CONTRIBUTION OF THE LARYNGEAL TUBE TO THE VOCAL TRACT TRANSFER FUNCTION UNDER DIFFERENT PHONATORY CONDITIONS

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Acoustic properties of the vocal tract (VT) result from its shape and can be dynamically adjusted during voice production[1]. Thereby the transfer function can be simulated by means of numerical simulation[2].

To evaluate the acoustical contribution of the laryngeal tube to the transfer function, several Finite-Element-Models of the whole VT from different subjects were derived from magnetic resonance images during sustained phonation of different vowels under two distinct phonatory conditions: classical singing and speech-like phonation.

Those models were then modified: all VT models were divided into two subsections at the entrance plane of the inner larynx, which corresponds anatomically to the aryepiglottic folds, the arytenoids and the upper laryngeal surface of the epiglottis. This resulted in a lower subsection which is identical to the laryngeal tube and an upper subsection containing the remaining VT above and besides the larynx.

The two subsections were fused crosswise with the respective counterparts of the other phonatory condition of the same subject and vowel. Thereby, the resulting VT hybrids contained a laryngeal tube in singing VT configuration and an upper VT subsections in speech-like configuration or vice versa.

Numerical simulations of the VT transfer functions were made for all conditions (all vowels in two phonatory conditions) with 1. complete real geometries, 2. the upper subsections alone without the laryngeal tubes and 3. singing-speech-hybrids.

As a result, the first two formants F_1 and F_2 remained stable during singing phonation compared to speech-like phonation. They were also - dependent on the vowel - only slightly affected by the removal of the laryngeal tube. In contrast, in the frequency range of 2 to about 4 kHz, a distinctive amplitude loss could be observed in the VT models consisting only of the upper subsections without the laryngeal tube.

VT models in singing configuration showed lower $F_{3\text{-}5}$-values than their respective counterparts in speech-like phonation. For the VT hybrids, the resonances shifted in direction of the configuration of the larynx. For instance hybrids of singing larynxes and speech-like upper VTs showed lower $F_{3\text{-}5}$ values than full speech-like VT models and vice versa.

The data demonstrate a shift of higher formants $F_{3\text{-}5}$ by the larynx. The effect is dependent on the used phonation mode.

Yet, by the presented analysis of the VT as the acoustical filter, the changes in the real acoustics can only be retraced partly. This underlines, that the actual vocal output is influenced greatly also by the glottal voice source.

LITERATURE:

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