Open Quotient and Breathiness in Aging Voices - Changes with Increasing Chronological Age and it's Perception

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In the past, a lot of work has been done to identify the acoustic properties of the aging voice. Asked for perceptive qualities of increasing age in voices, listeners sometimes report increased breathiness, at least for male voices. Perceived breathiness is linked to an increased Open Quotient (OQ_{EGG}), that was measured by Higgins & Saxman (1991) for sustained vowels. They found decreased OQ_{EGG}-values with increased age for females while the OQ_{EGG} increased for males as the speaker's age increased. The increase in OQ-values in male voices is interpretable in consequence of laryngeal changes with increasing age. Although laryngeal degeneration due to increased age seems to occur to a lesser extend in females, the decrease of OQ-values in elderly female voices couldn't be explained physiologically. Another acoustic manifestation of perceived breathiness is the acoustic energy distribution in the spectrum, especially the lowest spectral amplitude in the region of fundamental frequency. In Linville (2002) the spectral amplitudes in the region of f_0 (obtained by LTAS-measurements) increased with increasing age, independent from gender, which could be indirectly interpreted as increasing OQ_{EGG}-values for both females and males in the read speech material.
The first aim of this study is to measure OQ_{EGG} values in the EGG signal, not only for sustained vowels but also in isolated words and spontaneous speech samples. With the extended stimulus material we are able to not only replicate the results of Higgins et al. but also analyse whether the OQ_{EGG}-values depend on stimulus type. The second aim is to analyse quantitatively the relation between OQ-values and the perception of a speaker's age. For these purposes a perception test has been carried out, where listeners were asked to estimate speaker's age based on sustained vowel material.
Our data consist of sustained vowels, isolated words und spontaneous speech. Recordings were made of 60 speakers, 30 female and 30 male, where 50% of the speakers are young (18 – 30 years) and 50% old (59 – 82 years). The recordings consist of an audio-channel and a channel with the EGG-signal, whereas in this work only the electroglottographic signals were used. The stimuli of the perception test consist of sustained [a]-vowels varying in vocal effort (soft – normal - loud) during vowel production.
Our results show (i) that the decrease in open quotient values for elderly females as well as the increase for elderly males first-time found by Higgins et al. is apparent in our data for sustained vowels as well, and (ii) in addition we found increased OQ_{EGG} values with increasing age independent from gender for the word material and spontaneous speech, whereas the increase in the case of male speakers and word material is highly significant statistically. The results of the perception test show (iii) a strong positive relation between perceived age and OQ-values in male voices. The perception tests with female voices are still in progress. Results under point (ii) are in line with the findings of Linville and are plausible in terms of physiological laryngeal changes. Our results could be interpreted as following: Because (ii), a speaker's voice gets more breathy as age increases, for males to a greater extent compared to females. While the causes for the decreased OQ-values under point (i) remain unclear, it seems to occur in the sustained vowel material only. Facing (iii) our results show, that listeners know about the increased breathiness in elderly voices, and probably incorporate this knowledge in their estimation of a speaker's age.

Literature:

Higgins, M. & Saxman, J. (1991): *A Comparison of Selected Phonatory Behaviours of Healthy Aged and Young Adults*. In: JSHR, 34, 1000-1010.

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