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Progression of Voice Breaks in a Non-Pathological Voice as an Indicator of Aerodigestive Health

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To the Editor,

During normal aging, structural and functional changes in the aerodigestive tract can affect swallowing and breathing. Such changes are often evidenced in perceived voice production, which indicate a weakened or otherwise aging laryngeal system. These voice production changes, often starting in the fifth decade, can result in slower speech and elongated words¹; tremor, instability and aspiration²; reduced loudness³; speaking pitch changes⁴; and dysphonia⁵. These voice changes affect quality of life⁶ and may portend health concerns with swallowing function and breathing regulation.

One aspect of the aging voice which has received little attention is voice instability. The current study examines changes in the voices of two male subjects, whose voices were formally recorded for up to 50-year age span, to track the progression of their voice breaks/instabilities with age, potentially indicating greater aerodigestive age changes.

Both subjects were associated with a private (religious) university where they delivered frequent public addresses over a span of many decades. In addition to the unique longitudinal breadth of the speeches (40-50 years), several characteristics make the body of speeches unique: (1) a speaking style with reduced dynamics comparable to spoken conversations in the general population with a focus on intelligibility rather than a specific voice quality; (2) a consistent acoustical environment in one of two multi-purpose university arenas; (3) speeches of sufficient length (>20 minutes) to provide a sustained representative voice sample for analysis; and (4) the unique lifestyle of both speakers (i.e., abstinence from smoking, coffee, and alcohol), thereby removing variables potentially obfuscating age-

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specific changes to the physiology (i.e., common aerodigestive irritants and risk factors for vocal health issues removed variables).

Based on previous work^{7,8}, these subjects' spoken pitch and length of speech breath groups changed significantly in the mid to latter part of the sixth decade, with spoken pitch initially decreasing followed by a substantial steady increase. As discussed previously⁷, changes in spoken pitch and length of speech breath groups could highlight age-related deterioration of laryngeal tissue, laryngeal valving, lung vital capacity, and/or reduction of motor coordination.

In the current study, three independent listeners (one speech-language pathologist, two speech pathology graduate students) listened individually to the second 5-minutes of each speech and annotated the occurrence of a voice instability on a transcription. A voice instability was defined as either a perceptible sudden flip into a falsetto mode or a failure of voice onset when there was clear intent to speak. General roughness of voice was not considered to be a voice instability.

For each judge, the number of instabilities (see Figure) were normalized to the total number identified by the judge. There appear to be very few voice instabilities before 70 y/o. Nevertheless, there rate of instability occurrences continues to accelerate (occurrence axis is logarithmic). Unsurprisingly, there were a large number of judged instabilities later in life, with both individuals reaching about 10% of total judged instabilities in the late 80s and early 90s. The increase of instabilities, a reduction of speech breath group duration⁷, and an increase of spoken pitch (after decades of decrease)⁷ seem to all correspond.

Voice production depends on the physiology of the vocal folds and control of the musculature of the larynx. Further, because increases in the number of judged instabilities in the voice correspond with changes in spoken pitch, both of these changes are likely related to age-related physiological processes manifested in the larynx, such as tissue atrophy and bowing of the vocal folds. This result may explain the disparate findings of Sweeting and Baken⁹: although they did not see an increase of vocal onset delay in elderly adults compared to younger talkers, their older group was 65-74 y/o which was before the age that the instabilities were seen in the current longitudinal study.

Per source-filter interaction theory of speech production¹⁰, higher spoken pitch would increase the likelihood of vocal fold and vocal tract interaction with lower formant frequency vowels resulting in an increased number of instabilities. To test this hypothesis, future studies of phonetic content relating to the instabilities would be a logical next step. Systemic neuromuscular changes in the aerodigestive tract can be inferred from increases in vocal instabilities, changes in spoken pitch, and modifications of speech breathing. Because of the shared physiology, increased risk of dysphagia (the inability to swallow safely and efficiently) may also correlate with these changes. Additional studies may identify indicators of when further assessments and treatments of age-related changes (e.g., dysphagia, dysphonia) are needed, or when preventative exercise may assist in slowing age indicators⁷.

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Figure.
 Normalized number of instabilities (percent of total) chronologically for Speaker 1 (a) and Speaker 2 (b) as determined by three judges. The solid line is the exponential fit (azimuth is logarithmic) to the average percentage of breaks for the three judges.