Coarticulatory effects on /u/ and /y/ in female and male speakers of German

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The sound change /u/-fronting describes a phenomenon where over a period of time /u/ shifts to the front of the vowel space and becomes more /y/-like. Current theories consider the origin of sound changes like /u/-fronting in coarticulation (Beddor, 2009). In the case of /u/, coarticulatory fronting results from the influence of alveolar contexts. These fronted variants could cause the entire vowel category to shift to a more front target (Harrington, 2012). According to Labov (1990), the majority of such sound changes from below are led by women. That is, as sociolinguistic theories describe, because the use of specific phonetic units transfers social signs (Eckert & Labov, 2017) and could thus be an opportunity for females to compensate for their lower position in society (Eckert, 1989). This study aims to investigate, whether descriptions of a female lead in /u/-fronting could be explained by differences in acoustic-articulatory mapping between female and male speakers.

Acoustic vowel spaces of male speakers do not behave symmetrically to those of female speakers (Simpson & Ericsdotter, 2007). For example, F2 in /y/ differs between male and female speakers but not in /u/. In alveolar contexts, F2 of /u/ is raised compared to /u/ in non-fronting contexts due to coarticulatory effects. We investigate how coarticulatory fronting interacts with sex in acoustics and articulation. The same coarticulatory effect on the tongue movement could result in a greater effect on the acoustic output for females which could have been misleadingly interpreted as females being articulatory more advanced in the sound change of /u/-fronting.

19 speakers of standard German (11 female, 8 male) were recorded. Sagittal images of the tongue were acquired with the Articulate Instruments Micro US system, using a 10mm or 20mm microconvex probe and the probe-holder system developed by Derrick et al. (2018).
Participants produced single words, in which the target vowel was tense or lax /u/ or /y/, in bilabial, velar or alveolar contexts. In addition, speakers produced a continuum from /u/ to /y/ and vice versa.
Principal components (PCs) were derived based on the raw image data of /u/-/y/ and /y/-/u/ continua, separately for each speaker. The prcomp-function in R (R Core Team, 2020) was used to carry out the principal component analysis of the centred data. Upon visual inspection, the PC best reflecting the /u/-/y/ contrast was chosen. This eigenvector was used to compute the PC scores of the target vowels.
To allow for between speaker comparison, PC scores of the continua and target vowels were scaled between -1 and 1, with -1 corresponding to more /u/-like and 1 to more /y/ like tongue configurations.

Preliminary results based on the acoustically determined midpoint of the target vowels suggest that female speakers produce more extreme articulation: Their scaled PC scores for tense vowels reach values closer to -1 and 1, for /u/ and /y/ respectively compared to PC scores of male speakers. This could be interpreted as male speakers exhibiting more undershoot than female speakers. Only the PC scores of female speakers in lax /u/ are more centralized.

The effect of consonant context seems to have the same effect on articulation for female and male speakers: /u/ in alveolar context has higher PC values indicating a more fronted articulation as expected. However, the tense-lax contrast in /u/ is greater for females than for males. We still need to carry out acoustic analyses and put the articulatory data into context.

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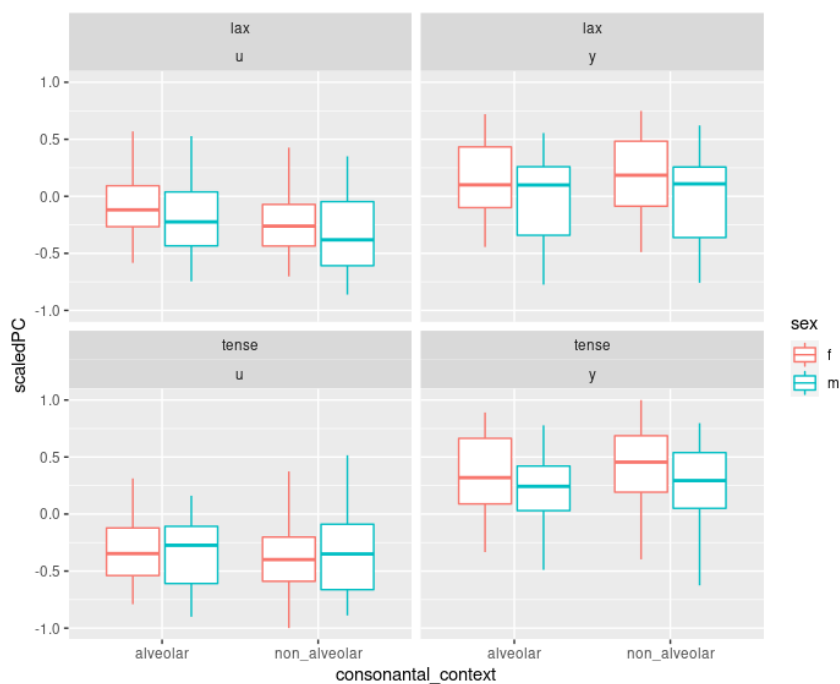
Figure 1: scaled PC scores retrieved at acoustically determined vowel midpoints of /u/ on the left and /y/ on the right and lax vowels on top and tense vowels at the bottom, separately for the alveolar and non alveolar consonantal contexts, color coded for sex.A negative PC scores indicates a more /u/ like tongue configuration, a positive score a more /y/ like configuration.