Tongue root and voicing in Hungarian singleton and geminate obstruents

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Voiced geminates are cross-linguistically uncommon due to the articulatory difficult of maintaining voicing over an extended period of time, and voicing has been found to vary in geminates in some languages, such as Tokyo Japanese which displays partial devoicing (Kawahara, 2015). Hungarian has been found to have variable voicing in singletons (Gráczi, 2013), but voicing in geminates remains largely unexplored. In this paper, we use electroglottography (EGG) and ultrasound to investigate articulatory correlates to voicing in geminate compared to singleton consonants in Hungarian.

Research questions: With EGG, we investigate whether voiced geminate obstruents are fully voiced in Hungarian, partially devoiced, or variable. With ultrasound, we investigate if Hungarian voiced obstruents are produced with advanced tongue root, an articulatory strategy which facilitates voicing. Given the articulatorily difficulty in producing voiced geminates, we predict partial or variable voicing in geminates and more use of advanced tongue root.

We also examine the nature of the relationship between voicing and advanced tongue root. Previous research (e.g., Ahn, 2018) has found advanced tongue root occurring with phonological but not necessarily phonetic voiced consonants. Given the variation in degree of phonetic voicing that we predict in Hungarian, we likewise investigate whether the language can provide additional evidence for the phonological patterning of advanced tongue root.

Methodology: Five native speakers of Hungarian were recorded with ultrasound and audio in Articulate Assistant Advanced (AAA) and with simultaneous audio and EGG in Audacity. They read six repetitions of a word list of geminate and singleton voiced and voiceless bilabial, alveolar, and velar stops, and alveolar fricatives in post-tonic position for a total of 960 tokens.

For analysis of ultrasound data, tongue contours were traced in AAA for frames at the point of maximum consonant constriction. The contours were converted to polar coordinates which acted as the dependent variable in linear mixed effects regression (lmer) models to determine where the radial distance between the ultrasound probe and the surface of the tongue differed across the consonants (reflecting differences in tongue shape and position). The predictors were consonant type (alveolar stop, alveolar fricative, bilabial stop, velar stop), gemination (singleton, geminate), voicing (voiced, voiceless), and normalized point along the tongue contour.

Electroglottography data was first synced with ultrasound data via the audio channels, and then percent voicing of the obstruents was measured in Praat. Lmer models were used to examine the effect of gemination and phonological voicing on percent voicing. An lmer model was also used to examine whether percent voicing or phonological voicing correlated most with shorter radii lengths (more advanced tongue roots) in the pharyngeal region of the tongue.

Results and discussion: EGG results indicated no significant difference in voicing between singleton and geminate consonants. However, while voiceless consonants were generally voiceless (range = 0-33%, mean = 8.7%, median = 7.5%), voiced consonants, both singleton and geminate, varied considerably in percent voicing (range = 3-100%, mean = 73%, median = 77%). See Figure 1. It seems that Hungarian geminates act similarly variable to what Gráczi (2013) found for singletons. They do not seem to be consistently semi-devoiced, or fully voiced.

Ultrasound results indicated that radius length did not significantly differ based on voicing (a factor with two levels based on phonological category: voiced, voiceless), but some significant interactions with place of articulation and radius number in pharyngeal and velar regions were suggestive of advanced tongue root for many voiced obstruents. See Figure 2.

When phonetic voicing was included in addition to phonological voicing in the lmer model, phonological voicing remained significant only in certain interactions, while percent voiced was a significant main effect (p = 0.0056). This is unexpected as it tentatively suggests that tongue root is better predicted by phonetic than phonological voicing in Hungarian, contrary to what Ahn (2018) found for devoiced stops in English. This may suggest that advance tongue root is not automatically implemented as a strategy to enhance voicing in Hungarian. Follow-up research will investigate the robustness of this finding with further analysis methods, and will compare to other languages with variable and semi-voiced geminates.

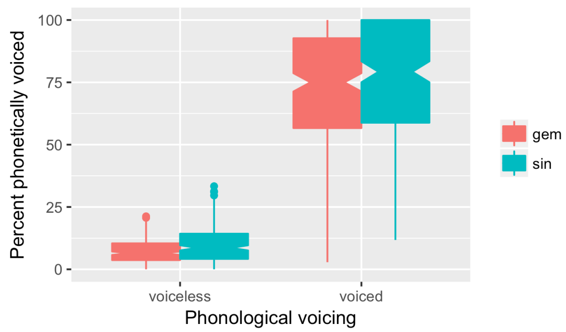

Figure 1. EGG percent voiced aggregated across all obstruents and speakers

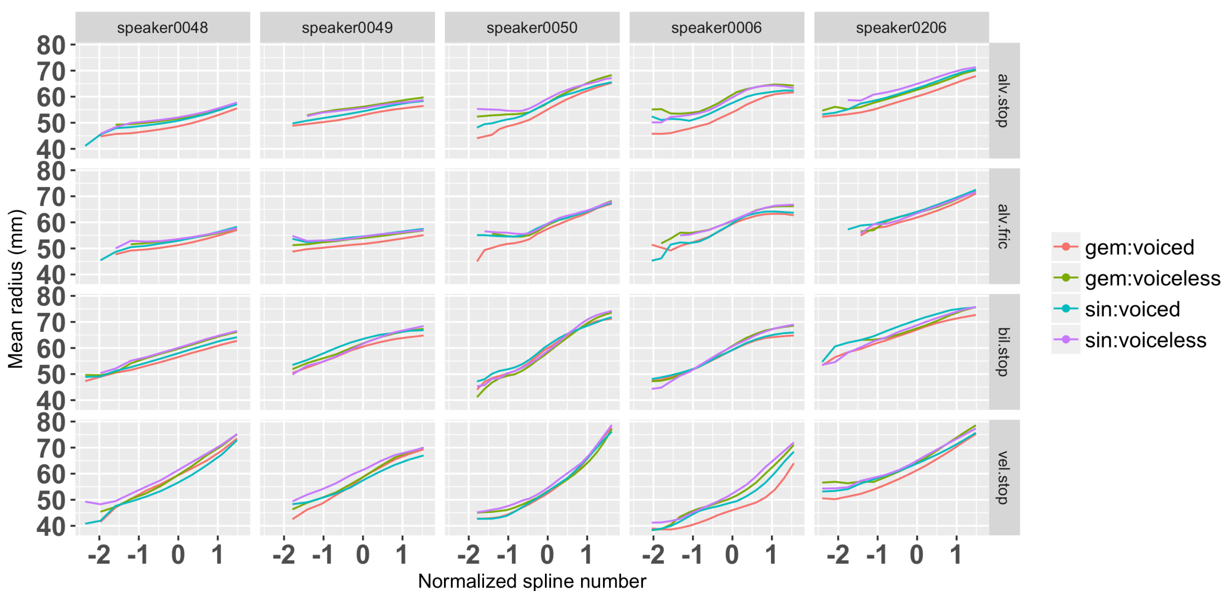

Figure 2. mean radius length between ultrasound probe and tongue surface in pharyngeal region for each speaker and consonant

References

Ahn, Suzy. 2018. The role of tongue position in laryngeal contrasts: An ultrasound study of English and Brazilian Portuguese. *Journal of Phonetics, 71*, 451–467.

Gráczi, Tekla Etelka. 2013. Zörejhangok akusztikai fonetikai elemzése a zöngésségi oppozíció függvényében (Acoustic phonetic approach to the voicing opposition of obstruents). PhD thesis, ELTE, Budapest, Hungary.

Kawahara, Shigeto. 2015. The phonetics of obstruent geminates, *sokuon*. Haruo Kubozono (ed.), *The Mouton Handbook of Japanese Language and Linguistics.* Berlin: Mouton Gruyter.