



HAL
open science

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

Alexis Dehais Underdown, Paul Vignes, Lise Crevier-Buchman, Didier Demolin

► **To cite this version:**

Alexis Dehais Underdown, Paul Vignes, Lise Crevier-Buchman, Didier Demolin. Human Beatboxing: Linking articulation, aerodynamics and acoustics of phonation types. 14th Pan-European Voice Conference, Aug 2022, Tallinn, Estonia. . hal-03777101

HAL Id: hal-03777101

<https://hal.science/hal-03777101>

Submitted on 14 Sep 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

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

Alexis Dehais Underdown¹, Paul Vignes¹, Lise Crevier Buchman^{1,2}, Didier Demolin¹
¹Laboratoire de Phonétique et Phonologie, UMR 7018 CNRS-Sorbonne Nouvelle, ²Hôpital Foch, Univ. VSQ

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.

REFERENCES

1. Blaylock, R. et al. (2017). Sounds of the human vocal tract. *INTERSPEECH*, 2287–2291.
2. Garellek, M. (2019). The phonetics of voice 1. In *The Routledge handbook of phonetics* (pp. 75–106). Routledge.
3. Kreiman, J., et al. (2014). Toward a unified theory of voice production and perception. *Loquens*, 1(1), e009
4. Paroni, A et al. (2021). Vocal drum sounds in human beatboxing: An acoustic and articulatory exploration using electromagnetic articulography. *The Journal of the Acoustical Society of America*, 149(1), 191–206
5. Proctor, M., et al. (2013). Paralinguistic mechanisms of production in human "beatboxing": A real-time magnetic resonance imaging study. *The Journal of the Acoustical Society of America*, 133(2), 1043–1054

Remerciements

We thank Hopital Foch, LABEX EFL, Université Sorbonne Nouvelle and the Laboratoire de phonétique et phonologie.

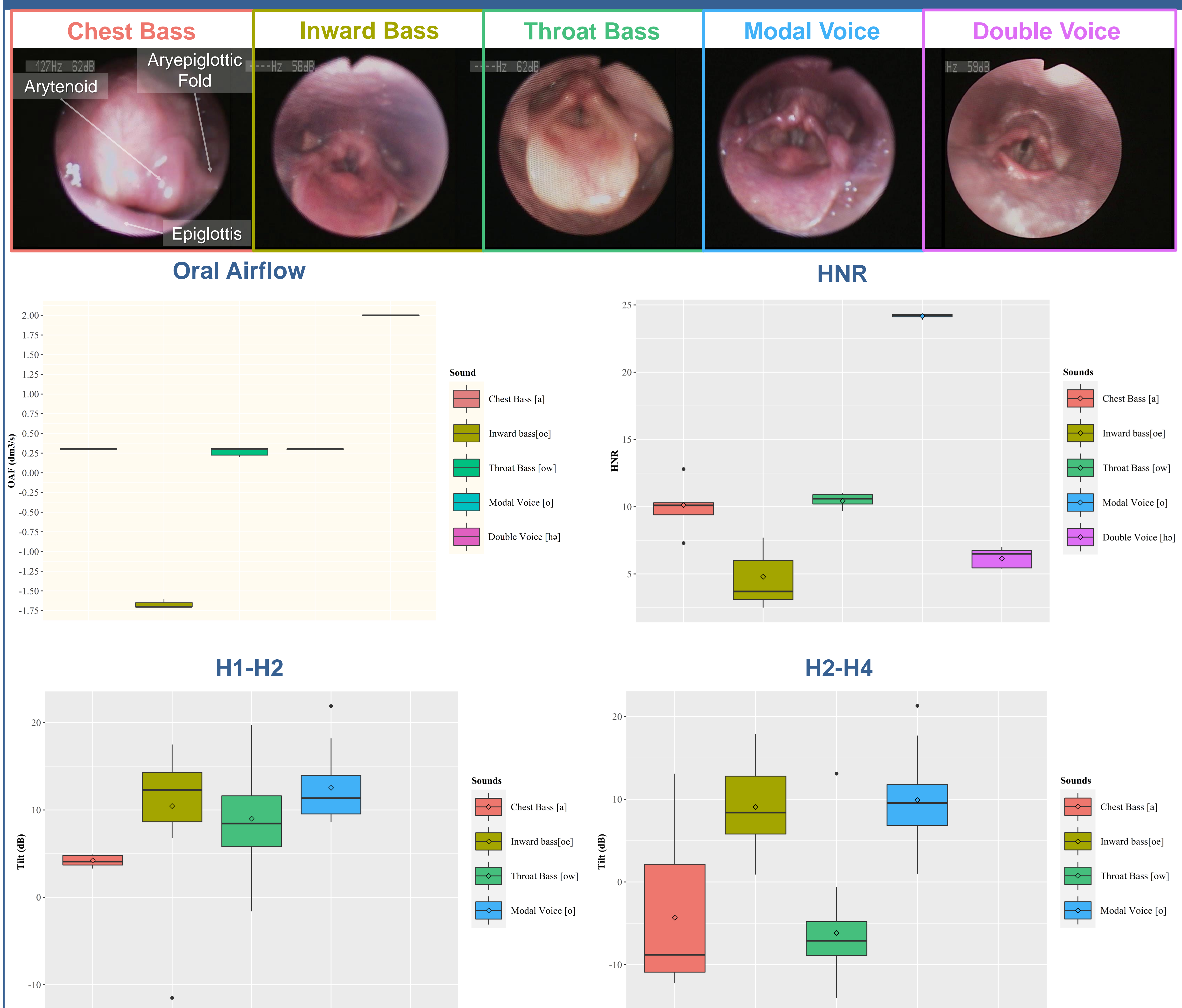
More on alex-under.fr



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 characterize 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



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.