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► To cite this version:

Nathalie Henrich Bernardoni, Maëva Garnier, John Smith, Joe Wolfe. Measurements of vocal-tract resonances in singing using the input-impedance technique. NYU International Voice Symposium, Jan 2012, New York, United States. hal-00769540

HAL Id: hal-00769540

<https://hal.science/hal-00769540>

Submitted on 2 Jan 2013

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Measurements of vocal-tract resonances in singing using the input-impedance technique

Nathalie Henrich, Maëva Garnier, John Smith and Joe Wolfe

(1) Speech and Cognition Department, GIPSA-lab, Grenoble, France

(2) School of Physics, UNSW, Sydney, Australia

Vocal-tract resonance frequencies are commonly estimated on the voiced sound spectrum by means of formant-estimation techniques. Yet, the main limitation of these techniques is the spectral spacing between voice harmonics, which gets broader when pitch increases (Arroabarren and Carlosena, 2006). This limitation is problematic for assessing singing productions, for which first harmonic may easily reach the first-formant frequency range (Joliveau et al., 2004). Recent methods developed for impedance measurement on musical instruments have successfully been applied to speech and singing (Epps et al., 1997; Joliveau et al., 2004; Henrich et al., 2006; Garnier et al., 2010; Henrich et al., 2011; Bourne & Garnier, in press). We will present the input-impedance technique, and its application to measure vocal-tract resonances in singing. We shall show measurements of the different resonance tuning strategies used by singers with different ranges and in different styles. The most widespread of these is tuning the first vocal tract resonance to the fundamental of the note sung, a technique practiced by many sopranos, whether trained or not, and also by lower voices on closed vowels at that top of their ranges. Tuning of the first resonance to the second harmonic is practiced by altos in belting and in Bulgarian singing. Much less consistently, male singers sometimes tune that resonance to the second or higher harmonics. In the extremely high range, above sopranos' high C, the range of the first resonance is exceeded. Of the singers we have studied who sing well above this pitch, all have tuned the second resonance of the tract close to the fundamental sung.

References

- Arroabarren I. and Carlosena A. (2006) Inverse filtering in singing voice: a critical analysis *IEEE Transactions on Audio, Speech, and Language Processing*, 2006, 14, pp. 1422-1431.
- Bourne, T. and Garnier, M. (2012) Physiological and Acoustic Characteristics of the Female Music Theatre Voice. *J. Acoust. Soc. Am.* (in press)
- Epps J., Smith J. R. and Wolfe J. (1997) A novel instrument to measure acoustic resonances of the vocal tract during speech, *Meas. Sci. Technol.* 8, pp. 1112–1121.
- Garnier M., Henrich N., Smith J., Wolfe J. (2010) Vocal tract adjustments in the high soprano range, *J. Acoust. Soc. Amer.*, vol. 127 (6), pp. 3771–3780.
- Henrich N., Kiek M., Smith J. and Wolfe J. (2006) Resonance strategies used in Bulgarian women's singing style: a pilot study. *Logopedics Phoniatrics Vocology*, vol. 32:4, 171 - 177.
- Henrich, N., Smith, J., & Wolfe, J. (2011) Vocal tract resonances in singing: Strategies used by sopranos, altos, tenors, and baritones. *J. Acoust. Soc. Amer.*, vol. 129 (2), pp. 1024-1035.
- Joliveau E., Smith J. and Wolfe J. (2004) Vocal tract resonances in singing: the soprano voice. *J Acoust Soc Am*, 116(4), pp. 2434-2439.