

# Phonetic cues can be reduced in response to minimal pair competition

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Also vital in this research:



Becky Sharp

# Road Map

- Lexical competition and hyperarticulation
- What exactly is hyperarticulation?
- Phonetic reduction as contrast enhancement
- Theoretical implications

# **COMPETITION & HYPERARTICULATION**

# Lexical-phonological competition

- Phonologically related words compete
  - neighborhood effects
  - cue-defined lexical minimal pairs
- Minimal pair competition effects
  - targeted hyperarticulation of cue of difference

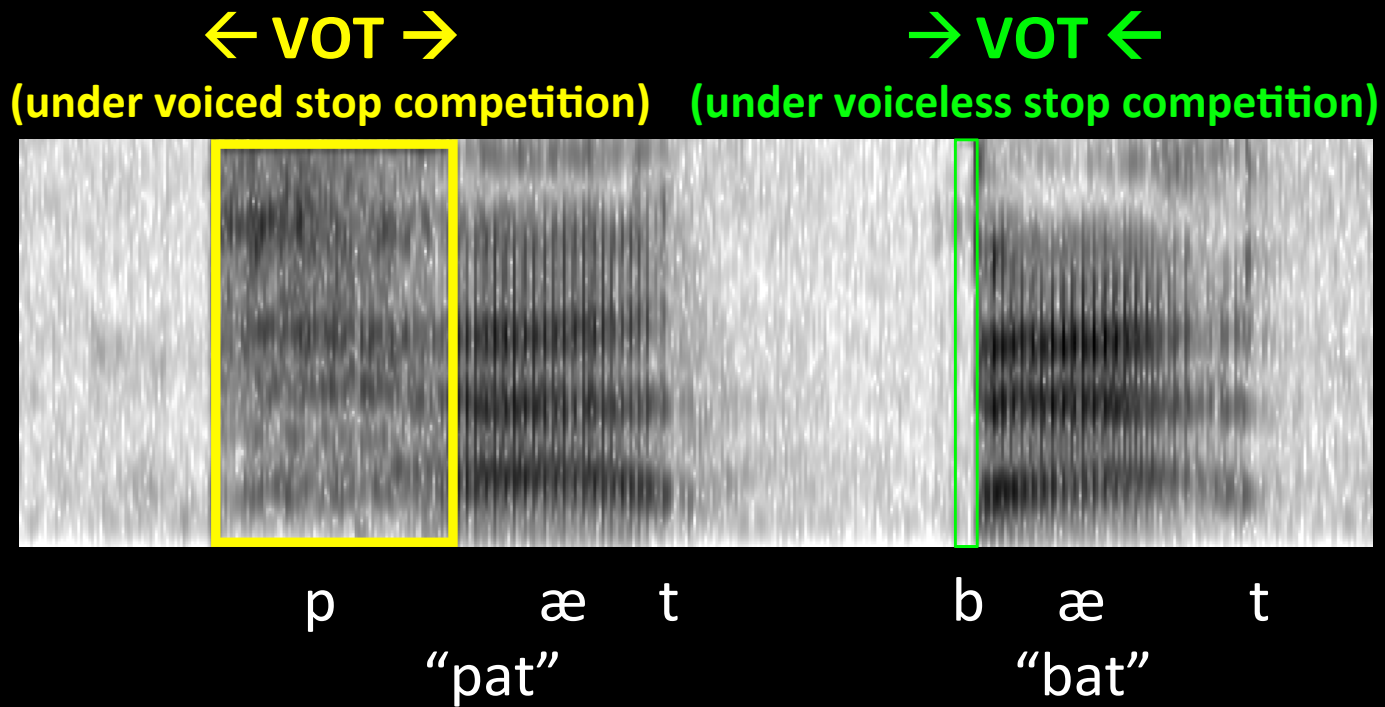
# Hyperarticulation

- What *is* hyperarticulation?
  - clear/slow/careful speech
  - contrast enhancement
- Can contrastive hyperarticulation come in the form of phonetic reduction?
  - shorter durations
  - less extreme articulatory gestures

# Contrastive Hypothesis

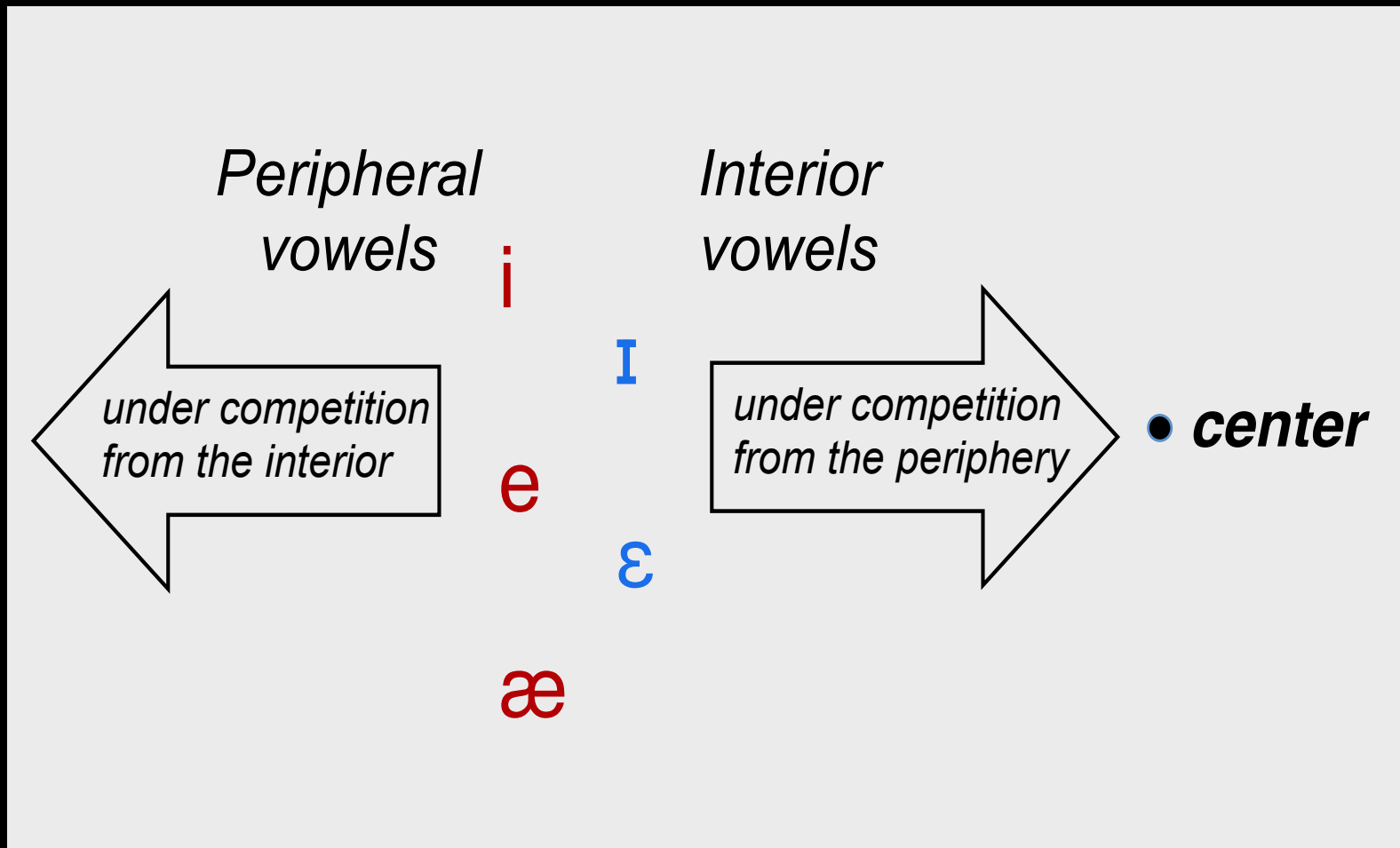
- Hypothesis:
  - lexical minimal pairs are, on average, articulated such that phonetic contrast is enhanced

# Voice onset time





# Euclidean distance from vowel space center



# Contrastive Hypothesis

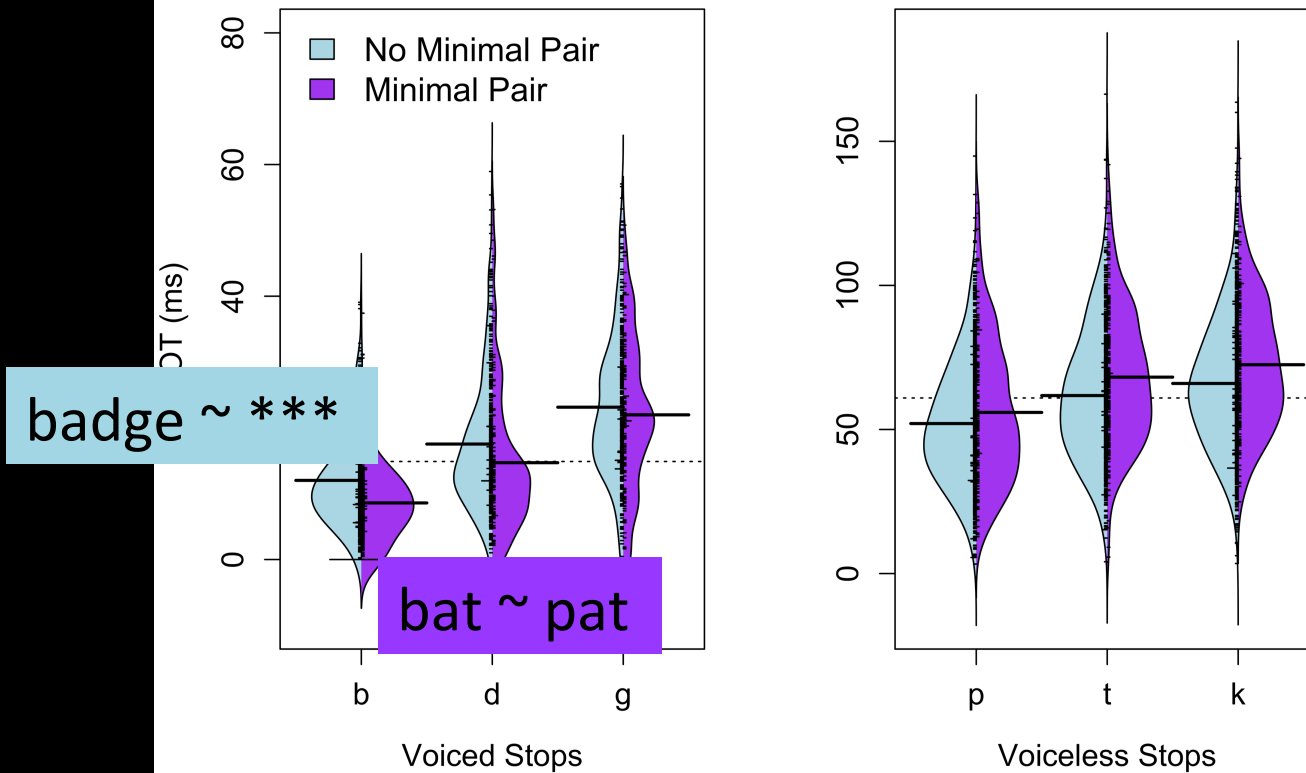
- Word-initial VOT:
  - longer VOT in voiceless stops with voiced stop minimal pair competitors
  - shorter VOT in voiced stops with voiceless stop minimal pair competitors
- Euclidean distance from vowel space center:
  - greater distance from center in peripheral vowels with interior vowel competitors
  - lesser distance from center in interior vowels with peripheral vowel competitors

**CONTRASTIVE REDUCTION OF  
TWO PHONETIC CUES IN  
CONVERSATIONAL ENGLISH**

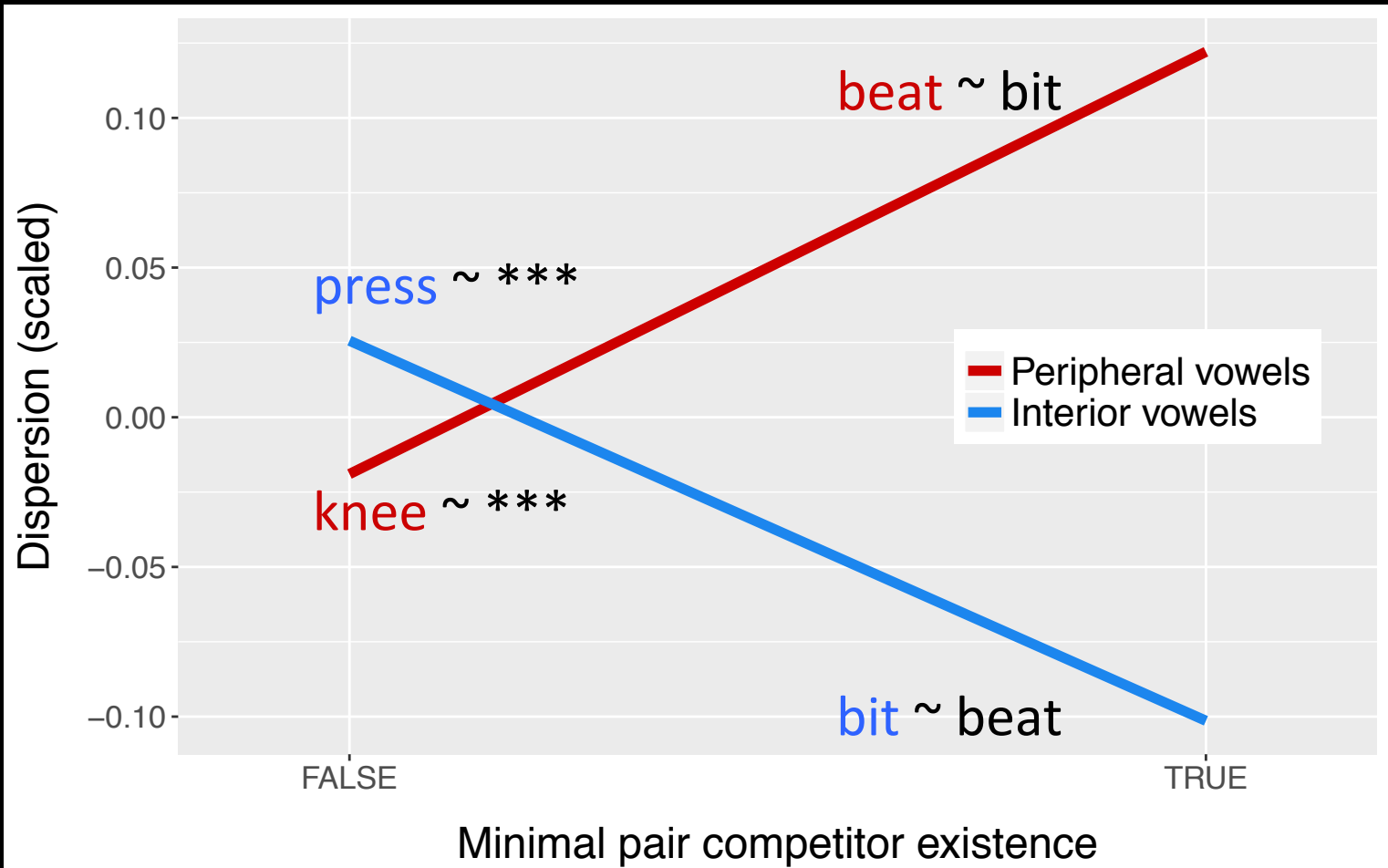
# Conversational speech data

- Buckeye Corpus of Conversational Speech
- Content words only (N, V, Adj, Adv)
- Word-initial stop voice onset time (VOT)
  - one- and two-syllable words
- Stressed vowel F1-F2 Euclidean distance from vowel-space center
  - one-syllable words only

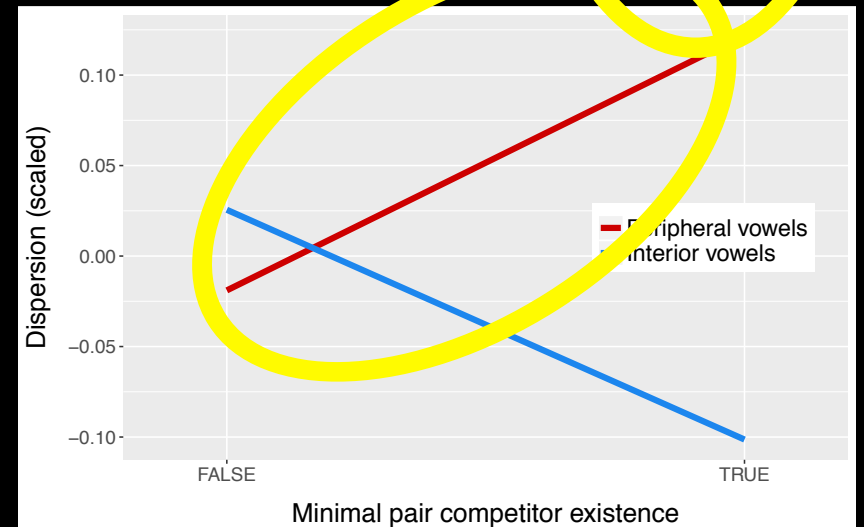
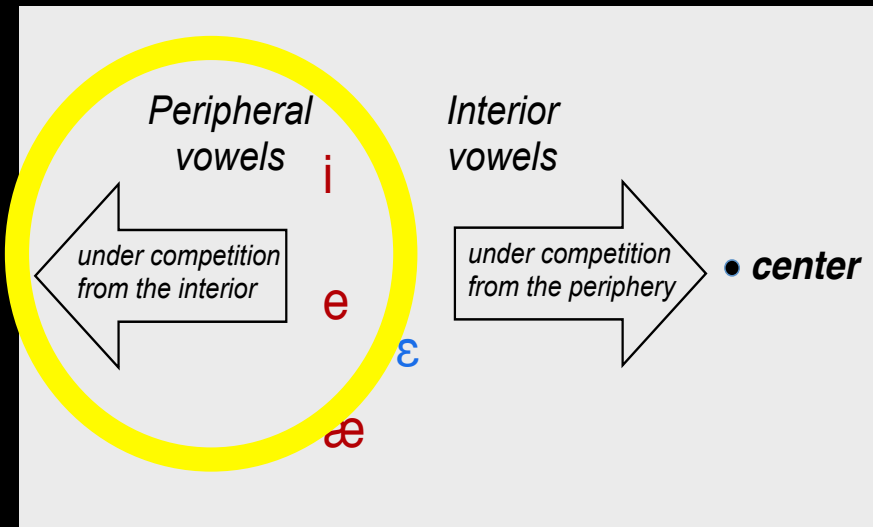
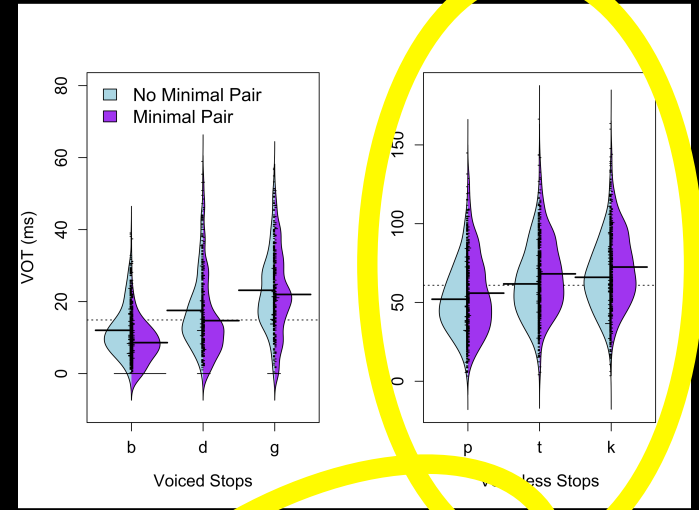
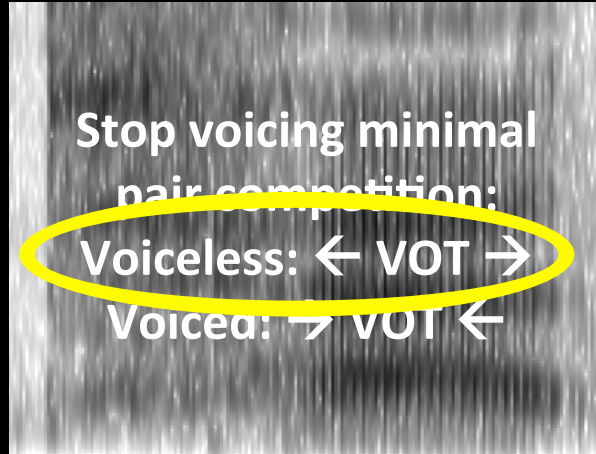
# Results: VOT



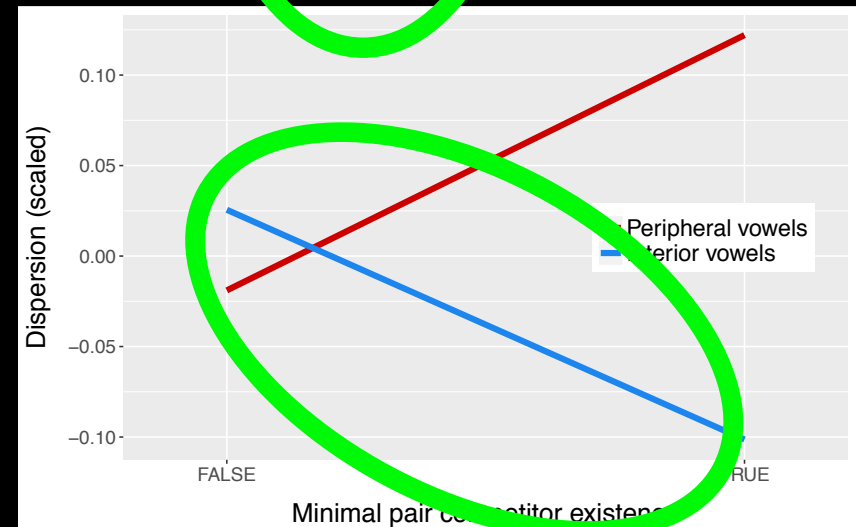
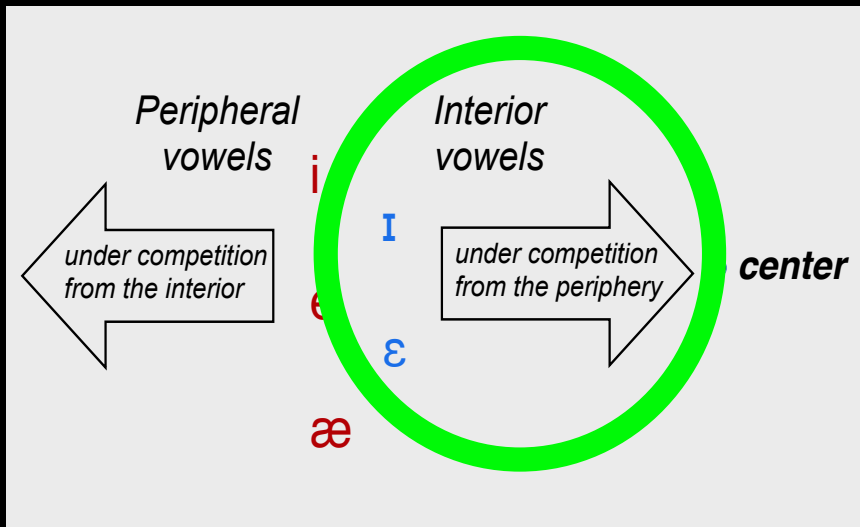
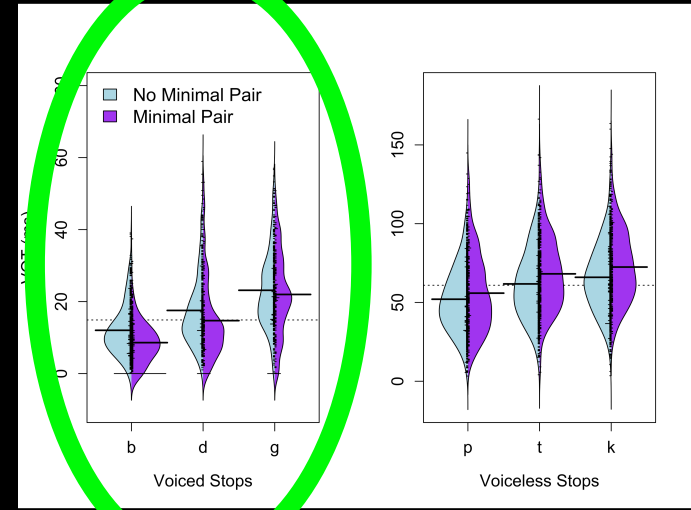
# Results: Vowel distance from center



# Results: Enhancement



# Results: Reduction





# THEORETICAL IMPLICATIONS

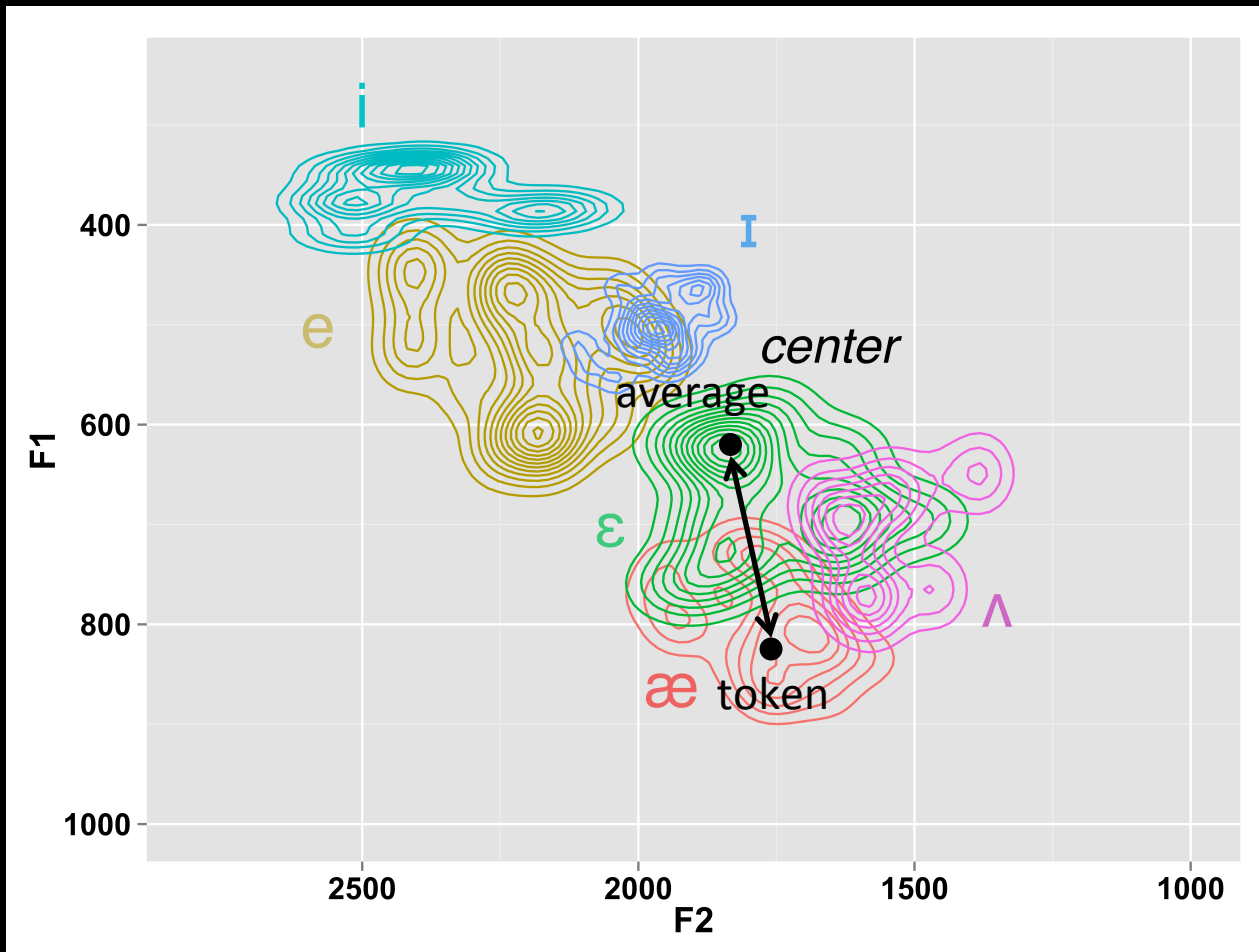
# Contrast enhancement

- Contrastive hyperarticulation of phonetic cues
  - cue-defined minimal pairs
- Realized as phonetic enhancement AND reduction

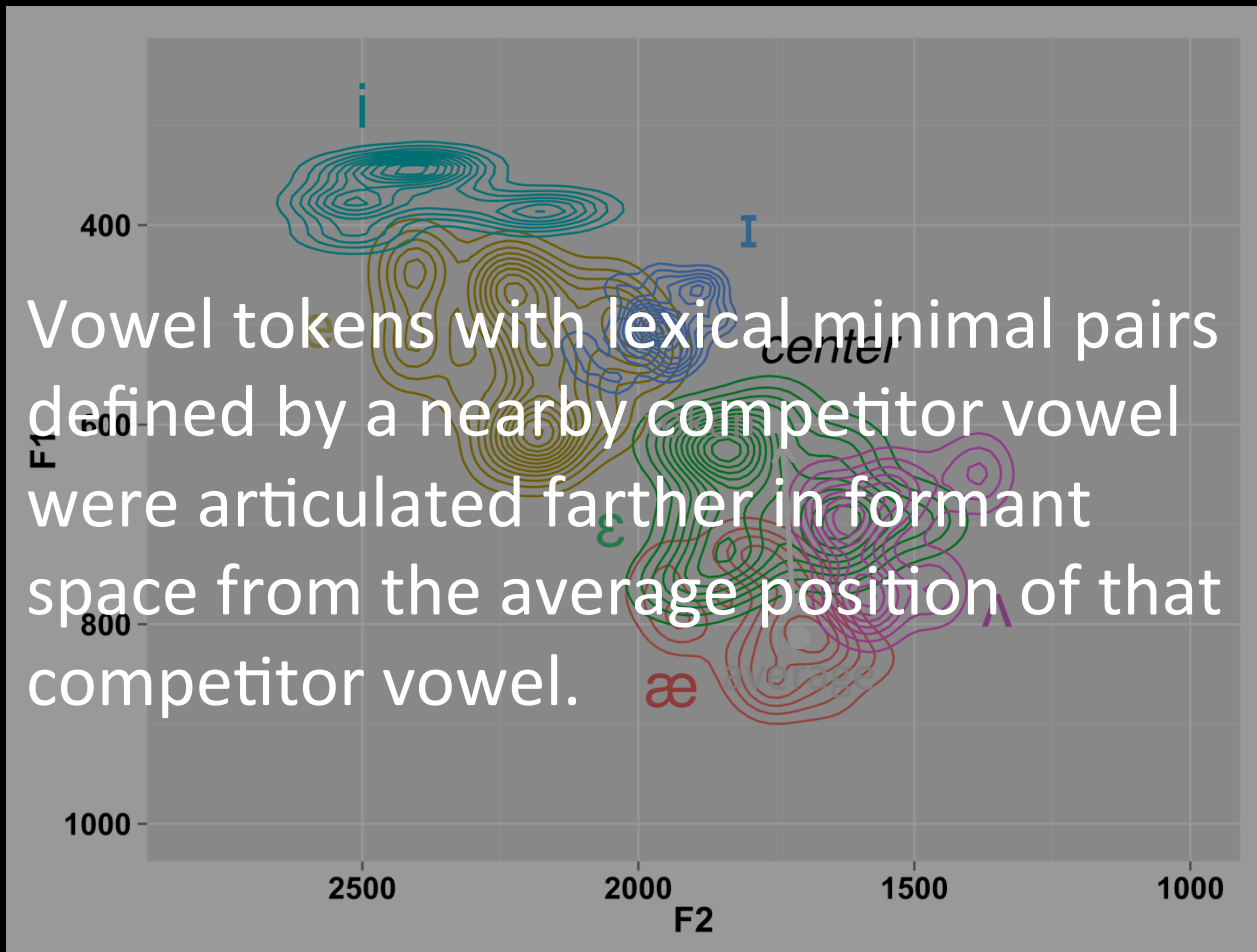
VOT: P**A**T ←————→ B**A**T

Formants: P**A**T ←————→ P**E**T

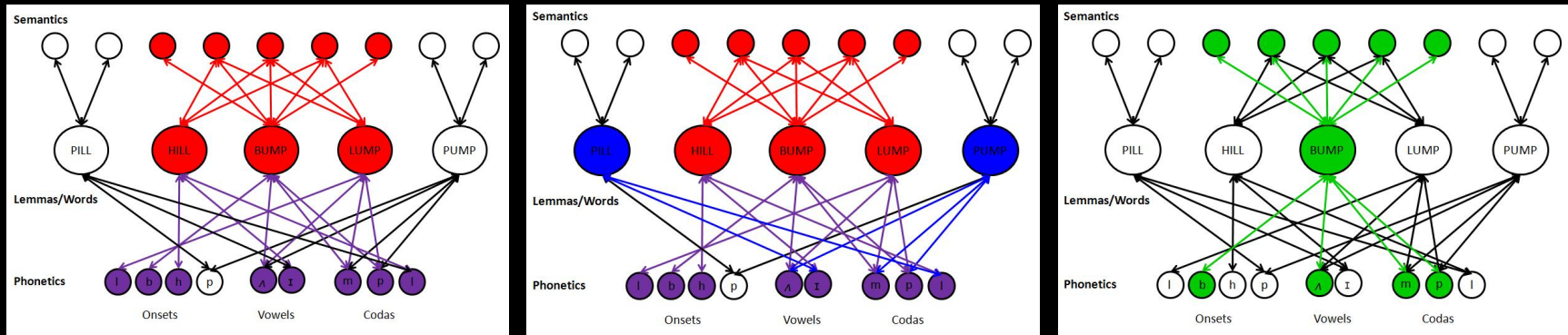
# Euclidean distance between vowels



# Euclidean distance between vowels



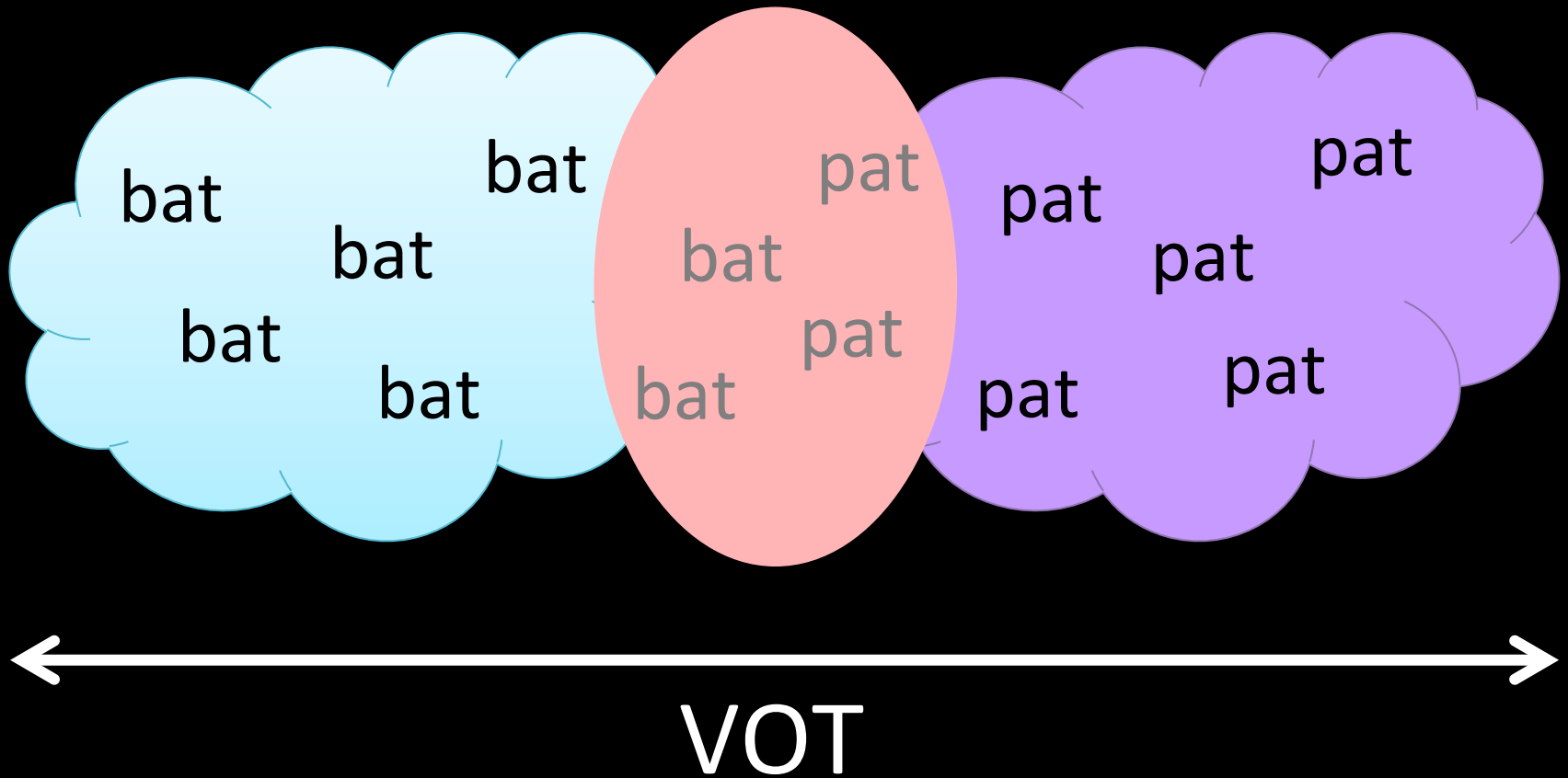
# Production-internal activation models



This approach must account for cue-specific *contrast-enhancement*, whether in the form of phonetic enhancement or phonetic reduction

Illustration based on Dell's interactive model (as presented in Martinet et al. 1994)  
Images from wikiversity.org, posted by Ben Parker

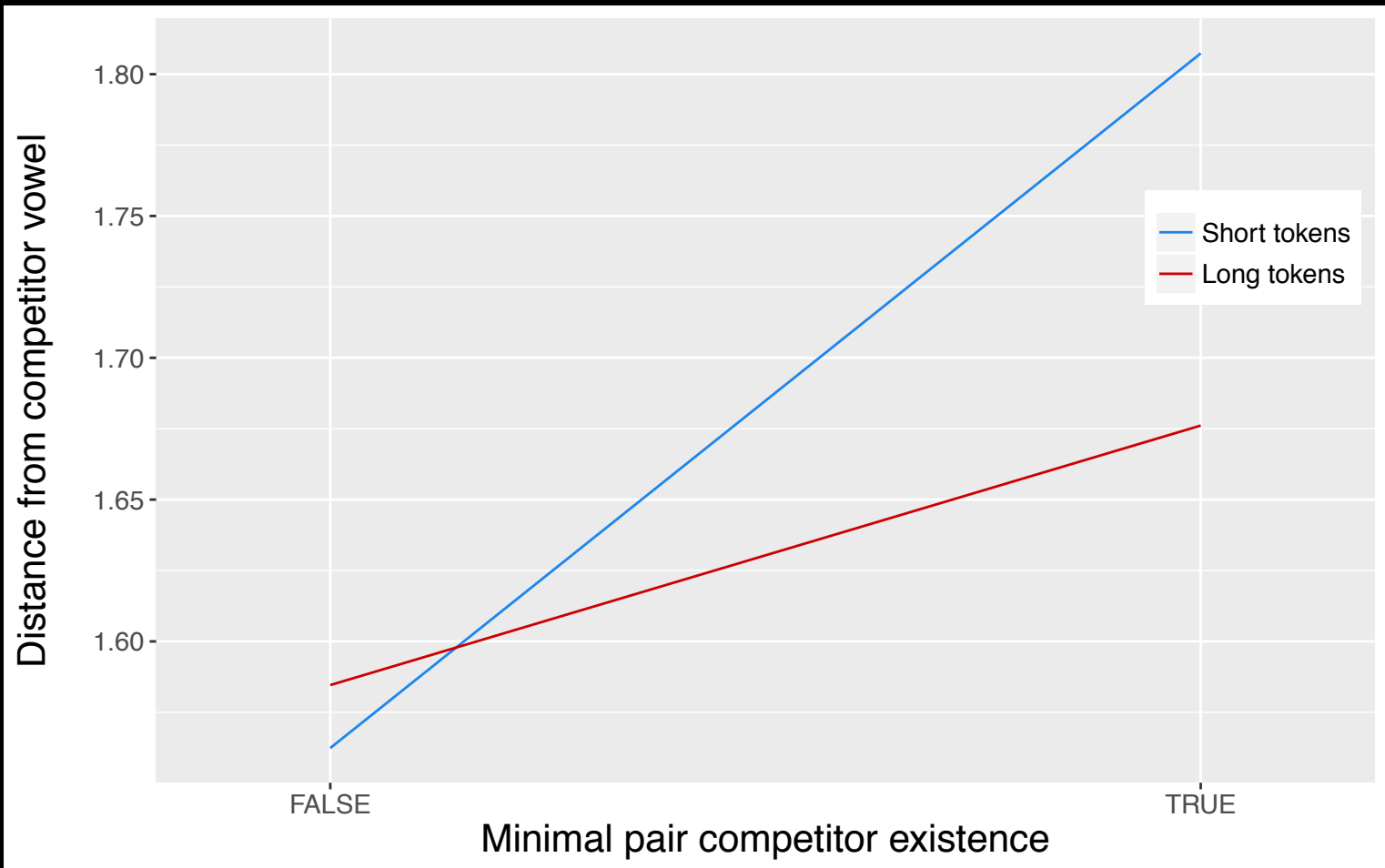
# Models that consider perception



# Effects of speech style?

- We find these effects robustly in reduced speech
- Evidence of competition-associated phonetic reduction not reliable in laboratory studies
  - (see, e.g., Ohala, 1994; Goldrick et al., 2013)
- Could contrastive hyperarticulation be most evident in more casual (reduced) speech?

# Effects of speech style?





# Conclusion:

## Reduction is a viable strategy

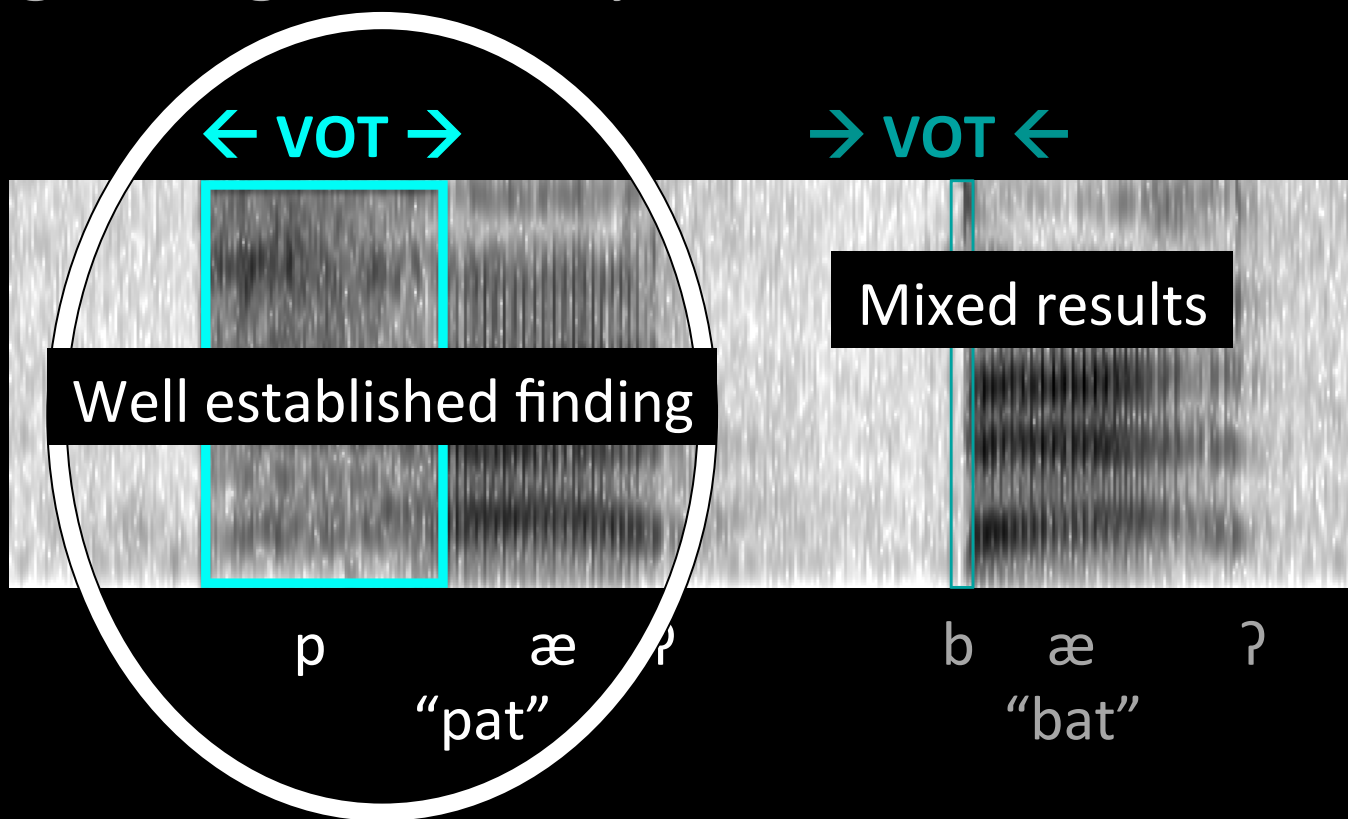
- In conversational speech, reduction is a viable strategy for achieving lexical contrast
  - possible more so in more “reduced” speech
- These results also found in lab-elicited speech, but not consistently
  - clarifications of misheard speech
  - communication tasks with direct minimal pair competition
- Suggests importance of communication

# THANK YOU!

(citations and references available upon request)

# Contrast enhancement

- Ought to go two ways...



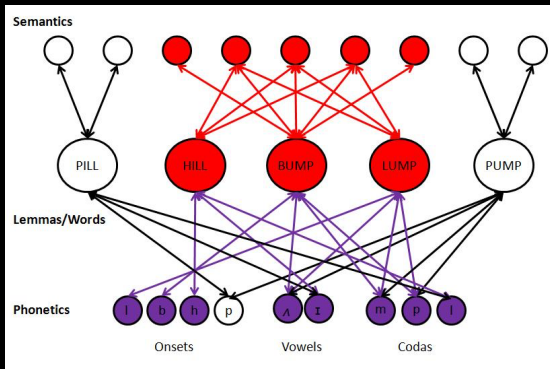
# Lexical-phonological competition

- Phonologically related words compete
  - lexical-phonological neighborhood density
- Evidence in production and perception studies
  - faster initiation of articulation
  - slower lexical decision
  - rate of speech errors

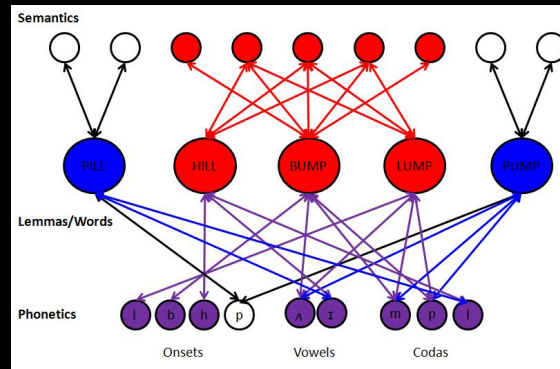
# Hyperarticulation

- Competition-associated hyperarticulation
  - enhanced phonetic durations
  - enhanced articulatory gestures
- Evidence from laboratory studies (English)
  - longer VOT in voiceless stops
  - vowel space expansion (but see Gahl, 2015)
  - OTHER STUFF

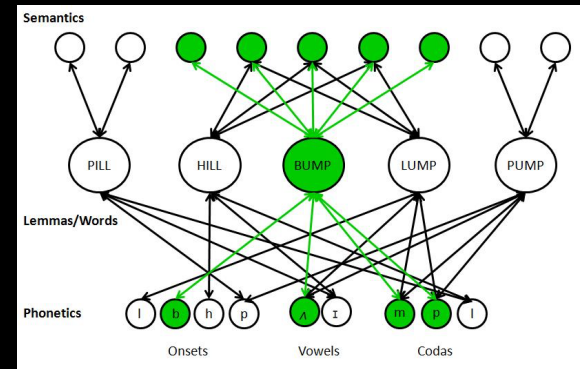
# Production-internal activation models



Activation spreads to related nodes, and cascades from layer to layer



Feedback from subsequent layers activates neighbors at preceding layers

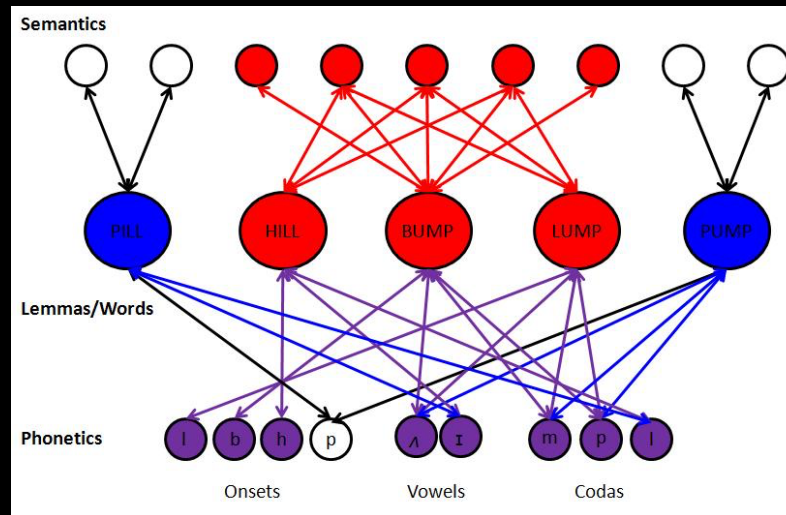


Selection of appropriate elements based on activation level. Most active bits selected.

Illustration based on Dell's interactive model (as presented in Martinet et al. 1994)  
Images from wikiversity.org, posted by Ben Parker

# Competition-driven reduction in activation models?

- Feature labels, negative activation / inhibition



Feature labels such as “short VOT” or “central vowel” could accompany segment nodes or be represented in an additional layer

Competition within specific features or cues could interact to enhance contrast. For example, the VOT feature for /b/ could be inhibited under competition from /p/

Whatever the strategy, this approach must account for cue-specific *contrast-enhancement*, whether in the form of “hyper-articulation” or “hypo-articulation”

# Models that consider perception

- Production-perception loop
  - Exemplar approach
  - Ambiguous tokens are less accurately or consistently stored in long-term memory
    - therefor less likely to contribute to exemplar cloud
    - can lead to exemplar clouds shifting apart over time
  - Specifically predicts importance of lexical minimal pairs, and contrast enhancement via reduction
  - This process is passive and automatic



# Models that consider perception

- Listener-oriented models
  - Speakers implicitly aware of potential perceptual difficulty
  - Speakers hyperarticulate to promote contrast
    - likely as a trade-off between communicative efficiency and articulatory effort
  - Speakers are sensitive to whether their efforts are effective, and hyperarticulate more or less accordingly
  - This process may be actively controlled