


The production and perception of epenthetic stops

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Background

- Ali et al. (1979) and Fourakis and Port (1986) have presented results consistent with the claim that in American English the distinction between epenthetic stops—e.g. the [t] in *prince*—and underlying stops—e.g. the [t] in *prints*—is a case of incomplete neutralization:
- epenthetic [t]s show shorter closure duration and are less likely to have a burst than underlying [t]s
- Yoo and Blankenship (2003) found no difference in the closure duration of underlying and epenthetic [t]s
- In addition, speakers maintain that words such as *prints* and *prince* “sound the same”


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Production study: Research questions and hypotheses

- Do the differences between the older studies and Yoo and Blankenship simply reflect the greater variability found in the Yoo and Blankenship (2003) data?
- Or could the discrepancy reflect a change in progress?
- If so, then
 - we should observe cross-generational differences in production
 - differences between epenthetic and underlying [t]s should be greatest among unfamiliar and infrequent words (e.g. *remittents* vs. *remittance*), and smallest among familiar and frequent words (e.g. *presents* vs. *presence*)
 - similarities should be smallest in word-medial position (where epenthesis is rarer, according to the sources, e.g. *fancy*) and greatest in word-final position (where epenthesis is frequent)

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Production study: Materials

- Eight near minimal pairs of words with [nts] and [ns] sequences
- Words were independently rated as familiar or unfamiliar (familiarity ratings match those in the Hoosier Mental Lexicon)
- Words were presented in naturalistic contexts that did not draw attention to the test pairs; e.g.

When she's in Laura's presence, Belinda always acts nervous. I hate shopping for presents, but this weekend I have to do it.

		Word-medial	Word-final
Familiar	fancy	antsy	intense events
	complacency	elephant-seals	presence presents
Unfamiliar	Mainside	bentside	evince cements
	remittency	Montserrat	crescence remittents


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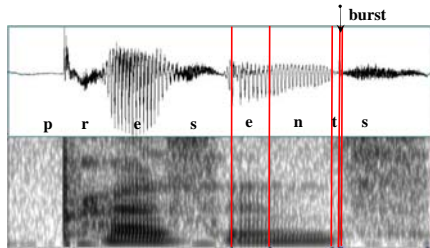
Production study: Methods

- **Speakers**
 - Native speakers of Southern Californian English; 10 speakers were between 18-23 years old; 9 speakers between 40-55 years old.
- **Procedures**
 - Six randomized repetitions of the sentences, four of which were used for measurement.
- **Measurements**
 - Duration of vowel, [n], stop closure, burst, and [s]
 - Frequency of [t] closure and burst

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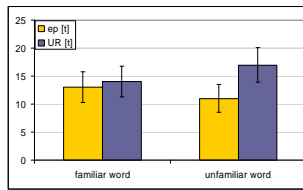
Segmentation example



Measurements
Duration of vowel, [n], stop closure, burst, and [s]
Frequency of [t] closure and burst

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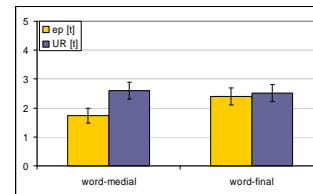
[t] closure duration



Regardless of speaker age, epenthetic and underlying [t] have similar closure durations in familiar words, but underlying [t]s are longer in unfamiliar words

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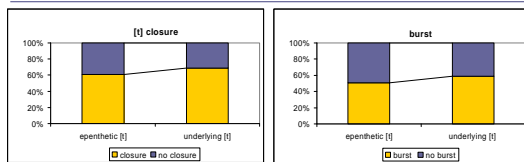
Burst duration



Regardless of speaker age, bursts are shorter in epenthetic [t]s than in underlying [t]s, but the effect holds only word-medially

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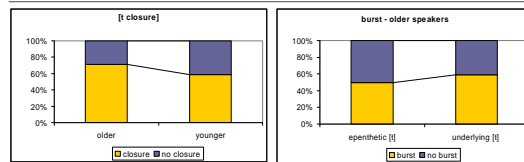
Effects of [t] type on [t] occurrence



- Regardless of speaker age, closure is more likely if [t] is underlying than if it is epenthetic
- Similarly, bursts are more likely to occur with underlying than epenthetic [t]

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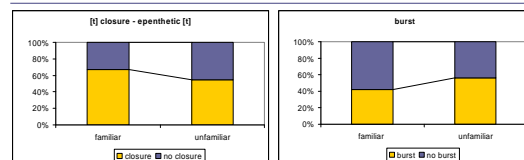
Effects of speakers' age on [t] occurrence



- [t] closure is more likely to occur in the data of the older speakers (for both underlying and epenthetic [t]s)
- For bursts, only the older speakers show greater likelihood of burst with underlying [t]s

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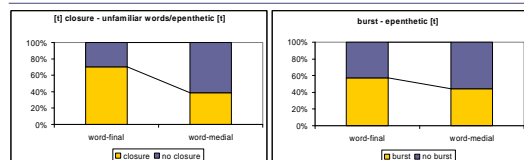
Familiarity effects on [t] occurrence



- In words with epenthetic [t], closure is more likely if the word is familiar (there is no such effect for words with underlying [t])
- Bursts, in contrast, are **less** likely to occur in familiar words

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Position effects on [t] occurrence



- In **unfamiliar** words with epenthetic [t], closure is more likely word-finally than word-medially
- In all words with epenthetic [t], bursts are more likely word-finally than word-medially

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Interim discussion

- There are few cross-generational differences in production, apart from the fact that older speakers are less likely to produce epenthetic [t]s with a burst
- Epenthetic [t]s are more likely in familiar words, where their closure duration is similar to that of underlying [t]s
- Epenthetic [t]s are more likely in word-final position, where they are also more likely to have a burst which is of similar duration to that of underlying [t]
- In short, epenthetic [t]s may not be produced as often as underlying [t]s, but when they are produced they are very similar to underlying [t]s
- These results suggest the beginnings of neutralization between [ns] and [nts] sequences, especially word-finally in familiar words

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Perception study:

Research questions and hypotheses

- Given the production results, listeners should have difficulty distinguishing [n(t)s] minimal pairs, but identification should be possible
- Frequent and familiar words (e.g. *prints-ponce*) should be more difficult to distinguish than infrequent and unfamiliar words (e.g. *quince-quints*)
- The presence of a burst and longer closure duration should favor “nts” responses, particularly in infrequent and unfamiliar words

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Perception study: Stimuli

- Three tokens each of
 - prince, prints* (frequent & familiar)
 - quince, quints* (infrequent & unfamiliar)
 - mince, mints* ((in)frequent & familiar)
- Elicited—in a carrier phrase—from two speakers of Southern California English in their early 20s
- All traces of [t] closure and burst were first removed from the tokens
- 0-72 ms of silence were spliced in between [n] and [s], in 12 ms steps
- For each adulterated token, two stimuli were created,
 - one without a burst
 - and one with a representative burst (the same for all stimuli)

Series of stimuli	
No Burst	Burst
0 ms sil_NB	0 ms sil_B
12 ms sil_NB	12 ms sil_B
24 ms sil_NB	24 ms sil_B
36 ms sil_NB	36 ms sil_B
48 ms sil_NB	48 ms sil_B
60 ms sil_NB	60 ms sil_B
72 ms sil_NB	72 ms sil_B

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Perception study: Methods

Listeners

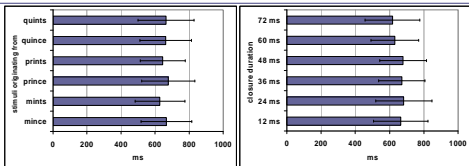
- 26 native speakers of American English 18-23 years old
- The data of two subjects, who failed to respond to more than 40% of the stimuli, were removed

Procedures

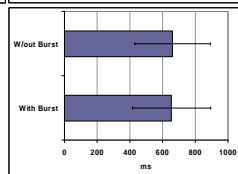
- Forced-choice identification: subjects saw a minimal pair on screen (e.g. *quints quince*) and selected the word they thought they heard
- Responses and reaction times were recorded, unless the subject failed to respond within 1500 ms after the onset of a stimulus
- The position of the words on the screen (left, right), and the order in which stimuli from the two speakers were heard were counterbalanced
- Stimuli were heard in random order, three times each, in blocks of ten; they were interspersed with fillers, at a rate of one filler for every two stimuli

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Response Times

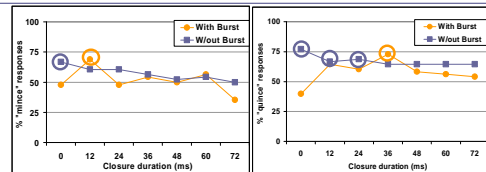


RTs were relatively long, but not affected by word identity, [t] closure duration, and burst.

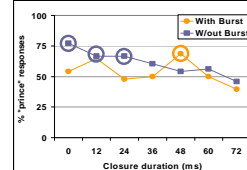


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Identification Rates



Binomial tests showed that these identification rates were not significantly different from chance, except for the circled data points ($p < 0.05$).



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Discussion

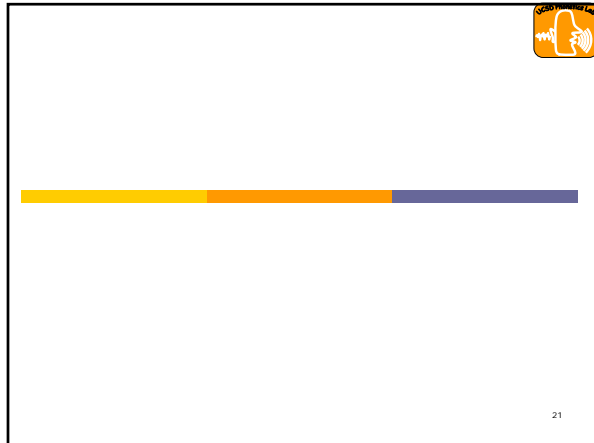
- The long reaction times and chance responses clearly show that the listeners found the task very difficult
- The listeners were also biased towards “nce” responses in the absence of strong evidence for a [t]
- In this sense, closure duration and the presence or absence of a burst did influence subjects’ responses.
- In light of the production results, the perceptual bias towards “nce” words suggests a mismatch between production and perception (alternatively, this bias could be interpreted as an influence of orthography on the responses; but Colavin’s near chance responses to a phoneme detection experiment do not support this hypothesis)
- Significantly, identification rate and the bias towards “nce” responses were not affected by word frequency or familiarity

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Conclusions

- The present production and perception results support the view that the contrast between [nts] and [ns] is currently neutralized (in Southern California English), at least in word-final position in familiar words
- Further production and perceptual tests are underway to investigate the effect of orthography on perceptual results, and to determine the extent to which neutralization applies to different styles of speech

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