

## Interaction between phonation mode and pharyngeal narrowing: A pilot EGG study

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This pilot electrographic (EGG) study investigates the interaction between (1) mode of phonation, i.e., whether the vocal folds are phonating in chest voice vs falsetto voice, and (2) whether the pharyngeal area is narrowed or not. The research is based on singing studies within the framework of the Jo Estill model of voice production [1], in which singers learn to control laryngeal and supralaryngeal articulation in order to produce different voice qualities. Two modes of phonation are referred to as *thick* and *thin* vocal fold modes, which tend roughly to correspond to *chest* and *falsetto*. Based on the cover-body theory of vocal folds proposed by [2], the thick fold mode involves vibration of both cover and body, the thin fold, only the cover or upper edge of the vocal fold. Thick and thin modes can also be referred to as Mechanism 1 and Mechanism 2 [3], respectively. The supralaryngeal settings studied in this paper are three: (1) normal pharynx (as it is during regular speech production), (2) anteriorly to posteriorly narrowed pharynx (APN) at the level of the tongue root (a possible setting for “opera-style”, [4]), and (3) lateral to medial narrowing of the pharynx (LMN) at the level of the oropharynx (a setting for “twang-style singing” [5], but also heard in ethonophonic speech acts [6]). The subject was a female phonetician, trained in the Estill method, but not a professional singer. We examined three sustained vowels (/i/, /e/ and /a/), for two modes of phonation (thin and thick) and three vocal tract configurations (normal, APN and LPN) for a total of 18 vowel sounds, all produced at in the range of 190 Hz to 245 Hz, and larynx height relatively maintained at mid position. Following Estill's voice model, we look for empirical data from physiological measurements, and compare them with previous research and proposals of phonation modes. F0 and OQ (open quotient, approximately the ratio between the open phase and the glottal cycle) values were estimated based on the derivative of the EGG signals, using Praatdet [7]. The results (Fig. 1), indicate that vowels produced with thick fold phonation mode have smaller OQ than those produced with thin folds. The results confirm findings of an earlier ARX-LF model analysis of these vowel sounds [8], and are also in line with previous studies, e.g., [3, 9], indicating that chest voice has lower OQ than falsetto.

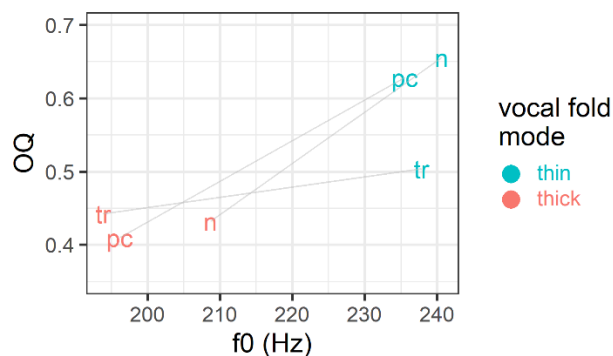


Figure 1. Mean OQ values of vowels produced with thick folds (red) vs thin folds (blue). In this figure, n indicates normal setting, tr indicates APN setting, and pc indicates LMN setting.

Moreover, the shape of the EGG pulses are distinctly different for (1) phonation mode and (2) vocal tract shape, as well as for (3) vowel. Comparison of thin folds (left column) with thick folds

(right column) of Fig. 2 indicates a more symmetrical glottal pulse shape for thin than for thick folds, similar to what was reported by Mayr [9]. Mayr suggests that the skewed shape of the thick phonation mode (which he refers to as chest voice, and Henrich [3], as Mechanism 1) indicates “a vibration with a clear mucosal wave” (p.1), which is due to the vibration of both the cover and body components of the vocal folds. Also, pharyngeal narrowing affects the glottal pulse shape: for both thin and thick folds, adding pharyngeal narrowing makes the EGG signal less symmetrical and more skewed. This finding is in line with voice teachers encouraging students to add pharyngeal narrowing in order to make folds less thin.

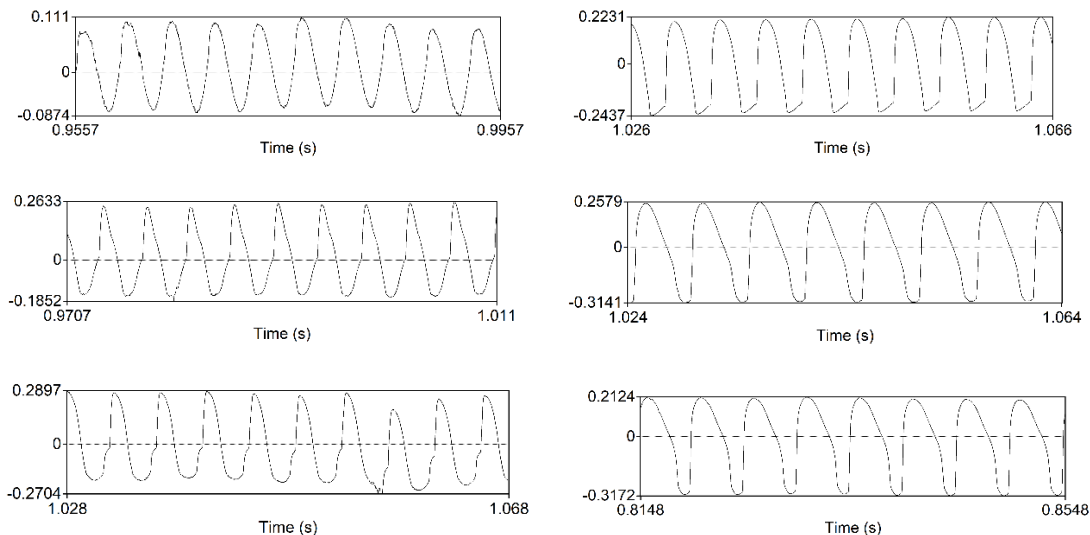


Figure 2. Glottal shape pulses of 6 different /i/ vowels, 2 phonation modes (thin and thick (left and right column, respectively) and 3 vocal tract settings (Normal (Top row), Anterior Posterior Narrowing (APN)(Middle row), and Lateral Medial Narrowing (LMN) (bottom row). Glottal pulse shapes for the vowels /a/ and /e/ are not shown due to space limitations.

## References

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