

Producing a singer's formant at high front vowels - some kinematical and anatomical aspects

K. J. van Zwieten and K. P. Schmidt, Functional Morphology, University of Hasselt, Belgium
in cooperation with Chamber Choir De Kleine Cantorij NPO, Tongeren, Belgium

In a series of scientific workshops for classical singers, our laboratory of Functional Anatomy tried to elucidate some kinematical backgrounds of the so-called singer's formant, "a merge between at least two formants, possibly F3 and F4" (Sterling, 2006). Recent measurements in a baritone by Radolf et al. (2012) showed that "a cluster of two or three formants was formed in the range of F2-F4 between 1.4 and 3.4 kHz for the vowel [i:]". Millhouse and Clermont (2006) demonstrated a distinct difference between F1 and F2, and a close proximity of F3 and F4 especially for the (sung as well as spoken) vowel /i/ in "Heed". Therefore we reconstructed some functional-anatomical phenomena in pronouncing the word "Heed", by means of a crossed four-bar-linkage model simulating jaw motion in a sagittal plane (Van Zwieten et al., 2001). Bars represent respectively the skull-base, the intercrossing bundles of jaw-elevating muscles masseter and medial pterygoid, and the mandibular angle. During uttering the high front vowel in "Heed", the tongue's dorsum is lifted, so as to narrow the linguo-palatal port, while the velo-pharyngeal port simultaneously closes (Ladefoged, 1993; Soquet et al., 2002). Although Sundberg et al. (2007) presume individual preference in the amount of this velo-pharyngeal closing during the production of a singer's formant, we rather interpret this as a tautening of the palatine aponeurosis by bilateral activity of the tensor veli palatini muscle, neuromotorically associated with a slight elevation of the mandible by bilateral activity of the medial pterygoid muscle. Of all muscles of the soft palate namely, only *m. tensor veli palatini* shares its motor nerve with the nerve for the jaw-closing *m. pterygoideus medialis*. (The other velar muscles receive motor branches from the vagus nerve.) Once taut, the palatal velum will allow its freely moving uvular muscle to more or less "close the velo-pharyngeal port". The nasal tract plus its sinuses then enhance resonance, thus favoring the production of a singer's formant once more. *Acknowledgements* : We would like to thank tenor Robert Luts, Professor of Singing, and bass Joris Grouwels, MSCE, for their help in preparing this survey.

References

Sterling R. (2006) FORMANTS. available at: http://www.mpedersen.org/images/uploads//FORMANTS_english_version.pdf (created 30 May 2006).

Radolf V., Nissinen A., Laukkanen A. M., Havlík R., Horáček, J. (2012) Computer simulation of musical singer's voice based on MRI and acoustic measurements. 18th International Conference Engineering Mechanics, Svratka, Czech Republic, May 14-17, 2012. Paper 184, 266-267.

Millhouse T. J., Clermont F. (2006) Perceptual characterisation of the singer's formant region: a preliminary study. Proceedings of the 11th Australian International Conference on Speech Science & Technology. Paul Warren and Catherine I. Watson, Eds. ISBN 0 9581946 2 9 University of Auckland, New Zealand. December 6-8, 2006. © Australian Speech Science & Technology Association Inc., 253-258.

Van Zwieten K. J., Hauglustaine S., Curvers L., Lippens P. L., Sholukha V. A., Ivanov A. A. (2001) Jaw opening and closing movements, comparative anatomical and biomechanical aspects. *European Journal of Morphology*, 39, 4, 246.

Ladefoged P. (1993) A course in phonetics, 3rd Ed. Chapter 1. Articulatory phonetics : The articulation of vowel sounds. Harcourt Brace Jovanovich College Publishers, Fort Worth Philadelphia San Diego New York Orlando Austin San Antonio Toronto Montreal London Sydney Tokyo

Soquet A., Lecuit V., Metens T., Demolin D. (2002) Mid-sagittal cut to area function transformations: Direct measurements of mid-sagittal distance and area with MRI. *Speech Communication*, 36, 169-180.

Sundberg J., Birch P., Gümöes B., Stavad H., Prytz S., Karle A. (2007) Experimental findings on the nasal tract resonator in singing. *Journal of Voice*, 21, 2, 127-137.