Title: Comparison of vocal productions in the two main laryngeal mechanisms in their overlapping area: influence of vowel and vocal training.

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Abstract :

The human larynx is known to be able to vibrate according to four different configurations called laryngeal vibratory mechanisms. In the western classical singing, only the two main laryngeal mechanisms M1 and M2 are used. Although there is a great overlapping area in terms of frequency and vocal intensity between M1 and M2, the transition between them is often a major inconvenient for classical singers, who seek a homogenous vocal quality among their whole tessitura. To sing in this overlapping area, they have developed two different strategies: either using only one laryngeal mechanism, or using both and getting trained to smooth the transition.

As a consequence, some singers are trained to use both laryngeal mechanisms, and some others are not. The aim of this paper is to explore the influence of these strategies on the spectrum of vocal productions and glottal vibration. What are the differences between M1 and M2 productions at the same frequency and vocal intensity? Do these differences depend on the vowel? On the vocal training? On gender or vocal category?

21 singers (8 females and 13 males) were recorded, singing crescendos and decrescendos on different notes in M1 and M2, on the vowels /a/, /i/ and /o/. The singers were all advanced amateurs or professional singers. Sound and electroglottographic signals were recorded. The study focuses on the repartition of the vocal energy among the spectrum in the overlapping area. Two frequency bands were defined, depending on the gender: the singer's formant frequency band (FB2) from 2 to 4.5 kHz for males and from 2.4 to 5.4 kHz for females, and another one (FB3) from 4.5 to 8 kHz for males and from 5.4 to 9.6 kHz for females. Open quotient values were also computed.

The results confirm that there are systematic differences in the averaged open quotient in the overlapping area between M1 and M2 productions. Females and counter-tenors keep an energy ratio in the singer's formant region very close in M1 and M2 on the vowels /a/ and /i/. But on /o/, a 6 dB difference was observed. For the other male singers, who are used to sing only in M1, this energy ratio is 6 dB higher in M1 than in M2 on the three vowels. The energy ratio in FB3 was globally lower in M2 than in M1. Finally, singers who are trained to sing in both mechanisms are able to obtain the same singer's formant level at a given frequency and intensity, especially on /a/ and /i/.

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These results suggest that there is no evidence that the vocal training addressed to a particular laryngeal mechanism would develop the singer's formant in both. But for singers who use M1 and M2, it is possible to obtain the same level in FB2 at a given frequency and intensity.