"I was jus' li**k**e all, wha**t**ever!": Variability of stops in conversational vs. laboratory speech of American undergraduates

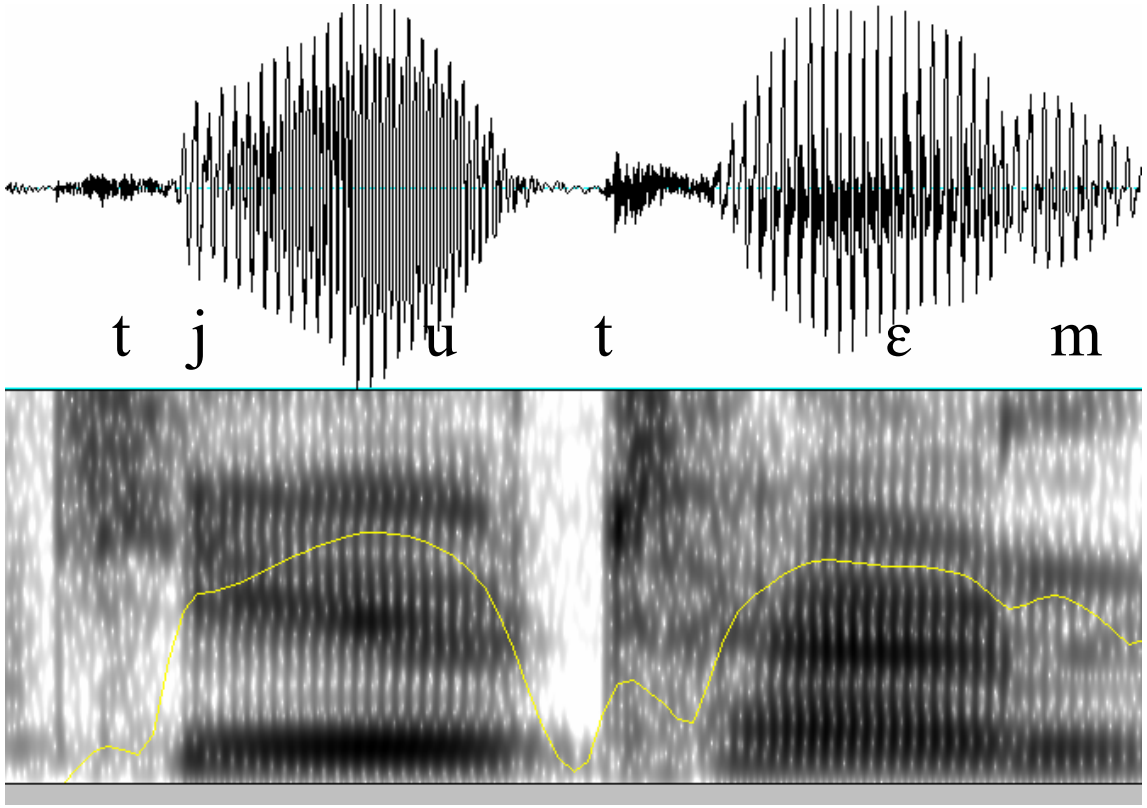
Natasha Warner
with Benjamin V. Tucker
Department of Linguistics,
University of Arizona

Speech Variability

- Speech is rampantly variable: segments, syllables, entire words get reduced or deleted (but not always) (cf. many papers by Ernestus et al., Pluymaekers et al. 2005, Johnson 2004, Greenberg 1997)
- Stops can become approximants (vowel-like), vowels can become devoiced (fricative-like)
- Despite all this, we usually understand it all fine!
- How much variability comes from phonology, from systematic phonetic sources, from random variation?

Examples

- What does this say?
- "Do you have time to talk to me for a little while?"

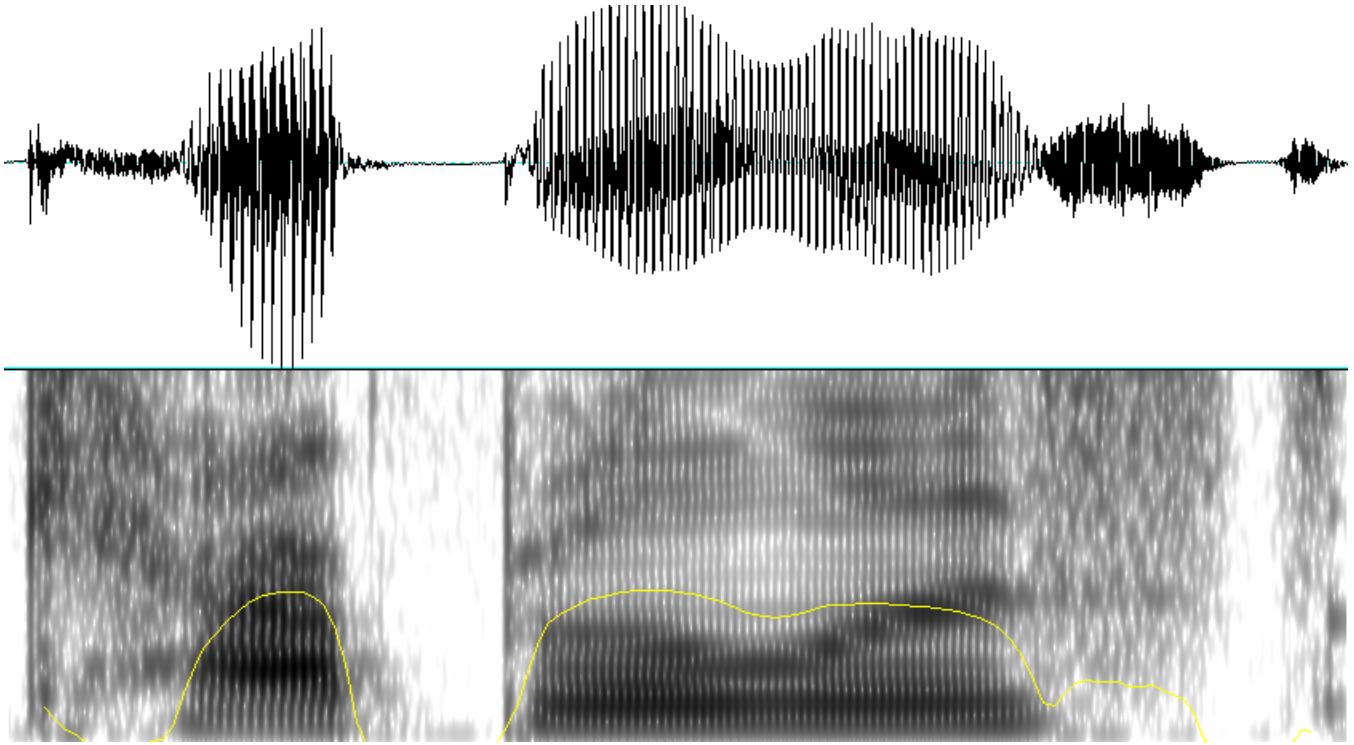


Do you have time…

Complete word "have" deleted

Segmental examples

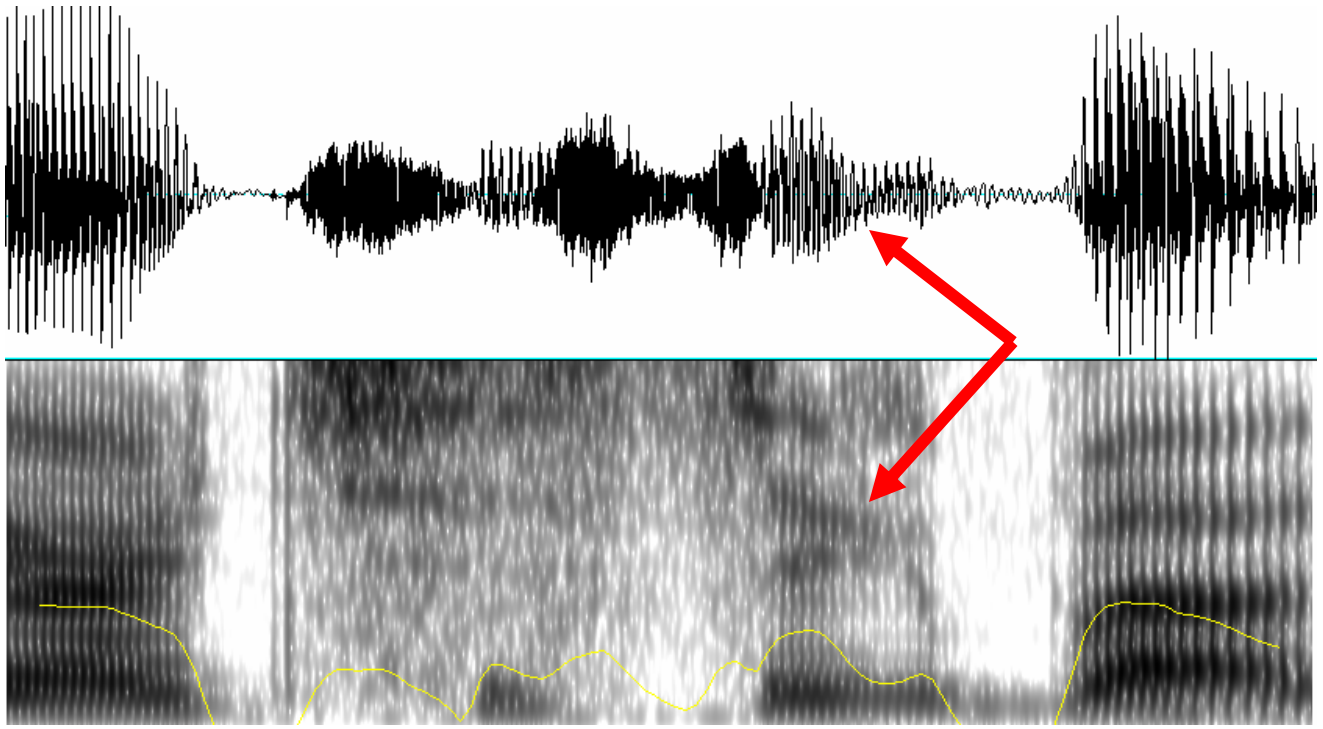
- Lest you think reduction only happens in casual, connected speech: "capi**t**alist"



Isolated word list reading, in sound booth.

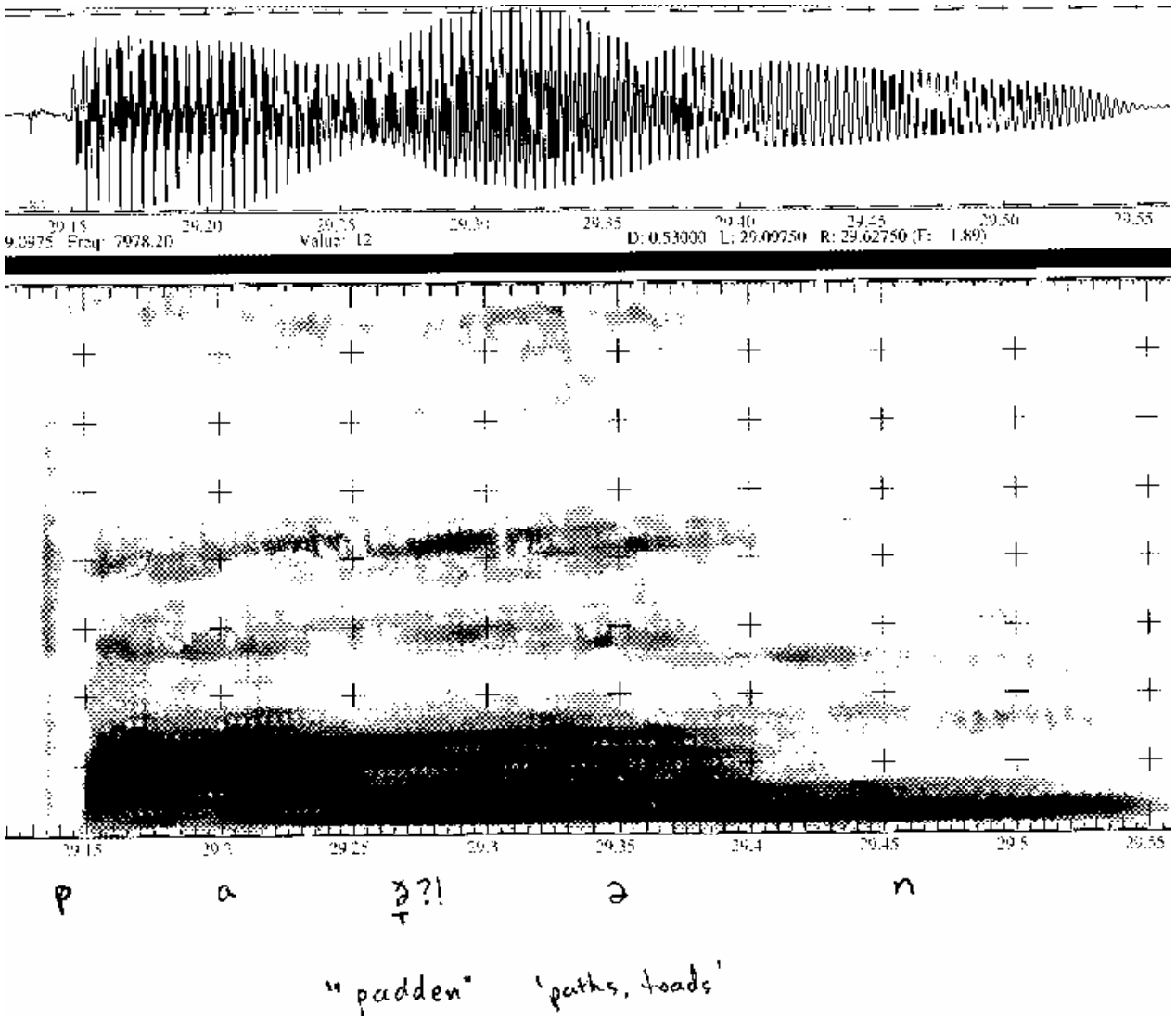
A voiceless stop doesn't have to be voiceless

- "She's very artisti**c** about things" (list reading)
- sentence "tic abou…"



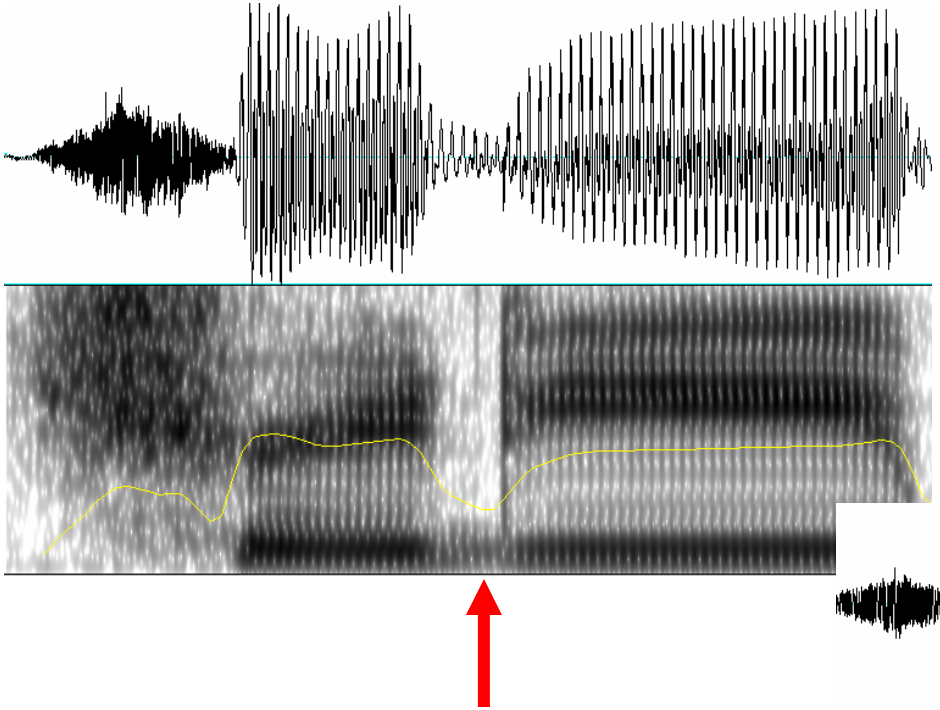
a ɹ t^h ə s (t) ə g ə b ʌ

And it's not just American undergrads who reduce stops



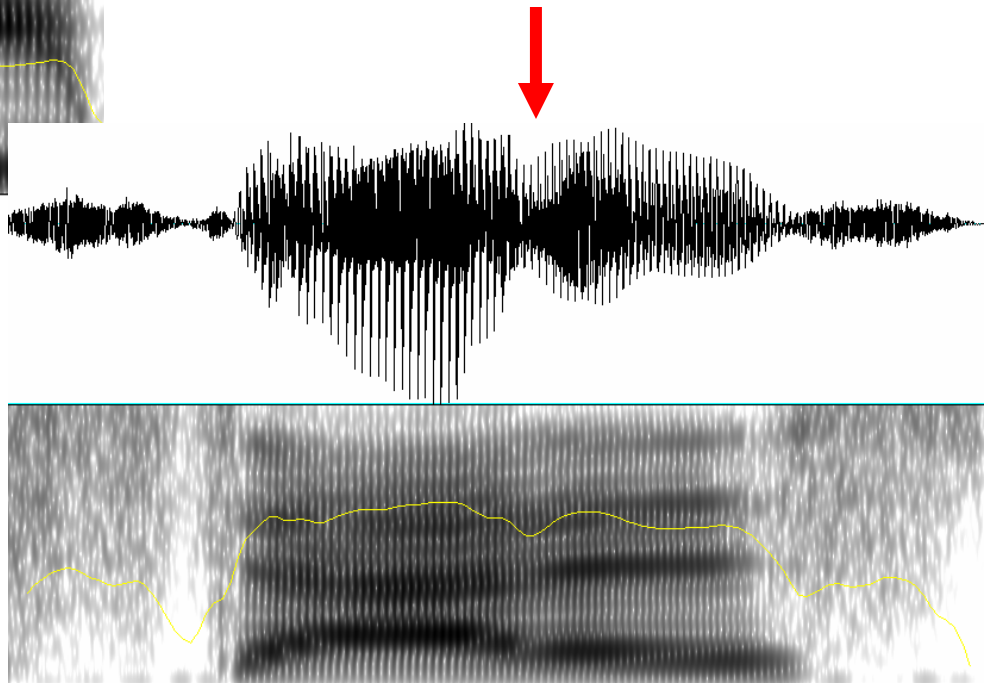
- MPI subject pool
- Isolated word list reading in a sound booth
- "padden" with /d/ realized as approximant
- Similar recording of "heden"

Main interest: flaps in comparison to other intervocalic stops



A clear flap:

"treaty"



A reduced one:

"status"

Flapping in Amer. English

- /t, d/ are traditionally said to become [ɾ] if intervocalic before unstressed syllables: butter, bottle, treaty, ladder, capitalist, …
- Even across word boundaries: but I, bad as it is…
- This seems to be pretty categorical, although not 100% (Patterson & Connine 2001)
- But there are claims that flapping is not a categorical phonological rule, but phonetic, gradient variability (Fukaya & Byrd 2005)

Phonetics and phonology in flapping

- "The underlying motivation for the phenomenon is a prosodic one that does not pick out a single place of articulation for a symbolic alternation" (Fukaya & Byrd 2005)
- They argue that general prosodic patterns lead to short articulations, which are perceived as a categorically different sound.

Our questions

- Does a categorical phonological rule apply to /t/ and /d/ (and not to /p, k, b, g/)?
- Does gradient phonetic variability apply to all stops?
- Is some phonetic variability systematic, and conditioned by word frequency, stress and segmental environment, speech style, etc.?
- How much variability is there within and among speakers?

What we're **not** asking

- Most past literature on flaps (Kahn 1976, Patterson & Connine 2005) focuses on **whether** /t, d/ flap in some environment. We're looking only at flapping environments, to see what happens **among** flaps.
- Past literature also compares /t, d/ to look for (in)complete neutralization. We compare /t, d/, but not with the purpose of finding differences that tiny.

Methods

- Intervocalic, pre-unstressed /p, t, k, b, d, g/
- 6 segmental environments and 2 stress environments:

Sample stimulus words by stop and stress

	Post-stress	Inter-unstress.		Post-stress	Inter-unstress.
/p/	appetite	precipice	/b/	inhibit	halibut
/t/	status	limited	/d/	credit	prejudice
/k/	recognize	applicable	/g/	magazine	esophagus

Sample stimulus words by segmental environment

Before schwa	status
Before syllabic /l/	cattle
Before /ɚ/	butter
Before full vowel /i/	pretty
After /r/	forty
Phrasal (Across word boundary, before schwa)	write a letter

Materials 2

- 10 items in each of the 6 segmental environments x 6 phonemes x 2 stress environments, where possible within the lexicon
- Several combinations of factors don't (or rarely) occur in the inter-unstressed environment:

quadrupedal [kwaˈdɹupəɾˌl]

synodal [ˈsɪnəɾˌl]

And our students won't know these words anyway!

Subjects & Procedure

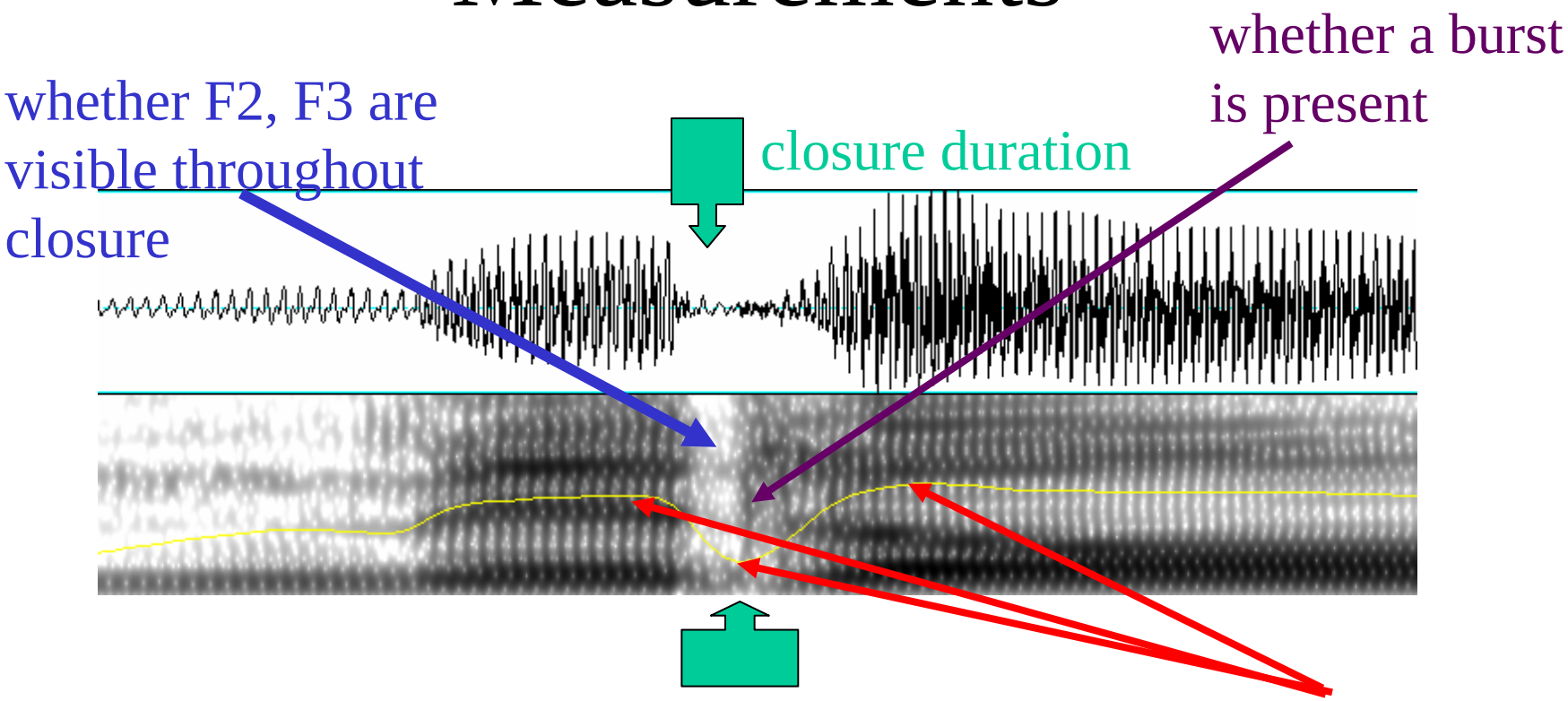
22 speakers recorded (4 analyzed so far)

- U of AZ undergraduates recruited from first year general education course
- End of semester effect?

3 speech styles recorded

- open conversation, with friend or family, by phone (in sound booth)
- story reading (2 targets/condition embedded in stories)
- isolated word list reading

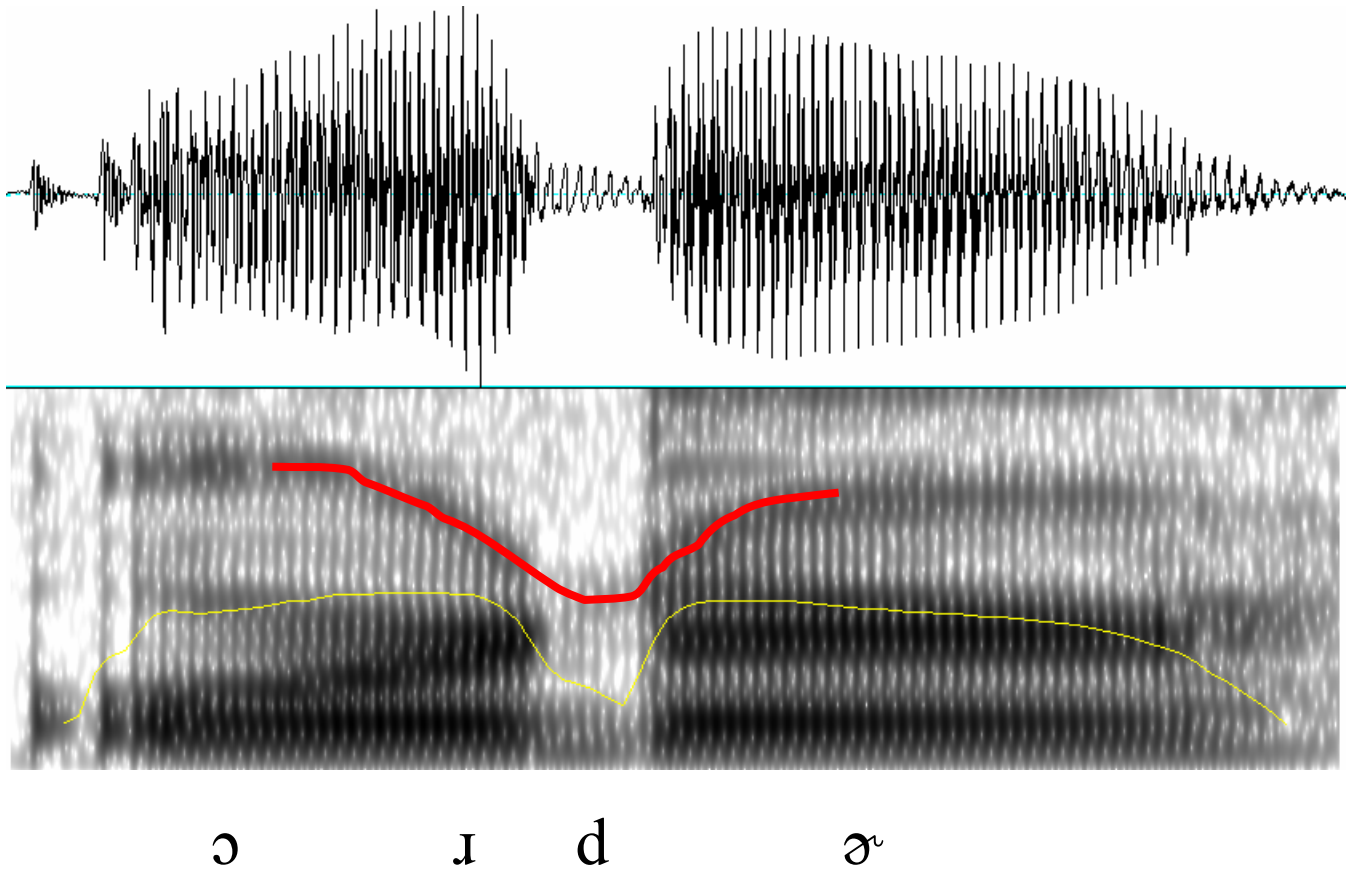
Measurements



If there is a voiceless part:

- dur. closure voicing
- VOT
- proportion voiceless

A surprising acoustic cue: F4

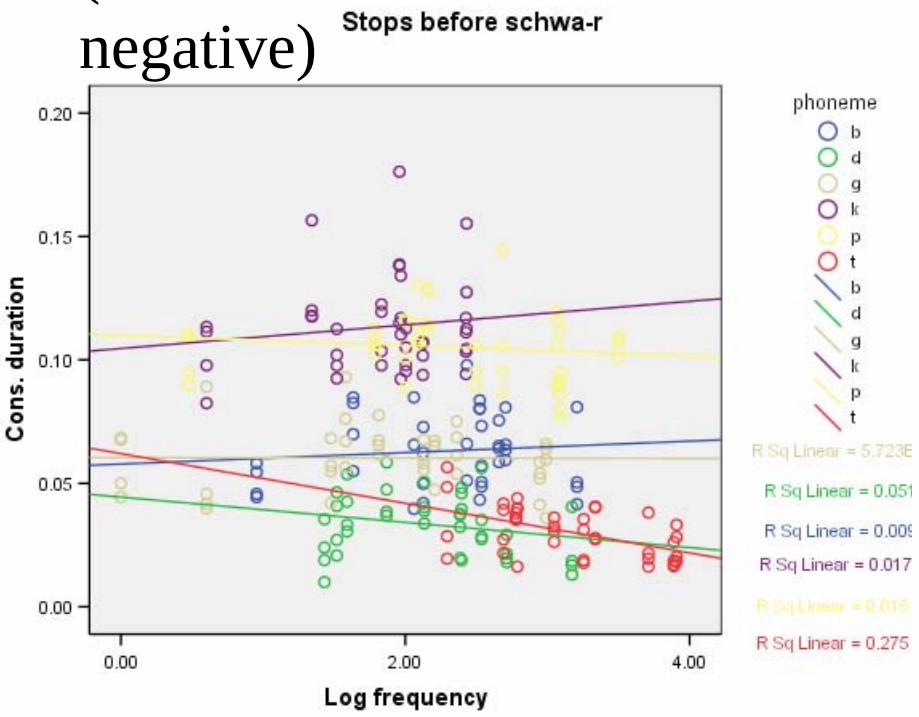


- Primarily around /r/'s
- F4 is hardly used for anything, except retro-flexes
- But this is timed to the flap, and occurs even for highly reduced tokens

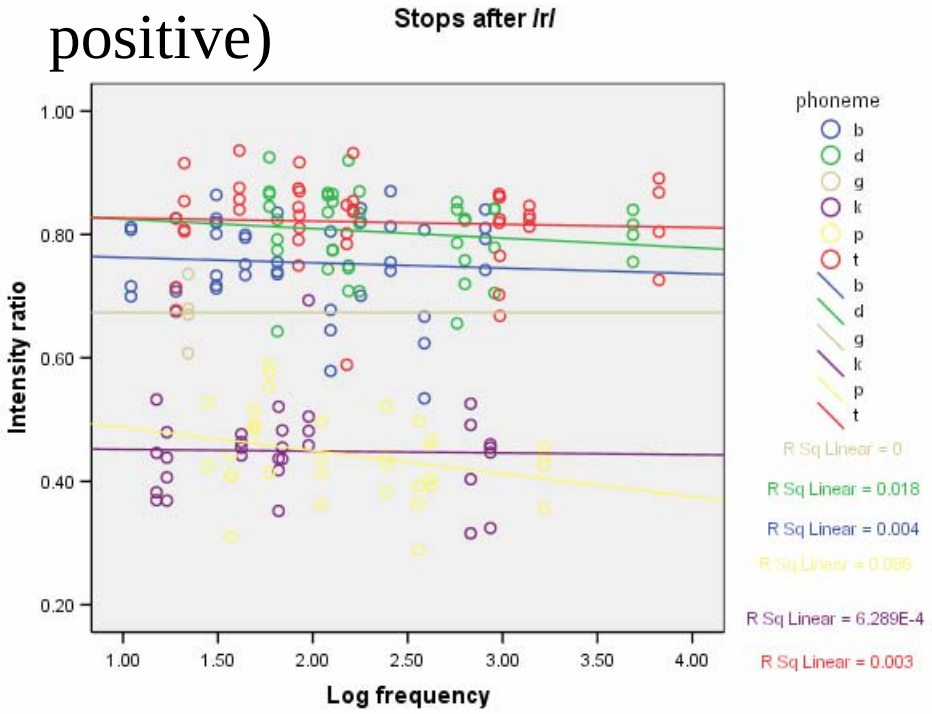
Results: Word frequency

- Frequencies from Celex and British Nat'l Corpus
- High frequency words not more reduced
- Patterson & Connine (2005): freq. effect on **whether** /t/ flaps

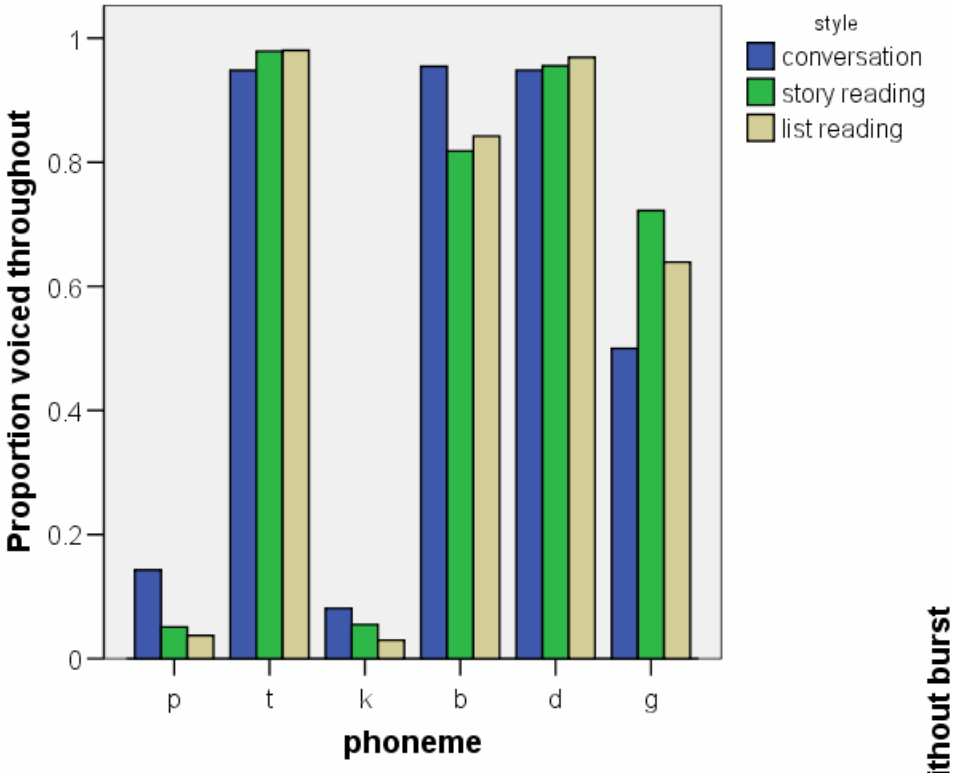
(should be negative)



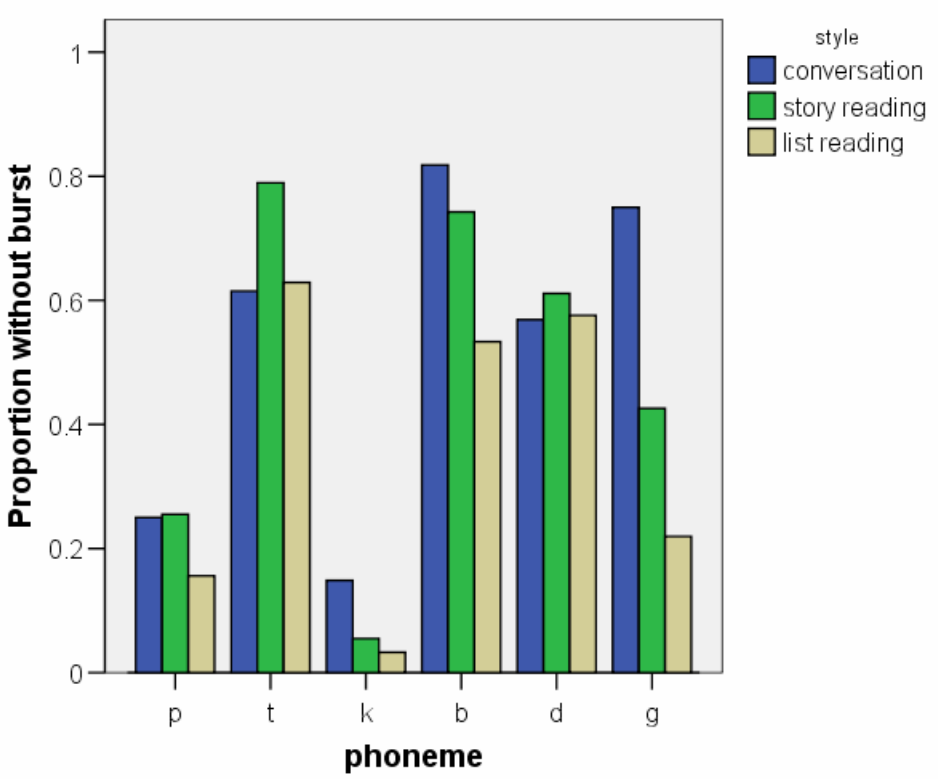
(should be positive)



Overall frequency of reduction

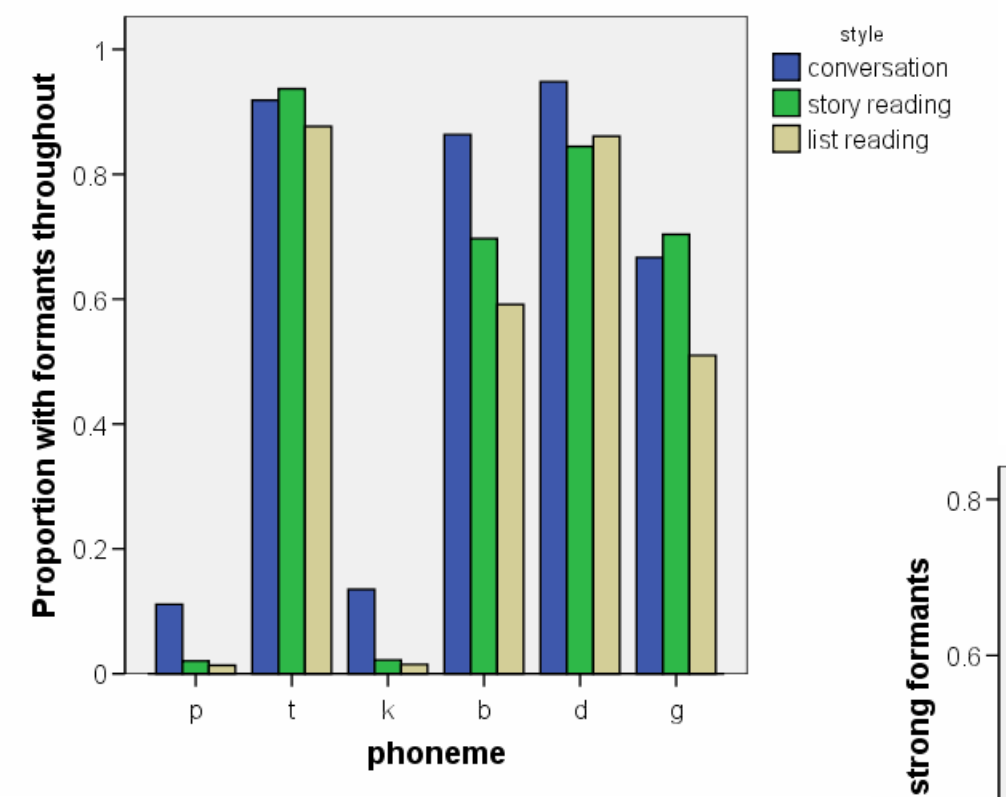


Clearly articulated stops would have bursts, and /p, k/ would be voiceless.

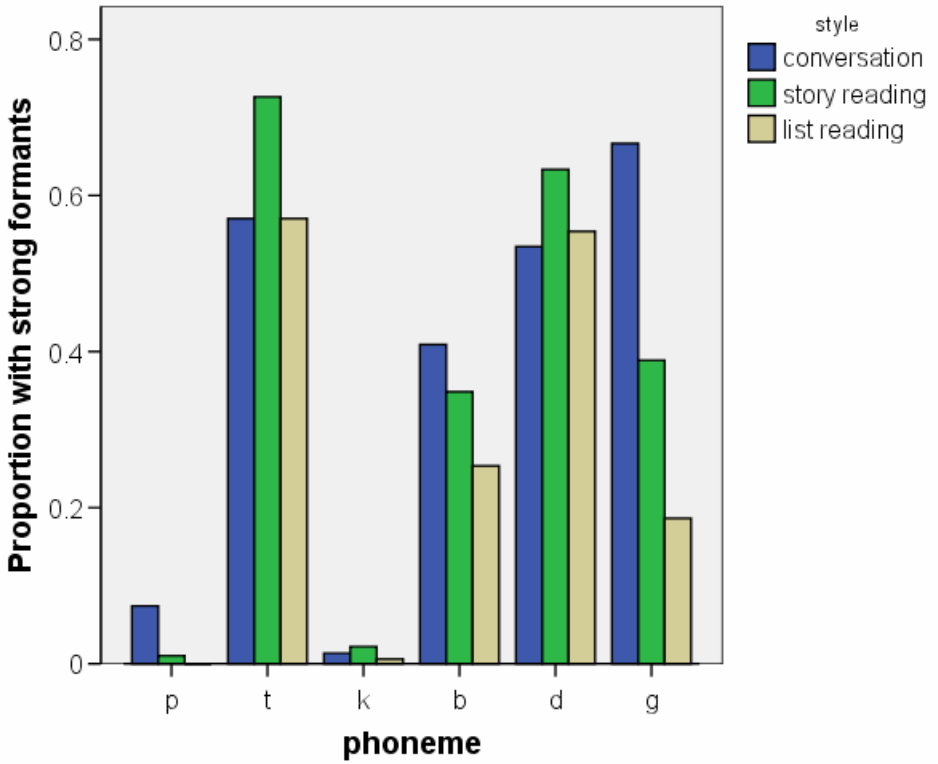


(For all measures except cons. dur., up is more approximant-like, down more stop-like.)

Frequency of reduction: formants

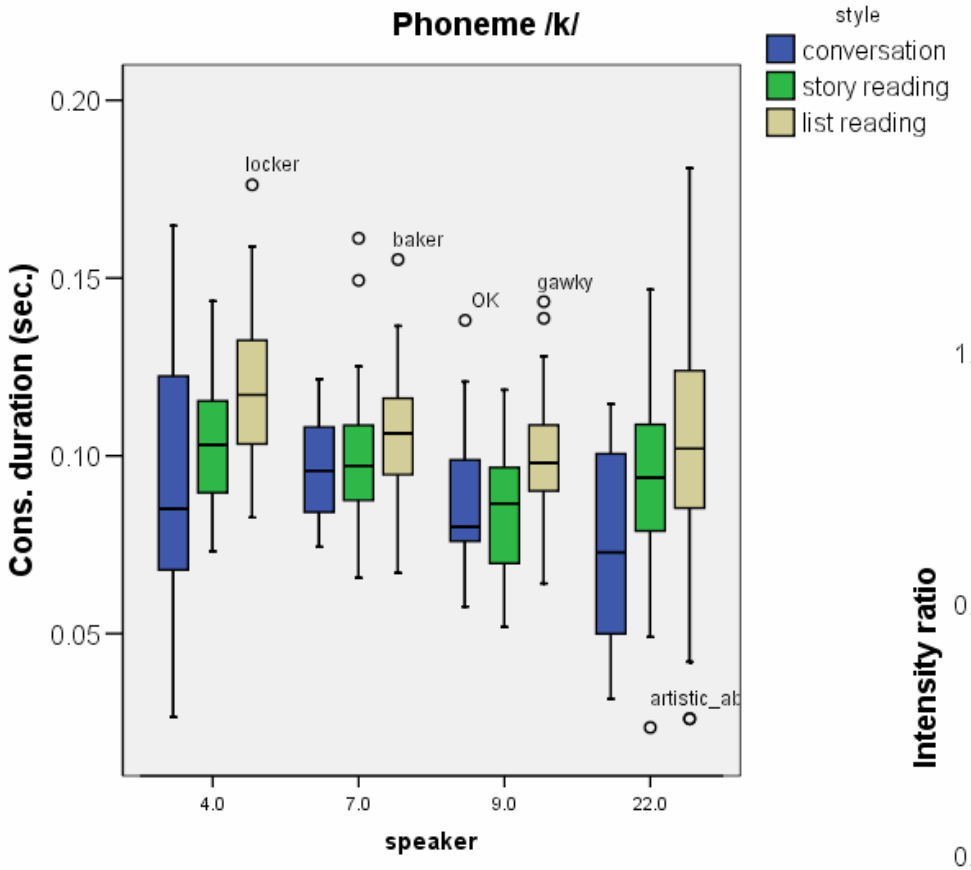


Clearly articulated stops wouldn't have formants.

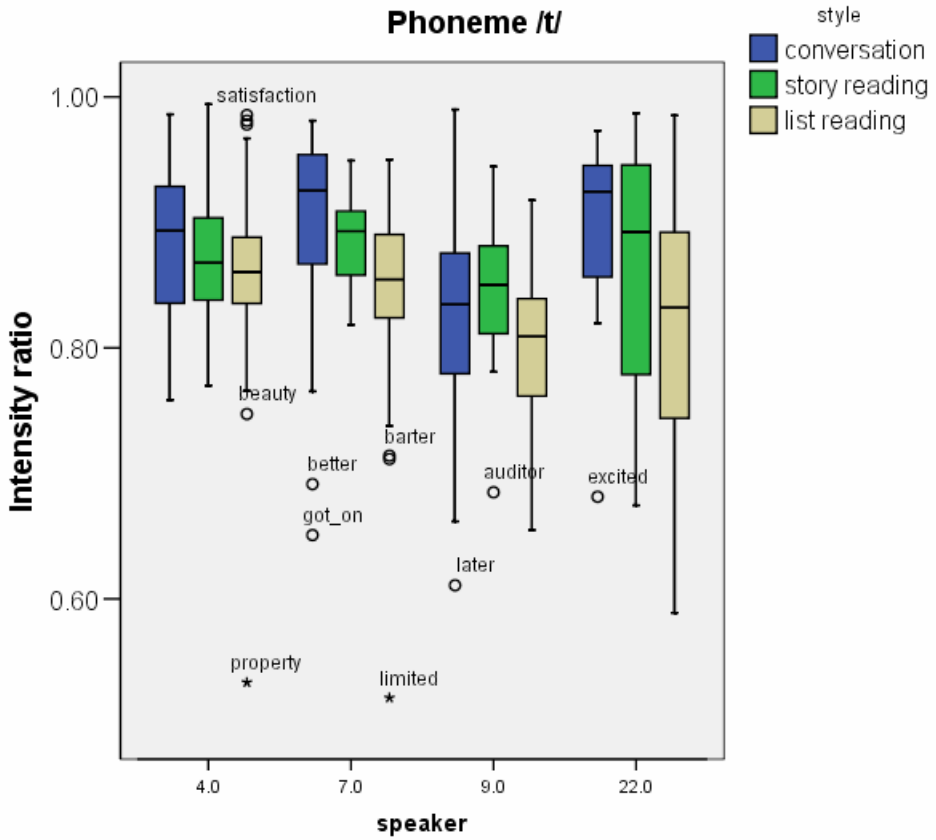


•Conclusion: There is a lot of reduction in the data, in all speech styles.

Degree of variability within speaker and phoneme



Substantial variability within speakers, some across speakers.



Some sign of more variability for casual speech, but unclear.

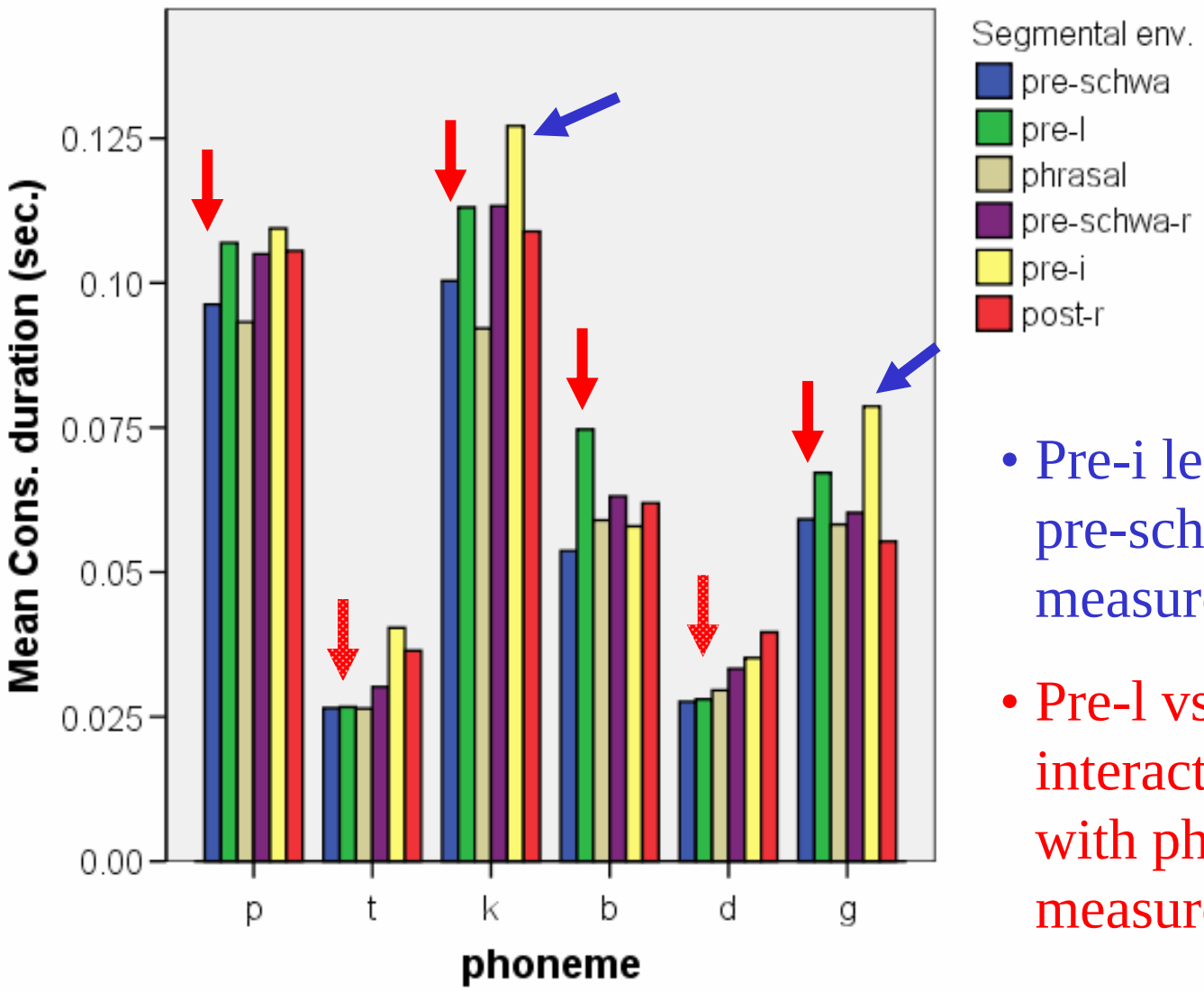
Effects of segmental environment

- Examined in word list reading, post-stress conditions only (full factorial design)
- Phoneme and segmental environment interact for most measures, but inconsistently
- Two interesting patterns:

➢ Stops appear to reduce less or differently before /i/ than elsewhere (because /i/ is peripheral?)

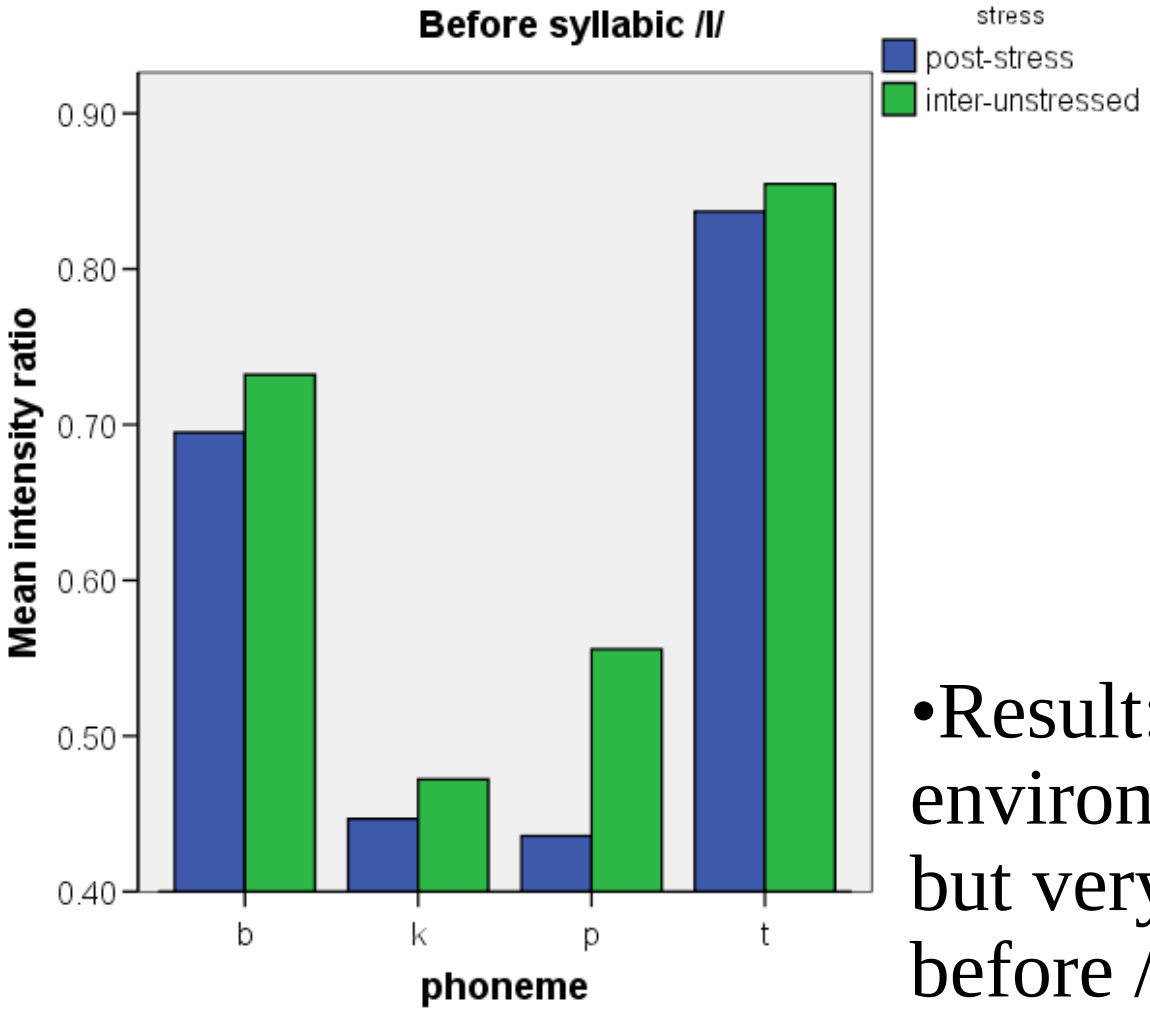
➢ /b, g/ appear to reduce less before [l̩] than elsewhere, while /t, d/ do not (shared pl. artic.)

Effects of segmental environment



- Pre-i less reduced than pre-schwa for 4/6 measures
- Pre-l vs. pre-schwa only interacts significantly with phoneme for this measure

Effects of stress environment



- All items are before unstressed syllables, but they can be either post-stress (e.g. 'city') or between unstressed (e.g. 'humanity')

•Result: inter-unstressed environment is more reduced, but very limited effect (sig. before /l/ by MANOVA)

Effects of speech style: deletions

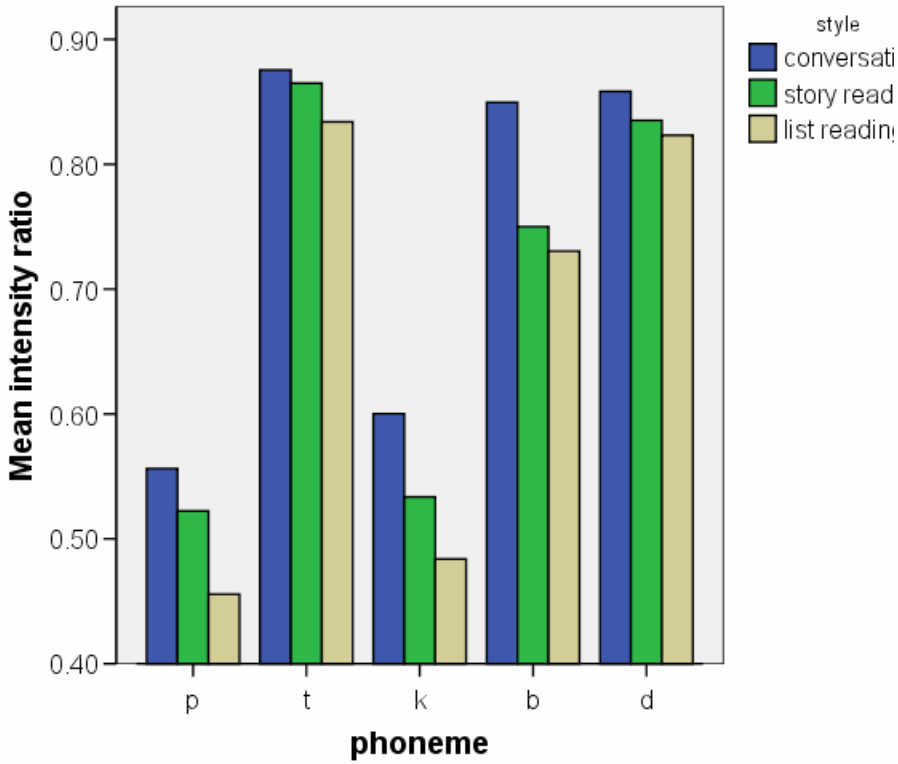
- In 36 out of 2735 stop tokens, the stop is so deleted we can't find any trace of it to measure.

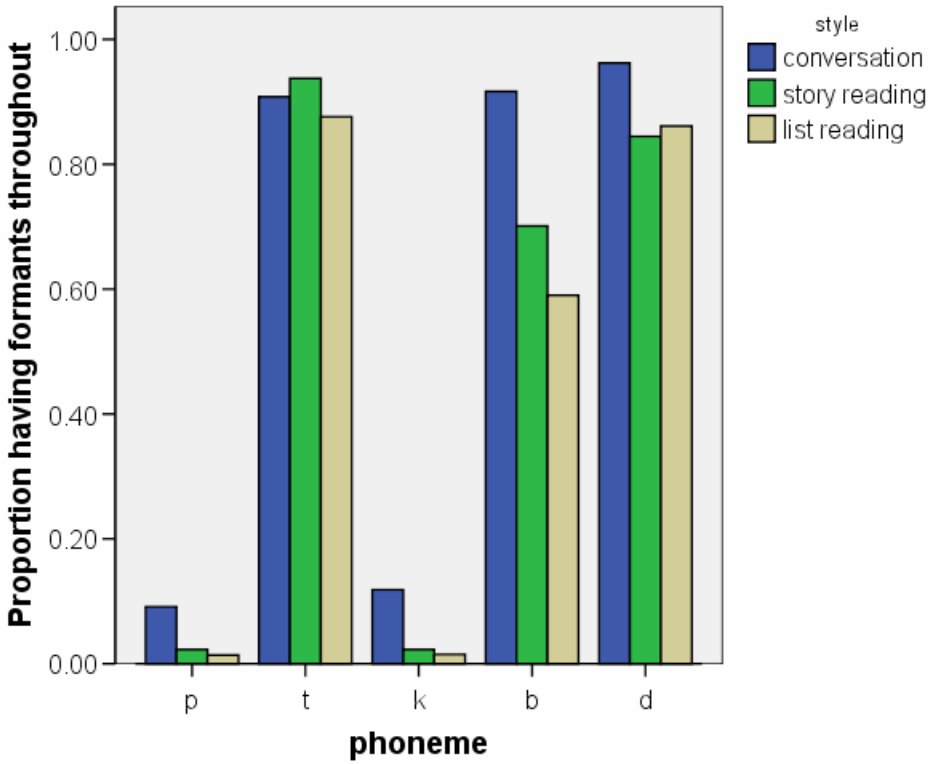
Number of tokens	Conver -sation	Story reading	List reading
deleted	23	11	2
not deleted	321	494	1884

•Complete deletions are rare (because we can label even highly reduced flaps), but significantly more likely in more casual speech.

Effects of speech style: reduction

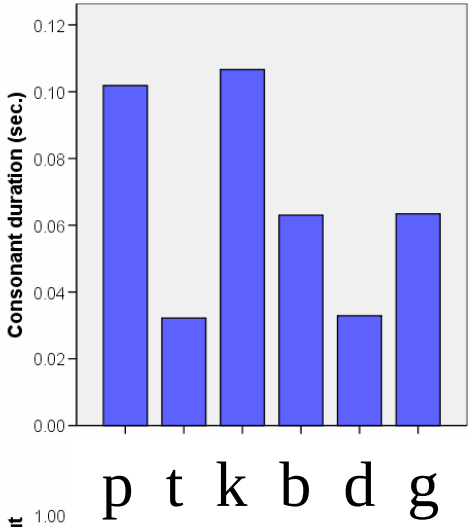
- More casual speech is significantly more reduced than careful speech on 5 of 6 measures.
- For some measures, there is less style effect for /t, d/, because of ceiling effects.

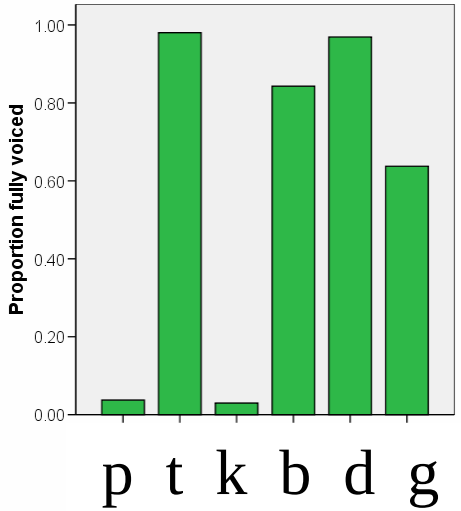


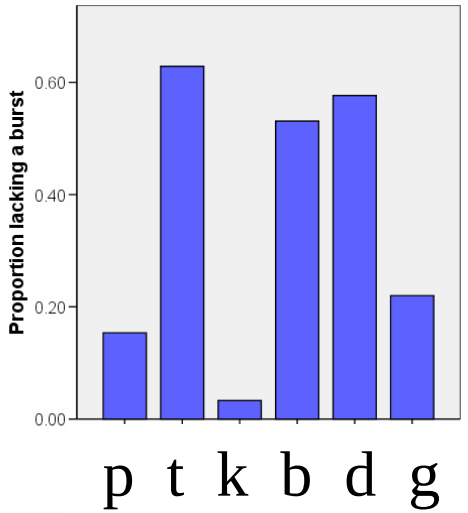


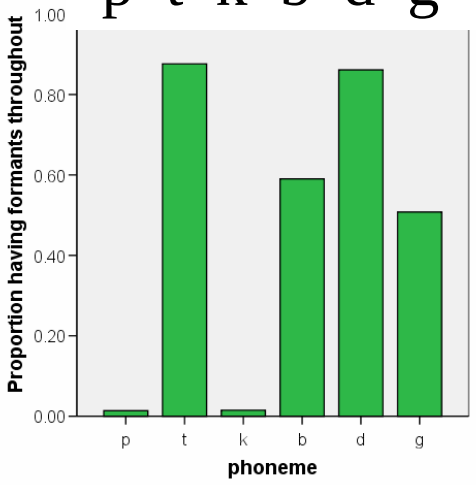
Effects of phoneme

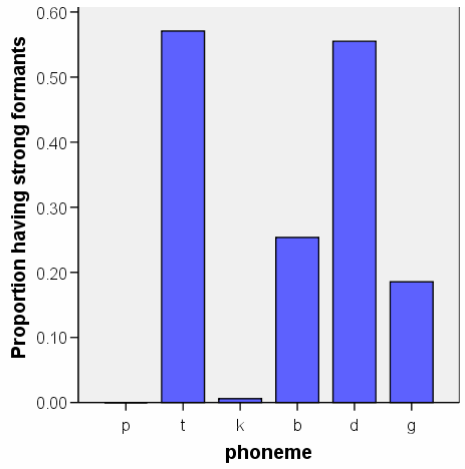
- /t/ behaves like a voiced stop (similar to /d/)
- /t, d/ are more approximant-like than /b, g/

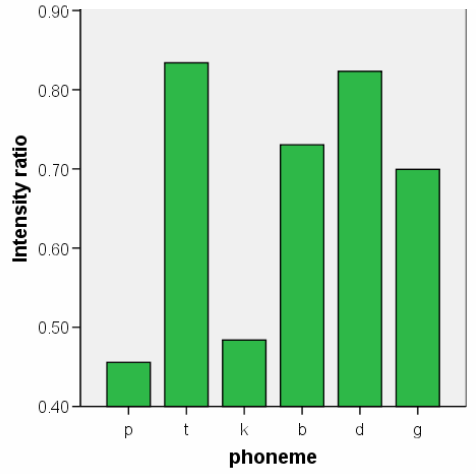












•/t, d/ are similar to each other

Is there phonology?

- Since /t/ behaves like a voiced stop, there must at least be a phonological process applying to /t/.
  - Patterson & Connine (2005) show it affects /t/ in almost all cases: close to categorical.
  - Our results show phonology puts /t/ in a different range from /p, k/: also categorical.
  - Effects of phoneme are far larger than any other systematic effect in the experiment: categorical, phonological effects may be larger than gradient phonetic ones.

Does phonology affect /d/ too?

- Results show /d/ does not differ from /t/: they are similarly approximant-like on a wide range of measures. /d/ and /t/ both differ from /b/ and /g/.

➢ Therefore, the same (or a similar) phonological process must apply to /d/, too.

➢ It does not apply to any of /p, k, b, g/.

➢ (We didn't measure prec. vowel duration. We show that a phonological process affects /t/ and /d/, not that the result is identical.)

Is this articulatorily based?

- It could just be that the tongue tip can move faster than other articulators, leading to faster gestures and/or gestural overlap, and this is a purely phonetic effect.
- But other languages, and even British English, don't have flapping!
- The phonological aspect could certainly be derived from the articulatory facts, but has to be phonologized: an abstract process.

So is phonology everything?

- No! There is considerable gradient phonetic variability as well.
- Systematic variability: more reduction in casual speech, more reduction in certain segmental environments (including articulatorily caused interaction), possibly more reduction for inter-unstressed stops and more for high frequency words.
- Substantial random variability as well.

Future research: production

- More speakers, especially less careful ones!
- More thorough investigation of systematic effects other than phoneme: speech rate, predictability, speaker's literacy level…
- Spanish bilingual speakers: Spanish systematically changes intervocalic "stops" to approximants. How will this affect speakers' reduction in English?

Future research: Perception and processing

- Does reduction from flap to approximant affect recognition of the phoneme?
- Of the word?
- Are you slower to recognize a reduced form because acoustic cues are weaker, or faster because it's a common pronunciation?
- Does preceding environment speech style affect this?

Perception and processing: planned experiments

- Phoneme monitoring, lexical decision, and cross-modal identity priming for /d, g/
- After no environment, fast casual speech environment, or slow careful speech environment.
- Also a perception experiment on what the acoustic cues to highly reduced flaps are: intensity dip, F4 drop??? How do listeners hear these at all, and so clearly?

Conclusions: summary

- Intervocalic stops in American English demonstrate a categorical, phonological, abstract effect on /t, d/ (flapping), as well as both systematic and random phonetic variability.
- Casual speech is more reduced than formal. Stress environment and word frequency have (thus far) limited effects.
- We understand each other despite a great deal of several types of variability.