The source of creak in Mandarin utterances

Yuan Chai
University of California San Diego
ICPhS 2019
08/09/2019

Motivation

- Creak associated with lexical tones:
  - **Low F0-dependent:** Mandarin Dipping Tone 3 (214) (Kuang, 2017a)
  - **F0-independent:** Jalapa Mazatec (Garellek & Keating, 2011)

- Creak associated with phrasing:
  - **F0-independent?**
    - Phrase-initial glottalization in English and Spanish (Garellek, 2013)
    - Repairs, repetitions, and hesitations (Zhuang & Hasegawa-Johnson, 2008).

Motivation

- Utterance-final creak: Low-F0 dependent or not?
  - Mandarin: Utterance-final position tends to be creakier than non-final positions (Belotel-Grenié & Grenié, 2004; Kuang, 2017b; Zhang, 2016).

  - Utterance-final creak is usually **accompanied by low F0** because of F0 declination as utterance proceeds (Yuan & Liberman, 2014).

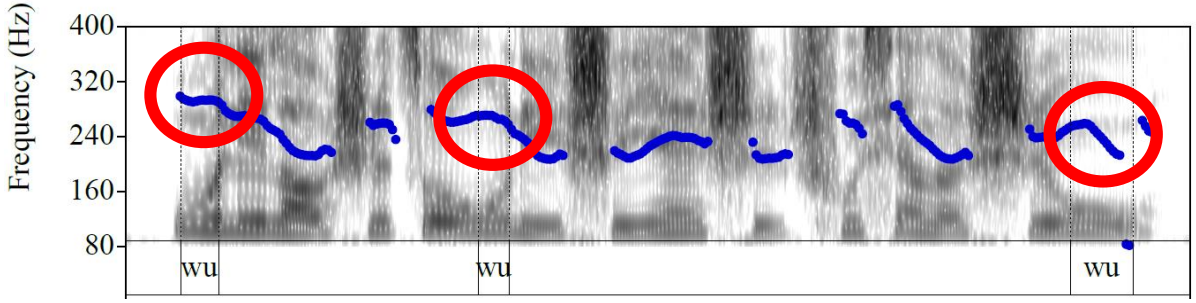
Research question

- Is the utterance-final creak induced by low F0 solely, or is also motivated by **position**?

- Hypothesis: The utterance-final creak marks utterance finality.
  - When F0 does not fall in the final position of utterances, the final position will still be creakier than non-final positions.

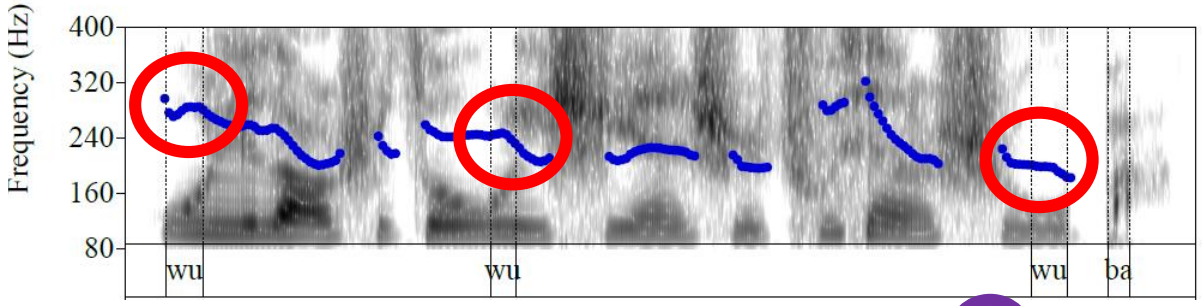
Four types of sentences: F0 pattern

Declaratives: F0 falling



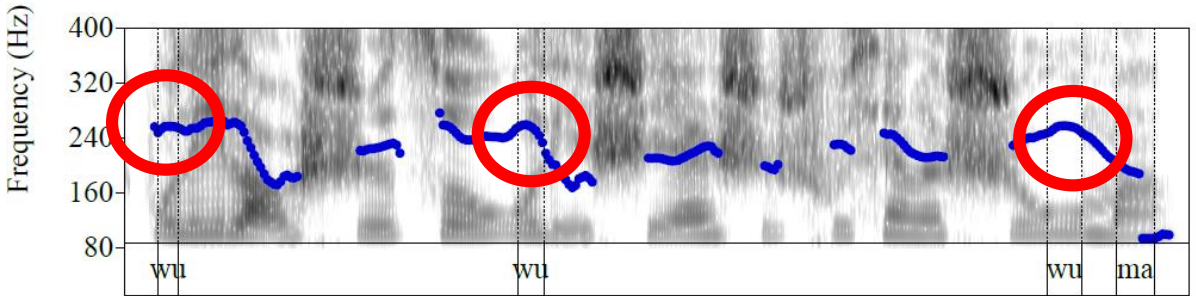
物理老师做物理实验时出现了失误。
The physics teacher made a mistake when doing a physics experiment.

“Ba” interrogatives: F0 falling



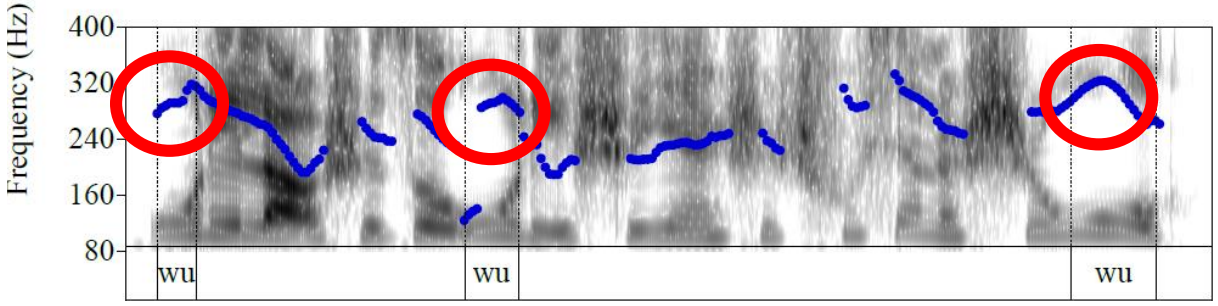
物理老师做物理实验时出现了失误吧?
The physics teacher made a mistake when doing a physics experiment, didn’t he?

“Ma” interrogatives: F0 not declining



物理老师做物理实验时出现了失误吗?
Did the physics teacher make a mistake when doing a physics experiment?

Bare interrogatives: F0 rising



物理老师做物理实验时出现了失误?
The physics teacher made a mistake when doing a physics experiment??

Experiment

- Subjects: 32 native speakers of Northern Mandarin dialect (25 women, 7 men) recruited using SONA system at UCSD

- Mean age = 19.9; Mean age of starting learning English = 6.6; Mean age of arriving US = 16.6

Experiment

- Stimuli: The same segment is placed at the initial, medial, and final position of the target sentence. Each target sentence is embedded in a dialogue. Sixteen experimental items in total.

Example: Bare interrogative

Target **wu4**li3 lao3 shi1 zuo4 **wu4**li3 shi2yan4 shi2 chu1xian4 le shi1**wu4**?
Physics teacher do physics experiment when appear PERF mistake
"Physics teacher made a mistake when doing a physics experiment??"

Context "Li always thinks that his physics teacher is very skilled. His physics teacher has a lot of experience in experiments and never makes a mistake. But Zhao told Li that their physics teacher made a mistake when doing an experiment during a lab session. Li was very surprised. He could not believe it and repeated Zhao's words, '**The physics teacher made a mistake when doing a physics experiment??**'"

Experiment

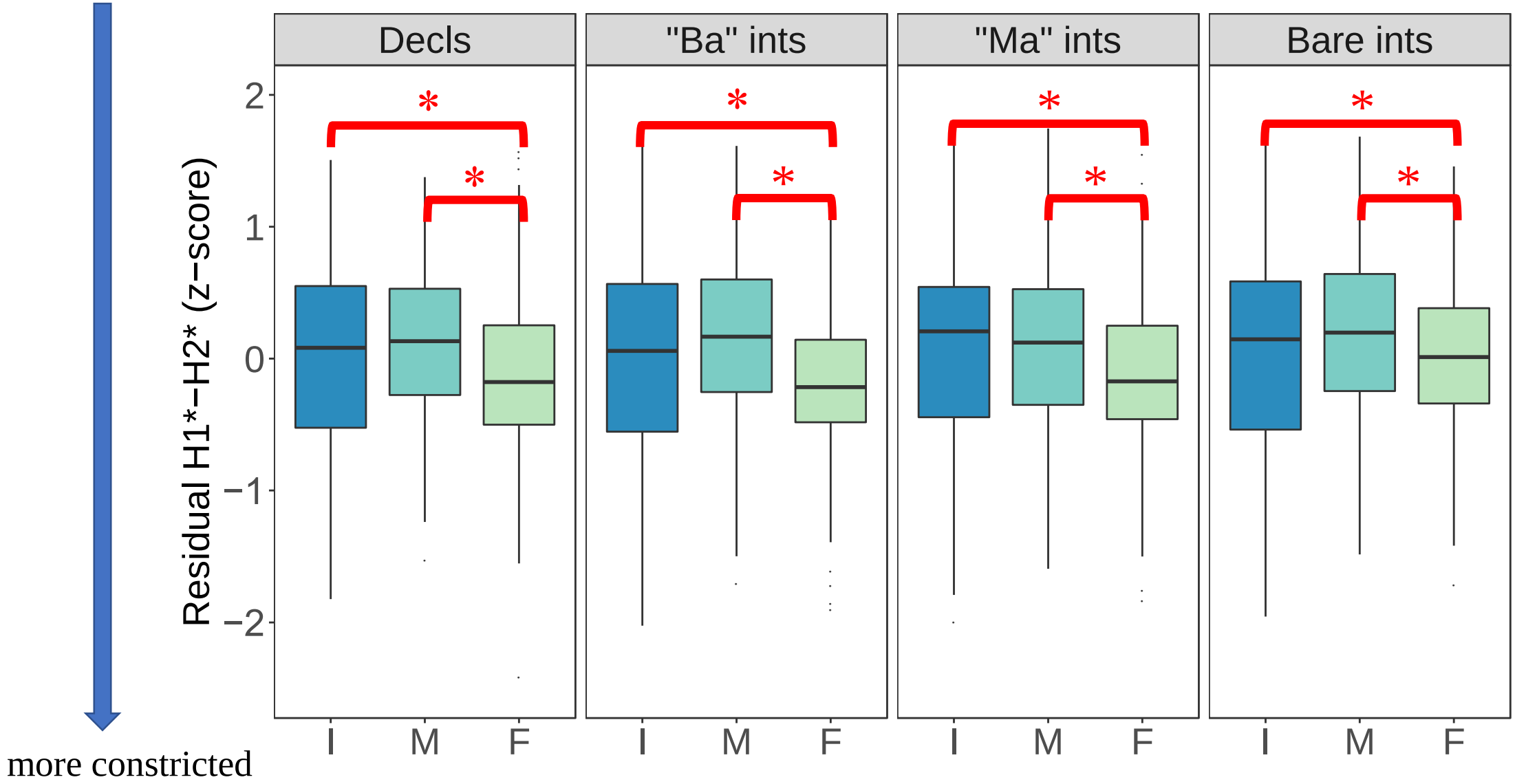
- Procedure:
  - Sixteen experimental items were split into four lists using a Latin-square design.
  - Each sentence type was tested by four items in each list.
  - Each speaker produced 48 dialogues in total; The stimuli are randomized and presented using Psycopy.
    (4 types * 4 items + 8 fillers) * 2 repetitions.

Measurements

- Measure of creak
  - H1*–H2*: lower H1*–H2* → more constricted vocal folds
  - HNR (*Harmonic-to-Noise-Ratio*): lower HNR → less periodic vocal fold vibration
  - Prototypical creak: Low F0, Low H1*–H2*, Low HNR

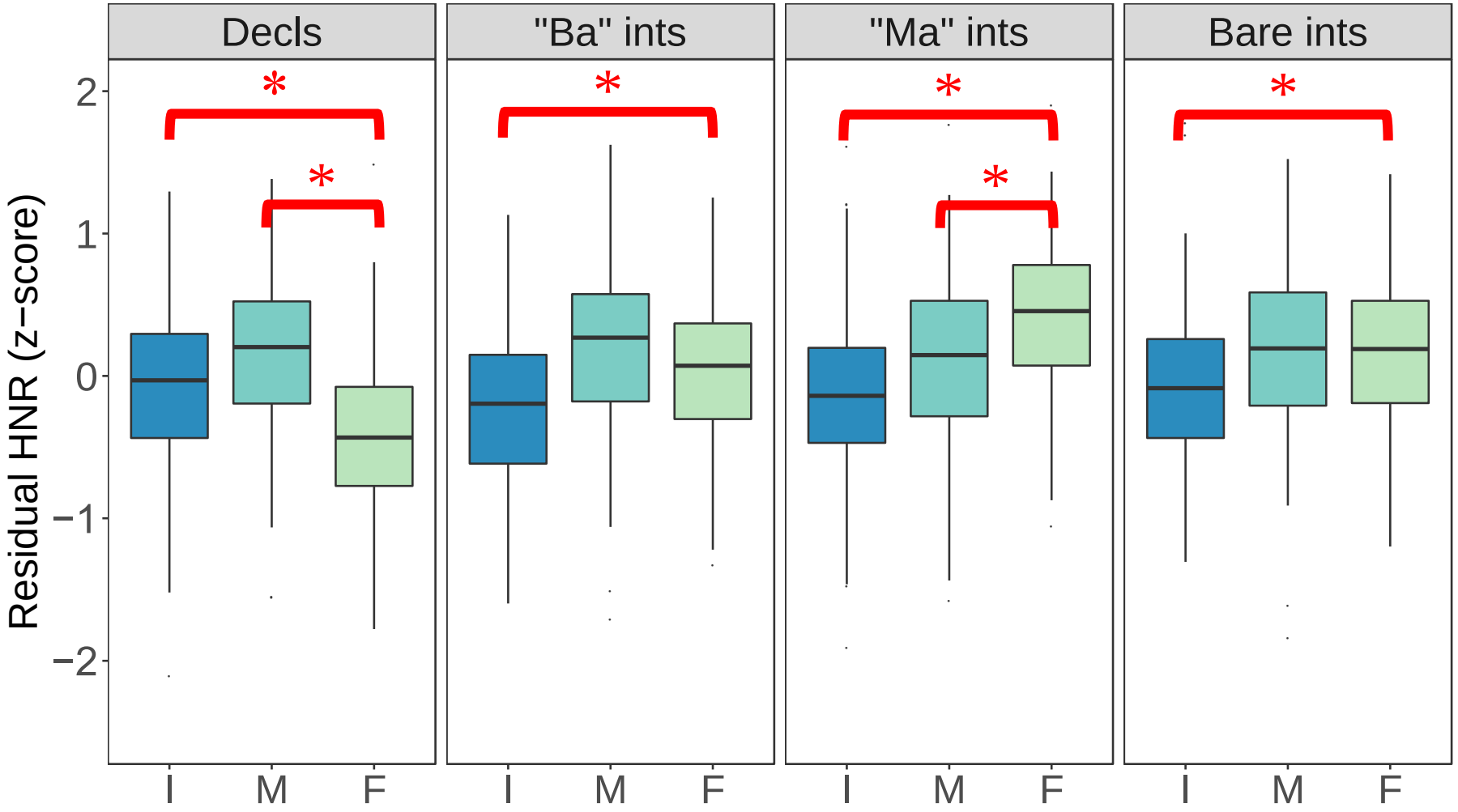
Results: H1*-H2*: Effect of utterance position

(I: Initial; M: Medial; F: Final)



Results: HNR: Effect of utterance position

(I: Initial; M: Medial; F: Final)



Less periodic

- Decl:
  F < I & M
- Ba int:
  F > I; F = M
- “Ma” int:
  F > I & M
- Bare int:
  F > I; F = M

Summary of results

- Is the utterance-final creak induced by low F0 solely?

- **Controlling for F0**
  - Degree of constriction (H1*–H2*): Final position is ***more*** constricted than non-final positions.

  - Different effects for HNR by sentence type:
    - Declaratives → final position is noisier
    - Bare interrogatives → final position is **not** noisier

    - Ba interrogatives → final position is **not** noisier
    - Ma interrogatives → final position is **less** noisy

No final particle

Has final particle

Discussion

- Why does voice quality differ by sentence type in such a way?

- Prominence is acoustically associated with higher F0, higher intensity (Breen et al., 2010), more vocal fold constriction (Garellek, 2014), and less noise (Huang et al., 2018).

- Proposal: **"Ma" and Bare ints** have **more prominent** final positions than **decls and "ba" ints** because the speaker has less belief in the proposition.

Conclusions

- The creak in utterance-final position in Mandarin not solely motivated by low F0.
- Controlling for F0, utterance position has independent effect on creak.
- The final position of **“ma” and bare interrogatives** is more prominent than that of **declaratives and “ba” interrogatives**.

Thank you!

- Thanks to Marc Garellek, Ivano Caponigro, and Gabriela Caballero for the guidance in constructing the study and revising the writing.

- Thanks to Qi Cheng, Ningning Huang, Yaqian Huang, and Yueyi Jiang for piloting the experiment.

- Thanks to the audience at LSA 2019 and PhonCo for feedback on prior versions of this project.

References

- Belotel-Grenié, A., & Grenié, M. (2004). The creaky voice phonation and the organisation of Chinese discourse. In *International symposium on tonal aspects of languages: With emphasis on tone languages*.
- Blankenship, B. (2002). The timing of nonmodal phonation in vowels. *Journal of Phonetics*, *30*(2), 163-191.
- Breen, M., Fedorenko, E., Wagner, M., & Gibson, E. (2010). Acoustic correlates of information structure. *Language and cognitive processes*, *25*(7-9), 1044-1098.
- DiCanio, C. T. (2009). The phonetics of register in Takhian Thong Chong. *Journal of the International Phonetic Association*, *39*(2), 162-188.
- Garellek, M. (2013). *Production and perception of glottal stops* (Unpublished doctoral dissertation). UCLA, Los Angeles, CA.
- Garellek, M. (2014). Voice quality strengthening and glottalization. *Journal of Phonetics*, *45*, 106-113.
- Garellek, M., & Keating, P. (2011). The acoustic consequences of phonation and tone interactions in Jalapa Mazatec. *Journal of the International Phonetic Association*, *41*(2), 185-205.
- Huang, Y., Athanasopoulou, A., & Vogel, I. (2018). The Effect of Focus on Creaky Phonation in Mandarin Chinese Tones. *University of Pennsylvania Working Papers in Linguistics*, *24*(1), 12.
- Kuang, J. (2017a). Covariation between voice quality and pitch: Revisiting the case of Mandarin creaky voice. *The Journal of the Acoustical Society of America*, *142*(3), 1693-1706.
- Kuang, J. (2017b). Creaky Voice as a Function of Tonal Categories and Prosodic Boundaries. In *INTERSPEECH* (pp. 3216-3220).
- Pompino-Marschall, B., & Żygis, M. (2010). Glottal marking of vowel-initial words in German. *ZAS Papers in Linguistics*, *52*, 1-17.
- Smith, C. L. (2002). Prosodic finality and sentence type in French. *Language and Speech*, *45*(2), 141-178.
- Yu, K. M., & Lam, H. W. (2014). The role of creaky voice in Cantonese tonal perception. *The Journal of the Acoustical Society of America*, *136*(3), 1320-1333.
- Yuan, J., & Liberman, M. (2014). F0 declination in English and Mandarin broadcast news speech. *Speech Communication*, *65*, 67-74.
- Zhang, H. (2016). Boundary effects on allophonic creaky voice: A case study of Mandarin lexical tones. *Tonal Aspects of Languages 2016*, 94-98.
- Zhuang, X., & Hasegawa-Johnson, M. (2008, May). Towards interpretation of creakiness in switchboard. In *Proceedings of Speech Prosody* (pp. 37-40).