# Measurements of voicing offset and onset in men and women: Further data

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## Abstract

Laryngeal models have contributed much to our understanding of vocal-fold function in recent years. A major achievement of modeling work has been to quantify the conditions required to initiate and maintain vocal-fold oscillation in larynx-like systems [1–6]. This work has indicated that achieving phonation requires a balance between vocal-fold parameters and aerodynamic forces. Vocal-fold parameters include the position of the vocal folds (degree of adduction, glottal shape), thickness of the folds, and tissue characteristics (longitudinal tension, damping), whereas aerodynamic factors include the transglottal pressure and the Bernoulli effect.

Developing realistic models and assessing their ability to account for voicing behavior across speakers requires having data on the conditions around phonation thresholds in multiple speakers. The goal of the work reported here is to quantify the extent of inter-subject in the conditions that effect voicing among normal men and women, and to explore male-female differences. Specifically, we investigate the conditions around phonation offset and onset in the context of intervocalic /h/. Given that multiple factors contribute to establishing and sustaining voicing, individual speakers may have considerable latitude in the specific factors they use to control voicing during running speech. On the other hand, to the extent that speakers have similar anatomical systems, some commonalities may be observed. Finally, the well-known differences in laryngeal anatomy between men and women [7] may lead to some consistent differences across gender.

Aerodynamic data were recorded from 10 normal, healthy adult speakers of American English (4 men and 6 women) producing the utterances "A Papa Hopper," "A Papa Hippie," "A Papa Hooper" at soft, normal, and loud voice. Analysis focuses on the intervocalic /h/ initiating the primary stressed syllable of the utterance. Approximately 225 tokens of /h/ were recorded from each speaker. Subglottal pressure was estimated from the peak intraoral pressures during the /p/ closures preceding and following the target /h/. Oral airflow was recorded using a Rothenberg mask. From the airflow signals, measures were made of the peak DC airflow during /h/; the times of voicing offset and onset; DC flow amplitudes at those times; and f0 and AC flow immediately preceding and following any voicing break (or, in tokens with no voicing break, at the peak of the /h/ abduction). For the utterances containing /a/, voice source measures (open quotient, speed quotient) were made from inverse-filtered versions of the oral airflow. Correlational analyses and principal components analysis were used to define the relationships among the measured variables.

The data suggest considerable inter-speaker differences in the factors most strongly related to phonation thresholds. The occurrence of a voicing break during /h/ also varies with vowel and loudness condition, with the direction of effect differing across speakers. Along with exploring group and speaker differences in the recorded data, we will also discuss recent modeling work using a two-mass model of the vocal folds coupled to a two-tube vocal tract to capture subject differences in both men and women. We believe that a combination of detailed measurement and modeling work will provide further insight into the range of parameter values speakers use to control voicing during running speech.

## References

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