American English V+/l/ and V+/r/ Sequences: Segments and Gestures

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1.1 Previous Studies

**Schwa-like** element perceived in AmE final V+/l/ & V+/r/ sequences

  - *excrecent* schwa
    - transitional vocalic element after high front vowels
tongue movement through /a/-like configuration from V to C

- **Lavoie & Cohn** (1999)
  - monosyllables of *non-low tense pure vowels* + /l/ or /r/
    - sesquisyllables
    - pronounced with 1 or 2 syllables

- **Hall** (2003, 2006)
  - *intrusive vowels* (vs. epenthetic vowels)
    - are *phonologically invisible*
    - cannot act as *syllable nuclei*
    - do **not** add a *syllable* to the word
    - do **not** involve the *addition* of a *vowel segment*
1.2 The Present Study

➢ OBJECTIVES

To **determine** whether V+/l/ and V+/r/ sequences undergo

- a phonological rule of epenthesis/insertion
- a phonetic process of coarticulation

- To explain the **presence** of the transitional vocalic element.

- To provide experimental data showing the durational and spectral (F1, F2 & F3) **characteristics** of V, T & C.

- To investigate the role of **speaking rate**.
  - To look for **variability** as a function of speaking rate:
    F1, F2, F3 & DUR values for V, T & C
  - To look into V-T and T-C relations:
    F1, F2 & F3 V-T and T-C differences
1.2 The Present Study

EXPECTED RESULTS

Variability as a function of speaking rate

• Duration differences between slow & fast productions
  – different rates (slow vs. fast)
  – intrinsic length of vowels

• F1, F2 & F3 values
  – V, T and C differences as a function of rate
    - different vowels
    - different transitions preceded by different vowels (coarticulation)
    - same consonant preceded by different transitions (coarticulation)
  – V-T and T-C differences as a function of rate
    - greater differences for V-T than for T-C

Articulatory Phonology theory
2. Method

2.1 Speakers

- 6 **subjects**: 2 female, 4 male; aged between 20-40
- speakers of **Midwestern** American English
- little or **no** specialized **phonetic training**

2.2 Stimuli

- **target words**: 15 $C_1VC_2$

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<th>feel</th>
<th>bill</th>
<th>pale</th>
<th>fell</th>
<th>pal</th>
<th>Poll</th>
<th>Paul</th>
<th>hole</th>
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$C_1$: non-lingual & oral to avoid/minimize coarticulatory influence

- **carrier sentence**: *Say ___ for me again.*
- + **distracters**
2.3 Data Collection

- **Production** study
- 10 randomized tokens
- PP presentation
- 2 **readings**: speaking rate variable controlled for
  - **slow** rate:
    - 4-second intervals
    - 3-second break every 20 tokens
  - **fast** rate:
    - 1-second intervals
    - 3-second break every 5 tokens
- 44,000 Hz **sampling rate**
- directly into a **computer**
- **Praat** speech analysis software
2. Method

2.4 Data Analysis

- **Segmentation** into 3 parts: V, T & C
  - "automatic" means
    - 1st derivative curve extraction for F1, F2 & F3 (Praat script)
      To identify
      - peaks of formant change
      - velocity maxima and minima
  - "manual" means
    - spectrographic **observation**
    - auditory **perception**

- **Measurements**
  - extraction – at midpoint (Praat script)
    - of F1, F2, F3 & DUR values
    - for V, T & C
  - calculation – of V-T & T-C differences
    - for F1, F2 & F3
2.4 Data Analysis

Measurement criteria

Say FEAR for me again.

2. Method

FEAR Slow Speaker 1

F1 Derivative
F2 Derivative
F3 Derivative
Say FEAR for me again.

**Measurement criteria**

**F2 Derivative**

- **Speaker 1**
- Data Analysis

**FEAR Slow**

**Say FEAR for me again.**
2.4 Data Analysis

Measurement criteria

FEAR F1 Derivative

FEAR F2 Derivative

FEAR F3 Derivative

FEAR Slow Speaker 1
2. Method

2.5 Statistical Analysis

- **Two-way factorial ANOVAs**

  - For **F1, F2, F3 & DUR** variability in **V, T & C**
    
    *Independent variables: Rate & Context*
    
    *Dependent variables: F1, F2, F3 & DUR mean values*
  
  - For **F1, F2 & F3** variability in **V-T & T-C differences**
    
    *Independent variables: Rate & Context*
    
    *Dependent variables: F1, F2 and F3 mean values from V-T & T-C differences*
3. Results

3.1 Two-Way ANOVAs: V, T & C

- For F1, F2, F3 & DUR variability in V, T & C
  - Independent variables: Rate & Context
  - Dependent variables: F1, F2, F3 & DUR mean values

- Overall significant differences for
  - 6 speakers
  - F1, F2, F3 & DUR
  - RATE
    - slow vs. fast
  - CONTEXT
    - /i/ vs. /ɪ/ vs. /ɛ/ vs. /æ/ vs. /ʌ/ vs. /ʊ/ vs. /u/
  - RATE*CONTEXT
    - /i/ fast = /i/ slow; /ɪ/ fast = /ɪ/ slow; /ɛ/ fast = /ɛ/ slow; etc.
    - need for one-way ANOVAs & post-hoc tests
    - vowels with similar parameters expected to behave similarly
3.1 Two-Way ANOVAs: V, T & C

- **Means** for V, T & C for 5 V+/r/ contexts
- **Overall tendency** for V, T & C means:
  - **smaller difference** between means in SLOW than in FAST
  - **smaller dispersion/separation** in SLOW than in FAST
  - **longer** for V to attain T target & for T to attain C target in SLOW than in FAST

[SLOW and FAST graphs showing differences in pitch (Hz) for V, T, and C with annotations for FEAR, FAIR, PAR, PORE, POOR]
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3.2 Two-Way ANOVAs: V-T & T-C Differences

- For F1, F2 & F3 variability in V-T & T-C
  
  Independent variables: Rate & Context
  Dependent variables: F1, F2 and F3 mean values from V-T & T-C differences

- Overall significant differences for
  - 6 speakers
  - F1, F2 & F3
  - RATE
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- Overall significant differences for
  - V + /l/ & V+/r/ sequences
  - V-T & T-C differences

EXPECTED

UNEXPECTED

- need for one-way ANOVAs & post-hoc tests
- vowels with similar parameters expected to behave similarly
3.2 Two-Way ANOVAs: V-T & T-C Differences

- **Means** for V-T & T-C differences for 8 V+/l/ contexts
- Overall **tendency** for V-T & T-C means:
  - greater differences in SLOW than in FAST
  - higher mean values in SLOW than in FAST
  - longer for V to attain T target & for T to attain C target in SLOW than in FAST
3.2 Two-Way ANOVAs: V-T & T-C Differences

- **Means** for V-T & T-C differences for 8 V+/l/ contexts.
- **Overall tendency** for V-T & T-C means:
  - greater differences in **SLOW** than in **FAST**
  - higher mean values in **SLOW** than in **FAST**
  - longer for V to attain T **target** & for T to attain C **target** in **SLOW** than in **FAST**
4. Discussion and Conclusions

- Despite **segmentation** into 3 parts,
  - V+/l/ & V+/r/ sequences = **segment 1 + transition + segment 2**

- **Variability**
  - Variable V, T & C as a function of **rate**
  - Variable T as a function of **rate**, V & C
  - **Greater V-T** than **T-C differences** as a function of **rate**

- Acoustic **data** and **results** so far:
  - evidence for dynamic process of **coarticulation**
    vs. discrete process of epenthesis/insertion
  - in accordance with **continuous** nature of **speech production**

- Speaking **rate differences**: accounted for by articulatory dynamics
  - **Increase** in speech rate
    vs. **decrease** in time for articulatory gestures to attain targets
  - The faster the rate,
    - the more **overlap** and **blending** in the transition
    - the more **difficult** to **determine** its **beginning** and **end**
Articulatory Phonology

Gestural Score

pool

Lips

Tongue Tip

Tongue Dorsum

Velum

Glottis

4. Discussion and Conclusions

Gestural Score

20/20