Tongue root movement in Hungarian intervocalic alveolar obstruents

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Introduction. Voiced obstruents are associated with advanced tongue root (TR) position compared to their voiceless counterparts for initiating or maintaining phonation (e.g. Westbury 1983; Proctor, Shadle, and Iskarous 2010). Although the TR-position difference was found in plosives, affricates, and fricatives, as well (e.g. Narayanan, Alwan, and Haker 1995; Ahn 2015; Coretta 2020), considerable within-speaker variation was found in its presence in American English fricatives (Ahn and Davidson 2016) and Hungarian intervocalic /z/ and /s/ (Gráczi et al. 2021). Ahn and Davidson (2016) explain their results by a possible wider obstacle allowing for less need of TR-displacement, but the Hungarian data did not strengthen this assumption (Gráczi et al. 2021). Comparing the results across the cited studies, the question of the role of the vowel context also arises: The larger pharyngeal volume in high vowels compared to low ones (Baer et al. 1991) might result in a higher resistance of high vowels against further pharynx enlargement, allowing for later or no TR-advancement in the following voiced obstruents than the lower vowels. The present study raised the following question based on the patterns described above: How do the vocalic context (front vs. back V) and the manner of articulation (plosive/fricative/affricate: MoA) interact in terms of the tongue root advancement in Hungarian voiced unaspirated and voiceless unaspirated obstruent pairs?

Methods. Hungarian alveolar obstruents (/d/, /t/, /z/, /s/, /ʣ/, /ts/) were embedded in /l/V_V/l/ nonsense words, where the vowels were identical either /i/ or /ɒ/. We have to note that intervocalic /ʣ/ in Hungarian surfaces as a long consonant in real words, while varies in non-sense words. The 12 nonsense words were read aloud by 5 native speakers of Hungarian 5 times each in random order among further nonsense words. The recordings were carried out by AAA ultrasound device, software (83 images/s), and an omnidirectional condenser microphone. The ultrasound probe was fixed by a helmet. The segment boundaries were automatically labeled (Mihajlik et al. 2009) and manually corrected in Praat (Boersma and Weenink 2023) based on the F_2 offset and onset. The tongue contours were drawn semi-automatically and manually corrected in AAA. The tongue root movement was traced by selecting the spline showing the largest position variance at the TR-region (see Coretta 2020). The consonant duration was normalised to an interval between 1 and 2. The TR-position was Z-normalized by speaker and multiplied by -1 so the higher number reflects more advanced TR. The preliminary data of three female speakers are shown, the manual correction of the remaining 2 speakers' tongue contours is being carried out. Generalized additive mixed models (GAMMs) were run in R (R Core Team 2022) with mgcv v1.8-26 following: Sóskuthy (2021) (Wood 2017; van Rij et al. 2022). Random slopes by the speaker and random smooths were included besides the ordered factors of MoA, voicing and their interaction both as parametric and smooth terms.

Results. The results for the **parametric terms** of GAMMs for the /i/ context only showed a significant difference in the general (mean) position of TR across the three MoAs, while the results for /ɒ/-context indicate that the averaged TR-position is significantly different for the factor voicing, and MoA as main effects. No difference was found in the **smooth terms** in any of the vowel contexts, which means that the shape of the TR-movement trajectories along the consonant is similar regardless of MoA and/or voicing. The **smooth-** (**Figure 1**) **and difference-estimates** indicate that the TR-position does not show any significant difference along the duration of the consonants in /i/-contexts, while in the case of /ɒ/-context, the TR is more advanced around the middle of the duration for voiced plosives and affricates, and along the entire duration of the voiced fricatives. The duration and duration ratio results of /ʥ/ were different than the other /z/ and /d/ but the voiced part ratio and tongue root movement varied with these.

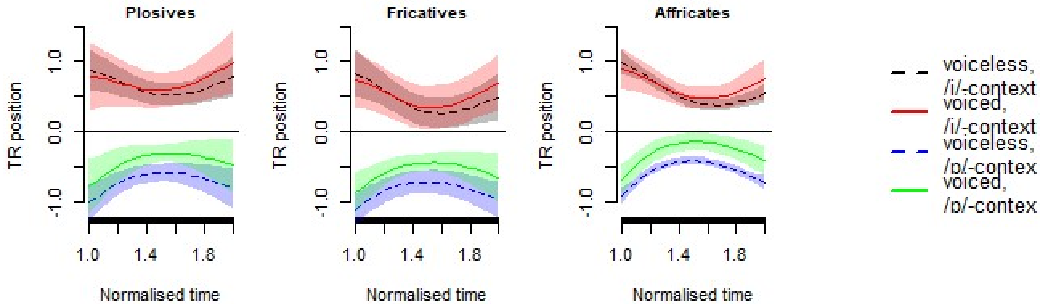

Figure 1: *The estimated TR-movement within the consonant duration (GAMMs were run separately for the vowels, 3 speakers' data).*

Discussion. The preliminary results of the present study indicate that the TR-advancement associated with the voiced obstruents compared to their voiceless counterparts is context-dependent, and the timing of the advancement when present varies across the manner of articulations.

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