Variation as a measure of goodness of a category

Malgorzata Cavar[1], Emily Rudman[2]
[1]Indiana University (USA), [2]Ohio State University (USA)

In this presentation, we look for an objective measure of a goodness of a category and how it may support phonological analysis. We know that for objects to be categorized as belonging to one category, the variation between the objects should be minimal, the smaller the better. Variation is commonly assumed to be a necessary prerequisite for language change. Thus, smaller variation can be taken to be a sign of a stable phonological system and of a strong link between the phonological abstract representation and its phonetic realization. Patterns showing more variation are probably more difficult to learn. In the area of language, Kuhl (2000) calls the detection of similarities, or patterns, in language input a major requirement of language processing. Consequently, it is probably not far-fetched to claim that consistent articulation patterns are more likely to reflect phonological categories and less consistent articulation pattern are likely to be an enhancement, rather than the other way round. I stipulate that the direct measure of variation in articulation or perception is a measure of the goodness of a category and may constitute evidence of phonological structure. Following the earlier observation that the tongue dorsum in palatalization is raised and fronted, and at the same time the tongue root is lowered and fronted (advanced), we have compared the variation in the position of the tongue root versus the variation in the position of the tongue dorsum in palatalized segments. We have found that the variation in the position of the tongue root is smaller than in the position of the tongue dorsum. In the study of Russian consonants, standard deviation of the tongue root relative advancement is st.dev=0.514844, that is, it is significantly smaller than the standard deviation of the tongue dorsum fronting (st. dev=0.6979004; p=4.441e-16 in Pitman-Morgan test), cf. Fig.1. The same tendency can be observed in vowels in the context of palatalized consonants. For example, the tongue root advancement shows smaller variability across target vowels, and across context consonants, than the dorsum fronting and raising, cf Fig. 2. We stipulate, that the measure of variance may provide evidence for the claim that phonetic palatalization is driven by the tongue root, and when phonologized, it is the tongue root feature that **initially** expresses the palatalization contrast.

We have also tested another hypothesis: if palatalization is a specified feature in Russian as opposed to underspecified lack of palatalization (or common velarization) or the other way round, since impressionistically there seems to be a bigger variation in the realization of non-palatalized consonants. To do this, we have compared the variation in the position of the tongue root and tongue dorsum in palatalized versus non-palatalized consonants. Variation in dorsum fronting for hard consonants alone for all speakers (st dev=0.6720775) is significantly bigger (p=0.0002277 in the Pitman-Morgan test) than for soft consonants (st dev= 0.5655854), cf. Fig. 3. The variation in the position of the tongue root is also minimally lower in soft consonants (st dev=0.378584204636168) than in hard consonants (st.dev = 0.398246155034798), though here the Pitman-Morgan test did not demonstrate that the difference is significant (p=0.261), Fig. 4, so the evidence is inconclusive.

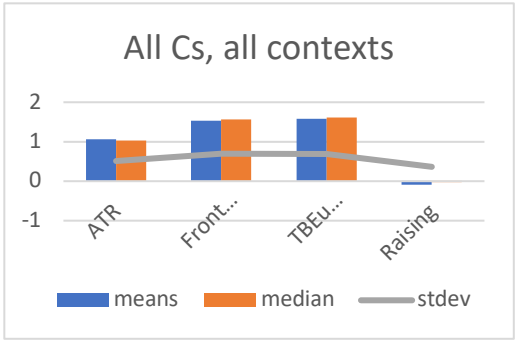

Figure 1. Means, medians and standard deviations for tongue root advancement (ATR), dorsum fronting, combined dorsum fronting and raising (TB Euclidean) and dorsum raising in palatalized consonants.

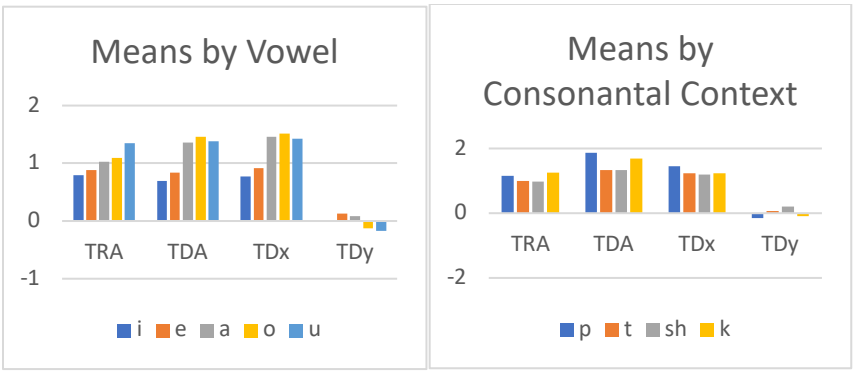

Figure 2. Russian vowels. Left panel: TRA (Tongue Root Advancement), TDA (Tongue Dorsum Advancement), TDx (Tongue Dorsum Fronting), and TDy (Tongue Dorsum Raising) in the vowels adjacent to palatalized consonants in Russian as compared to vowels in non-palatalizing context (in cm) Mean values from 9 speakers. 5 vowels in all investigated consonantal contexts. Right panel: TRA, TDA, TDx, and TDy in the SCC vowels as compared to HCC vowels (in cm) Mean values from 9 speakers. All vowels in 4 consonant contexts.

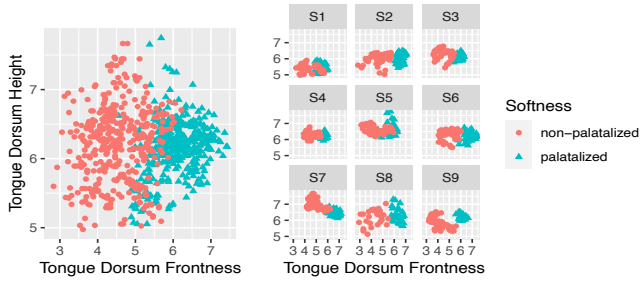

Fig. 3. The location of the highest point of the dorsum. Aggregated data for all speakers (left) and in individuals (right).

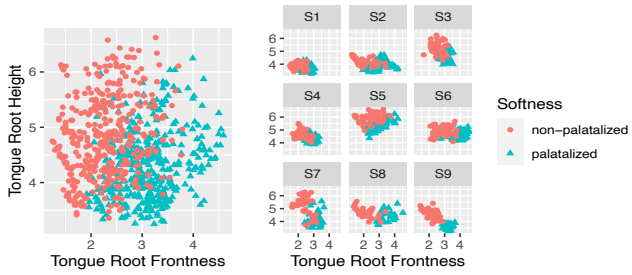

Figure 4. The location of the point on the surface of the tongue root opposite the tendon of the genioglossus. Aggregated data for all speakers (left) and in individuals (right).