

Register Transitions in the Singer's Voice as Defined by Acoustical Pattern Analysis

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Objectives: The appropriate performance of register transitions is essential for classical singer to smoothly reach all regions of their voice range. However, there are controversies among teachers and voice professionals about the nature of register transitions. Recently we detected typical frequency patterns of the male upper register transition (Neumann et al., 2005). A new study aims on the detection of changes in acoustical patterns which characterize the female register transition between chest and middle register.

Method: Repeated audio, electroglottographic, and equivalent subglottic pressure signals of 11 male operatic singers were recorded during singing scales on open back vowels and passing the register transition. Additionally, audio and electroglottographic recordings were taken from 10 female singers who sung ascending scales on [a:], [e:], [i:], [o:], and [u:].

Results: A spectrum analysis of the audio signal revealed that the second harmonic (H2) dominates in the male 'chest', resonated by the first formant (F1), as well as the fourth harmonic (H4), supported by the second formant (F2). During the *passaggio*, H2 level decreases because it loses the resonance of F1, while now F2 tunes to the third harmonic (H3). At the same pitch H4 level drops because H4 is not supported by F2 anymore. For females, preliminary results for the vowel [a:] passing the register transition (fundamental frequency F0 around 300 to 400 Hz) are the following: F1 resonates harmonics between 600 to 700 Hz and F2 harmonics between 1150 to 1250 Hz. Because the audible register transition is mostly paralleled by a prominent resonance change around 1200 Hz, especially the tuning of F2 on the next harmonic which approaches the transition seems to characterize the register transition. Dependent on the individual singer, H2 or H3 are prominent at F0 around 300 to 400 Hz, probably because they are resonated by F1. Simultaneously, the harmonics H7 to H5 pass with rising pitch the frequency region of F2, which starts to amplify H7 at a F0 around 140 Hz. From F0 around 300 to 400 Hz on F2 first resonates H4, followed by H3 from F0 = 350 Hz on and finally H2 from F0 = 400 to 450 Hz on.

Discussion: The transitions from the male chest to the head register and from the female chest to the middle register are marked by characteristic changes in frequency patterns of the partials H2, H3, and H4 (males), and H2 to H7 (females) respectively and of the first two formants, defining an objective distinction between those registers. Interindividual differences may indicate different *passaggio* strategies.

Conclusion: Typical frequency patterns for both the described male and female register transition seem to exist and allow for a register definition basing on objective parameters.

References:

Neumann K, Schunda P, Hoth S, Euler HA (2005) The interplay between glottis and vocal tract during the male *passaggio*. *Folia Phoniatri Logoped* 57, 308-327.

Neumann K, Thoma J (2007) Objectifying register transitions in the female singer's voice by acoustical signal analysis. Poster to be presented at the Voice Foundation's 35th Annual Symposium, May 30 - June 3, 2007, Book of abstracts.