Phonation in Nine* Languages

P. Keating¹, J. Kuang¹, C. Esposito², M. Garellek¹, S. Khan¹,³

¹UCLA; ²Macalester College; ³Brown University

Introduction

Across languages with phonation contrasts, the phonation categories are distinguished by a variety of measures (e.g. Gordan & Ladefoged 2003), but these are inter-related and far outnumber the contrasting categories.

Our questions:
- What is a low-dimension space (acoustic, physiological) for voice quality?
- How are the phonation categories of different languages located in this space?

Language Samples

We compare and contrast other phonations of 10 languages from 4 groups:

- Zapotec (Tonal; 15 speakers)
- Gujarati (Non-tonal; intonational creak)
- Mandarin (Tonal; NO EGG AVAILABLE; 10 speakers)
- White (modal vs. breathy)

Acoustic Measures

Electroglottographic signals were recorded with the audio for 8/10 languages. Automated EGG measures were made by EggWorks, a free UCLA program.

EGG measures:

- CQ_H. Contact Quotient, here using the "hybrid" method with 3/7 threshold
- PIC. Peak Increase in Contact (the peak positive value in the EGG derivative, like DECPA (Michael 2004))
- PDC. Peak Decrease in Contact (the peak negative value in the EGG derivative)
- OP_DUR. Closing duration
- SQ: Skew quotient (ratio of CL_DUR/OQ_DUR)

Categories across languages

Boxplot of CQ_H of 16 phonation categories in 7 languages with EGG data.
- Boxplots only cluster within a limited middle range of values
- Within languages, cross-category differences are often small, although always statistically significant
- The "same" category can be very different across languages
- Languages with more categories do not necessarily have less variable categories

Low-dimensional phonetic spaces

Multi-Dimensional Scaling of spectral and EGG measures
- All 16 language-specific phonation categories in these 7 languages
- Male speakers only
- For each measure are normalized from 0 to 1 for all languages together
- 3-D solutions and 2-D planes of 3-D solutions are plotted

Spectral measures
- Dimension 1 distinguishes some languages (relates to H4*, A1*, A2*, A3*)
- Dimensions 2+3 (right) together distinguish breathy vs. non-breathy along one diagonal, and group languages together by contrast types: Gujarati vs. 3-category languages vs. tense/lax languages (where Mandarin patterns)

Differences on Dimension2 relate most to H1*-H2*; differences on Dimension3 to H1*-H2*, H1*-A1*/A2*/A3*

EGG measures
- Dimension 1 distinguishes some languages, and most breathy/lax vs. creaky/tense (relates most to SQ, PIC, PDC)
- Dimension 3 distinguishes modal from others (relates to CQ, as does dmm2)
- Dimensions 1+3 together (right) distinguish languages, and creaky/tense

Conclusions

Low-dimensional phonetic spaces for phonation can be derived from acoustical and physiological measures of phonation. These dimensions can:
- In the spectral space, languages seem to group together by type of contrast.
- In the EGG space, phonation categories in most of the languages seem to group together by type of category, with breathy, the most variable category.

References & Acknowledgments

- Thanks to NSF grant R16-720304; to Yen Shue for VoiceSauce and Henry Tevrani for EggWorks.

* In fact, only 7 reported here