Human Beatboxing: Linking articulation, aerodynamics and acoustics of phonation types

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INTRODUCTION

Human Beatboxing (HBB) is a musical technique produced with vocal tract movements. Beatboxing literature focuses on supralaryngeal gestures for drum imitations. We chose to focus on phonation types of electronic sound imitations. Electronic sounds are originally produced by computers. Beatboxers are able to imitate them using laryngo-pharyngeal structures to produce phonation.

Inverse filtering is a good method to study phonation from the acoustics and to estimate the glottal source spectrum by removing the filter function of the waveform. We are interested in testing acoustic measures such as H1-H2, H2-H4 (spectral tilt) and HNR (Harmonics-to-Noise Ratio) on atypical and more extreme vocal behavior, that is HBB. Lower spectral tilt (i.e. H1-H2, H2-H4) correlates with greater glottal constriction (e.g. creaky voice) and higher spectral tilts with greater glottal spreading (e.g. breathy). Low HNR correlates breathy phonation while high HNR with modal voice. Based on laryngoscopic, aerodynamic and acoustic data we want to know whether glottal source spectrum measures match articulatory and airflow data according to Kreiman et al. (2014) model of voice.

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### Remerciements

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Methods

- Methods :
  - ✓ Flexible nasofibroscopy
  - ✓ Aerodynamics (pressure and airflow)
  - ✓ Acoustics
- Participants : 2 males, 2 females
- Corpus :
  - ✓ "Chest Bass" (egressive aryepiglottic voice)
  - ✓ "Inward Bass" (ingressive aryepiglottic trilling)
  - ✓ "Throat Bass" (egressive ventricular voice)
  - ✓ "Double voice" (egressive breathy falsetto voice)
  - ✓ Modal voice

- Analysis :
  - ✓ Articulatory description based on laryngoscopic data
  - ✓ Airflow description to define whether it is ingressive or egressive & to characterized glottal opening
  - ✓ Spectrographic analysis prior to formant extraction to get the characteristics of the filter
- Measures :
  - ✓ F0, F1, F2, F3, F4, F5 (for inverse filtering)
  - ✓ Source spectrum by means of inverse filtering
  - ✓ H1-H2 & H2-H4
  - ✓ HNR (Harmonics-to-Noise Ratio)

Results

| Chest Bass | Inward Bass | Throat Bass | Modal Voice | Double Voice |

Oral Airflow

HNR

H1-H2

H2-H4
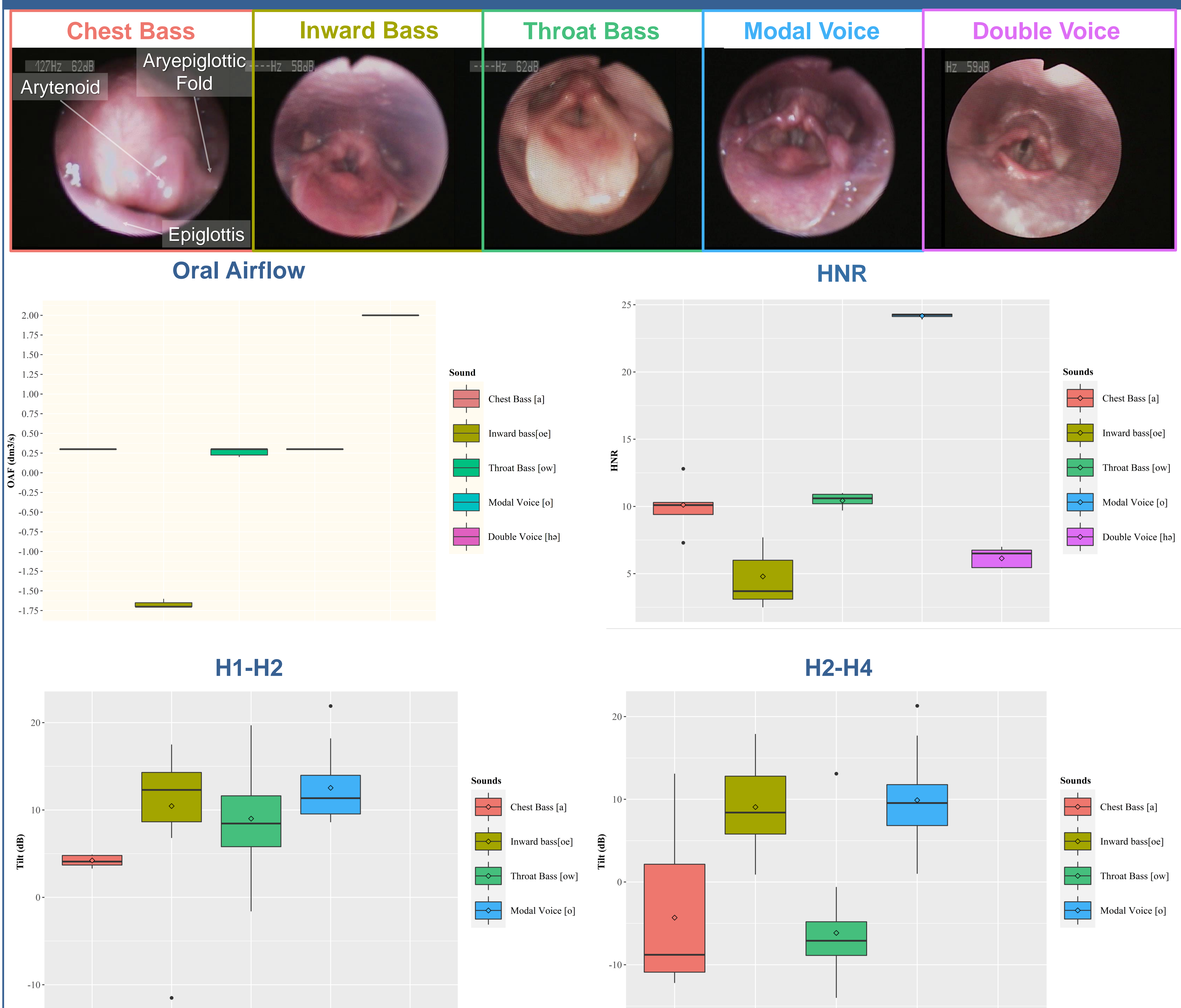
Discussion

- F0 values are unusually low for the chest bass (41-46Hz), the inward bass (57-79Hz) the throat bass (87-91Hz) and very high for the double voice (535Hz) while modal voice is 130Hz.
- Airflow allows to distinguish the double voice & inward bass (i.e. open glottis) *versus* modal voice, chest bass & throat bass (i.e. closed glottis).
- Spectral Tilt along with HNR measures distinguish between regular phonation (i.e. modal voice), irregular phonation (i.e. chest bass, throat bass) and "noisy phonation" (i.e. inward bass, double voice).
- The acoustic analysis matches the laryngoscopic and aerodynamic observations but further analysis is needed to better understand phonatory capacities among beatboxers.