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

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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.

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