Monkey vocal tracts are not so “speech ready”

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Introduction

Monkey vocalizations are important for studying evolution of speech. During about 50 years, this was considered as blocked until *Homo Sapiens* since the anatomy of monkey and “other nonhuman primate” is not set for producing upper vocal tract formant modulations [1]. Two recent publications [2,3] claimed against this theory that monkey vocal tract is “speech ready” and that a high larynx combined with a flat tongue are not a handicap. The main message is that only the brain had to evolve to control an existing tongue musculature able to shape constrictions and cavities as human. It has been shown that (1) baboons can produce some vowel qualities [3] (2) some vocal tract shapes compatible with vowel production are present on sagittal X-Ray views of the macaque [2]. This has been completed by [4] with a collection of published spectrograms.

Results

Considering all of these results, we observe that vowel quality /i/ is never produced, as well as the vowel quality /a/ which shape is retrieved on sagittal X-Ray views only. We develop the hypothesis that it is the consequence of the lack of tongue rounding necessary to make various constriction locus along the palate and the back of the (too small) pharyngeal cavity. First, in order to analyze the articulatory potential of monkeys, we have built a set of tube-models comparable to sagittal views (Figure 1). We see that for /u/ only a small pharyngeal cavity is remaining after tongue retraction (state 1). The main vowel qualities observed and compiled by [3,4] are close to the /u/ and in this framework they are well explained by mouth opening and tongue protrusion derived from this configuration. An exception is the baboon’s wahoo vocalization and a second specific model has been developed to gauge the articulatory potential of animal in comparison with human. This model shows that /wa/ can be produced without constriction, but that the /wa/-/hoo/ transition is different for man and baboon because with a flat tongue, the constriction place cannot be moved from forward to backward. This is another direct consequence of monkey’s anatomy.

Conclusion

With a flat tongue and a high larynx, an archaic articulatory potential is present allowing the production of proto-vowels. Nevertheless, the monkey cannot produce every articulatory movement necessary for speech production and the vocal tract anatomy had to evolve further.

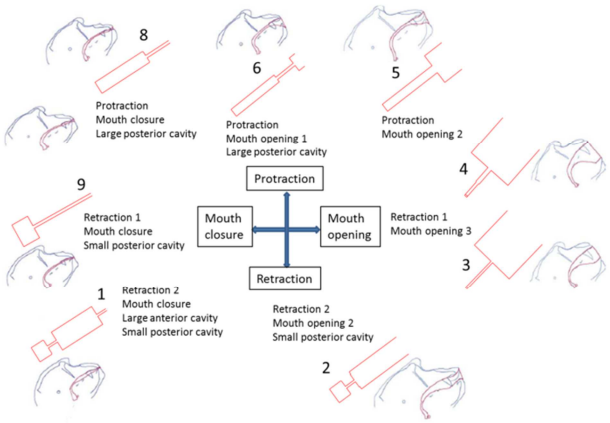

Figure 1: Direct anatomical comparisons between tube models and sagittal drawings provided by [2], concerning tongue-palate constriction, mouth aperture and the size of the back cavity. The articulatory states (1-9) are identified with simple rules: (a) the tongue is protracted or retracted with 2 levels (see [5]) (b) the mouth is the anterior part of the oral cavity which includes the tongue tip and the lips, and it is close or open with 3 levels (c) when the tongue is retracted, a back constriction forms a small posterior cavity (1,2,9) or a thin uniform section (3) (d) the tongue tip is entangled with the tongue and when this is retracted at level 2, the tip is also retracted to make a large anterior cavity with close lips (1) or a uniform section with open lips (2). Finally these variations are well described with two parameters for mouth and tongue well controlling F1/F2 variations. This leads to 3 extreme states having high constrictions ratio and comparable to those of the human vowel qualities /u/ (1), /i/ (8) and /a/ (3,4). This is also compatible with the basic IPA description of the human vowel chart in which F1 variation follow jaw opening/closing and F2 variation follows the front/back tongue movement.

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