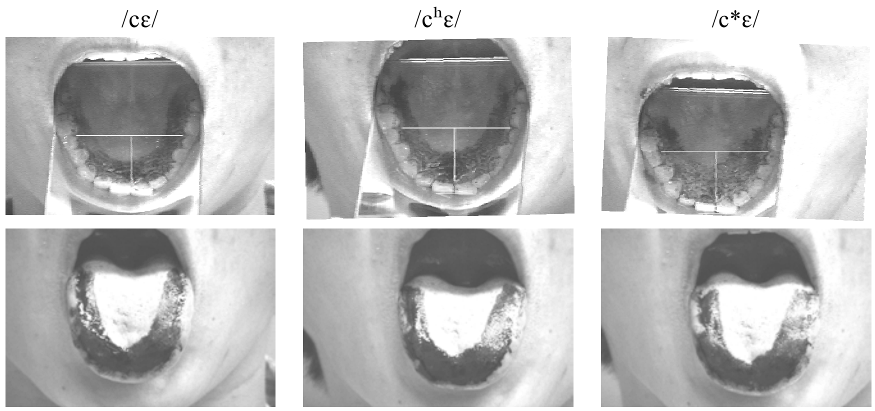

Figure 13. Representative palatograms and linguograms of initial coronal affricates for male speaker M1.

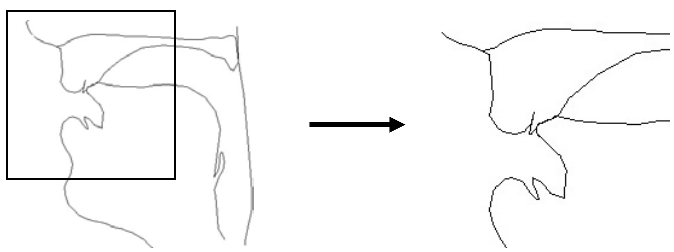

Figure 14. Midsagittal diagram showing M1's articulation of Korean plain, aspirated and tense affricates.

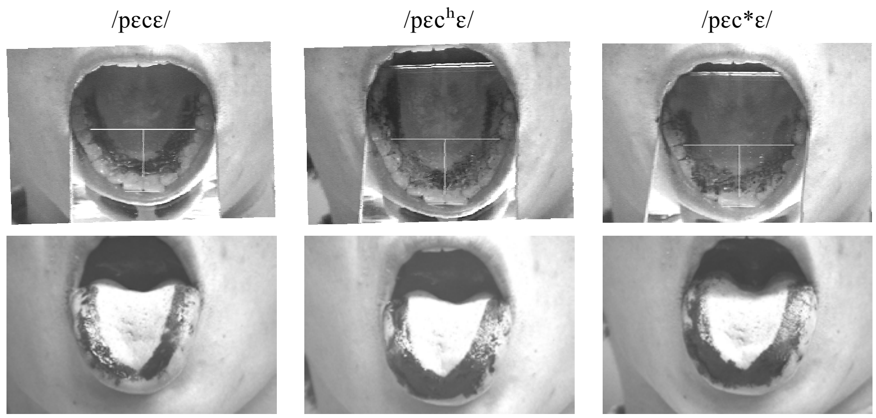

Figure 15. Representative palatograms and linguograms of medial coronal affricates for male speaker M1.

3.3. Fricatives

Recall that measures 'a' and 'b' (that is, point of frontmost contact in the midline and contact length in the midline, respectively) could not be reliably measured for fricatives, and as such, alternative measures 'd' and 'e' were used to compare them. The photographs in Figure 16 seem to imply a larger amount of tongue-palate contact for the tense fricative than for the lax fricative. However, as with the analyses of stops and fricatives, a one-way ANOVA revealed no main effect of the lax-tense distinction on any of the three palate measures for fricatives—there were no statistically significant differences in point of rearmost contact, amount of side contact, or gap width. (Measure 'd': $F[1,18] = .055$, $p = .8167$; measure 'c': $F[1,16] = .832$, $p = .3754$; measure 'e': $F[1,18] = 1.211$, $p = .2856$.) This is contrary to the findings reported by S. Kim (2001, 2003) based on EPG data. Nor was any effect of position-in-word found for the fricatives. (For measure 'd': $F[1,18] = .082$, $p = .7775$; for 'c': $F[1, 16] = 1.102$, $p = .3093$; for 'e': $F[1,18] = .044$, $p = .8364$.)

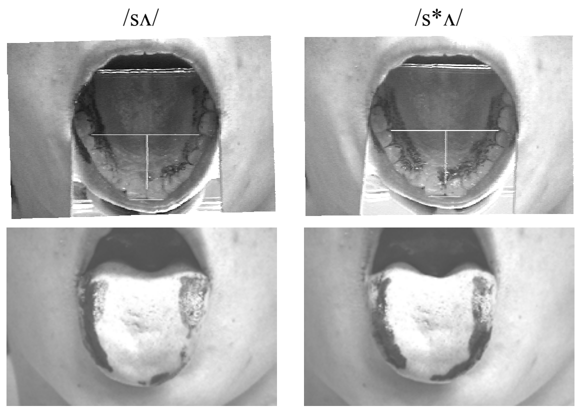

Figure 16. Representative palatograms and linguograms of initial coronal fricatives for male speaker M1.

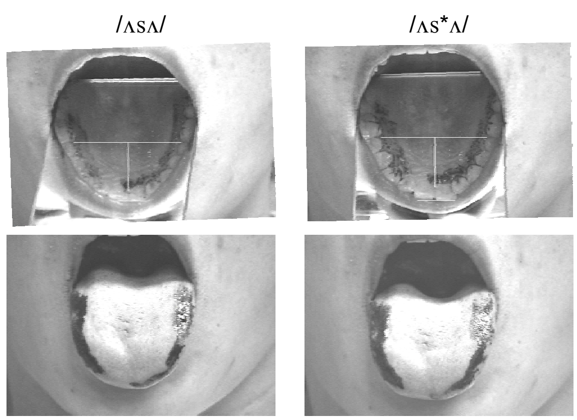

Figure 17. Representative palatograms and linguograms of medial coronal fricatives for male speaker M1.

A midsagittal reconstruction for speaker M1's fricatives is shown in Figure 18.

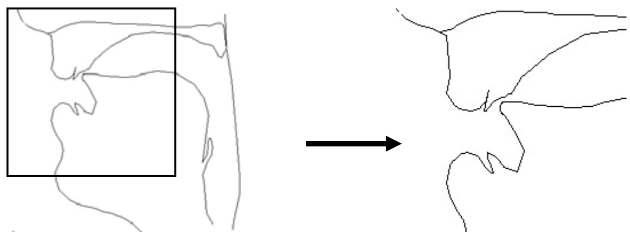

Figure 18. Midsagittal diagrams showing M1's articulation of Korean fricatives.

3.4. Place differences related to manner of articulation.

Does manner of articulation affect coronal place of articulation? Our data allow us to directly compare stops and affricates, but not fricatives, since the measurements for the latter class of sounds were not comparable to those used for the first two classes (refer to §2.5). As compared with the stops, the point of frontmost contact is consistently slightly further back on the teeth in the affricates (in a one-way ANOVA, $F[1,56] = 32.843$, $p<.0001$). Figure 19 shows means for point of frontmost contact as a percentage of calibration line *'v'*, while Figure 20 illustrates range of variation around the means. Particular examples of these differences can be seen by comparing the palatograms in Figures 10 and 13, or Figures 12 and 15.

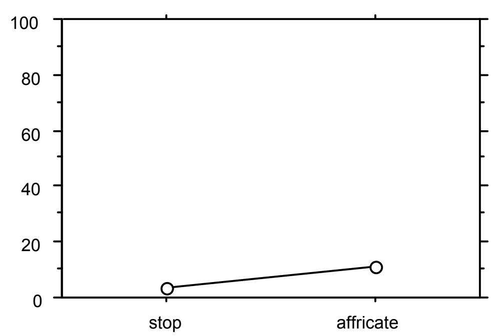

Figure 19. Means for point of frontmost contact, for stops and affricates. The ordinate scale shows percent of calibration line 'v'.

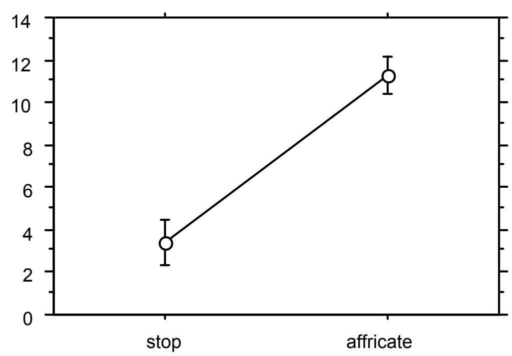

Figure 20. Means and standard error for point of frontmost contact, for stops and affricates. The ordinate scale shows percent of calibration line 'v'.

Four of the five speakers showed this difference in the placement of stops versus affricates; for the fifth (speaker M2), there was no significant difference between the two manners. As summarized in Figures 21 and 22 (the result of a two-way ANOVA for the factors 'speaker' and 'manner'), palatograms for four of the five speakers record contact further forward in the stops than in the affricates. Speaker M2, however, shows stops that are as "retracted" (vis-à-vis other speakers' stops) as affricates. In Bonferroni/Dunn post hoc pairwise comparisons, speaker M2's articulatory strategy of using identical target points on the passive articulator differs significantly from that of each of the other speakers. Among the remaining four speakers, male speaker M1's patterns differ significantly from each of the female speakers, in having point of frontmost contact slightly but significantly further back than female speakers, in both stops and affricates. The three female speakers do not differ from each other in post hoc comparisons.

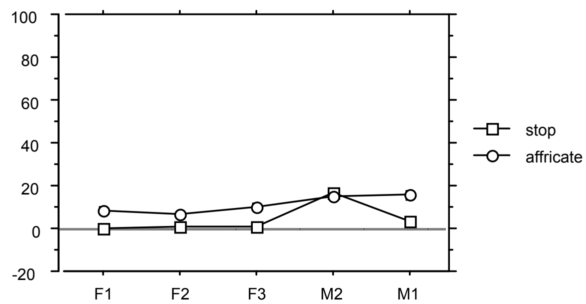

Figure 21. Means for point of frontmost contact, for stops and affricates, by speaker. The ordinate scale shows percent of calibration line 'v'. Means for stops are depicted with squares; means for affricates by circles.

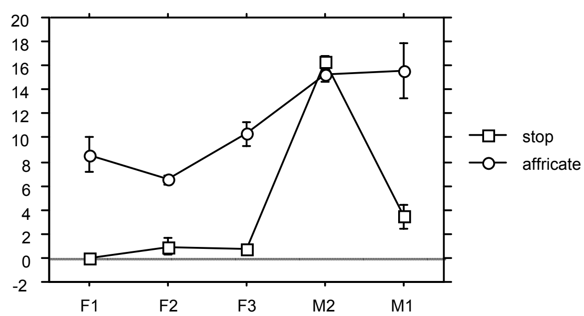

Figure 22. Means and standard error for point of frontmost contact, for stops and affricates, by speaker. The ordinate scale shows percent of calibration line 'v'. Means for stops are depicted with squares; means for affricates by circles.

As for contact length, a one-way ANOVA for manner does not reveal significant differences between stops and affricates ($F[1,56 = 5.223$, $p = .0261$), but results suggest a possible trend—stops may have slightly longer midsagittal contact than affricates. Means and standard error are shown in Figures 23 and 24.

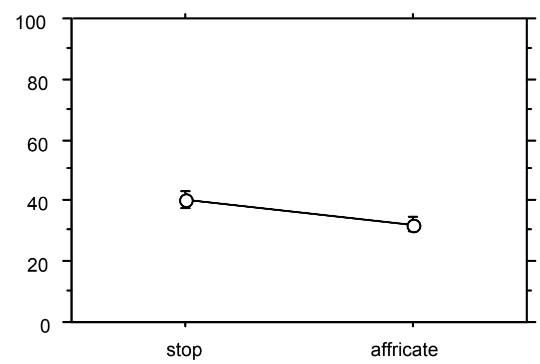

Figure 23. Means for midsagittal contact length, for stops and affricates. The ordinate scale shows percent of calibration line 'v'. Note that the difference between these means approaches, but does not reach significance (p=.0261).

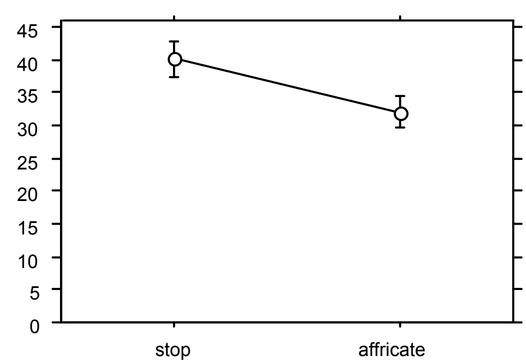

Figure 24. Means and standard error for midsagittal contact length, for stops and affricates. The ordinate scale shows percent of calibration line 'v'. Note that the difference between these means approaches, but does not reach, significance (p=.0261).

No main effect of manner (stops versus affricates) on side contact was found, in a one-way ANOVA ($F[1,53] = 1.305$, $p = .2584$.)

Although fricative articulations could not be directly compared with those of stops and affricates, after visual inspection of the fricative palatograms we interpreted the target place of articulation to also be the base of the teeth, where they meet the roof of the mouth; i.e., the denti-alveolar region, as also reported by S. Kim (2001:10).

3.5. Gender Differences: Stops and Affricates

Although this investigation was not intended to focus primarily on gender-related differences in articulation, such stylistic differences are often systematic in languages. The data in this study were coded for speaker's gender, and when tested on this factor, showed robust differences. However, because of the small number of speakers in each gender group, results reported in this section should be taken to be suggestive rather than demonstrative. A one-way ANOVA found gender to be a significant differentiating factor for measure 'a', point of frontmost contact. As mentioned in the discussion of Figures 21 and 22, for female speakers this point was slightly but consistently further forward on the palate, and this was true whether or not the "outlier speaker" M2 was included in the analysis. (In an ANOVA over the five speakers, $F[1,56] = 29.340$, $p<.0001$. With M2 excluded from the analysis, $F[1,46] = 7.602$, $p = .0083$.)

There was no effect of gender on midsagittal contact length. (With M2 included, $F[1,56] = .027$, $p = .8704$. With M2 excluded, $F[1,46] = 3.954$, $p = .0527$.)

Taken together, these two results imply that the tongue's position was further forward in the female speakers' coronal articulations than it was in the males'. A comparison of men's and women's patterns of contact on the tongue indicates that in the women's articulations, the tongue tip itself has not made contact with the palate, but is probably in a slightly interdental position. In contrast, in the male speakers' articulations the marking material extends all the way to the tongue tip. Figures 2 and 10 show linguograms of stops, for speakers F1 and M1 respectively. Figures 17 and 25 show linguograms of fricatives, for speakers M1 and F1 respectively.

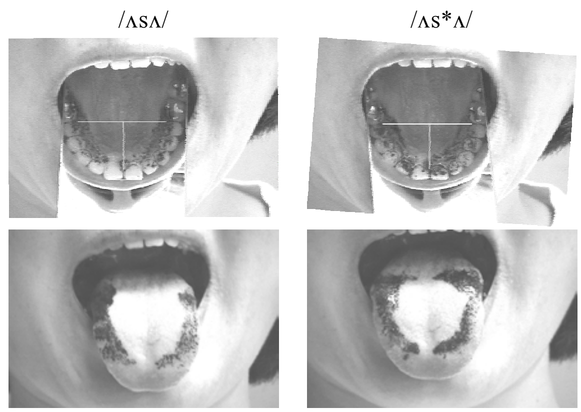

Figure 25. Representative palatograms and linguograms of medial coronal fricatives for female speaker F2.

To summarize, in this study the women's articulations were *laminal* denti-alveolar, while the men's articulations were *apico-laminal* denti-alveolar. Midsagittal diagrams showing differences in use of the active articulator are shown in Figures 26 and 27.

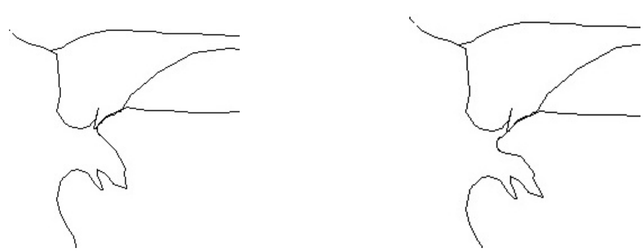

Figure 26. Midsagittal diagrams showing tongue position in articulation of Korean stops. Left panel depicts apico-laminal denti-alveolar stops of speaker M1. Right panel depicts laminal denti-alveolar stops of speaker F1. Note that target area on the palate is the same for both.

Figure 27. Midsagittal diagrams showing tongue position in articulation of Korean fricatives. Left panel depicts apical dental fricatives of speaker M1. Right panel depicts laminal dental fricatives of speaker F2. Target area on the palate is the same for both.

Consistent with these interpretations of our data are the results of an ANOVA for the factor 'gender' on measure 'c'—side contact. For these speakers, gender had a significant main effect on side contact at the first molar ($F[1,53] = 18.266$, $p<.0001$ with all five speakers included; $F[1,44] = 18.115$, $p = .0001$ with M2 excluded). The women's articulations exhibited less side contact than those of the men. This difference implies a lower tongue position behind the constriction in the women's articulations, consistent with the interdental tongue position inferred from the linguograms.

4. GENERAL DISCUSSION AND CONCLUSION

Several findings emerged from our static palatographic study of Korean coronal obstruents. First, stops, affricates and fricatives all showed evidence of a denti-alveolar target. Second, affricates were articulated slightly further back than stops, for four of the five speakers. Third, a speaker's gender appeared to affect contact area on the tongue: female speakers in this study made laminal articulations, whereas male speakers made apico-laminal ones.

In addition, in contrast to the findings of Shin & Hayward (1997), Cho & Keating (2001), and S. Kim (2001), no significant effect of the lax-aspirated-tense contrast was found on any of the measures reported here. This factor did not affect either place of articulation (frontmost or rearmost contact) or midline length of contact in our results, implying that the lax-aspirated-tense distinction need not necessarily involve concomitant place distinctions.

A striking feature of these results is that they differ substantially from the findings of various EPG studies: as already noted, such studies typically report alveolar or post-alveolar points of articulation for the Korean coronals, with differences in the nature and extent of the closure tied to the lax-aspirated-tense contrast, at least for stops. How can this be?

One possibility is that the discrepancies reflect differences in the methodology—static palatography versus electropalatography. As noted previously, an anonymous referee suggests that static palatography can induce hyperarticulation that might lead to suppression of place distinctions due to ceiling effects. This matter is certainly worthy of further investigation, and should be taken into account in interpreting our findings.

Another possibility, suggested by the same referee, is that the differences have to do with our subjects' age. It is worth noting that the subjects in our study and those in H. Kim's study (which also reports denti-alveolar place of articulation for affricates) are generally under age 25. In contrast, the referee notes, subjects in many earlier studies, including those of Cho (2001), Shin (1996) and Shin & Hayward (1997), are now in their late thirties and early forties. The referee goes on to note that s/he has 'recently observed impressionistically' that place of articulation for affricates has 'shifted from post-alveolar to (denti-)alveolar' for young people.

This raises the possibility of systematic age-related differences in the pronunciation of Korean coronals. This possibility, along with the suggestive gender-related differences we have observed, point to the need for a larger scale socio-phonetic study of Korean coronals.

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