The Interaction of Syllabification and Voicing Perception in American English

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Acknowledgements
The current work is supported by
NIDCD [grant # R03 DC04095-01A2]
NSF [grant # BCS-9910701].
Background:

- Types of phonetic explanation in phonological models

A phonological phenomenon is due to …

1. Phonetic strategy
2. Low-amplitude phonetic pressures acting historically
Topic: Syllable-conditioned voicing allophony (in Am. Eng)

- Stops have very different renditions in various low-level prosodic locations.
  - #CV… /d/ → [t] ([d] or [d])
    /t/ → [tʰ]
  - …VC# /d/ → [d] or [t ]
    /t/ → [t ] or [?]  
  - Vowel dynamics differ before /d/ and /t/ in …VC#. 
A generative approach

A generative approach specifies allophonic by rule.

- Language specific feature-changing rules indicating varied segments.
- Language specific realization rules affecting rendering of (say) [voice].

But …
Allophones ‘fit’ syllable location.

- **Onsets:**
  Temporally compacted and more extreme in articulation.

- **Codas:**
  Temporally distributed and less extreme in articulation.
Jakobson, Fant, & Halle (JFH)

Relationship b/w allophony & syllabic location:

- Syllable positions also are 'strong' or 'weak'.
- /t/ is 'strong' and /d/ is 'weak'.
- Aspiration and voicing are redundantly specified to the main contrast.

➡️ The phonemic strength and syllabic strength add up, yielding allophony.
“Two positions are discernible in the Danish word - strong and weak. In monosyllabic words the strong position for a consonant is at the beginning of the syllable and the weak position, at its end.”

(JFH, 1952, p.5)

<table>
<thead>
<tr>
<th>Phoneme</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong /t/</td>
<td>t</td>
</tr>
<tr>
<td>Weak /d/</td>
<td>d</td>
</tr>
</tbody>
</table>

[Reproduced from JFH, 1952, p.6]
Recent approach on syllable

- Syllabification and syllabic context-induced variation are due to segmental factors.

- Factors involved are
  - Contrast Maximization
  - Cue Enhancement
  - Acoustic Modulation
  - Frequency-based Collation
Silverman (ms)

American English allophones

- **CV**
  - *Lenis* (/d/) drifts toward neutral (voiceless).
  - *Fortis* (/t/) driven toward aspiration by perceptual selectivity.

- **VC**
  - *Lenis & Fortis* drift toward neutral (voiceless);
    - Reorient to a durational contrast in the dynamics of preceding vowel and closure;
    - Glottalization enhances the shortening for the voiceless category.
Silverman (Cont.)

- Speakers simply copy distributions of phones from a previous generation.

- Allophony is entirely due to perceptual selectivity which subtly biases productions from generation to generation. Individual speakers do not optimize their code.

- Perceptual selectivity tends to produce certain types of sequencing which can *post-hoc* be abstracted into syllabic units.
Questions:

Is there a detectable relationship between syllable position and the 'voicing' contrast?

In perception ...

- Does 'voicing' affect syllabification?
- Does syllable position affect 'voicing'?
- Do articulatory factors modulate these perceptual effects?
Syllabic parsing

- Fast speech rates induce perceptual resyllabification (Stetson, 1951).

/ ib…. ib….ib…ib..ib.ib.ib/

→ [ib…..ib….ib…bi..bi.bi.bi]

- Phenomenon allows us to examine correlates of syllabic affiliation.
Production Experiment

*Speech materials:*

- 4 native speakers of Am. English.
- Repeated syllables with accelerating speech rates (450 ~ 200 ms/σ).
- Rates were controlled by a metronome.
- 4 different syllables were repeated.

<table>
<thead>
<tr>
<th></th>
<th>Coda structure (VC)</th>
<th>Onset structure (CV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>/b/</td>
<td><em>eeb</em></td>
<td><em>bee</em></td>
</tr>
<tr>
<td>/p/</td>
<td><em>eep</em></td>
<td><em>pea</em></td>
</tr>
</tbody>
</table>
Production ➔ Perception

From vowel offset to vowel onset

Eeb at Slow rate

Eeb at Fast rate
Perception Experiment

**Stimuli:** Spliced 3 syllables per stimulus.

**Listeners:** 23 native listeners of Am. English
Mean ages=20 (range: 18 ~ 23)

**Task:** 4-alternative forced choice test.

‘What do you think the speaker is repeating?’

4 choices are: eeb, eep, bee, or pea.
Predictions: Syllabification

- **JFH**:  
  - Voiceless items are better onsets.  
  - Voiced items are better codas.  
  - Voiceless stops should encourage resyllabification as onset, voiced stops should resist to it.

- **Silverman**:  
  - Voicing allophony indirectly (historically) related to parsing, should have no effect on syllabification.
Regression Results: Perceived Syllabification

<table>
<thead>
<tr>
<th></th>
<th>$R^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syllabification (Intended)</td>
<td>.633</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Rate</td>
<td>.061</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Voicing</td>
<td>.001</td>
<td>.503</td>
</tr>
</tbody>
</table>
Summary: Syllabification

- Our data supports Silverman’s model.
  - Syllabification is not affected by voicing differences.
  - Affiliation is independent of the fortition/lenition continuum.
  - Segmental sequencing might generate allophony, but syllabification does not seem to be cued by such differences.
Predictions: Voicing

- **JFH (extension):** If syllabification induces allophony ‘on-line’,
  - Onsets tend to be voiceless.
  - Codas tend to be voiced.
Predictions: Voicing (Cont.)

- If the connection b/w syllabification and allophony is just historical,
  - Both voiced & voiceless forms should be equally well cued in either syllabic position.
  - No effect.

- Silverman:
  Non-optimal systems are the rule.
  Systems are not optimized, but arise from historical dynamics. Specifically...
Predictions: Voicing (Cont.)

Onsets:
– /d/ occupies ‘unmarked’ category.
– /t/ occupies ‘marked’ location.
– Production factors should push onsets toward the “more natural” /d/ distribution.

Codas:
– No prediction. Vowel dynamics are not discussed.
Onsets: Bias toward voicelessness

Speech rate (Slow – Fast)

% /p/ responses

/b/ /p/
Codas: Bias toward voicedness

Speech rate (Slow - Fast)

% /p/ responses

/b/
/p/
[Reproduced from JFH, 1952, p.6]
Regression Results:

- Onset effect of /b/-devoicing seems to be due to the voiceless glottal gesture being ‘too big’ for fast rate renditions.

- Coda effect of /p/-voicing is very subject dependent. Seems to be due to weakening of glottal gesture and shortening and weakening of closure.
Onsets tend to produce perceptions of /t/.

Codas tend to produce perceptions of /d/.

Markedness is irrelevant for this task.

JFH (extension) is right.
Summary: Voicing (Cont.)

- While voicing does not affect parsing, position does affect voicing. Rate change affects this effect.
  ➔ This effect is rooted in articulatory strategy.

- Syllabic allophony is not due only to historical dynamics, but is plausibly due to a factor encoded in the synchronic production system.
Conclusion

- Diachronic modeling (historical dynamics) of phonetic pressures on phonological system has merit.
- However, simply copying previous generations with a subtle bias underestimates the connectedness of variation to its articulatory sources.
- Articulatory factors seem to be partially responsible for English stop allophonic shifting.
- Such factors are synchronically apparent.
References


Silverman, D. (ms). English alveolar stops, and the nature of allophony, University of Illinois at Urbana-Champaign.


