Variability in /s/ production as a function of palate shape

Background
- Individuals vary in tongue shape for /s/ (Bladon and Nolan 1977)
- /s/ can be apical (tip up) or laminal (tip down)
- Individuals may have one, other, or both palates
- Brunner et al. (2009) found flatness of palate correlated with reduced articulatory variability (in front vowels)

Questions
- How are people articulatorily variable in /s/ production?
- How are people acoustically variable in /s/ production?
- How does amount of variability relate to palate shape?

Hypotheses
- Individuals with flatter palates exhibit less articulatory variability than those with domed palates
- Individuals have similar acoustic variability

Methods
- Word reading task; carrier phrase “I’m a _____”
- Lingual ultrasound with simultaneous synchronized audio
- Ultrasonix SonixTablet using a C9-S/10 microconvex transducer at 107 fps held in place with stabilization helmet
- Swallow to obtain palate trace
- Plaster dental casts

Stimuli
- onset: sob, sew, sea
- coda: boss, dose, piece

Participants
- 20 (6 male) native monolingual speakers of California English
- 18-35 years old

Analysis
- EdgeTrak (Li et al. 2005) + SSANOVA (Davidson 2006, Mielke 2013) for qualitative analysis of subset of data (4 speakers)
- Ultrasound: by-subject principal components analysis on ultrasound images to quantify variability
- Area between extreme values of PC1 calculated (below) to compare articulatory variability between participants
- Acoustic measure: spectral peak frequency
- Palate: coronal slice from palate cast taken between #15 & #16 teeth

\[ \alpha = \frac{2}{3 \sqrt{d/w}} \] as per Brunner et al. (2009)

Observations and Results
- Vowel a strong cross-subject predictor of /s/ tongue shape
- Palate a strong cross-subject predictor of /s/ acoustic variability

Discussion & Conclusions
- Strong correlation between acoustic variability and palate shape (contra Brunner et al. (2009) prediction)
- No correlation between articulatory variability and palate shape (relevance of tongue body for /s/?)
- Desire to maintain consistency in acoustic output is overridden by articulatory demands in /s/ production

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Selected References