An acoustic comparison of palatal fricatives and whistled fricatives in Xitsonga

Seunghun Lee[1], Melanie Pangilinan[2], Sang-Im Lee[3] and Shigeto Kawahara[2]
Central Connecticut State University[1], Rutgers University[2], New York University[3]

SYNOPSIS: This paper compares the acoustic properties of "whistled fricatives" and palatal fricatives in Xitsonga, two fricatives that sound similar to each other impressionistically. Despite its name, our data does not support consistent lip protrusion in whistled fricatives, in line with an observation about whistled fricative in other languages (Changana: Shosted, 2011; Shona and Kalanga: Maddieson, 2003; Tshwa: Shosted, 2006; Zezeru: Bladon et al., 1987). Lip rounding would have resulted in low fricative spectra energy and lowering of formants in surrounding vowels. However, actual measurements demonstrate that fricative spectra show higher energy distribution than the palatal fricative; no evidence for lowering of formants in surrounding vowels was found either. Our study instead shows that the whistled fricative involves a constriction that is fronter than the palatal fricative, most likely retroflex. With this result in mind, we consulted video recording of whistled fricatives in Xistonga, and found no consistent lip rounding. We conclude that labial gesture is not the defining property of whistled fricatives, and instead suggest that they are presumably retroflex fricatives without constant lip protrusion.

METHOD: In the form of fieldwork elicitation, four native speakers of Xitsonga were recorded, pronouncing singular and plural suffixes, each containing a palatal fricative and a whistled fricative. We measured the acoustic properties of these fricatives, mainly, formant transitions in surrounding vowels and spectral moments of fricative spectra.

RESULTS: As exemplified in Figure 1, palatal fricatives (=[sh]) show raising of F2 and F3 toward the consonant both in the preceding vowels (V1=[a]) and following vowels (V2=[i]). On the other hand, whistled fricatives (=[sw]) show flat formant transitions. The lack of formant lowering suggests that labial constriction is not present for whistled fricatives, as lip constriction would have resulted in lowering of formants. As we compare the two fricatives, the formants are higher next to palatal fricatives than whistled fricatives, indicating that the constriction of whistled fricatives is off the palate.

The spectral moment analysis—especially COG and skew—shows that whistled fricatives have higher energy concentrations than palatal fricatives, although the difference was small (about 300Hz in COG). This result suggests that the resonant cavity in front of the constriction is slightly shorter for whistled fricatives than for palatal fricatives, suggesting that whistled fricatives have fronter place of articulation. The whistled fricatives are most likely retroflex, as their COG is not as high as alveolar [s]. Furthermore, the results again do not support the presence of lip protrusion, as lip protrusion would have resulted in a longer resonance cavity.

Discussion: The acoustic analysis shows that Xitsonga whistled fricatives are likely to be retroflex fricatives without lip protrusion. To further verify this conclusion, we consulted video recordings of whistled fricatives in Xitsonga, which show that lip protrusion is not consistently present (Figure 2)—indeed the speaker sometimes even spread their lips as he produces a whistled fricative (Figure 2c). We conclude that labial gesture is not the defining property of whistled fricatives in Xistonga, as recently suggested by Shosted (2011).

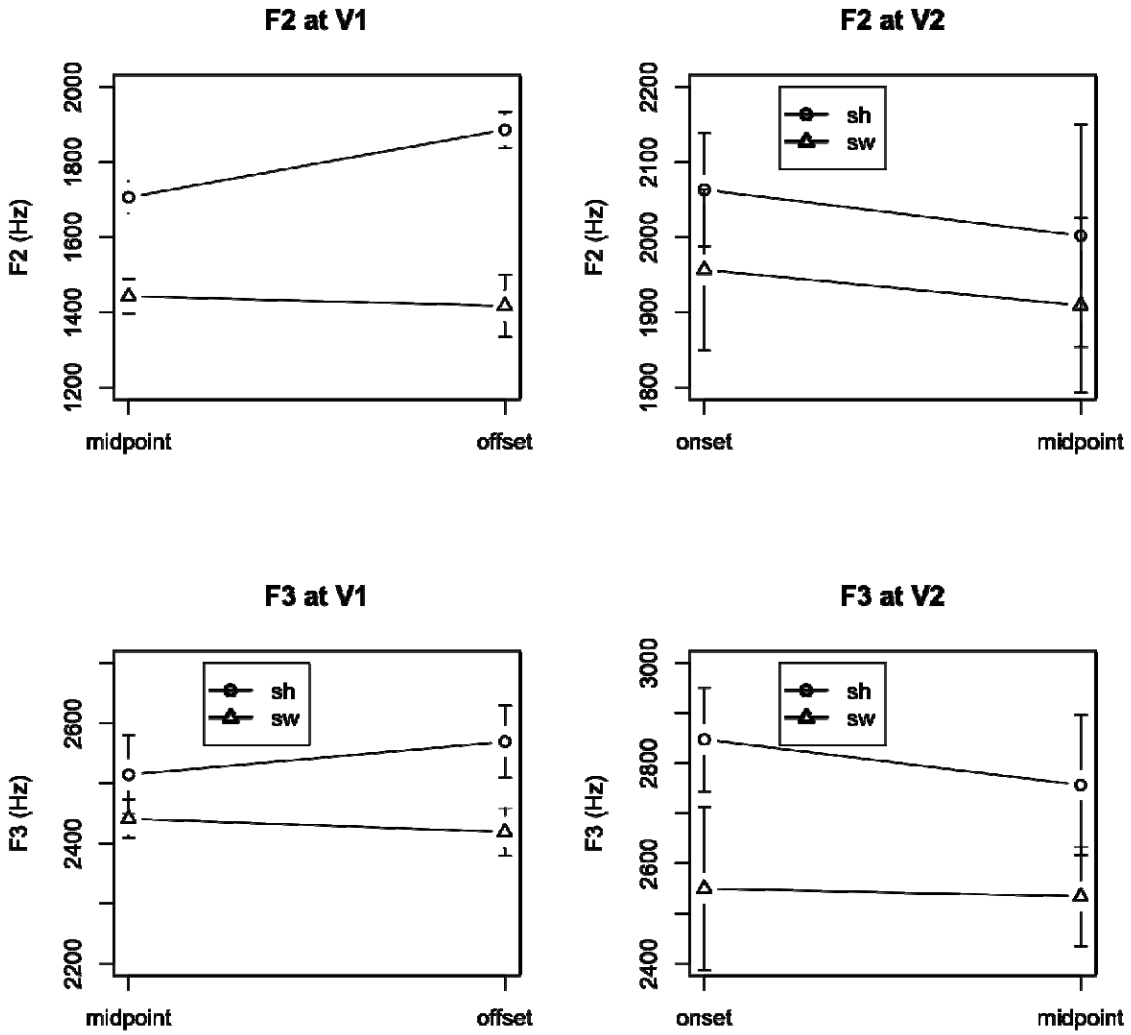
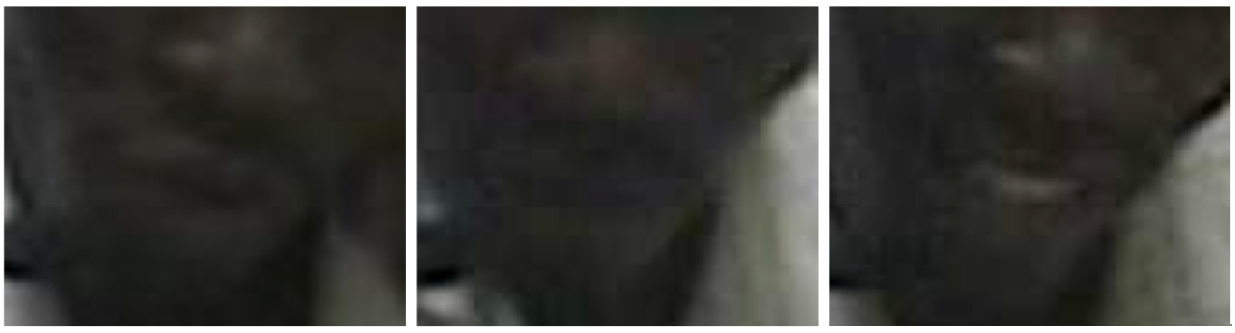


Figure 1. Representative formant transition patterns. V1 is always [a] and V1 is always [i]



a. rounded b. neutral c. spread

Figure 2. Video recordings of whistled fricatives.