

The mechanics of palatalization: A dynamic account

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In this study we investigate the formation and progression of the phonetic palatalization gesture in 10 native speakers of Polish using a 3D/4D ultrasound. In particular, we have traced and compared tongue splines in following frames directly before, during, and directly after the palatalized sound, as for example, in Fig. 1d. We have also tracked over time the changes in the vertical position of the three parts of the tongue (front, middle and back) separately to describe how the individual tongue parts raise or lower over time throughout the palatalization gesture, and how these changes in the height of the different parts are correlated time-wise. In particular, the displacement in height of the tongue contour in each frame and the tongue contour in the first frame was calculated for each part of the tongue separately. The tongue contour in the first frame functioned as a baseline reference point. Each subsequent frame deviated from the initial frame as the speech sounds were produced. Greater displacements from the tongue contour in the first frame indicated larger movements from the baseline, and zero displacement indicated no movement from the baseline. Positive displacements indicated raising, and negative displacements lowering, as in Fig. 1c. We test the following two hypotheses: (1) that apart from the changes in the dorsal area, the tongue root area also shows systematically a radical change of the position in palatalization, (2) that the crucial movement in the tongue root area occurs before the movement of the tongue dorsum.

Further, an investigation of the dynamic aspect of palatalization gives insights into the general mechanics of the gestures. Generally, two types of gestures are observed: an arch and a pivot ([1]). An arch consists in 'squeezing' the articulator which results in the elevation of the central part of the articulator. A pivot-type gesture consists in pushing in of one of the extreme areas of the articulator resulting in the elevation of the other extreme of the articulator. The third type of gesture has been stipulated, a shift ([2]). This inspired another question: (3) What type of gesture is palatalization?

We analyze two types of palatalized consonants in Polish: allophones with a secondary palatalization like [pʲ, tʲ] and prepalatals, which are inherently palatalized and function in Polish as phonemes (cf. [3], [4], [5]).

In all analyzed cases in the study we have observed an advancement (i.e. lowering and fronting) in the tongue root area, and fronting and/or elevation of the dorsum. In many cases, we could observe also lowering of the tongue blade. The lowering of the tongue root is not synchronous with the fronting and/or elevation of the dorsum. Instead, in all those cases where we could observe the formation of the gesture, the lowering of the tongue root area occurs before (0.5s and more, depending on the segmental context of the palatalized sound) dorsum raising, cf. 1c. The lowering of the blade is also delayed in comparison to the tongue root advancement. We have also observed differences between the phonemic and allophonic palatalization with respect to the dynamic aspect of the gesture. In terms of the type of the gesture, nearly all images showed a clear pivot or a double pivot pattern, cf. Fig. 1d.

References

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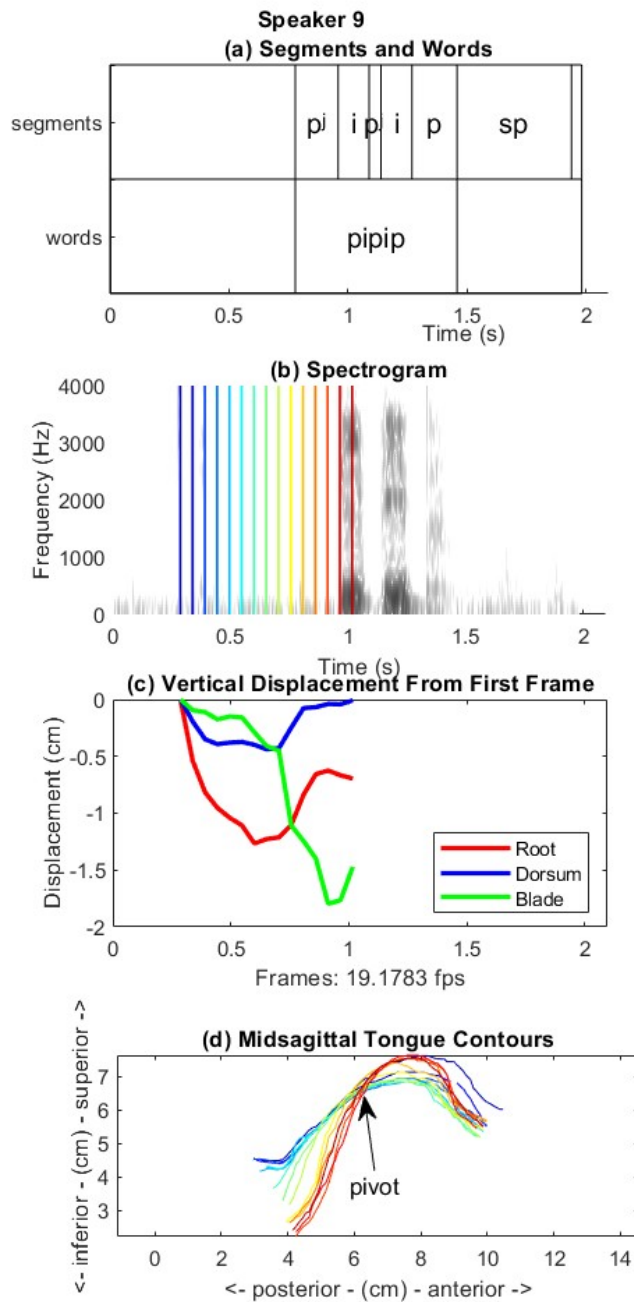


Fig. 1. Allophonic palatalization in Polish. (a) segmentation of the word with the initial palatalized [pj]. (b) spectrogram with the location of the consecutive frames on the ultrasound image, color coded from deep blue (earliest frames) over green and yellow to deep red (latest frames). (c) the difference in the vertical position of each part of the tongue between the initial frame and the frame at any given time. (d) overlaid splines in consecutive frames from deep blue (earliest frames) over green and yellow to deep red (latest frames), the colors coordinated to the scheme in image (b).