ARTICULATOR CONSTRAINTS AND THE DESCENDED LARYNX

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Introduction. The descent of the larynx is a hotly debated topic in the evolution of language. Some argue that it can be explained as an adaptation to producing more and more distinctive speech sounds while others argue that a descended larynx is not necessary for distinctive speech, and that it has descended for other reasons.

Recently, computer modelers have joined the debate by building models of the vocal tract and investigating what sounds can be produced (Boë, Heim, Honda, & Maeda, 2002; Carré, Lindblom, & MacNeilage, 1995). However, the different groups draw diametrically opposite conclusions, even though they use very similar methods. While Carré *et al.* find that a pharyngeal cavity is essential for producing distinctive speech sounds and that therefore the descended larynx is adaptive, Boë *et al*. find that their model of the Neanderthal vocal tract (with a smaller pharyngeal cavity) can produce as distinctive vowel sounds as a modern human vocal tract. They therefore conclude that a descended larynx is not adaptive for speech.

The two studies find the same thing, but interpret it differently. They both find that two cavities of controllable size are essential for producing the range of sounds in modern speech. Carré *et al*. see this as proof that a pharyngeal cavity and thus a descended larynx are necessary, while Boë *et al*. claim that a back cavity can also be made without a descended larynx. Both conclusions are debatable, however, as neither model has realistic constraints on what configurations can be made by movement of the tongue, jaw and lips. In Carré *et al*.'s model, motion is unconstrained, while in Boë *et al*.'s model it is constrained by deformations that have been statistically derived from observed human vocal tract motion. In order to investigate the difference in acoustic range between human-like and ape-like vocal tracts, one must use models that have realistic constraints on articulator motion.

The Model. We propose to use an articulatory synthesizer that is based on the actual geometry of the vocal tract and on physical control of the articulators. The Mermelstein (Mermelstein, 1973) model fulfills these criteria. It will be used for investigating the potential vowel space of modern humans. It is straightforward

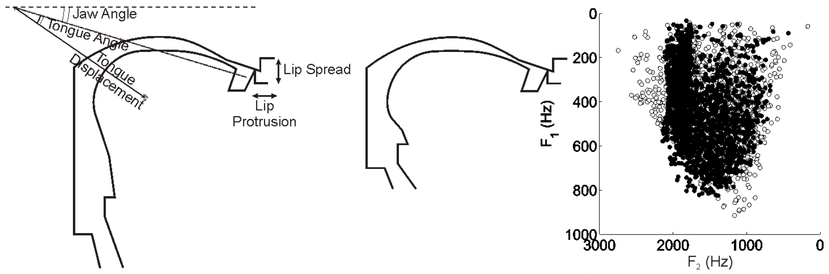

Figure 1: The Mermelstein model and the controls used here (left). The modified ape-like model (middle). The possible vowels (right). Open circles indicate the human tract, filled circles the ape-like tract.

to modify this model so that it conforms more to an ape-like vocal tract with a higher larynx (figure 1). It will then be investigated how this influences the range of sounds that can be produced with the same constraints on movement of the articulators.

Preliminary Results. In figure 1 it is shown which vowel positions can be reached by the two models (assuming equal length of the vocal tracts). It is clear that the human-like vocal tract is able to produce more distinctive vowels than the ape-like tract. These results are preliminary, however. The articulatory model needs to be refined, using more realistic data about ape- and Neaderthal vocal tracts, it must be made continuously variable and the results must be analyzed more carefully.

The results do seem to indicate, however that a lowered larynx allows for more distinctive vowel sounds, because it allows more different configurations of the front and back cavity, given constraints of articulator movement. A tract with a higher larynx is more articulatorily constrained. It can therefore tentatively be concluded that a descended larynx has adaptive value for speech.

References

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