SyRG Review, Dec 18 2003

Gestural Syllable Position Effects in American English, 1995

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Paper Summary

- Goal
  - A theory of syllabification and coarticulation
- Approach
  - Framework of Articulatory Phonology
- Claim
  - Syllable structure emerges from gesture coordination
  - Analyze three cases to support thesis
  - Full proof is a bigger task

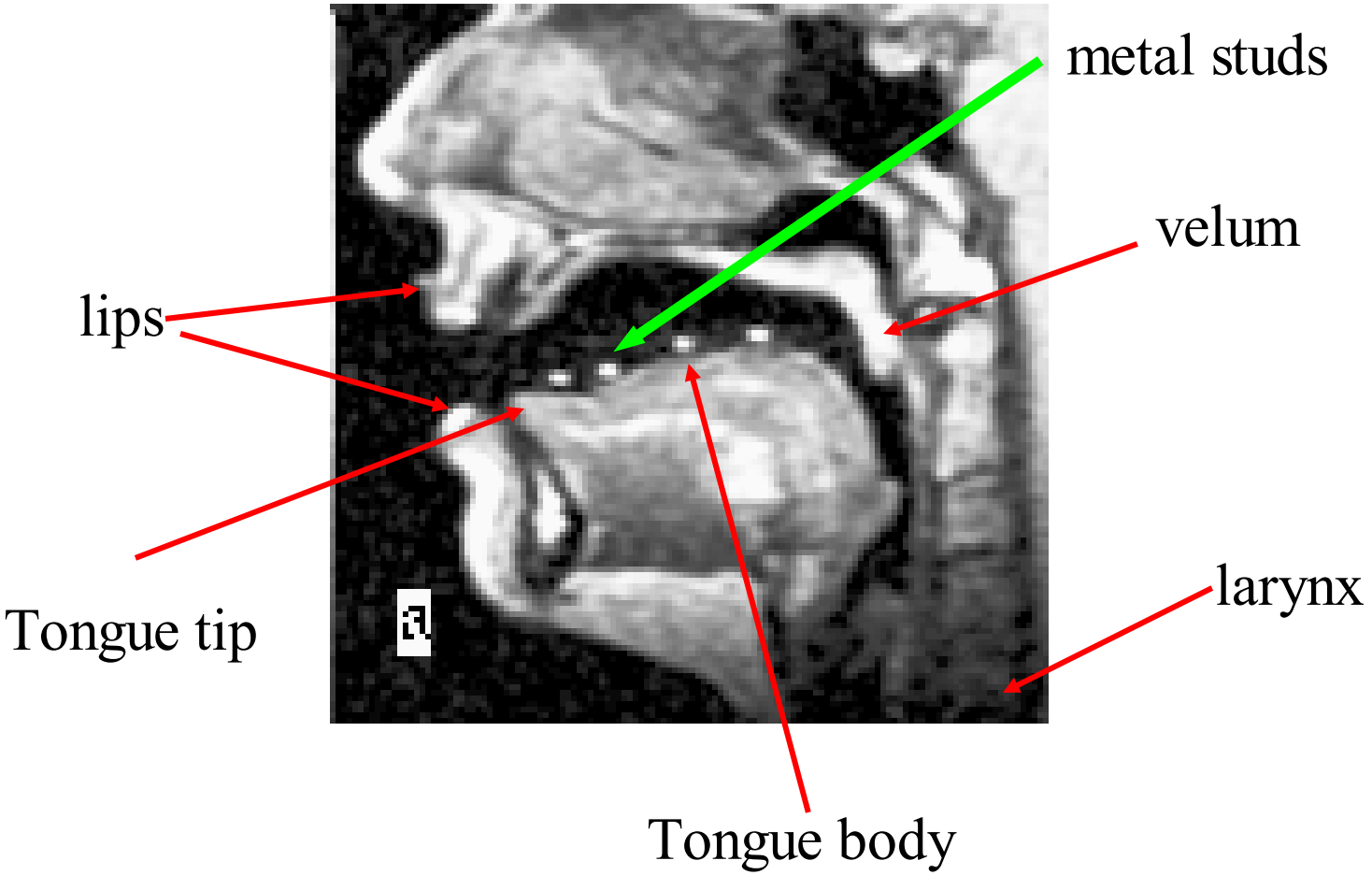
Phenomena Studied

- Compare timing of related gestures
  - Light /L/ versus dark /L/
    - i.e. Syllable initial vs. final
    - 'leap' / 'peel'
  - Initial versus final nasal consonants
    - /M, N, NG/
    - 'see more' / 'seem ore'
  - Data collected with x-ray microbeam
    - Measure height of tongue tip and dorsum

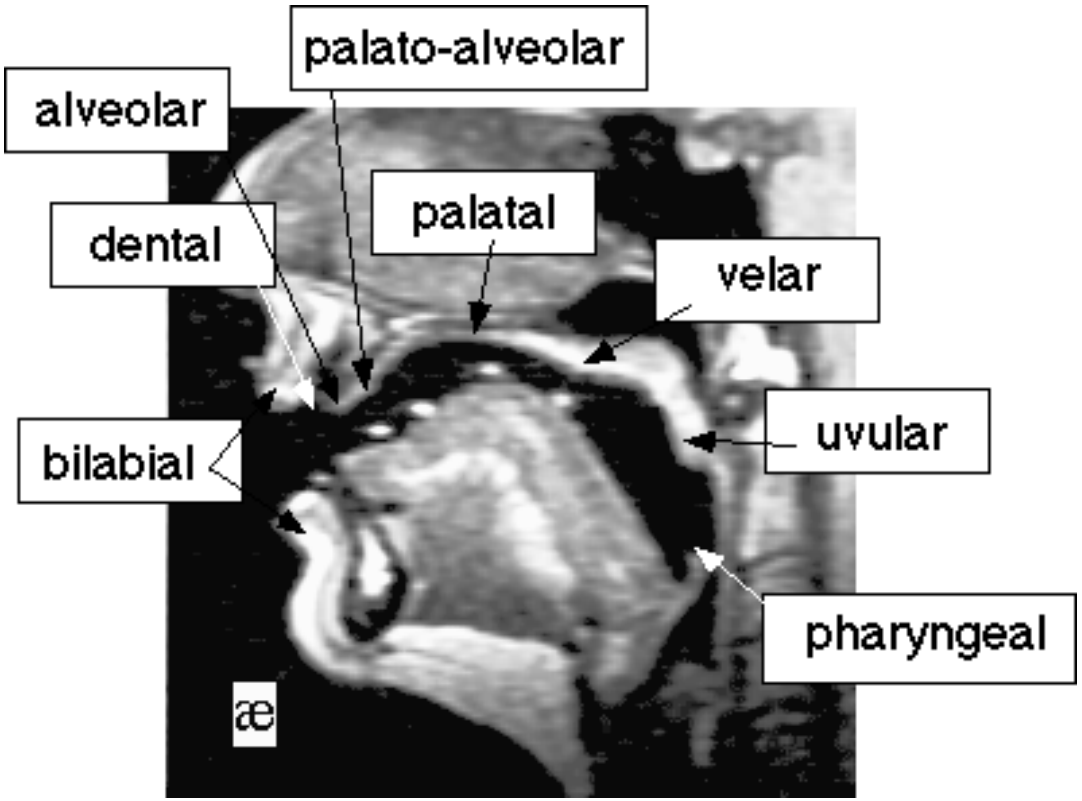
Articulatory Phonology

- Architecture of Framework
  - Basic unit – vocal tract gestures
  - Gesture – formation of constriction
  - Lexical unit – organization of gestures
  - Subsystems – five tract variables
    - Lips, tongue tip, tongue body, velar opening glottal opening
  - Gestural constellation – group of related gestures

Vocal Tract Organs



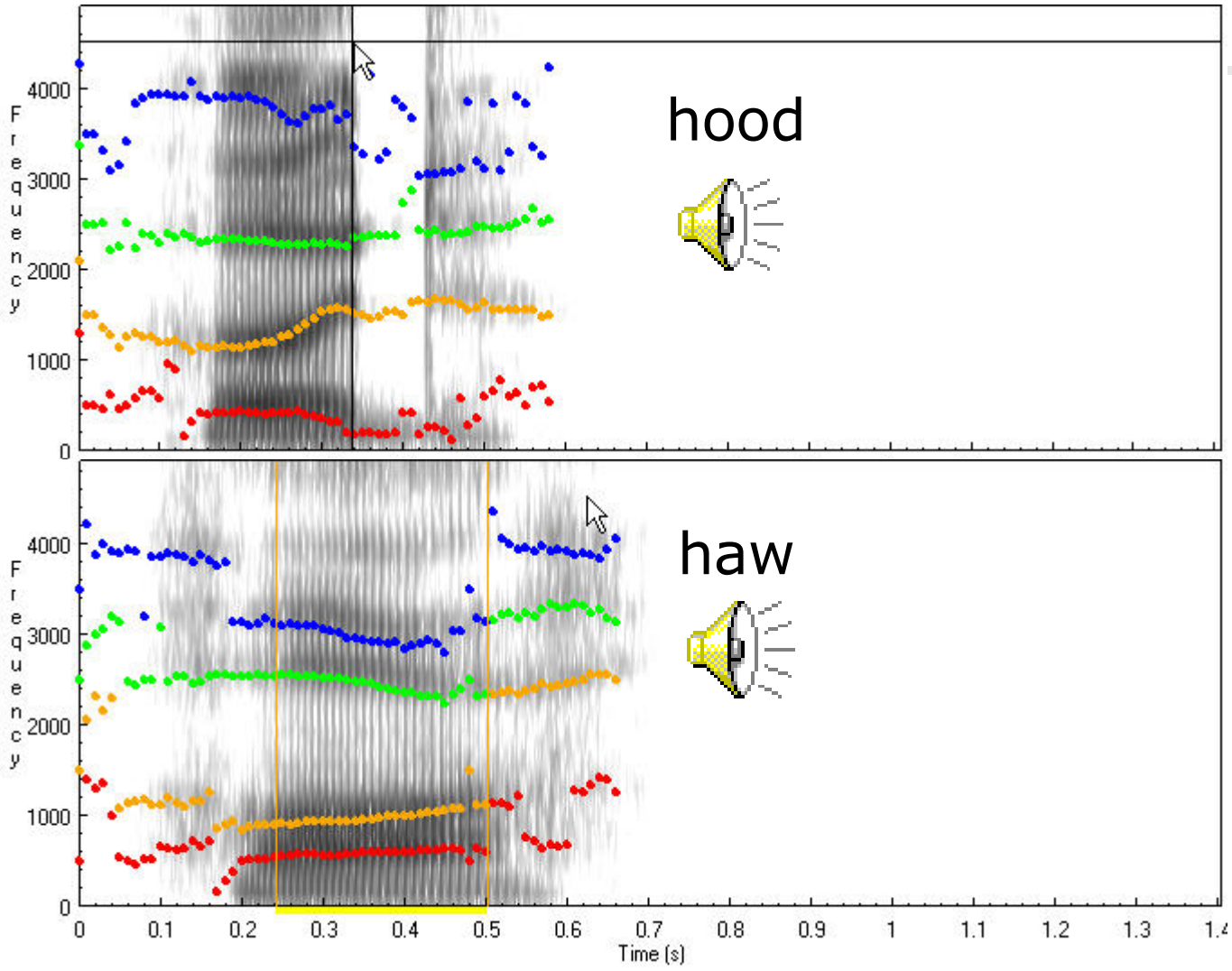
Constriction Locations

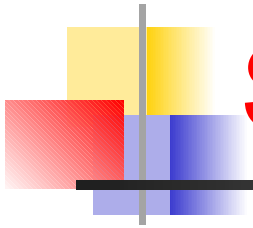


Why this approach?

- Relates generation to production
- Account for continuity in speech
  - Coarticulation effects
  - Speed dependent reduction
  - Model segment assimilation
- Segments are not perfectly sharp
  - Vowels and consonants overlap

Clean vs Overlapping Segments





Strong Gestural Hypothesis

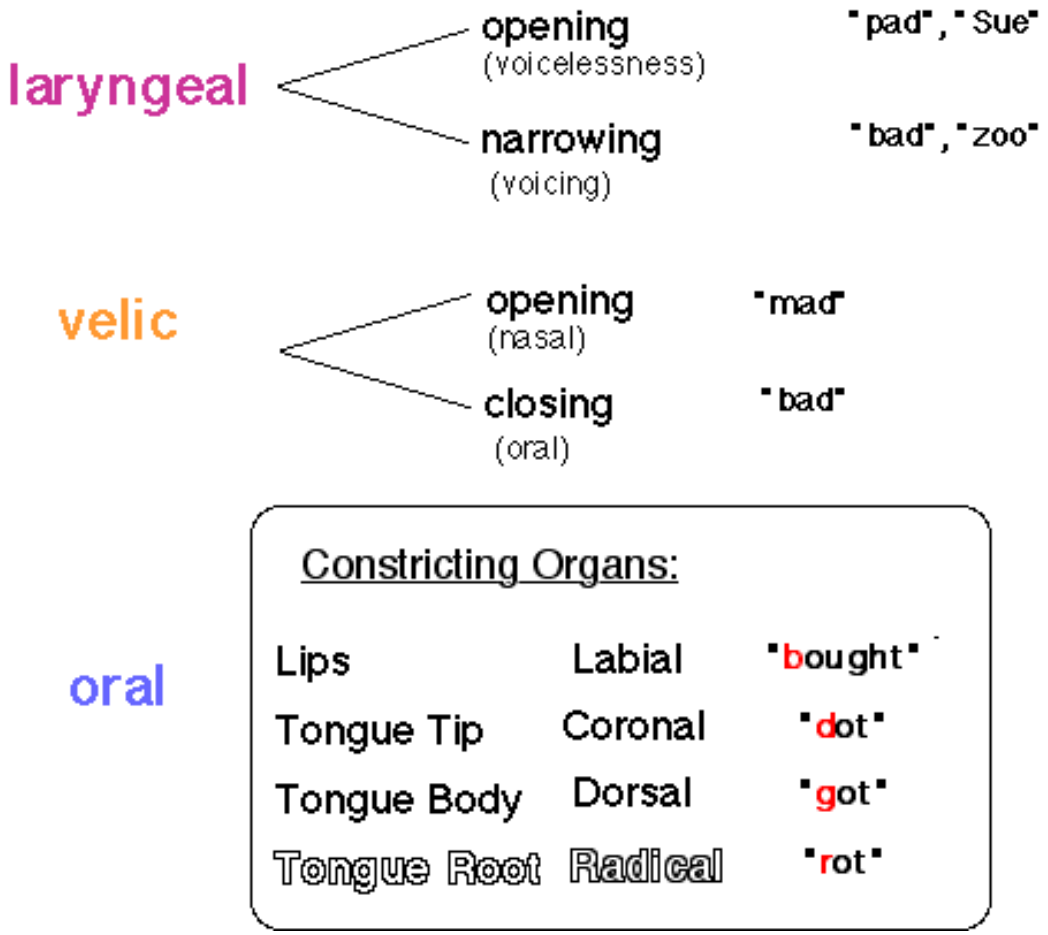
- There are no phonemes in the brain!
  - There are only vocal tract articulations
  - Gestures are the unit of speech information
  - Speech is produced by generating a stream of gestures, not target phonemes
  - Speech is decoded by interpreting gesture streams from sight and sound
  - A daring claim about neurolinguistics
  - Compare to Weak Hypothesis

Articulations in a Segment

- Segments are composed of articulations called gestures.
- Gestures is a constriction [ack!] consisting of:

1. An articulator (e.g. tongue, lips, etc.)
2. An articulatory action.
    - constriction degree (how constricted?)
    - constriction location (where constricted?)
3. Duration of action

Gesture State Variables



X-Ray Sagittals of /L/ and /R/

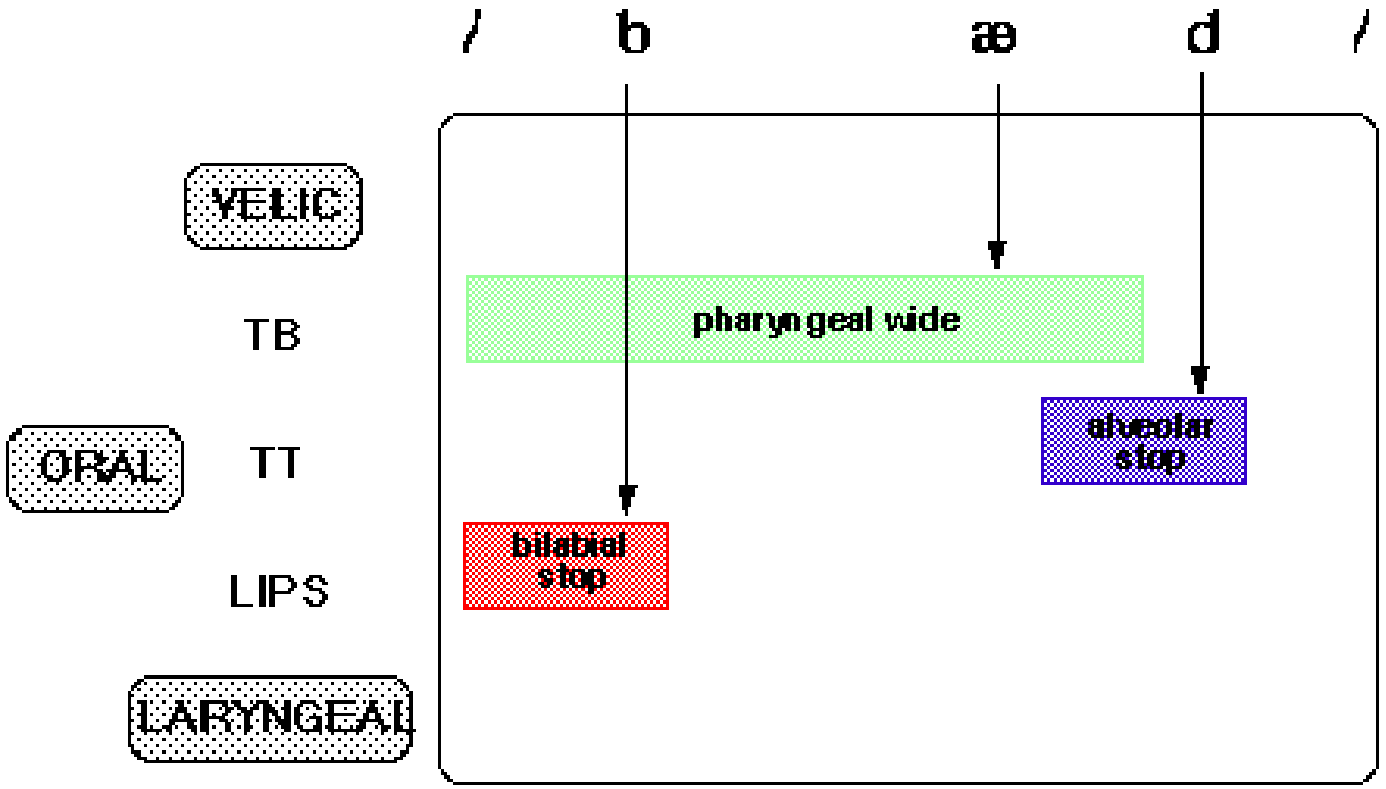
Multiple Oral Constrictions

- /L/ – "lie"
  - Coronal + Dorsal
  - Traditional IPA description
    - voiced alveolar lateral oral approximant
- /R/ – "rye"
  - Labial + Coronal + Root
  - Traditionally IPA description
    - voiced alveolar central oral approximant

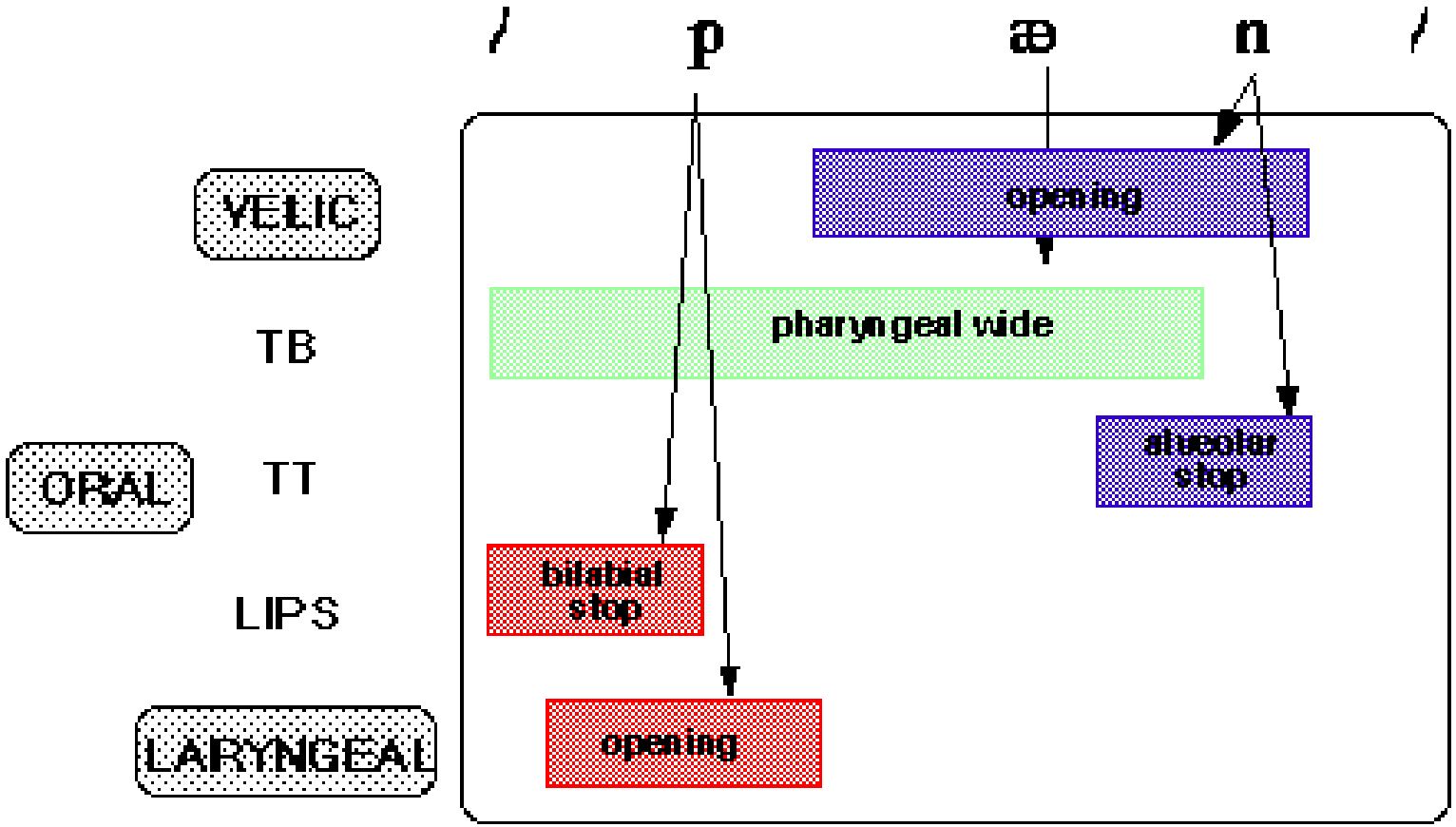
Gestural Scores

- Like a Musical Score
  - Articulatory Phonology system of transcription
  - Comprises 5 tracks that denote (discrete) time evolution of state variables
  - Phonetic transcription viewed as a 1D projection from 5D space of contrasting articulations

Gestural Score for 'Bad'



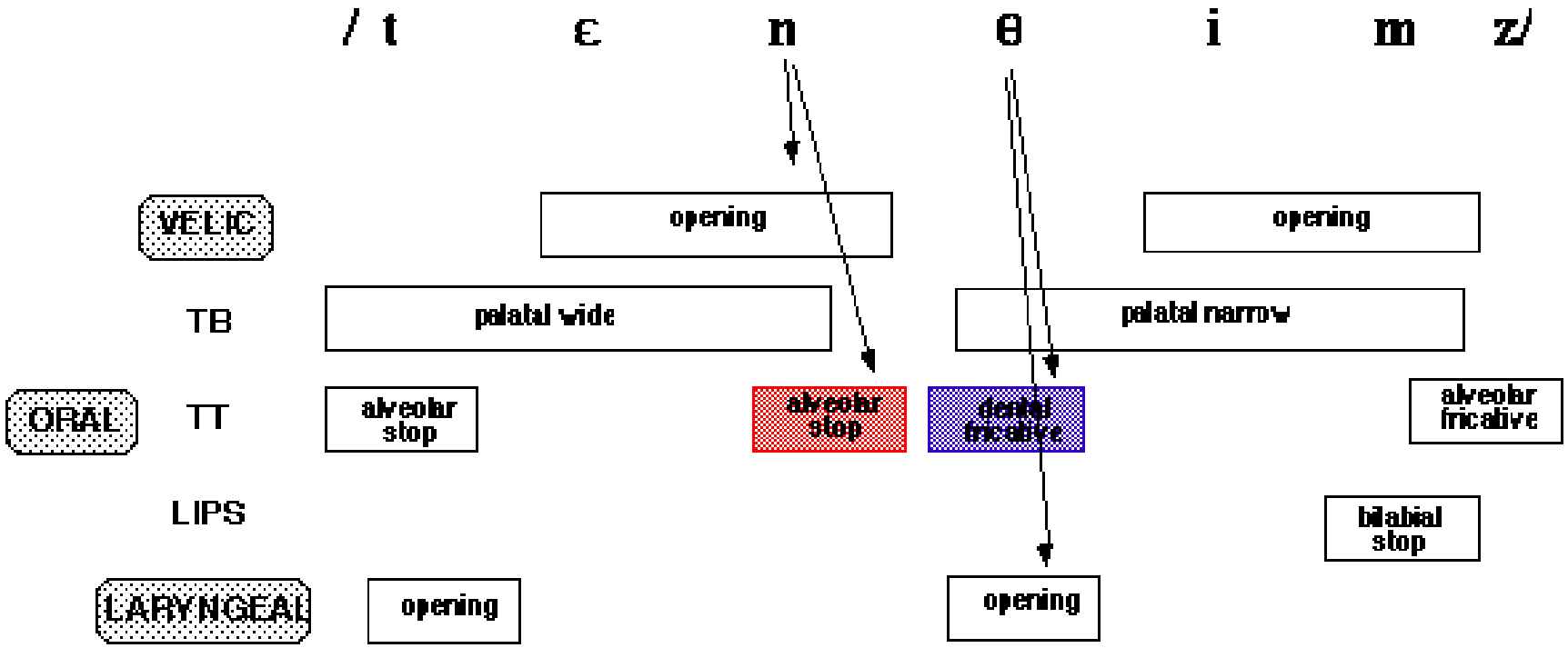
Gestural Score for 'Pan'



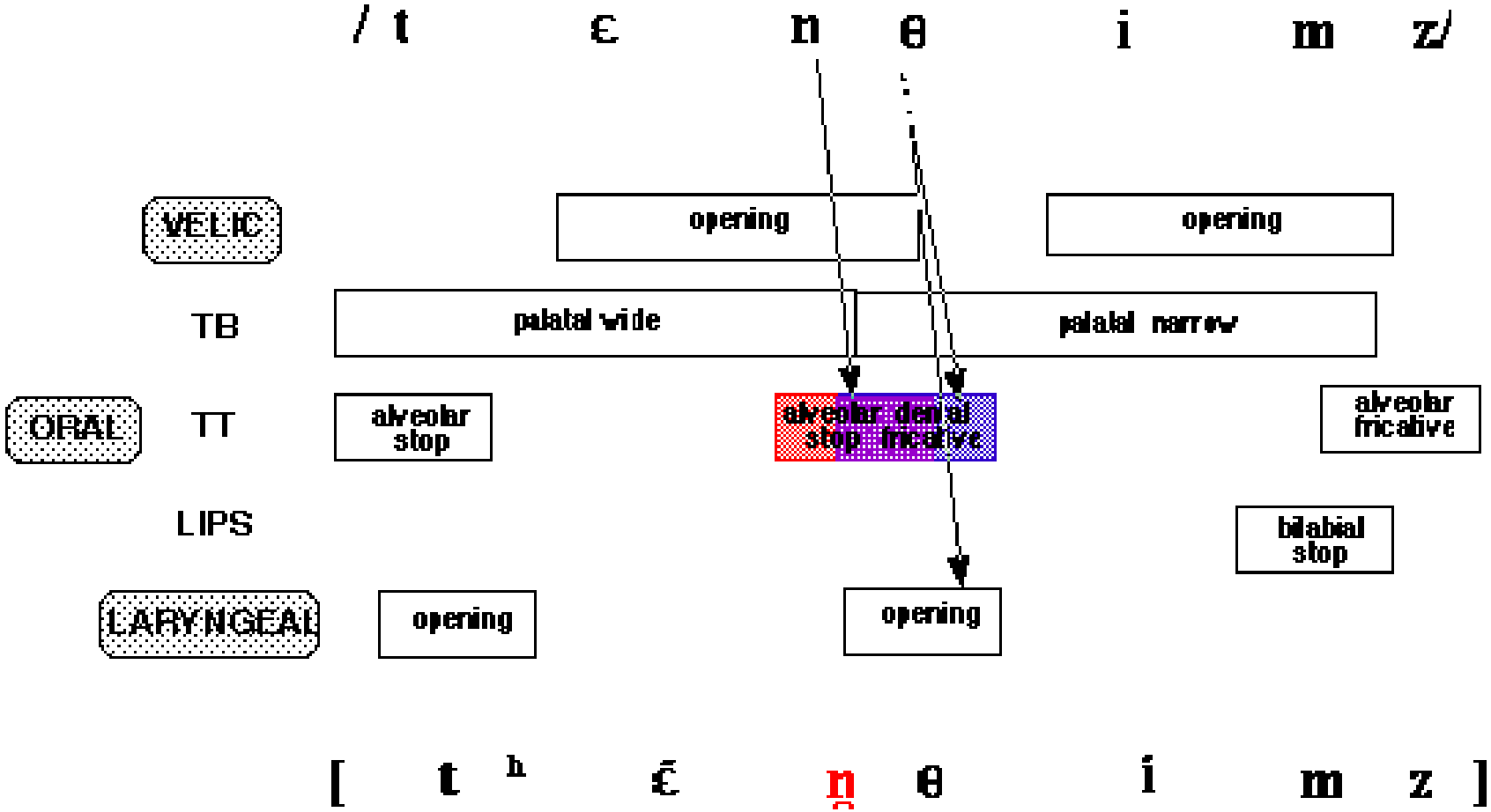
Careful vs Casual Speech

- Shown in score as degree of overlap
  - Doesn't express quantitative change in degree of constrictions or place of constriction, though
  - Phonetic difference expressed in details of narrow transcription
  - e.g. 'ten themes'

“ten themes” spoken carefully



“ten themes” spoken casually



Gesture Contrasts of /M/

- Two related gestures
  - 1. velar opening (nasalization)
  - 2. oral stop closure
    - /M/ - lips, /N/ - alveolar, /NG/ - velar
- Experiment: contrast 2 productions
  - Syllable initial – 'see more'
  - Syllable final – 'seem ore'

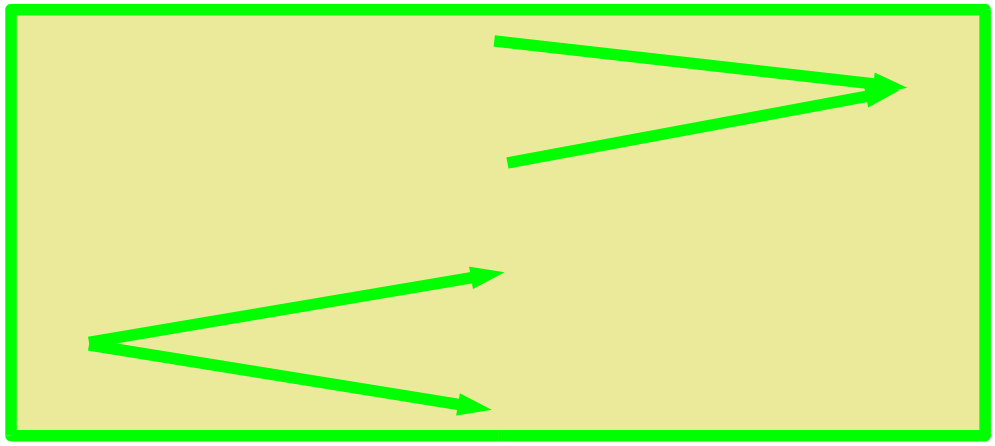
Gesture Timing of /M/

see more

Lips closing

Velum opening

seem ore



Lips closing

Velum opening

Gesture Score of /M/

- Contrast realized in extent of velar openings
  - In particular, initiation of opening, relative to preceeding vowel
  - Offers a more specific explanation
  - [draw score diagram on whiteboard]

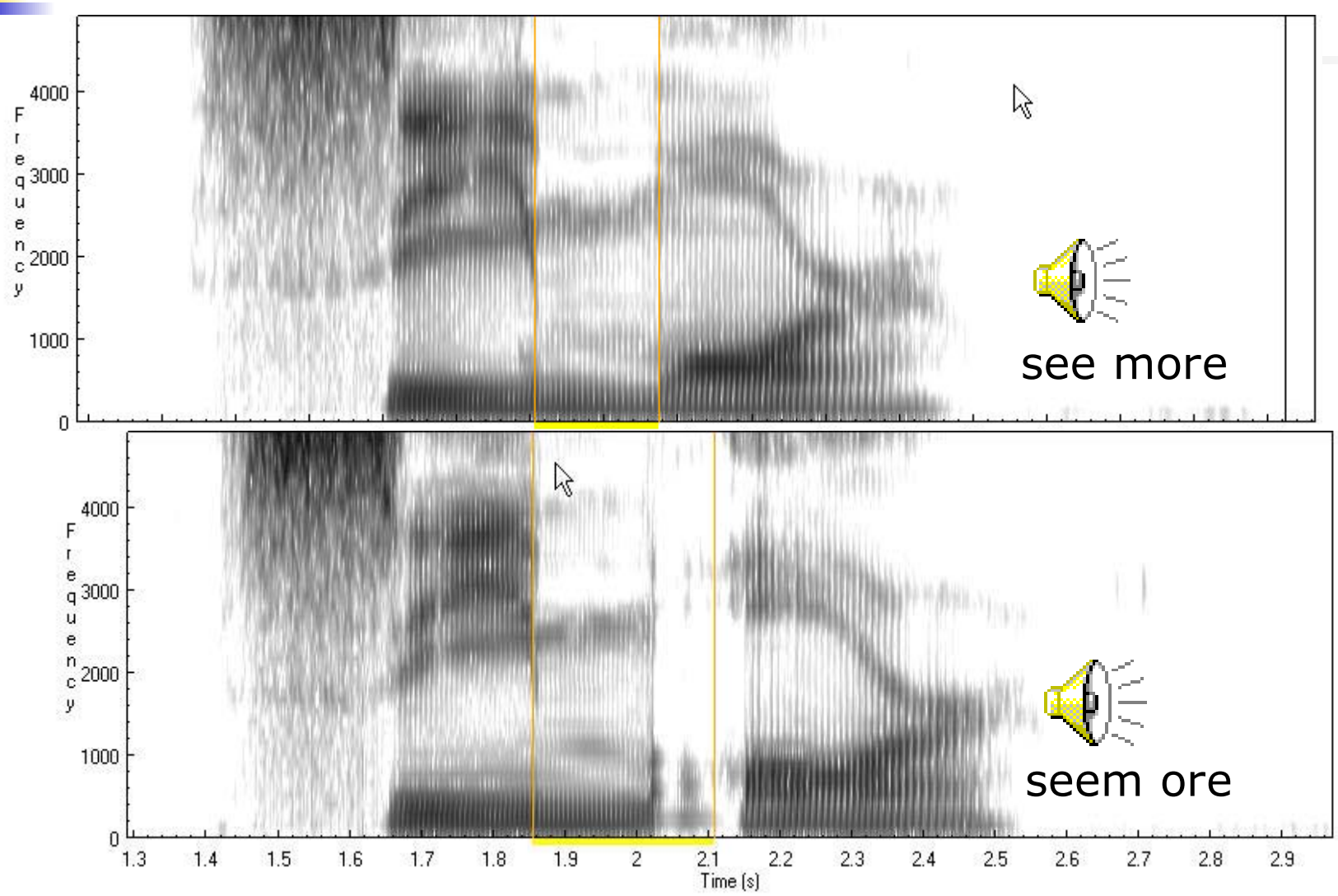
Compare to Segmental Feature Description

- Nasal stops (e.g. /M/)
  - Initial and final versions are denoted with the same symol
    - There is no [+back] feature
  - But a final /M/ colors the preceding vowel – makes it nasalized
- Example: 'see more' vs. 'seem ore'
  - See also traditional syllable diagram

Limits of Gestural Score

- Compare these 5 productions
  - 'seymore'
  - 'see more'
  - 'seem ore'
  - 'seem more' (careful)
  - 'seem more' (casual)
- [draw syllable diagram on whiteboard]

Syllable Initial vs. Final /M/



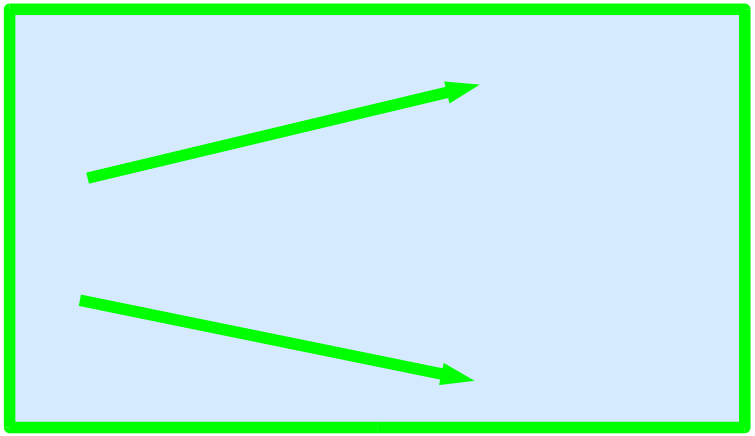
Gesture Contrasts of /L/

- Two related gestures
  - 1. tongue tip constriction
  - 2. tongue back movement
- Contrast productions
  - Syllable initial – 'give Leap buttons'
    - Traditionally: [-back] light L
  - Syllable final – 'give peeL buttons'
    - Traditionally: [+back] dark or velarized L

X-Ray Sagittals of /L/

Gesture Timing of /L/

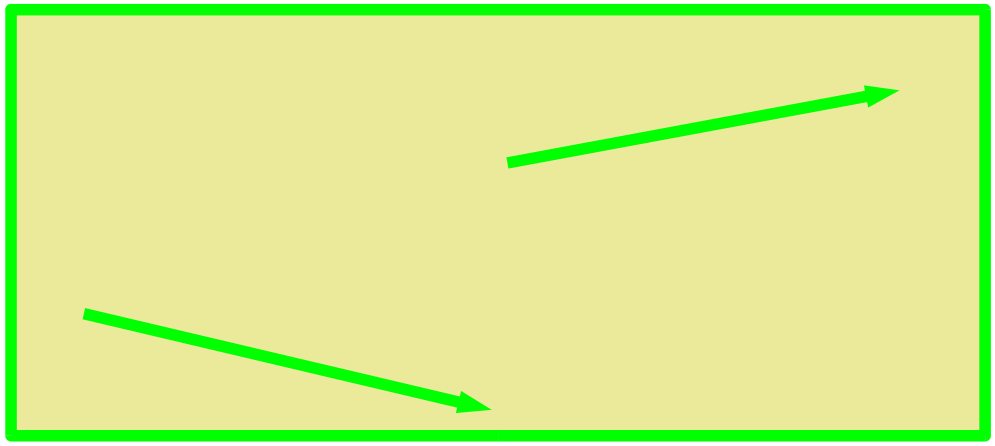
give Leap



Tongue tip up

Tongue dorsum retracts

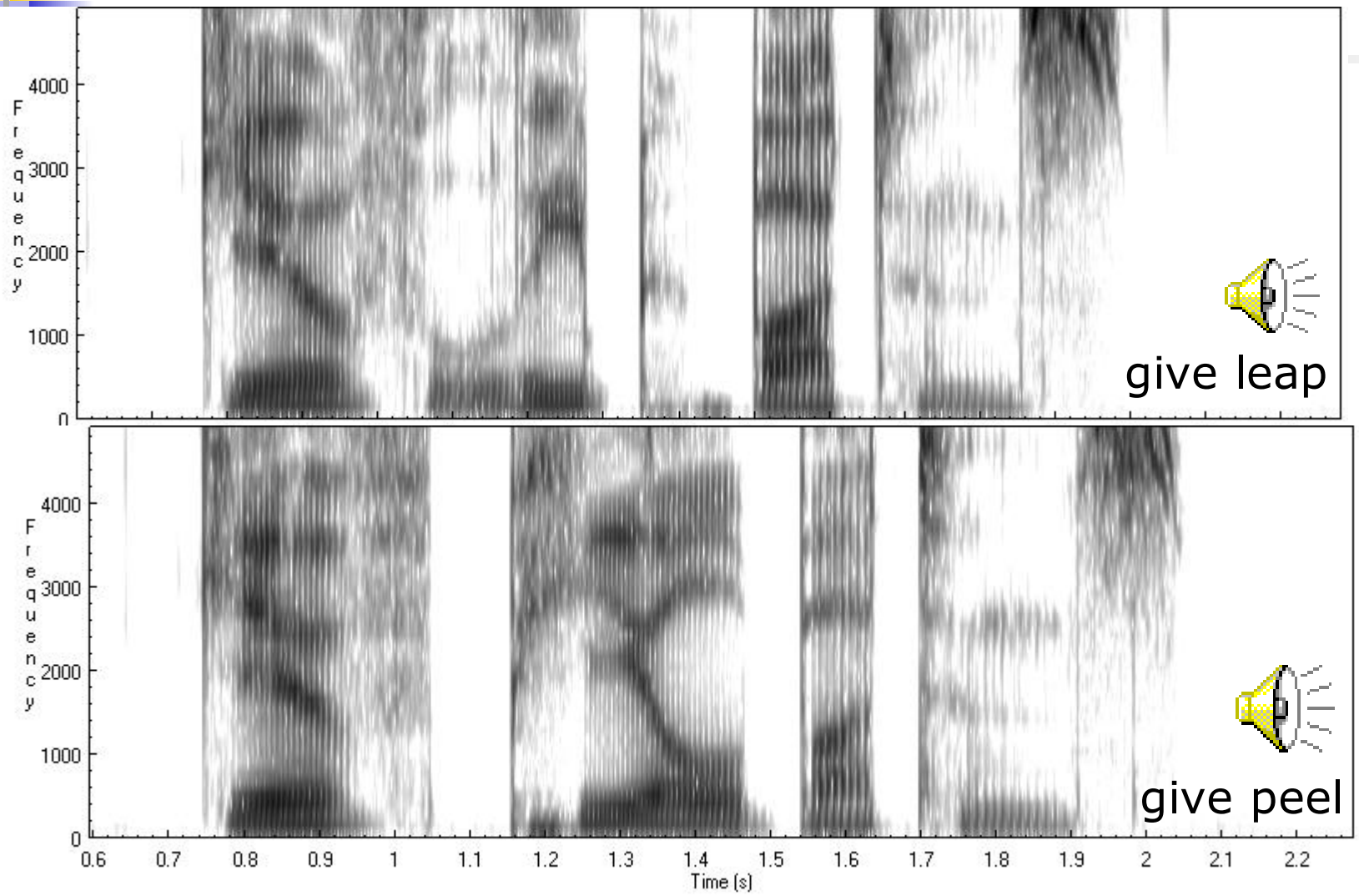
give peeL



Tongue tip up

Tongue dorsum retracts

Syllable Initial vs. Final /L/



Generalization

- Nasals and Laterals share a common gestural score that is not expressed in standard descriptions
- Comment
  - Doesn't provide a theory of syllable structure in terms of articulations, or why it affects gestural timing in this way
  - Still needs a model to derive acoustics

Interesting Speculation

- Replacement of final consonants from language with nasalized vowels
  - e.g. In French
  - Late oral closure of tongue leads to reduced perception
  - Reduced perception leads to reduced production
  - Over generations the language transforms

Final Consonant Reduction

- Measured reduction in articulation of syllable final consonants
  - Doesn't answer why there is final reduction
    - To set up stress on the next syllable?
  - But it's a well conducted experiment

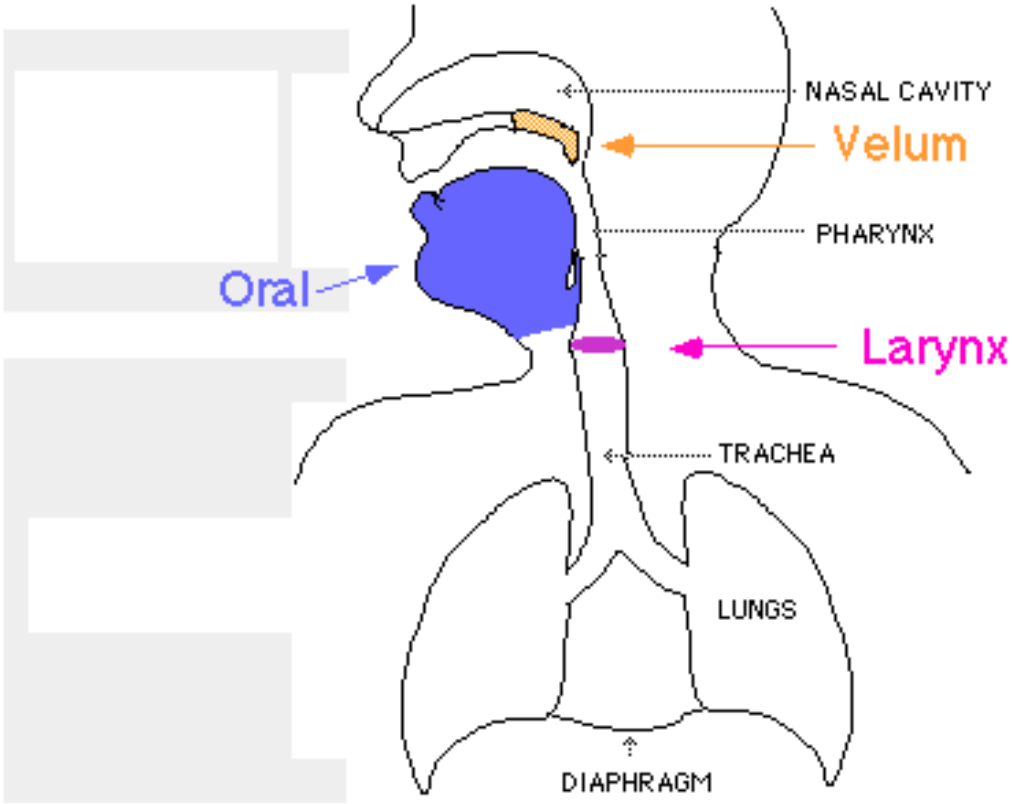
Conclusion

- Suggests a wider generalization for English
  - For syllable-final phonemes, broad constrictions preceed narrow constrictions, which are otherwise simultaneous events

Extra Slides

- ... follow

Vocal Tract Organs



Gesture combinations and consonants

- Thus, from these gestures we can form 9 combinations in English.

Velic:	Closing	Closing	Opening
Laryngeal:	Narrowing	Opening	Narrowing
Labial	"bought"	"pot"	"Mott"
Coronal	"dot"	"tot"	"not"
Dorsal	"got"	"cot"	"kong"

	Lips	Tongue Tip	Tongue Body	Velum	Larynx
b	bilabial stop				
p	bilabial stop				opening
m	bilabial stop			opening	
d		alveolar stop			
t		alveolar stop			opening

Relation of traditional five-term description of consonants to gestural analysis:

- (1) Laryngeal gesture results:
  - voiced (<laryngeal narrowing)
  - voiceless (<laryngeal opening)
- (2) Location of oral constriction gesture
  - bilabial, labiodental
  - dental, alveolar, palato-alveolar
  - palatal, velar, uvular, pharyngeal
- (3) central or lateral
- (4) Velic gesture results:
  - nasal (<velic opening)
  - oral (<velic closure)
- (5) Degree of oral constriction gesture
  - stop
  - fricative
  - approximant