# 5aSC10. Lexical and Phonotactic Effects on the Perception of Rate-induced Resyllabification

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## Main Points

* Perception of syllable affiliation is sensitive to rate in repetitive speech
* The strength of these perceptions differs for different consonant and vowel combinations
* Some of these differences seem to be due to lexical biases either in perception or production
* Perceptual shifts in syllable affiliation correspond to modes in speech production
* Glottal timing is a poor index to these correspondences

## Background

### Rate-induced Resyllabification

Stetson (1951 and much earlier), Tuller & Kelso (1991), de Jong (2001a,b), deJong *et al* (2001a,b)

### A Perceptual Phenomenon

**'eep … eep … eep .. eep .. eep . pea pea pea pea'**

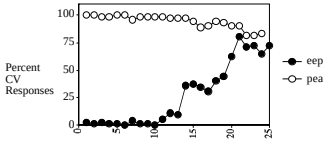



Figure from deJong et al (2001a)

* Repeated CV forms (such as 'pea', hollow symbols) identified as CV's
* Repeated VC forms (such as 'eep', filled symbols) identified as VC's at slow rates (to the left)
* BUT: Perceived as CV's at faster rates (to the right)

**Note:**
**Fast VC's are identified as CV's only 75% of the time**

### A Production Phenomenon

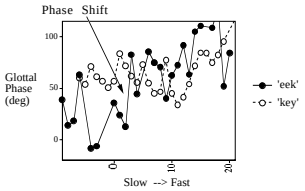



Figure from data in deJong *et al* (2001b)

* Tuller & Kelso (1991) index syllabic organization with glottal phase (y-axis above)
* Glottal phase = timing of peak glottal opening with respect to 360 degree syllable repetition cycle
* Glottal phase earlier for slow rate VC's (filled symbols) than for CV's (hollow symbols)
* Glottal phase for VC's shifts to values for CV's at fast rates

## Questions

**1) Previous work focuses on labial consonants. Does the phenomenon generalize to other segments?**

**2) Examples often are non-words resyllabified into words. Is resyllabification due to lexical status?**

**3) Are perceptual shifts due to articulatory phase shifts?**

## Methods

### Stimuli

**METRONOME PACER:** controls repetition rate
* Start slow (450 ms/syll.) increase to fast (200 ms/syll.)

**TEXT PROMPTS:** Simple bisegmental forms:

| FACTORS | TYPES | EXAMPLES |
|---|---|---|
| 1) sequence | **CV vs. VC** | ('bee' vs. 'eeb') |
| 2) vowel | **/ i / vs. / ae /** | ('eeb' vs. 'ab') |
| 3) voicing | **'voiced' vs. 'voiceless'** | ('eeb' vs. 'eep') |
| 4) place | **labial vs. coronal vs. velar** | ('bee' vs. 'tea' vs. 'key') |

Total forms = (2*2*2*3) = 24 (- labial + /i/ = 20)

**ARTICULATORY RECORDINGS**
* Recorded at Haskins Laboratories
* Include following information:
  - Acoustic traces digitized at 20 kHz
  - Glottal transillumination traces at 635 Hz

(Glottal transillumination traces are the output of a photo-transducer placed externally, which detects a light source placed in the upper pharynx, modulated by the size of the glottis; Baer *et al.*, 1983.)

**TALKERS**
* 3 Speakers of varied linguistic experience
* Speaker glottal patterns are quite different, apparently due to language background
* Current paper focuses on one American English talker

**SPLICED SYLLABLES**
* Extract 21 three-syllable portions of signal
* Splicing technique checked for no effect on identifications (de Jong *et al.*, 2001a)
* 20 types X 21 syllables/utterance = 420 stimuli

### Listeners

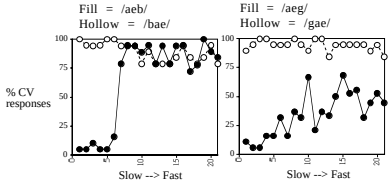
* 73 American English speaking listeners in their 20's
* No reported hearing loss
* 18 - 19 listeners/responses for each stimulus
* Listeners below 70% consistency removed

### Task

* Matlab protocol on PC platforms
* Listen to three-syllable slices, repeat if desired
* Tell if vowel precedes or follows consonant
* Identify consonant: 'p' 't' 'k' 'b' 'd' 'g'

## General Result

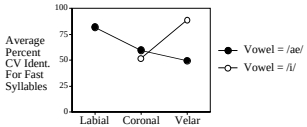
* Fast rate VC stimuli tended to be labeled as CV
* Degree of CV identification varied considerably
* Two contrasting examples below




## Why?
## Segment Differences?

**ANALYSIS**
* Take %CV responses for last (fastest) five VC stimuli
* ArcSine Transform
* Submit to 3-factor ANOVA
  Vowel (/i/ vs. /ae/)
  Place (labial vs. coronal vs. velar)
  Voicing ('voiced' vs. 'voiceless')

**RESULTS**
* No Significant Voicing Effects
* Significant Vowel X Place Interaction and Main Effects for Vowel and Place (shown below)




* Labials and Velars with /i/ resyllabify
* Coronals resist resyllabification
* Velars with /ae/ also resist resyllabification

### Acknowledgements

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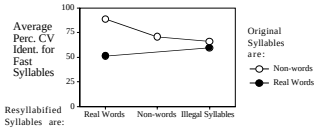
## Lexical Status ?

**ANALYSIS**
* Take ArcSine %CV responses for last five VC stimuli
* Submit to 2-factor ANOVA
  Stimulus (real-word vs. non-word)
  Resyllabified (real vs. non vs. illegal)

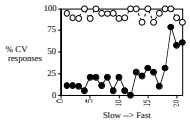
| **Stimulus is** | Real word | Non-word |
|---|---|---|
| **Alternative is** | | |
| Real word | it -> ti | ik -> ki |
| Non-word | | id -> di; ig -> gi; |
| Illegal | aet -> tae; aed -> dae | aek -> kae; aep-> pae<br>aeg -> gae; aeb -> bae |

**RESULTS**
* Significant effect of Stimulus status
* Marginal (non-sign.) interaction




**EXAMPLES**

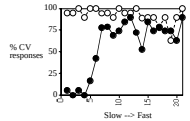
Real /aet/ ('at') doesn't become illegal /tae/




However:

Real /aed/ ('add') does become illegal /dae/

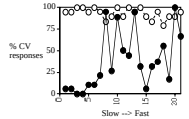
C.f. examples in previous column




Hence, entire phenomenon isn't due entirely to lexical status

Also, some identification patterns are quite complicated

Here, /it/ ('eat') irregularly called /ti/ ('tea')



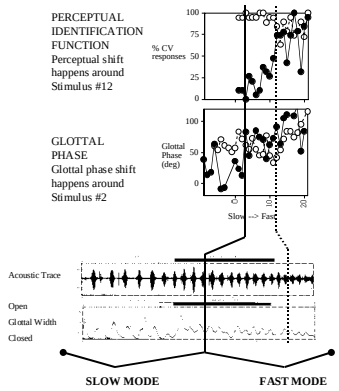

## Glottal Phase Shifts?

**RESTRICTIONS**
* Voiced coda stops
  - generally do not have glottal openings
  - some acquire them at fast rates
* Some voiceless coda stops (e.g., /aet/ in this study)
  - have glottal closures, rather than openings

**PROBLEMS**
* In voiceless coda stops with glottal phase shift
  - perceptual shifts do not always occur (e.g., /it/, at bottom of previous column)
  - perceptual shifts do not synchronize with phase shift (e.g., /ik/ example below)

PERCEPTUAL IDENTIFICATION FUNCTION
Perceptual shift happens around Stimulus #12

GLOTTAL PHASE
Glottal phase shift happens around Stimulus #2




## Summary

1. The robust perception of resyllabification in labial stops is not found in coronals or in some velars

   Possibly this is due to the relative acoustic strength of release in coronal and some velar onsets. The absence of such releases discourages identification of fast rate VC's as onsets

2. Resyllabification perception may partially be due to biases in favor of identifying real lexical items

   However, lexical status doesn't encourage mislabeling fast rate stimuli. Also, resyllabification also happens when lexical status is not directly involved.

3. While articulatory modes might account for shifts in identification, glottal phase is a poor measure of it

### References

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