Lip Trill: Aerodynamic, Acoustic, and Laryngeal Interactions

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INTRODUCTION

The **lip trill** is a voice exercise commonly used by singing voice teachers and speech language pathologists to help their clients maximize vocal output while minimizing vocal effort. This rehabilitative exercise, produced by the simultaneous vibration of the vocal folds and the lips, has been suggested to:

- increase respiratory function[1]
- reduce the tension of orofacial musculature[2]
- facilitate the sensation of frontal resonance via vibration[2]
- lower the vertical laryngeal position while narrowing the aryepiglottic opening[3]

In combination, these proposed benefits of the lip trill may result in more resonant voice production and easier access to higher singing voice registers with less laryngeal tissue trauma, creating a healthier voicing production for singers and speakers alike. The **specific objective** of this study was to investigate the relationships between aerodynamic and acoustic signals during lip trills in the hopes of providing a deeper understanding for speech pathologists and singing voice teachers as to how these proposed benefits may be produced during a lip trill.

METHODS

One trained female singer performed lip trill with and without voicing and a lip trill followed immediately by a /bap:/ syllable string. The purpose of this syllable string was twofold: to both assess the un-occluded vocal fold contact (via electroglottography, or EGG) of an /a/ vowel for this participant, which serves as a 'control', and to provide a method of estimating subglottal pressure during the production of the /p:/. Audio, airflow, EGG, and oral air pressure signals were obtained. EGG was used to compute EGGW25 and EGG height, both measures of vocal fold behavior, and fundamental frequency (f_o).

CONCLUSIONS

The results indicate that lip trill **greatly reduced glottal adduction** in this participant. This may be beneficial for voice users, either speakers or singers, who tend towards hyperadduction. During the lip trill, the EGGW25 and EGG height decreased as the lips separated, contrary to what was expected, indicating a **complex relationship among transglottal pressures, adduction, and airflow**. Conversely, f_o increased during lip separation as expected, albeit to a greater magnitude than anticipated. Unvoiced lip trill resulted in higher oral air pressures presumably due to the lack of glottal airflow resistance.

RESULTS

The main findings from this study are as follows:

- Participant's EGGW25 reduced from 0.5 during vowel production (more vocal fold contact) to 0.2 (less contact) during trill.
- Oral air pressure during voiced lip trill never reached atmospheric pressure and was higher during unvoiced than voiced lip trill production.
- EGGW25, EGG height, and fundamental frequency changed regularly within a lip trill cycle:
- EGGW25 and EGG height decreased with lip opening,
- Fundamental frequency increased by as much as three semitones above the target frequency.

RAW SIGNALS

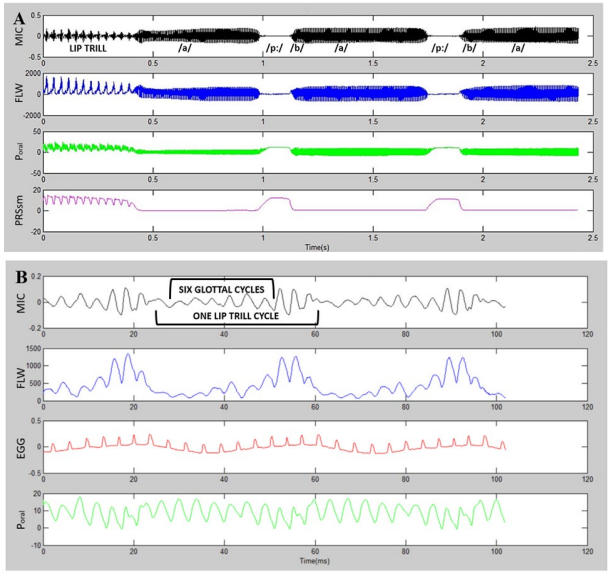

Fig. 1: Panel A: transition from lip trill into spoken /ap: bap: ba/. Channels in descending order: audio (MIC), airflow (FLW), oral air pressure (Poral), and smoothed oral air pressure (PRSsm). Panel B: c. 3 cycles of lip trill, in descending order: microphone, airflow, EGG, and unsmoothed oral air pressure. The time durations are different in A and B.

REFERENCES

[1] Titze, I. R. (2004). Theory of glottal airflow and source-filter interaction in speaking and singing. Acta Acustica-Acustica, 90, 641–648.

[2] Titze, I. (1996). Voice Research: Lip and Tongue Trills--What Do They Do for Us?. Journal of Singing-The Official Journal of the National Association of Teachers of Singing, 52(3), 51-52.

[3] Savareh, S., Moradi, N., Yazdi, M. J. S., Soltani, M., & Latifi, M. (2023). Immediate effects of semi-occluded vocal tract exercises as a vocal warm-up in singers. Journal of Voice, 37(6), 875-880.

SMOOTHED SIGNALS

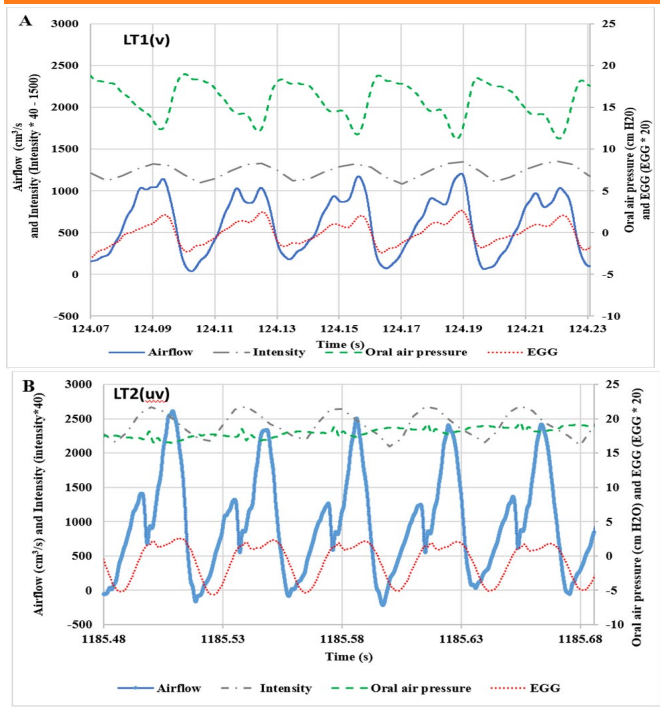

Figure 2: Four recorded, smoothed signals of A: voiced (token LT1(v)) and B: unvoiced (token LT2(uv)) lip trill. From top to bottom: audio intensity (left vertical axis), oral air pressure (right vertical axis), airflow (left vertical axis), and EGG DC shifts (right vertical axis). Audio intensity and EGG DC shifts have been manipulated to represent them on this figure.

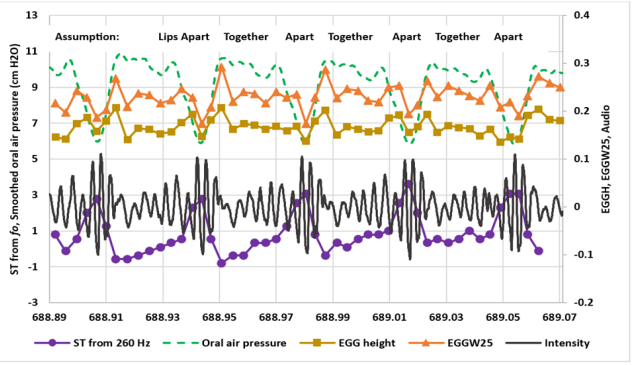

Figure 4: From top down: Smoothed oral air pressure (Poral) (left vertical axis), EGGW25 (right vertical axis), EGG height (EGGH) (right vertical axis), raw audio signal (right vertical axis), and f_o in semitones (ST) (left vertical axis) during five lip trill cycles.