Acoustic comparison of /t/ glottalization and phrasal creak

Marc Garellek and Scott Seyfarth

Department of Linguistics, UC San Diego
mgarellek@ucsd.edu

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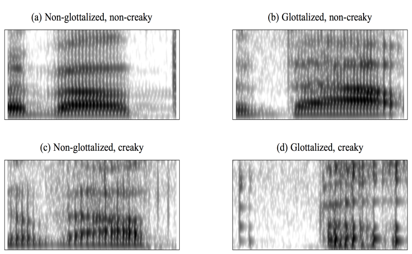
Introduction

- In American English, creaky voice has several linguistic origins, such as:
  - /t/ glottalization – *about* [əbaʊʔ]
  - Phrasal creak – creaky voice that is prosodically conditioned, e.g. phrase-final creak.
- Different sources of creaky voice can co-occur on a single word (Fig. 1).

Is /t/ glottalization acoustically distinct from phrasal creak?

Fig 1: 'about' with glottalization/ creak



- Listeners can distinguish minimal pairs like glottalized 'motley' [mɑʔli] and creaky 'Molly' [mɑ̰li] (Garellek 2015).
  - ➢ This suggests different articulatory mechanisms and acoustic realizations.

Research questions:

- Do different linguistic sources of creaky voice have distinct articulations and acoustic attributes?
- Part of a broader effort towards taxonomy of types of creaky voice based on their acoustic characteristics and uses in language (e.g. Keating et al. 2015).

Corpus and measures

- 40 Ohioan speakers from Buckeye Corpus (Pitt et al. 2007), gender-balanced.
- Words with coda /t/ in simple codas, realized as [t] or [ʔ] (annotations from corpus, hand-checked).
- Phrasal creak was identified based on corpus log files, hand-checked.
- Vowel before /t/ was analyzed

Measure	Explanation
H1*-H2*	Difference in amplitude between H1 & H2
H2*-H4*	Difference in amplitude between H2 & H4
H1*-A1*	Difference in amplitude between H1 & harmonic nearest F1
H1*-A2*	Difference in amplitude between H1 & harmonic nearest F2
H1*-A3*	Difference in amplitude between H1 & harmonic nearest F3
H4*-2K*	Difference in amplitude between H4 & harmonic nearest 2000 Hz
2K*-5K*	Difference in amplitude between Harmonic & nearest 2000 Hz harmonic nearest 5000 Hz
F0	Fundamental frequency
CPP	Cepstral peak prominence
HNR05	Harmonics-to-noise ratio <500 Hz
SHR	Subharmonics-to-harmonics ratio

- Measures correlated with common properties of creaky voice, relative to modal voice:
  - ➢ Lower spectral tilt (H1*-H2* through 2K*-5K*)
  - ➢ Lower f0
  - ➢ Lower periodicity (CPP, HNR05)
  - ➢ Stronger subharmonics (SHR)
- Each measure was standardized within speaker, outliers removed (~20% of total data).
- In total, 8751 vowels were analyzed:
  - ➢ Non-creaky = 7665; Creaky = 1086
  - ➢ [t] = 3253; [ʔ] = 5498
- For each measure, we included average value and change in measure from first to final third of vowel.

Analysis

- Linear discriminant analysis (LDA): contribution of the acoustic measures to the identification of glottal stops and phrasal creak.

Confusion matrix from LDA:

Actual ➡ Predicted ⬇	Non-creaky [t]	Creaky [t]	Non-creaky [ʔ]	Creaky [ʔ]
Non-creaky [t]	1803	144	631	89
Creaky [t]	10	2	10	3
Non-creaky [ʔ]	1057	214	4098	573
Creaky [ʔ]	7	16	49	45

Fig 2: LD1/LD2 space with 50% CIs

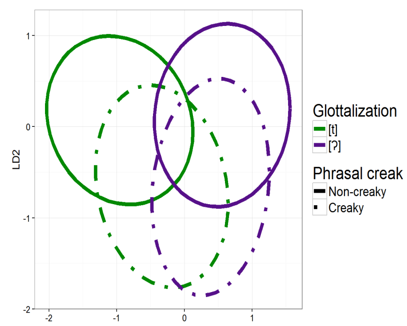
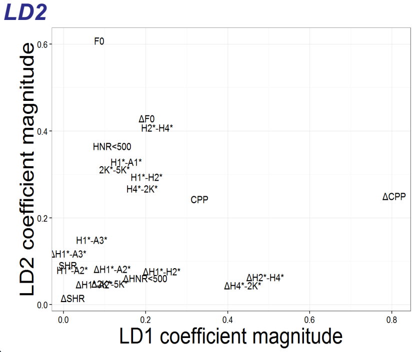


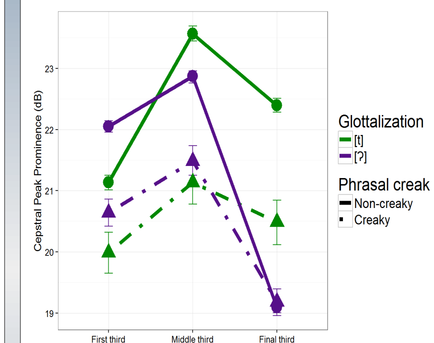
Fig 3: Predictor coefficients in LD1/ LD2



Discussion

- Glottalization shows large drop in periodicity over course of vowel.
- As expected, phrasal creak is characterized by lower f0.

Fig 4: Changes in CPP over vowel



- Given that listeners are sensitive to pitch and noise measures (Garellek et al. 2016), listeners likely use these characteristics to differentiate different types of creaky voice.
- Spectral tilt measures less effective predictors of creak/glottalization, perhaps due to variability in realization of creak:
  - ➢ Some speakers show increase in spectral tilt measures, consistent with vocal fold spreading (cf. Slifka 2006).

Acknowledgments

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References

1. Garellek, M. (2015). Perception of glottalization and phrase-final creak. *JASA 137*: 822–831.
2. Garellek, M., Samlan, R., Gerratt, B. R., & Kreiman, J. (2016). Modeling the voice source in terms of spectral slopes. *JASA 139*: 1404–1410.
3. Keating, P., Garellek, M., & Kreiman, J. (2015). Acoustic properties of different kinds of creaky voice. *ICPhS* 18.
4. Pitt, M. A., Dilley, L., Johnson, K., Kiesling, S., Raymond, W., Hume, E., & Fosler-Lussier, E. (2007). Buckeye Corpus of Conversa- tional Speech (2nd release),
5. Shue, Y.-L., Keating, P., Vicenik, C., &. Yu, K. (2011). VoiceSauce: A program for voice analysis. *ICPhS 2011*.
6. Slifka, J. (2006). Some physiological correlates to regular and irregular phonation at the end of an utterance. *JVoice 20*: 171–186.