A Representationally Consistent Model of Vowel Nasalization

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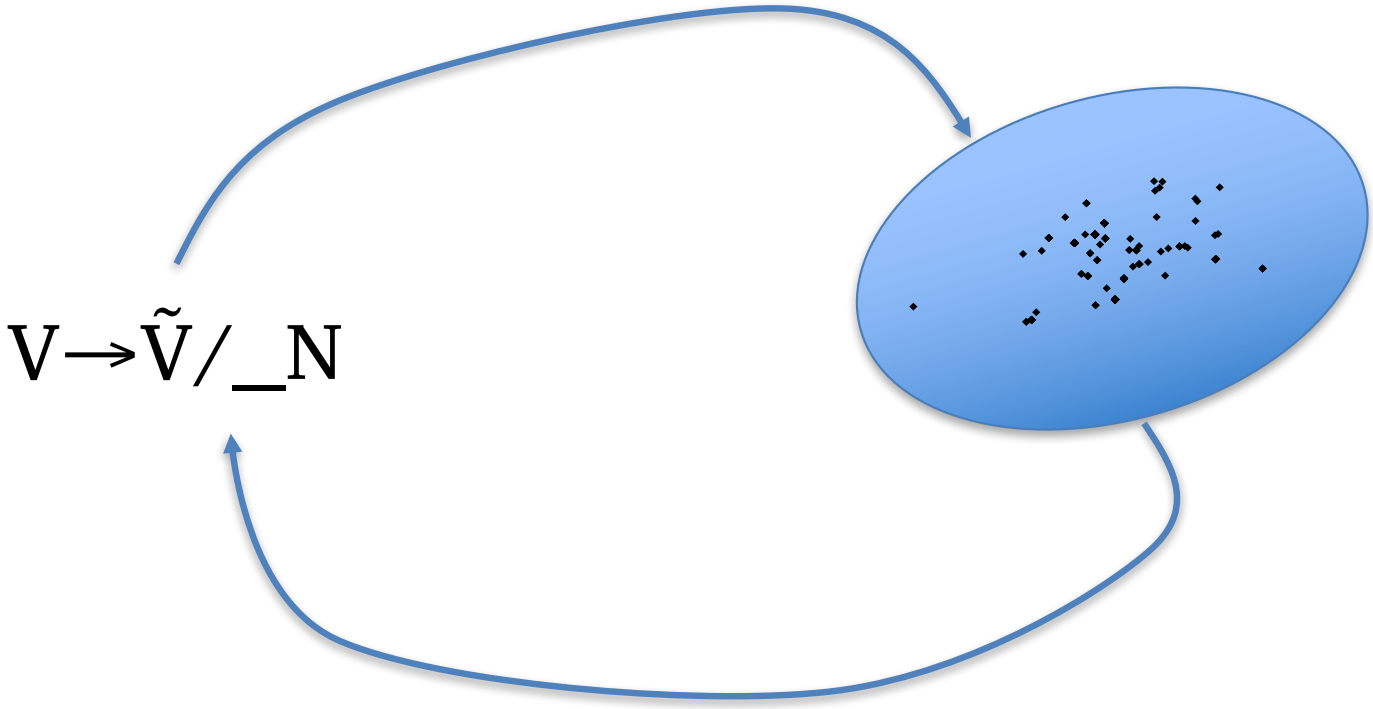
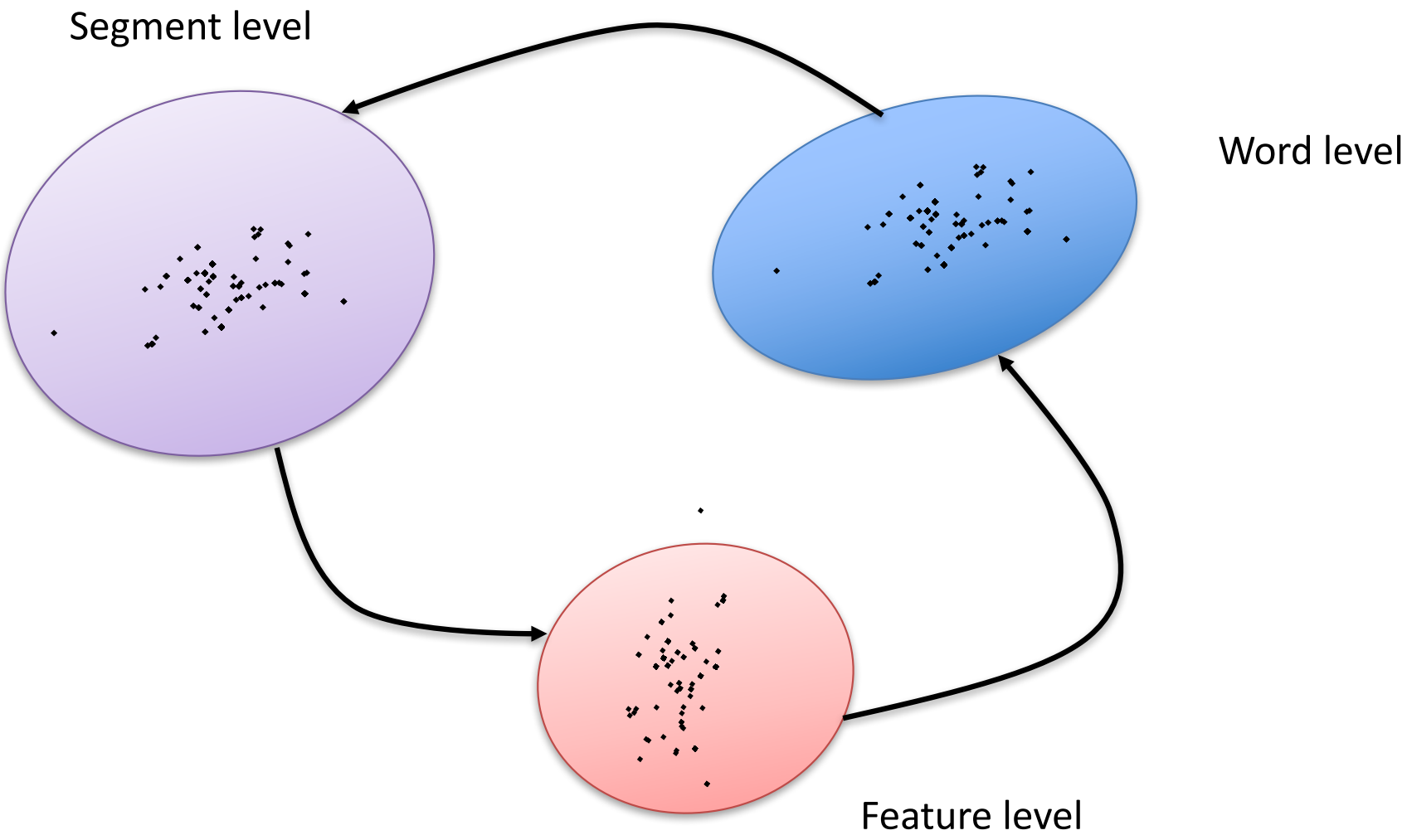
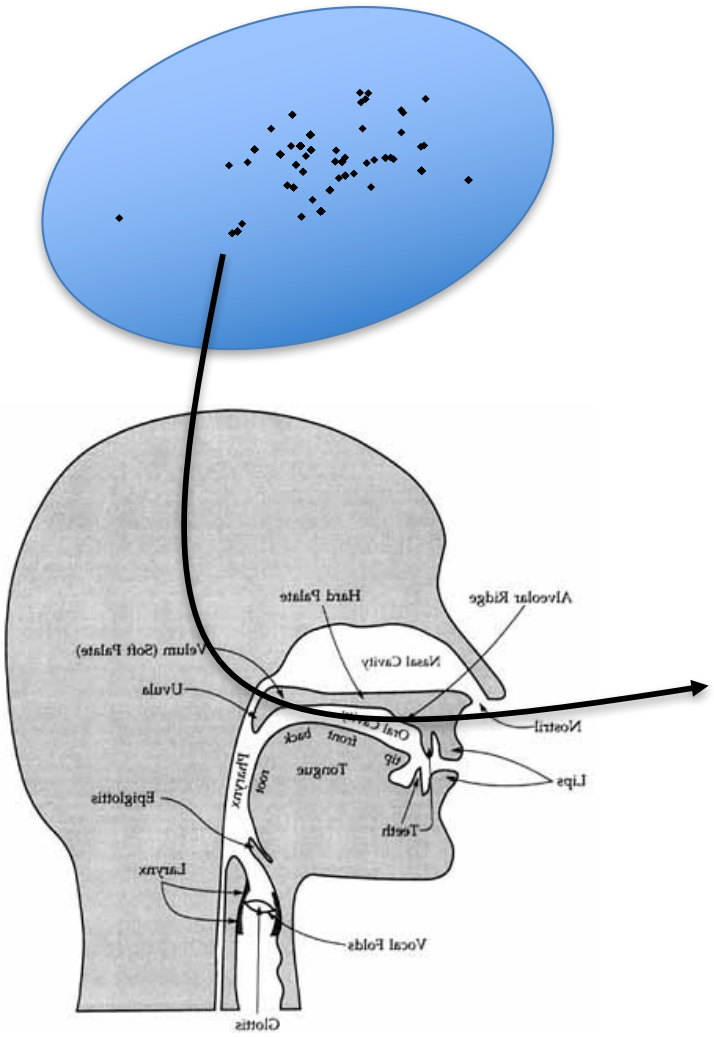
Modeling & Theory

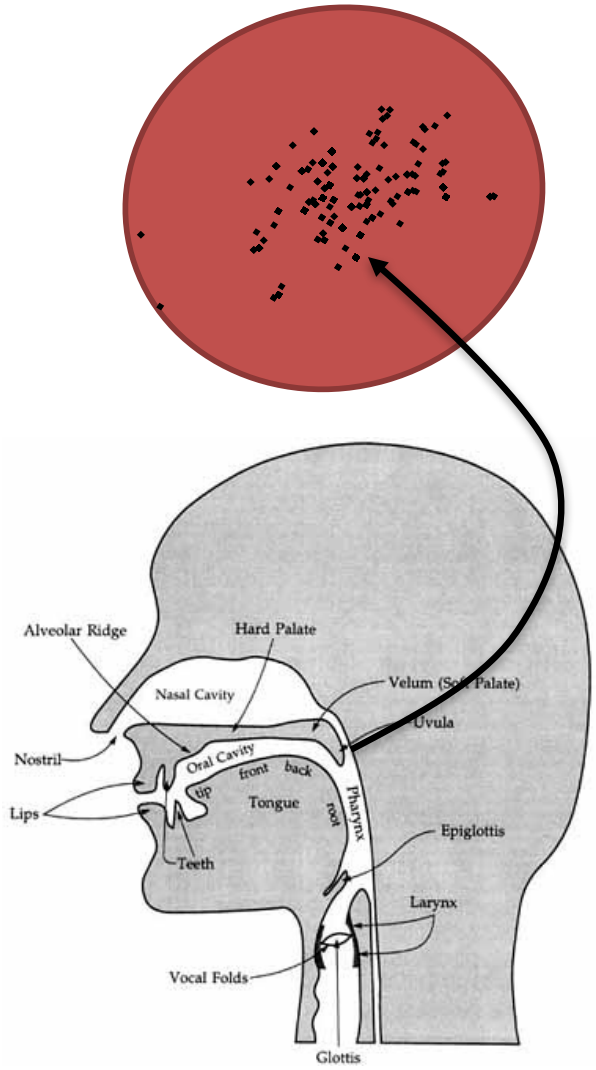


Model & Model



Model & Model

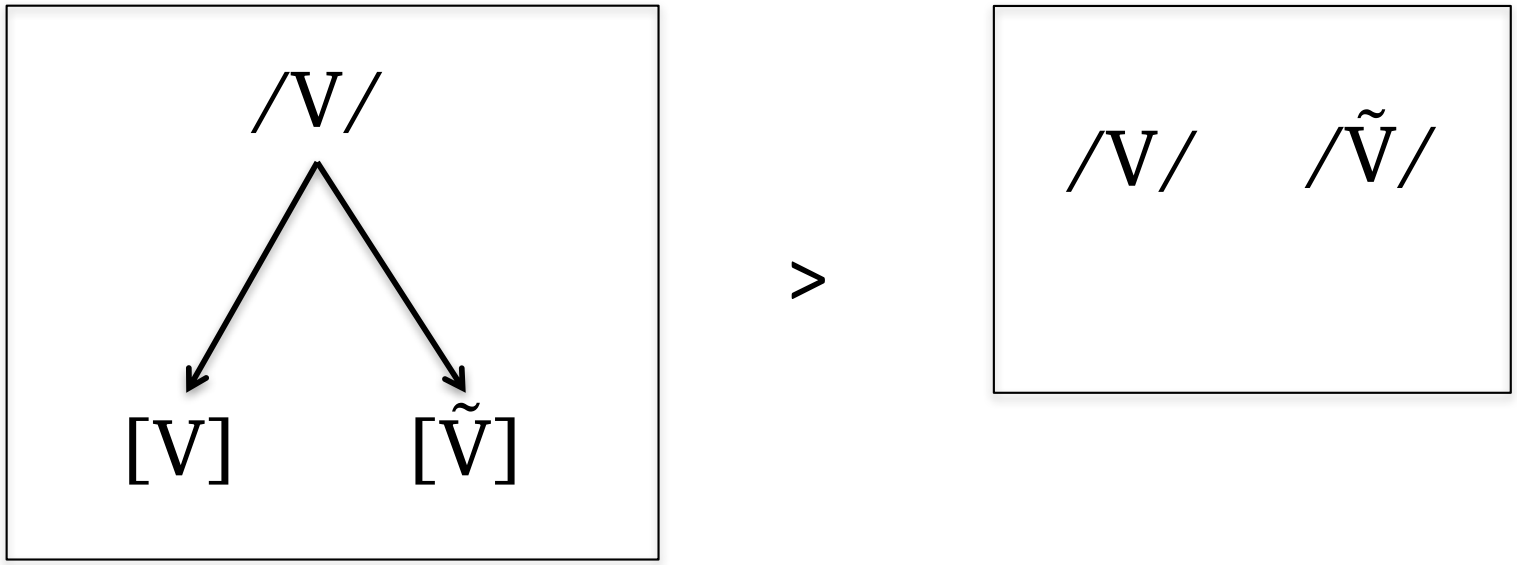




Production/Articulation

Perception/Auditory

Theory & Theory

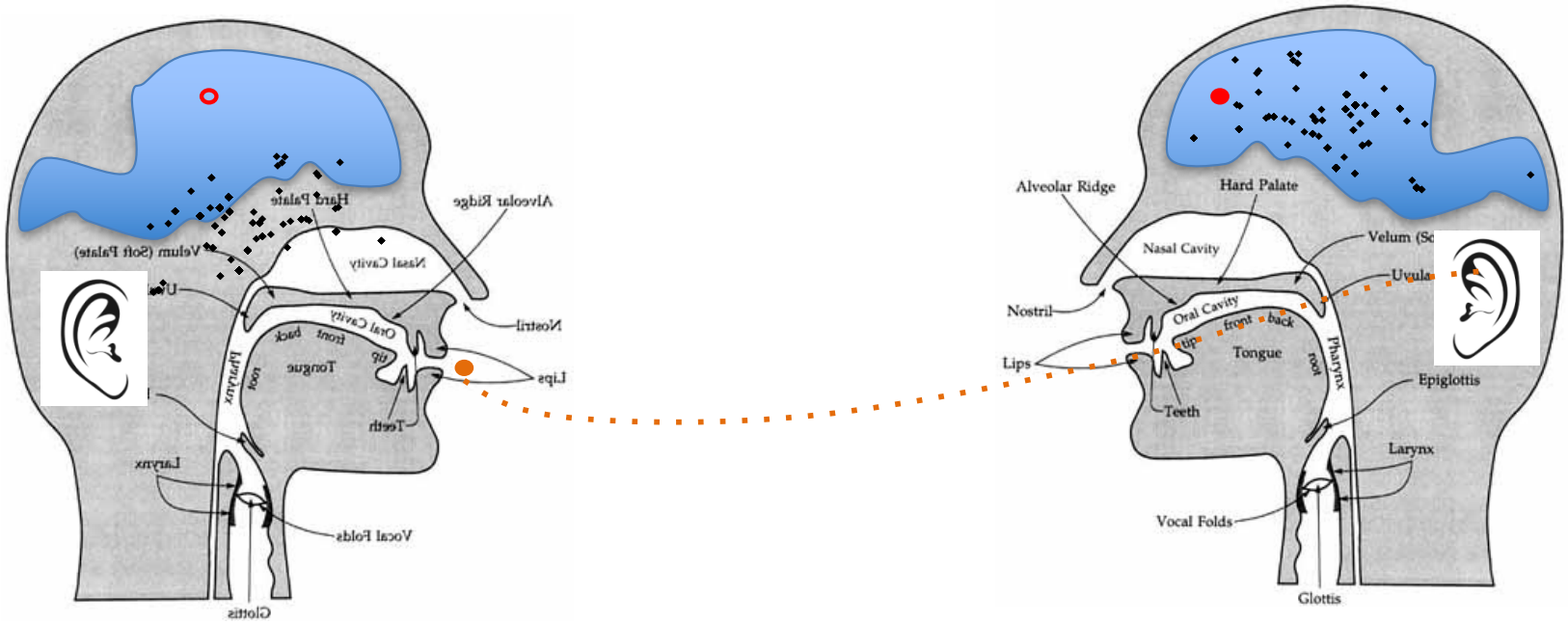


Minimal Pair Test as diagnostic or definition?

Outline

1. Exemplar modeling
    1. Feedback Loop (Iterativity)
    2. Production to Perception Transformation
2. Historical Linguistics
    1. Chicken
    2. Egg
3. Proposed Model
    1. Keep synchronic variation
    2. (Keep) whole-word storage
    3. Add explicit parsing
        1. segmentation/decomposition (word to segment level)
        2. Mapping from acoustic to articulatory targets
    4. Add misparsing/misperception (Ohala)
4. Unexpected (?) Consequences of Representational Consistency

Exemplars

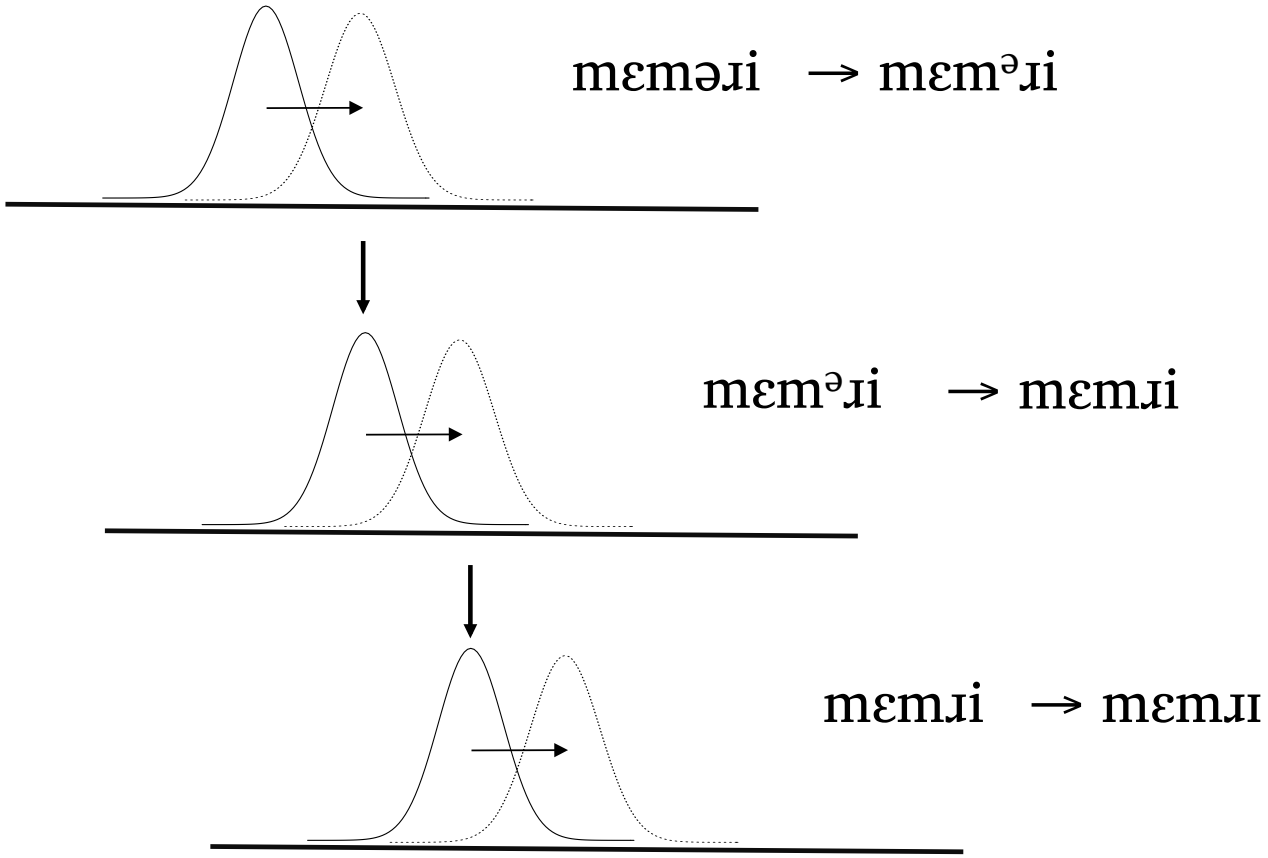


1. Select token at random from cloud
2. Produce token (with some production bias)
3. Hear token (with auditory bias)
4. Categorize token, and add back to cloud

Perception-Production Loop

Exemplars

Iterativity



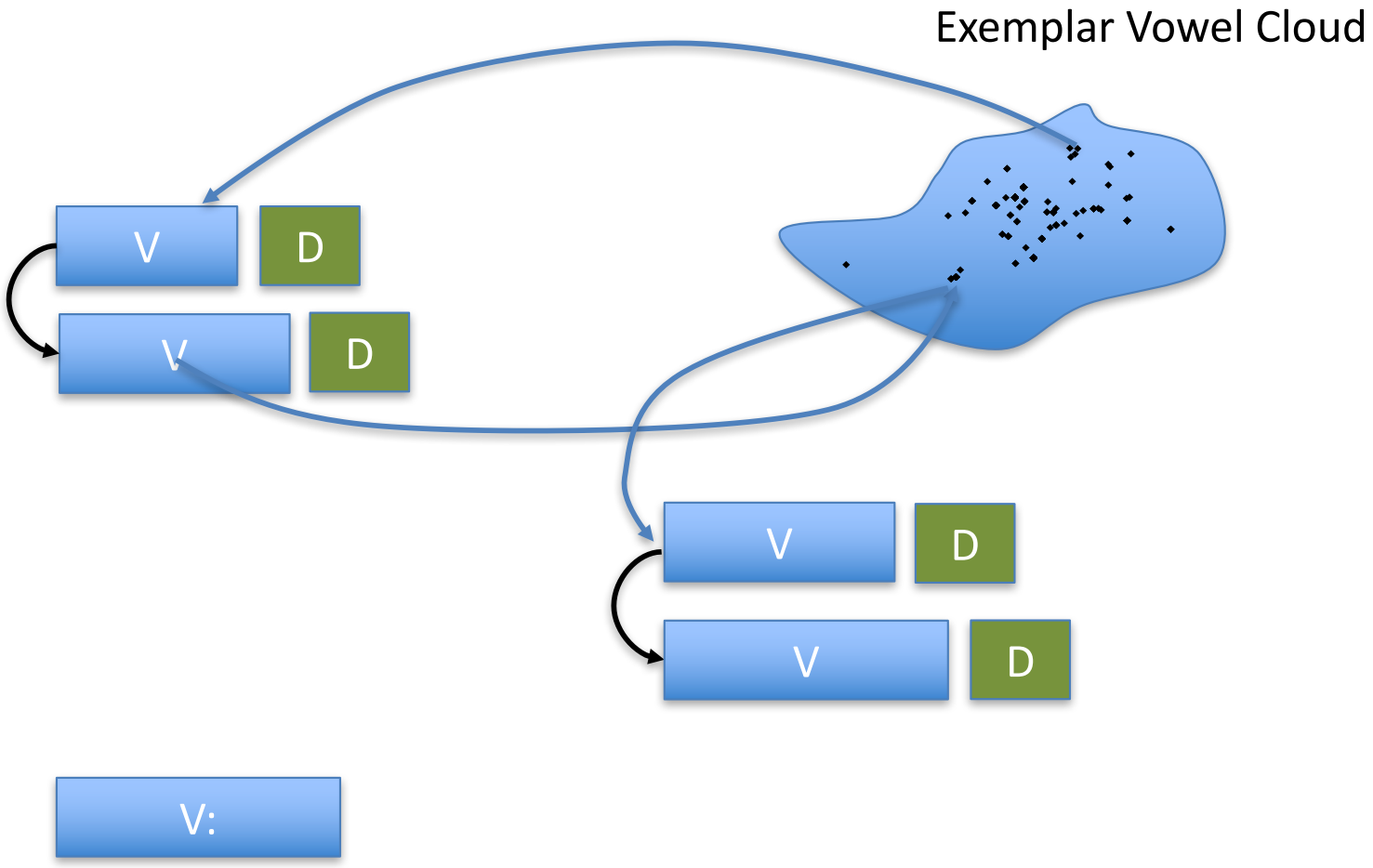
Exemplars

- More generally, iterativity as the continued application of a "phonetic bias"
  - Shortening/reduction [Pierrehumbert 2001; Wedel 2012]
  - Vowel lengthening [Soskuthy 2013]
  - /u/ fronting [Soskuthy 2015]
- But iterativity only really makes sense if you think of these "phonetic biases" as the most abstract kind of phonological rules, meaning:
  - They apply without reference to the phonetic details of their input
  - And simply add or subtract a fixed value along some phonetic dimension

Vowel Lengthening

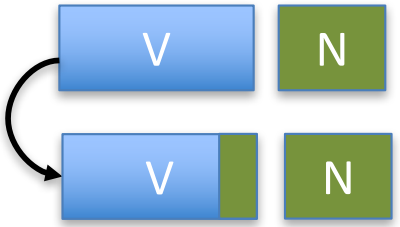
Vowels are longer before voiced stops

Vowels are lengthened before voiced stops

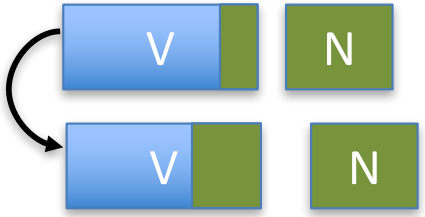


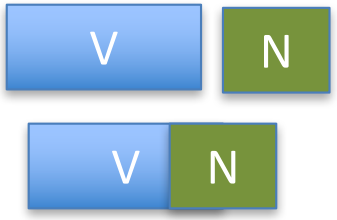
Vowel Nasalization

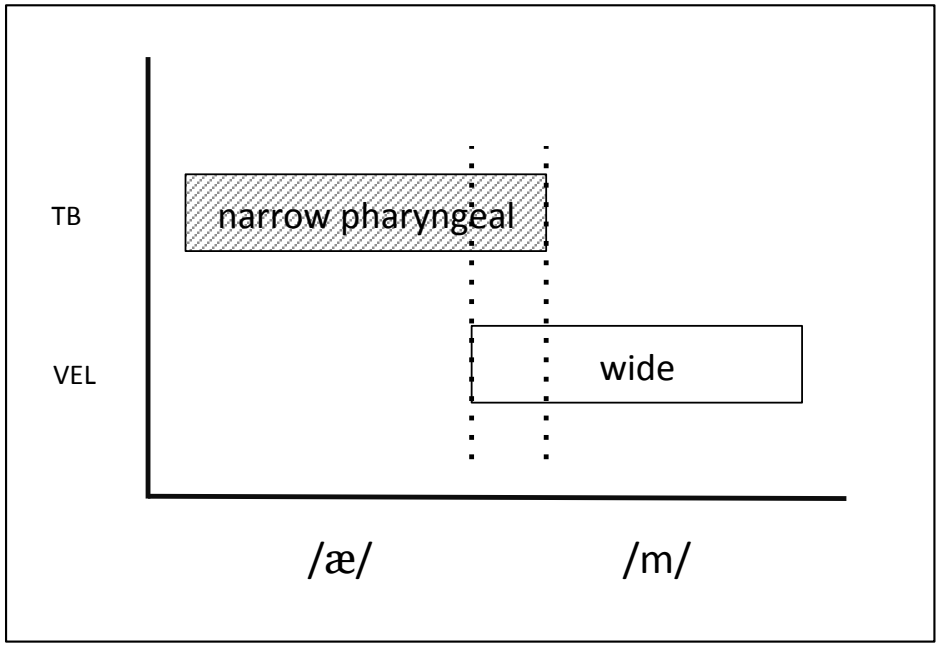
$$V \rightarrow \tilde{V} / \_N$$

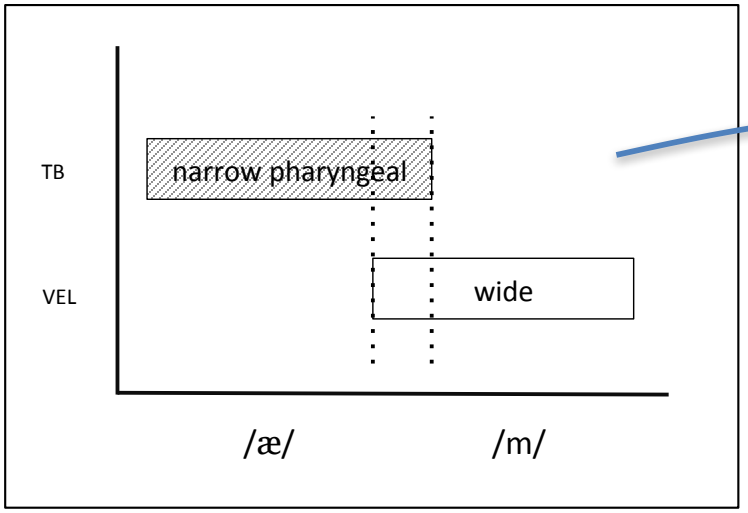


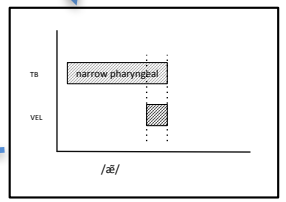
Addition of fixed unit of ‘nasality’



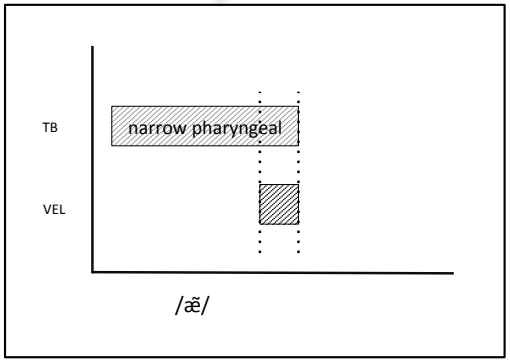

V
N
V
N


TB
narrow pharyngeal
VEL
wide
/æ/
/m/

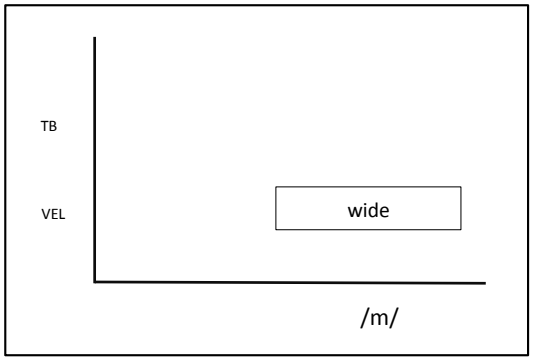

TB
narrow pharyngeal
VEL
wide
/æ/
/m/

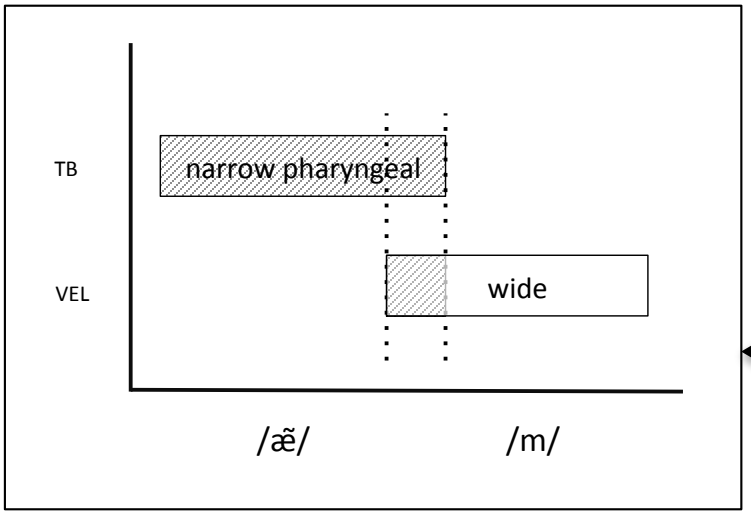

TB
narrow pharyngeal
VEL
/æ/

=


TB
narrow pharyngeal
VEL
/æ̃/

+


TB
VEL
wide
/m/


TB
narrow pharyngeal
VEL
wide
/æ̃/
/m/

Representations

- Distinct perception and production representational tokens
- Non-trivial mapping between the two
- No process of nasalization (rule/bias/whatever)

Historical Linguistics

$$V+N > \tilde{V}$$

V+N > Ṽ

- Story I:
  - Phonetic Rule: V→Ṽ/_N
  - Compensation: ṼN →  → VN
  - N > 0
  - Ṽ →  → Ṽ

V+N > Ṽ

- Story II:
  - Phonetic Rule: V→Ṽ/_N
  - /VN/ > /ṼN/ *
  - N > 0
  - [Ṽ]

* If  analysis involved then this becomes Ohala account

Misperception/Misarticulation/ Misanalysis

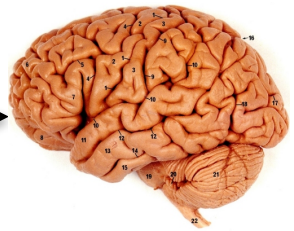
[Ohala et al.]

/VN/

↓

[ṼN]

/ṼN/



N > 0

Inherently ambiguous surface form

Representations

- No assumption of prior V, N units
- No concatenation/composition: V+N
- No allophonic rule
- N loss correlated with $\tilde{\text{V}}$ emergence

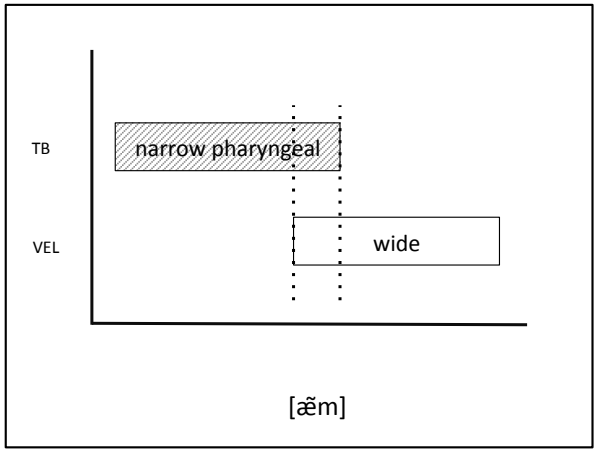
The Model

1. Whole unit input (word level)
2. Segmentation that converts perceptual input to production targets
3. Ambiguity in segmentation (~ feature misparsing)
4. Perception-Production Feedback Loop

The Model

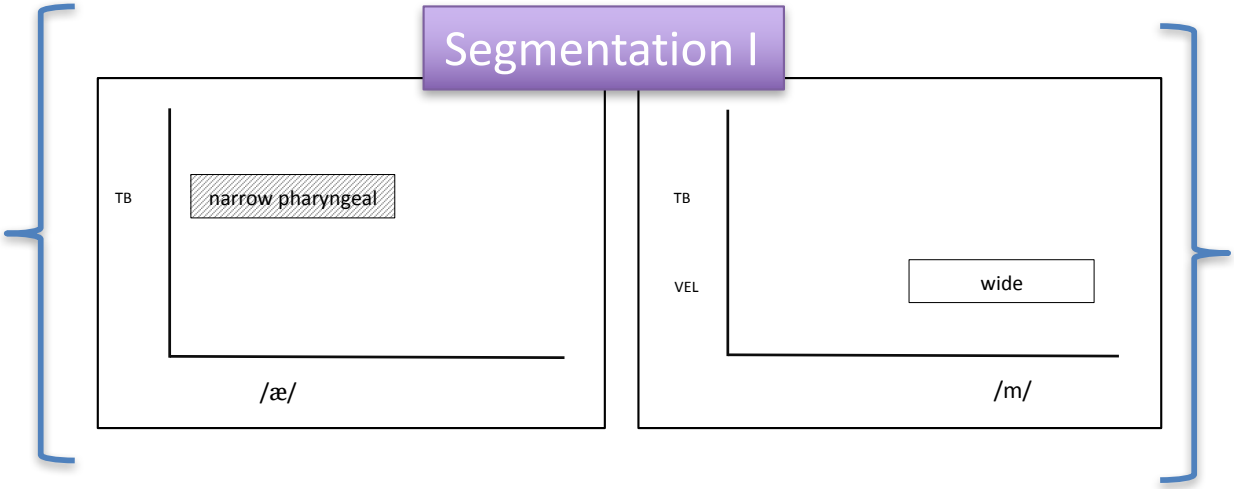
‘perceptual token’

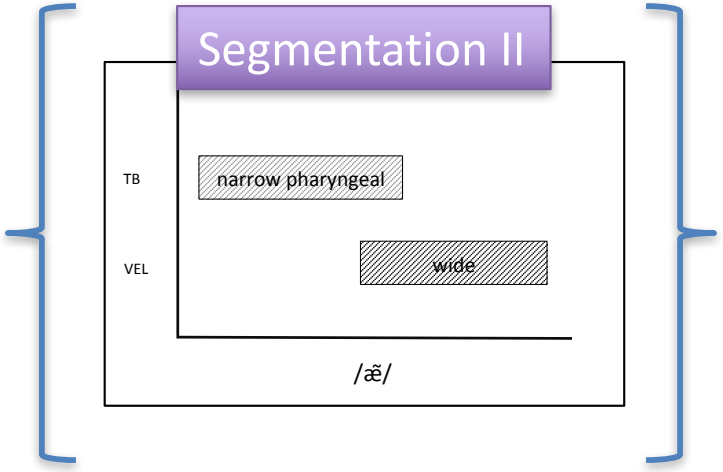
Word level



Velum lowering gesture overlapping with tongue body gesture

Stored production tokens

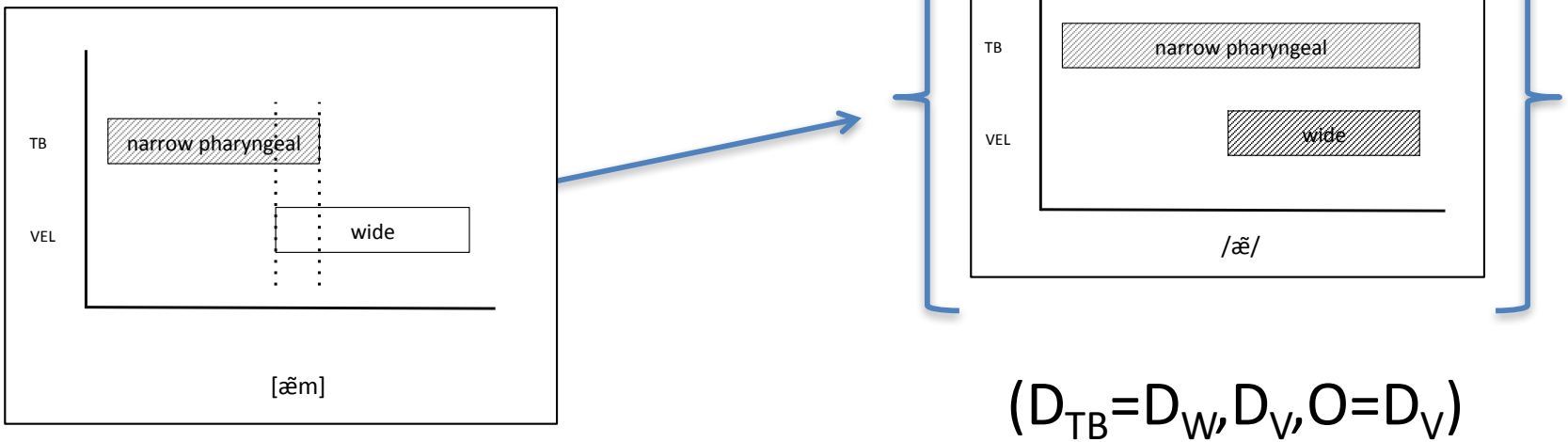




The Model

5. Change happens during the transformation from perceptual to production tokens
6. The representational choice itself affects the values that are stored for a particular token
   (not unlike Goldinger's echo)

The Model

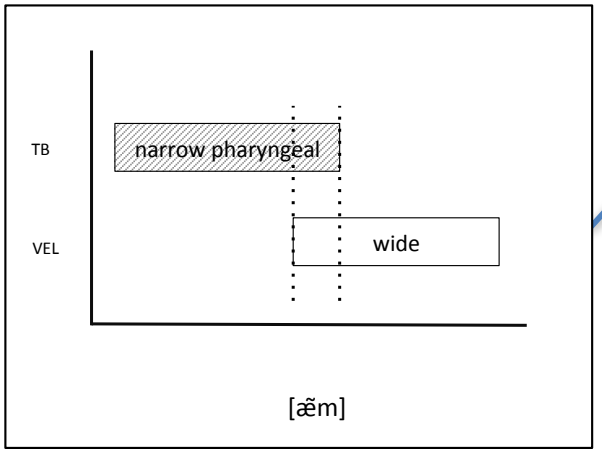


(D_{TB}, D_V, O)

$(D_{TB}=D_W, D_V, O=D_V)$

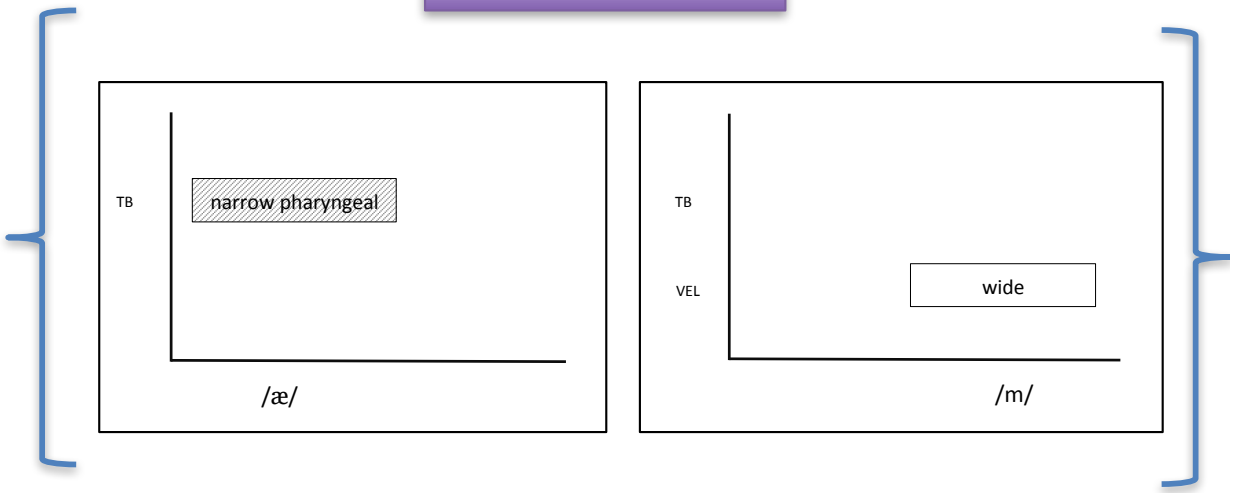
Vowel duration and overlap both increase

The Model



(D_{TB}, D_V, O)

Segmentation I



(D_{TB}, D_V)

Overlap is calculated at time of production at word level

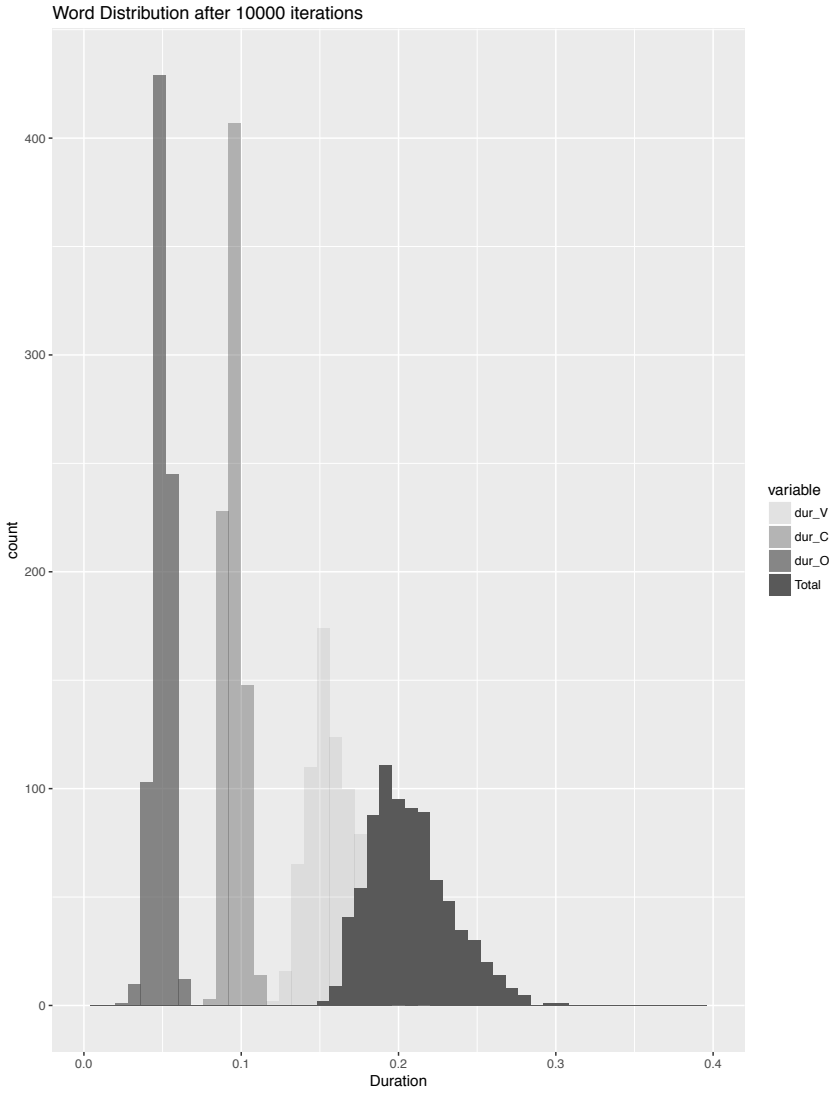
The Model

5. Change happens during the transformation from perceptual to production tokens
6. The representational choice itself affects the values that are stored for a particular token (not unlike Goldinger's echo)
7. Probability of each segmentation is a function of the input token
    1. Larger overlap, and shorter duration make Segmentation II more likely

The Model

- Partial feedback loop possible:
  - Larger overlap, and shorter duration make segmentation II more likely
  - Segmentation II increases overlap
  - Rinse and repeat
- Independent change in word-level gestural coordination (fluency?) triggers change
  - Closer coordination of gestures in segmentation I productions results in shorter words
  - Shorter words make segmentation II more likely
  - Rinse and repeat
- Independent change in word distribution triggers change at lower representational levels
  - Shorter word productions (frequency-based reduction?)
  - Change in speech rate distribution?

Results


Word Distribution after 10000 iterations
count
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
Duration
variable
dur_V
dur_C
dur_O
Total

Summary

Borrowed

- 'covert' (sub-phonemic) representations are where the action takes place (Exemplarists)
- 'change' is always happening (Variationist)
- Misperception is source of sound change (Evolutionary Phonology)
- Actuation= change in distribution of variants is what changes (cf. Soskuthy, et al.)

Re-Imagined

- V+N analysis is not privileged or assumed
- Perception to production transformation is explicitly implemented
- Fluency = reduced variation (not reduced duration)
- Partially independent variables incorporated into change (Duration is correlated with segmentation analysis)

Conclusions

- Each piece is not particularly novel on its own
- But combined the resulting model
  - Reverses standard assumptions of exemplar modeling
  - Situates actuation at a different representational level
  - Alters the actuation problem itself in potentially interesting ways
  - Increases ecological validity

Thanks!