VARIATION OF ANATOMICAL FEATURES AND THE SHAPE OF PHONOLOGICAL SYSTEMS

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The possible role played by anatomical features on the shape of phonological systems was discussed a few times in the past. Catford (1977) summarized some of the early findings about variation in tongue length, the *crico-thyroid* muscle and the presence of *risorus* muscle in human populations. Ladefoged (1984) suggested that differences between the vowel systems of Yoruba and Italian have a biological (anatomical component). Traill (1985) showed that most !xóõ San have no alveolar ridge.

This suggests that small anatomical differences may create variations which can influence the sound patterns found in the world's languages.These variations might be one of the factors explaining the shape of sound systems in human languages. Other factors are the the categorization of these variations and their cultural transmission across many generations. Therefore biological factors (anatomical and genetic) may influence linguistic typology and contribute to explain variation in phonetic systems. This has to be demonstrated with convincing examples.

Karitiana, a Tupi language spoken in Brazil, offers a good case to discuss these issues. The vowel system of this language does not have a high back vowel [u], something which has been observed in several other Tupi languages and other Amerindian languages such as Navajo. The vowel system of the language has 5 vowels : [i,e,a,ɨ,o]. The lack of a high back vowel is explained by the absence of the [round] feature in the phonological system of the language. Ménart (2002) showed that high back vowels [u] can have two articulatory protoptypes, one velar and the other palatal. The absence a [+ round] feature with a palatal propotype produces a central vowel [ɨ]. Then one has to explain why there is a mid-back [o] in the system. This vowel is normally a [+ round] vowel. Acoustic, video and contact EMG made with several Karitiana speakers showed that there is no rounding and protrusion present when Karitiana speakers produce [o] vowels. This is not a mid back [- round] vowel. This is a [o] vowel produced with no lip rounding and protrusion. The correct acoustic output is likely obtained by adapting the tongue and larynx positions in the vocal tract when compared to a vowel with lip rounding.

To check how this was possible, Staveness et al. (2013) proposed a model showing that this is the activation of the *marginalis* and *peripheralis* parts of the *oricularis oris* muscle that play a role in the production of Karitiana [o] vowels. The model gives a lip configuration showing a realistic –but still rough- approximation of the vowel [o] produced by Karitiana speakers. Therefore one can hypothesize that this is the muscular command produced by Karitiana speakers. There is no need to suppose muscles fibers lacking. We can also hypothesize that the other muscles fibers are not activated and that they become less important or less developed.

These findings that should be tested in other languages with similar vowels systems, suggest that the use of specific features or muscles fibers can trigger acoustic variations. These variations can be transmitted to other speakers and propagate in a community within generation or a geographical area. The stability of some of these features over generations is because phonetic and phonological systems behave as kinds of basins of attraction.