

# EFFECTS OF A PROFESSIONAL CLASSICAL SOLO SINGER EDUCATION ON VOCAL TRACT ADJUSTMENTS DURING SINGING – A LONGITUDINAL STUDY

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## **Abstract**

Acoustic properties of the vocal tract (VT) result from its shape and can be dynamically adjusted during voice production<sup>1</sup>. Thereby the lower VT is considered of special relevance to higher formants like the singers formant cluster<sup>2</sup>. This study analyzes the detailed morphology of parts of the epilaryngeal tube, the hypopharynx with the piriform sinuses, and the laryngeal ventricle.

In previous investigations we have demonstrated the feasibility of analyzing the 3D vocal tract morphology during sustained phonation in detailed subsections<sup>3</sup>. It was shown that a group of male classical singing students used different vocal tract adjustments within the lower vocal tract in singing compared to speech-like phonation<sup>1</sup>.

In a follow up study we now applied the same examination protocol of magnetic resonance imaging during sustained phonation for a longitudinal comparison after three years of solo singer education.

Again, the twelve male student singer subjects were asked to produce sustained German vowels /a/, /e/, /i/, /o/, /u/ at 220 Hz (A3) in a 3T MRI machine (Verio, Siemens Medical Solutions, Erlangen, Germany). The task was to be executed in a classical singing style with a well-controlled low vibrato and a speech-like phonation at a medium loudness. The acquisition time was 12.1 seconds for each recording.

With help of a semi-automatic algorithm the resulting images were segmented along the air-tissue-border with a centerline-based approach. The image stack was transformed to a set of images whose planes were orthogonal to the tangent of the centerline. In a mid-sagittal image two different centerlines were inserted – one straight from the dens axis to the upper anterior arytenoid rim for segmentation of the hypopharynx and the second curved, so that the way into the epilaryngeal tube and the vestibular folds lying orthogonally were sliced. The assembled two-dimensional segmentations allowed for measurements of the lower VT, e.g. the epilarynx tube, within the centerline-based coordinative system in three dimensions.

The results show similar adjustments of the lower VT morphology in singing vs. speech. The relative increase of the hypopharyngeal area and volume parameters in singing tended to be greater after three years of academic singing studies. A greater increase in singing could be also observed for the epilaryngeal region for certain vowels.

The findings offer some explanations of possible long term effects of a singer solo education on functional adjustments during singing.

## LITERATURE:

1. Mainka A, Poznyakovskiy A, Platzek I, Fleischer M, Sundberg J, Mürbe D. Lower Vocal Tract Morphologic Adjustments Are Relevant for Voice Timbre in Singing. PLOS ONE 2015;10:e0132241.
2. Sundberg J. Articulatory interpretation of the "singing formant". J Acoust Soc Am 1974;55:838-44.
3. Mainka A, Platzek I, Mattheus W, Fleischer M, Müller AS, Mürbe D. Three-dimensional Vocal Tract Morphology Based on Multiple Magnetic Resonance Images Is Highly Reproducible During Sustained Phonation. J Voice 2016.