THE CROOKED RELATIONSHIP BETWEEN TONGUE SHIFT AND F2 IN /U/-/Y/-TRANSITIONS

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In this study, we analyse speaker-dependent differences in the mapping between articulation and acoustics of /u/-/y/ transitions and consider possible systematic differences between female and male speakers.

It is known that acoustic variation between speakers can be systematic and linked to anatomical differences between biological females and males (Fitch & Giedd, 1999). Many studies have focused on mean fundamental frequencies and the distribution of phoneme targets in a F1-F2 space, but less is known about possible differences emerging in coarticulated segments or transitions within diphthongs.

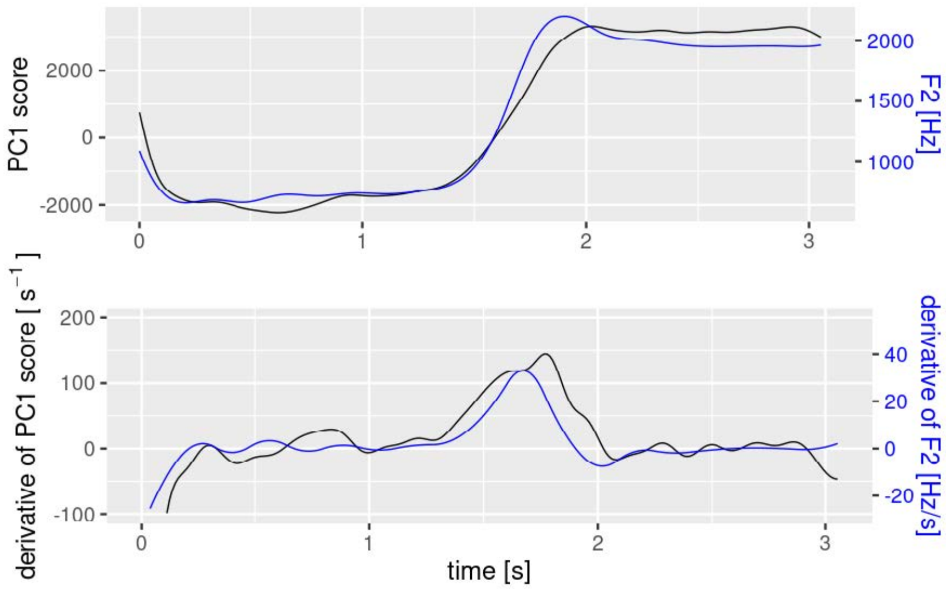
According to the quantal theory of speech (Stevens, 1989), the relationship between articulation and acoustics is also not linear within a speaker: In stable regions, a certain amount of articulatory movement results in less change in the acoustic output than in unstable regions, where a similar amount of articulatory movement results in a much greater change in the same acoustic parameter. Studies suggest that the region of the sub-glottal resonance frequencies can be viewed as one such unstable region (Stevens & Keyser, 2010). The second subglottal resonance which is robust within a speaker lies between 1350 and 1600 Hz. In the vicinity of the subglottal resonance frequency, a sudden jump in F2 occurs. In particular, this phenomenon has been observed in the spectrum during the transition of a diphthong with tongue movement from back to front in the vocal tract (Lulich et al., 2012). The region of subglottal resonance might overlap with F2 in fronted /u/ in alveolar consonant context especially for female speakers, magnifying the acoustic coarticulatory effect.

By analysing continuous articulatory transitions from /u/ to /y/ and vice versa we investigate the direct dependency between the articulatory movement and resulting acoustic output. We aim to detect regions of linear and non-linear acoustic-articulatory relationships and investigate to what extent speaker-dependent patterns can be observed.

19 German speakers (11 females) produced 4 to 6 repetitions of such /u/-/y/ and /y/-/u/continua. To quantify the articulatory data, captured by means of ultrasound, principal component analysis (PCA) on the time-varying raw image data was performed (Hoole & Pouplier, 2017). Separately for each speaker, the principal components (PCs) were computed based on all frames from each repetition of the continuum. Upon visual inspection, the PC best reflecting the /u/-/y/ contrast was chosen per speaker. The corresponding F2 was extracted from the recordings of the speech signal.

An example of the F2 and PC score trajectory of a /u/-/y/ production by one female speaker is shown in Figure 1. The derivatives of these trajectories were calculated to detect regions of greater movements.

Our findings will form part of our long-term goal of determining whether there is evidence that in fluent speech coarticulatory effects, both in timing and magnitude, can be expected to be affected by the differences in the acoustic-to-articulatory mapping between female and male speakers.



1: /u/-/y/ production by a female speaker: On the top the low-pass filtered PC1 score trajectory in black and the corresponding smoothed F2 trajectory in blue; on the bottom their derivatives. In this example, articulatory movement for the transition from /u/ to /y/ begins earlier than the F2 movement and ends later (in the region around time points 1.25s to 2s).

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