Perceptual benefits of English coda stop glottalization

Marc Garellek, Department of Linguistics, University of California, Los Angeles

marcgarellek@ucla.edu

Background

• In English, coda-stops may be 'glottalized,' i.e. produced with simultaneous glottal closure.

• This phenomenon is sometimes called *glottal reinforcement* (Higginbottom 1964), and its occurrence is known to vary according to prosodic and segmental factors (Pierrehumbert 1995, Huffman 2005)

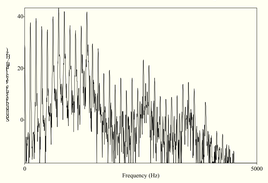
- More common for coda-/t/ and coda-/p/
- More common when followed by sonorant than by obstruent
- More common phrase-finally than within a prosodic phrase.

• Because of glottal reinforcement, adjacent vowels are often produced with some coarticulated **laryngealization** or creaky voice:

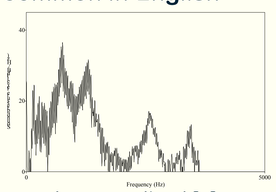
- this type of coarticulation was found to be more extensive in words with lower relative frequencies, i.e. more confusable words (Garellek 2011)
- Speakers might increase coarticulation in order to aid the listener (Scarborough 2004).

▪ Laryngealization could be beneficial to the listener because:

- It helps indicate the presence of a coda-stop, since other codas are not known to trigger laryngealization. (Phonological view)
- It may provide *phonetic* cues as to *which* stop follows the vowel, because it increases higher frequencies in the spectrum
  - Formant transitions could be amplified in laryngealization.
  - Especially beneficial if the coda stop is unreleased, as is common in English



Modal [a]



Laryngealized [a]

Research Questions

The goals of this study are:

1. To determine if vowel laryngealization aids in coda stop perception in English
2. To determine whether the benefits of laryngealization (if any) interact with release of the following coda stop
3. To determine whether any benefit of laryngealization is due to higher energy around formant transitions

Method

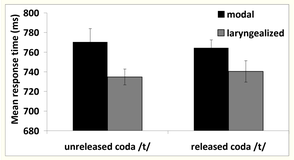
- Phoneme monitoring task for /t/. Targets were monosyllabic English words ending in /t/, e.g. /beɪt/
- Targets differed in whether the preceding vowel was modal vs. laryngealized, and whether the /t/ was released.
- Stimuli recorded by female phonetically-trained native English speaker.

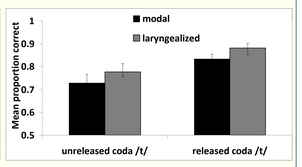
/beɪt/ 'bait'	Modal	Laryngealized
Released	[beɪt]	[bḛɪt]
Unreleased	[beɪt̚]	[bḛɪt̰]

- Laryngealized vowels had smaller values for H1*-H2* and H1*-A1*/2/3, as expected.
  - Modal vs. laryngealized did not differ in average F0.
- Controls and fillers:
  - Words with /t/ onset, e.g. 'team'
  - Other alveolar codas, e.g. 'bean'
  - Coda-less minimal pairs, e.g. 'bee'
  - Words ending in codas /p, k/
  - All stimuli appeared equally with modal and laryngealized vowels
- 18 native English participants
- Experiment run in MATLAB, practice round had feedback to ensure /t/ monitoring for unreleased codas
- Analysis included linear mixed-effects regression models (stop release and phonation as fixed effects; subject and item as random effects) to analyze RT and proportion correct.

Results

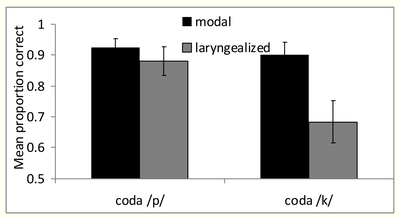
Effect of laryngealization and coda /t/ release:





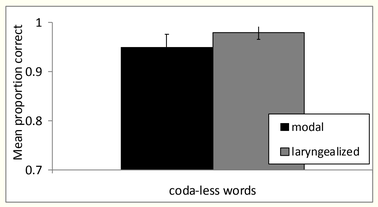
- Laryngealized tokens ⇒ faster RT, more accurate
- No significant contribution of lexical frequency, F0, duration
- Released /t/ tokens ⇒ more accurate

Effect of laryngealization on codas /p, k/:

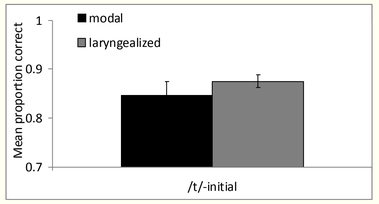


- Less accurate if preceding vowel is laryngealized.
- Worse effect of laryngealization on /k/ vs. /p/ could be phonological → coda /k/ unlikely to glottalize.

Effect of laryngealization on coda-less words:



- *More* accurate if preceding vowel is laryngealized.
- Surprising effect found for all /t/-<u>initial</u> words:



Discussion

- These results support both phonological and phonetic accounts of why laryngealization could be useful to English listeners
  - Phonological view ⇒ Listeners associate laryngealization with coda /t/.
  - Phonetic view ⇒ Listeners use laryngealization for formant transition perception.

	Accuracy if laryngealized	Phonol.	Phonetic
Coda /t/	Improved	✓	✓
Coda /p, k/	Worsened	✓	
No coda	Improved		✓
Onset /t/	Improved		✓

- If laryngealization in general helps listeners in /t/ monitoring, then it could explain why glottal reinforcement occurs in languages with unreleased stops
  - It can 'alleviate' the perceptual loss of stop release information by providing additional cues.

Conclusions and Future Directions

• This study shows that laryngealized voiced quality can be used by listeners to monitor for /t/.

• Listeners are generally more accurate and faster at monitoring for /t/ when the vowel is laryngealized.

• The findings support both a phonetic and phonological account for why laryngealization may be beneficial.

• Further work needed to explain coda /p, k/ effects.

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Acknowledgements

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