates expected to distinguish affricates from fricatives (based on previous work on English) were not successful in separating the categories, exposing the need for different metrics to capture the distinction.

Keywords: Korean, affricates, fricatives, dialects.

1. INTRODUCTION

The place of articulation of Korean coronal affricates is considered a salient dialectal marker, with Northern affricates produced with a more anterior constriction than Southern affricates (e.g. [1]). However, the limited instrumental work on Northern dialects ([2, 3]) and variable findings from recent studies on Seoul Korean call this traditional description into question. Furthermore, very little work has explored the manner of articulation of affricates. We examine the acoustic realization of place and manner of the word-medial lenis affricate, as compared with its fricative counterpart, across Northern and Seoul speakers.

Although traditionally described as palatal (e.g. [4,5]), articulatory work suggests that the primary constriction for Korean affricates actually occurs in the alveolar region [6,7,8] (though [8] notes that there is still more postalveolar contact in affricates than in their (alveolar) fricative counterparts). The small number of speakers in these articulatory studies makes it difficult to generalize across dialects, but recent acoustic work has begun to explore dialect- and age-conditioned variation. [9] found more anterior productions of word-medial affricates in young female speakers from Seoul, and acoustic analysis by [3] of word-initial affricates in the same dialect groups examined in the present study found that while Seoul speakers' affricates were produced further back than their fricatives, speakers of Northern dialects produced the two at the same place.

Perhaps because the articulatory definition of an affricate seems relatively straightforward, cross-linguistic phonetic investigations of affricates have not focused on the details of manner of articulation. However, several studies in the "trading relations" literature have tried to isolate the acoustic event(s) distinguishing the English voiceless [ʃ]-[tʃ] contrast and found that short frication duration, fast frication rise time, presence of burst, high amplitude rise slope, and (for non-initial segments) presence of stop closure characterize affricates (vs. fricatives) in perception and production ([10-13]; [14] found an effect of rise time in the opposite direction).

There have been few instrumental studies targeting the affricate manner of articulation in Korean. However, the work that has been done is in line with the English patterns, showing that longer frication duration and longer rise time both play a role in the Korean fricative-affricate distinction in both production ([15]) and perception ([16]), with frication duration serving as a more dominant cue than rise time. Finally, although not the main focus of the paper, [6] noted that productions of intervocalic lenis affricates (the object of the current study) did not always show a full occlusion; that is, stop closure was not always present. The author attributes this variability to articulatory reduction and notes that the affricate tokens which did not show full closure still (impressionistically) sounded like "true" affricates, and not fricatives.

The variable findings on place and the limited work on manner call for a systematic study of dialect- and age-conditioned variation in Korean affricate production. In the current work, we explore to what extent Northern vs. Seoul speakers make use of acoustic cues assumed to be relevant to the place and manner distinctions.

2. METHODS

Participants: Speakers represent two dialects spoken by ethnic North Koreans residing in China (Hamkyeong (HK) and Phyeongan (PA)), and Seoul speakers from two age groups (Table 1).

Table 1: Participant demographic information

	Northern dialects		**Seoul dialect**	
	Hamkyeong	Phyeongan	Older	Younger
Speakers	10 F, 11 M	10 F, 13 M	15 F, 17 M	10 F, 14 M
Birth year	1950 (σ=7)	1950 (σ=7)	1955 (σ=6)	1988 (σ=3)

Stimuli: The current work focuses on the word-medial affricate in /sɛ**c**ɑŋ/ (새장, *birdcage*) and, for comparison, its fricative counterpart in the near-minimal pair /se**s**ɑŋ/ (세상, *world*).

Procedure: Target words were randomized within a wordlist used for a larger study. Speakers read three repetitions of the wordlist, with words produced in isolation. Northern dialect speakers were recorded in Dandong and Qingdao, China, at a local residence, and Seoul speakers were recorded at Seoul National University Linguistics Laboratory.

Acoustic measurements: In total, 594 tokens were analyzed (2 words x 3 repetitions x 100 speakers, 6 tokens omitted because of noise in the signal or misprouncIation). Consonants were manually segmented into the following acoustic events: **stop closure** (if any), **burst** (if any), **visible frication**, and **aspiration** (if any). The presence vs. absence of stop closure was often ambiguous (discussion and examples in Section 3.2.1); therefore, these annotations are to some extent subjective.

Prior to spectral analysis, tokens were pre-emphasized (from 50 Hz, 6 dB/octave), then band-pass filtered from F3 (calculated individually as each speaker's F3 in the vowel /a/) to 22050 Hz (this region was chosen to minimize the influence of energy from the lower formants, which was still present in many tokens after pre-emphasis, also cf. [17]). An FFT spectrum was computed over a 25 ms Hamming window centered around the point of maximum frication intensity in the consonant (calculated automatically from the filtered sound). We found it most consistent to measure **Center of Gravity (COG)**, an acoustic correlate of place of articulation ([17,18]), at this point, instead of e.g. the midpoint of frication, because the time course of frication was highly variable across tokens. We also used the time of maximum frication intensity, divided by the total consonant duration, as a durational measure in itself: **Time to Intensity Max**. We also calculated the more traditional **Rise Time** (cf. [10]) as the absolute time from onset of frication to maximum intensity. Note that the difference between these two measures is that Time to Intensity Max includes closure duration (if any) and is proportional to total consonant duration. **Amplitude Rise Slope** (cf. [13]) was calculated as the maximum slope (first derivative) of the intensity curve.

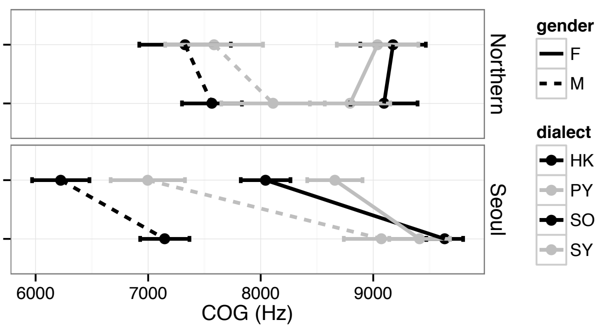
Statistical analyses: We used repeated measures ANOVAs to compare values for each acoustic dimension of interest in the affricate /c/ vs. the fricative /s/. Two sets of tests were performed for each dimension: first, to test for large-scale dialectal variation, a two-factor ANOVA tested the effect of Segment (/c/ vs. /s/, within subjects) and Dialect Region (Northern vs. Seoul, between subjects) on the acoustic dimension of interest. Then, to explore subgroup variation, separate ANOVAs for each dialect group were used to check for interactions of Segment with Gender and Subdialect (for Northern speakers, HK or PY) or Gender and Age (for Seoul speakers, Older or Younger). Since our focus is variation in production of the consonantal contrast, only significant interactions involving Segment are reported.

3. RESULTS

3.1. Affricate place of articulation

Figure 1 compares affricate place of articulation (as estimated by COG at the maximum point of frication intensity), compared to the fricative place of articulation for each subgroup. ANOVA results across the two main dialect groups (Table 2) show that the two groups differ in their use of COG to define the /c/-/s/ contrast: while Seoul speakers produce /c/ with a lower COG (i.e. more posterior) than /s/, Northern speakers do not produce significantly different COG for the two segments.

Figure 1: Mean and standard error for affricate (/c/) vs. fricative (/s/) COG, by dialect and gender.



Turning to subgroup variation, the effect of Segment was stable across dialect and gender within the Northern speakers. On the other hand, for Seoul speakers, the three-way interaction of Age, Gender, and Segment was significant (F(1,52)=14.8, p<.001), as were interactions between Age and Segment for two genders separately (Female: F(1,23)=5.8, p=.024; Male: F(1,29)=9.7, p=.004). Follow-up tests confirmed the pattern seen in Figure 1: all Seoul subgroups showed a COG contrast between affricates and fricatives (/c/ fronter than /s/, all groups p<.05), but the size of the effect was different, with younger females showing the smallest contrast of any of the subgroups.

3.2. Affricate manner of articulation

3.2.1. Visual inspection of spectrograms

Percentages of affricate tokens with visible closures or visible bursts are shown in Figure 2. Although younger Seoul females produced a majority of tokens with closure and burst, the majority of tokens from all other groups showed neither closure nor burst (i.e. not actually produced as affricates, by the articulatory definition).

Figure 2: Percentage of tokens with visible closure (left) or visible burst (right), by dialect and gender.

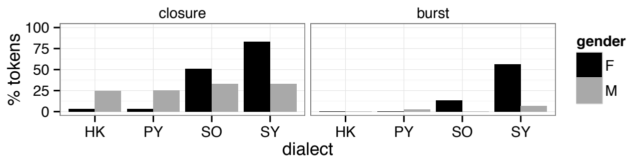
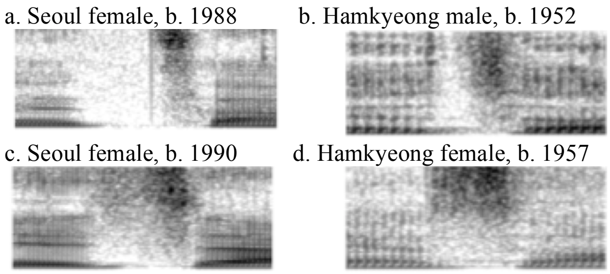


Figure 3 shows four sample spectrograms. Although some stop closures were very clear (e.g. 3a), most were ambiguous, and there was a continuum between tokens like 3b (annotated as closure) and 3c (annotated as no closure). Therefore, counts for closure duration given are meant to give a general impression of the patterns; the acoustic metrics in the following section (e.g. Time to Intensity Max) provide a more objective measure. Phonetic voicing was present in most tokens, as expected in intervocalic lenis stops in Korean ([19]).

Figure 3: Spectrograms of four affricates, all shown with frequency ceiling of 10 KHz and with 60 ms of the surrounding vowels.



We also consider the observation by [6] that even in the absence of a complete constriction, affricate tokens still do not "sound like" fricatives. Inspection of our acoustic data has left us mostly in agreement with this observation; although most affricates do not show stop closure, they still don't "look like" their fricative counterparts. This is most apparent in terms of intensity contour, which usually begins very low (whether or not there is complete closure) and gradually intensifies through the consonant, whereas fricatives show a more stable intensity contour across the consonant. Nevertheless, some tokens showing relatively stable frication (e.g. 3d) are not easily distinguishable (visually or auditorily) from fricatives.

Table 2: Results of repeated-measures ANOVAs testing the effect of Segment (/c/ vs. /s/) and Dialect (Northern vs. Seoul) on each acoustic dimension. Results from the two-way ANOVA are shown in the left column. The right two columns show simple effects of Segment for each dialect separately, along with means and direction of effect. Nonsignificant results are in gray.

		Northern vs. Seoul		Northern (effect of Seg.)		Seoul (effect of Seg.)	
		F=	*p=*	*F=*	*p=*	*F=*	*p=*
COG	segment	68.9	<.001	1.2	.277	92.1	<.001
	dialect	1.17	.282	/c/ < /s/		/c/ < /s/	
	interact	36.1	<.001	8213, 8359 Hz		7339, 8699 Hz	
Fric. duration	segment	64.8	<.001	16.8	<.001	48.3	<.001
	dialect	6.1	.016	/c/ < /s/		/c/ < /s/	
	interact	6.3	.014	63, 71 ms		52, 69 ms	
Rise time	segment	0.5	.478	3.3	.076	4.3	.043
	dialect	6.6	.012	/c/ > /s/		/c/ < /s/	
	interact	7.1	.010	41, 37 ms		32, 37 ms	
Amp. rise slope	segment	0.1	.779	13.0	<.001	2.8	.102
	dialect	11.4	.001	/c/ < /s/		/c/ > /s/	
	interact	10.6	.002	4394, 5438 Hz		6415, 5718 Hz	
Time to max intensity	segment	667.1	<.001	290.6	<.001	380.7	<.001
	dialect	1.0	.328	/c/ > /s/		/c/ > /s/	
	interact	5.5	.022	68 vs. 45 ms		71 vs. 44 ms	

3.2.2. Spectral and temporal measures

Manner-related acoustic measurements are summarized in Figure 4, and a summary of statistics from the large group-level ANOVAs is provided in Table 2. Significant results from subgroup analyses are reported in-text.

Frication duration: ANOVA results show that Seoul and Northern speakers differ in the extent to which frication duration distinguishes their productions of affricates vs. fricatives: while both groups produce a significantly shorter frication interval for /c/ than for /s/ (as expected), this contrast is larger for Seoul speakers.

Rise Time: A significant Segment by Dialect interaction and subsequent follow-up tests show that the Seoul and Northern speakers differ in their use of rise time in affricates relative to fricatives. Northern speakers' affricates and fricatives do not have significantly different rise times, although there is a statistical trend (p=.076) in the opposite direction than expected (/c/ having a *longer* rise time than /s/). Seoul speakers show a significant difference in rise time, with /c/ having an overall shorter rise time than /s/ (as expected).

Amplitude Rise Slope: Seoul and Northern speakers again differed in their use of amplitude rise slope to signal the affricate-fricative contrast. Northern speakers showed an effect in the unexpected direction, with steeper maximum slopes for fricatives than for affricates, while Seoul speakers showed no difference overall. The Northern speakers' effect of Segment was stable across subgroups; however, the Seoul group showed a significant Segment by Gender interaction, and follow-up tests confirm the pattern seen in the graph in Figure 4: Females (but not males) show a significant effect of Manner in the expected direction (/c/ has higher slope than /s/, $F(1, 24)=6.96$, $p=.014$).

Time to intensity max: The two dialects differed in the effect of Segment on this durational measure, as shown by a significant interaction; the effect is robust in both dialect groups, but slightly larger for Seoul speakers.

4. DISCUSSION

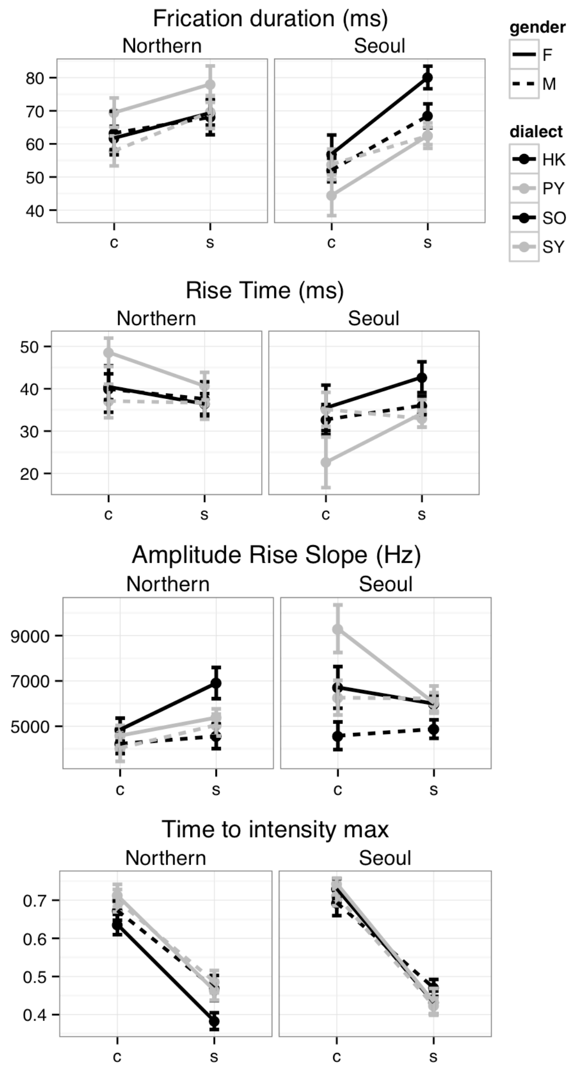
Results for place of articulation supported predicted patterns. The neutralization of the place contrast by Northern dialects mirrored and extended previous findings by [3] for word-initial affricates, and the results also replicated the finding of [9] that (younger) female Seoul speakers showed less of a place contrast than males.

However, in terms of the acoustic cues expected (based on previous work on the English [ʃ]-[tʃ] contrast) to differentiate Korean intervocalic /c/ and /s/, the distinction looks rather tenuous. Northern speakers show very few stop closures, only a very small mean difference (8 ms) in frication duration, an unexpected longer and less abrupt intensity rise for /c/ than /s/, and no place of articulation contrast. Instead, the somewhat ad-hoc Time to Intensity Max seems to be the best candidate of the acoustic dimensions we have considered. Even for Seoul speakers, who *do* distinguish the contrast on several dimensions, (including frication duration), Time to Intensity Max appears to separate productions most consistently. Furthermore, some of the effects (Maximum Amplitude Rise and presence of closure) appear to be carried by females.

One potentially relevant discrepancy between the English and Korean manner contrasts is the presence of voicing in the Korean affricate, whereas the focus of English work has been on the voiceless [ʃ]-[tʃ] contrast. Although it is not immediately apparent how this would effect the specific cues measured in the current work, voicing-conditioned differences in acoustic correlates of the affricate-fricative contrasts should be explored in the future.

In sum, this study has shown that impressionistic accounts of dialectal differences in affricates have an acoustic basis, most notably in the place of articulation contrast produced by Seoul, but not Northern, speakers. In terms of manner, with the exception of younger Seoul females, who produce for the most part true affricates, the fricative vs. affricate contrast does not seem to be well-defined by the acoustic cues which were expected to play the largest role, even though fricatives and affricates are produced differently (and perceived as different by native listeners). Whether this unexpected result is indicative of an idiosyncratic realization of the manner contrast in Korean, or of the general inadequacy of the English-based cues for the fricative-manner contrast cross-linguistically, is a subject for future research.

Figure 4: Use of acoustic dimensions signalling manner of articulation (Frication duration, Rise Time, Amplitude Rise Slope, and Time to Intensity Max) across affricates and fricatives, by dialect and gender.



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