

The Interaction of Syllabification and Voicing Perception in American English

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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 [d̥])
 / t / → [t^h]
 - ...VC# / d / → [d] or [t]
 / t / → [t] or [ʔ]
 - Vowel dynamics differ before /d/ and /t/ in ...VC#.

A generative approach

- A generative approach specifies allophony 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.**

JFH (Cont.)

“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.)

Phoneme	Position	
	Strong	Weak
Strong /t/	t	
Weak /d/	d	d
		ð

[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.

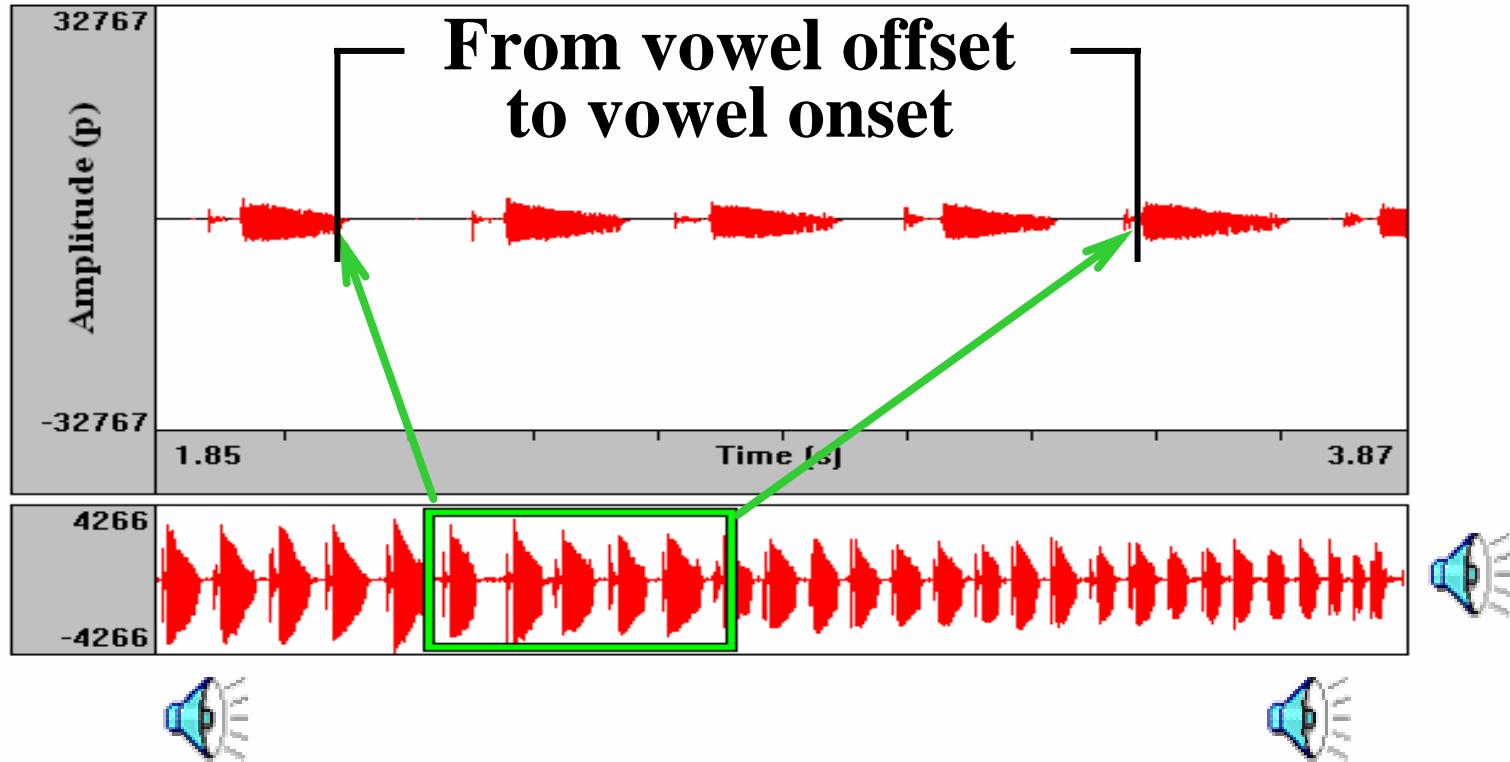
Production Experiment

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.

	Coda structure (VC)	Onset structure (CV)
<i>/b/</i>	<i>eeb</i>	<i>bee</i>
<i>/p/</i>	<i>eep</i>	<i>pea</i>

Production → Perception



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

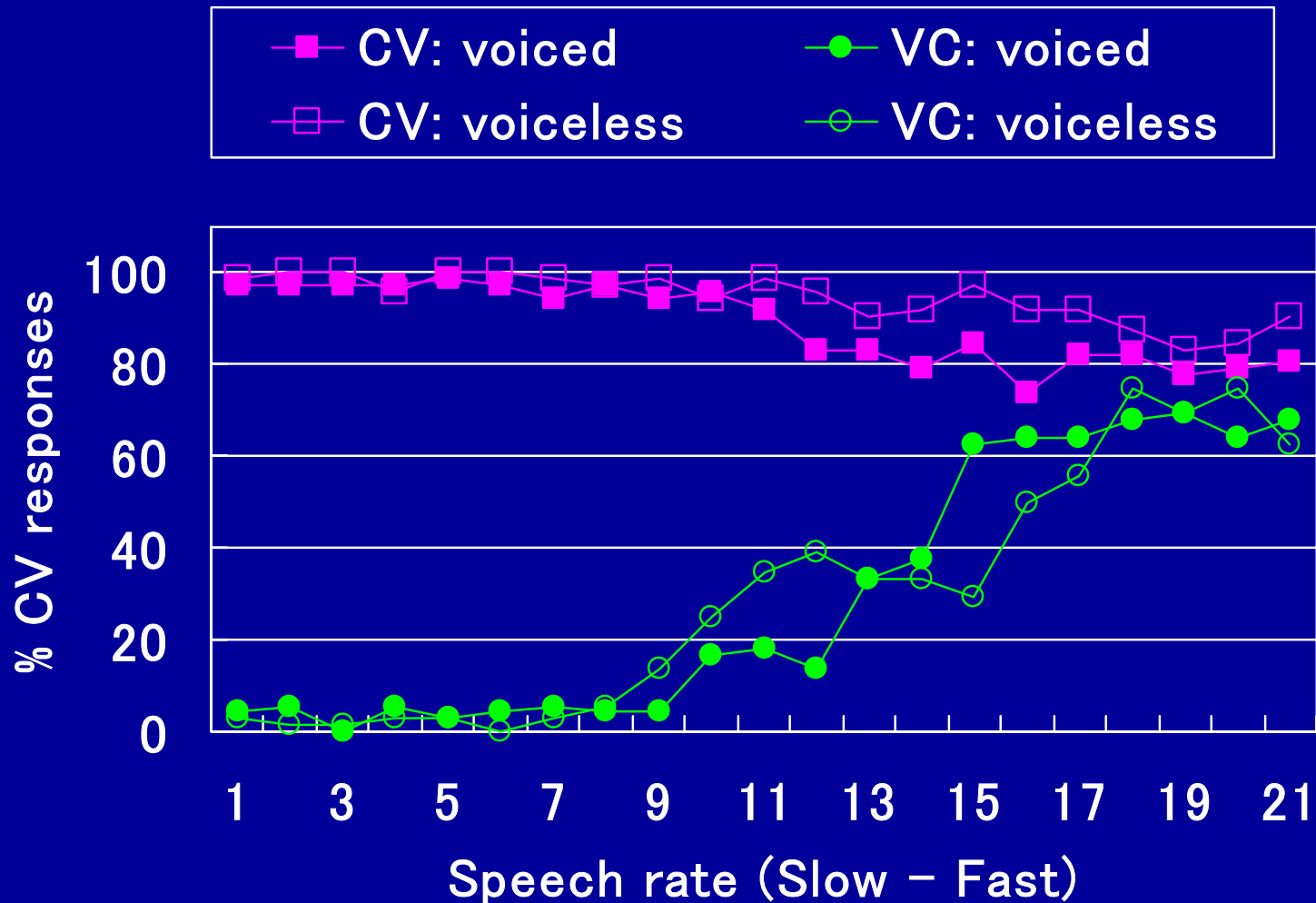
■ JFH:

- 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.

Perceptual shift & Neutralization



Regression Results: Perceived Syllabification

	R^2	p
Syllabification (Intended)	.633	<.001
Rate	.061	<.0001
Voicing	.001	.503

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.)

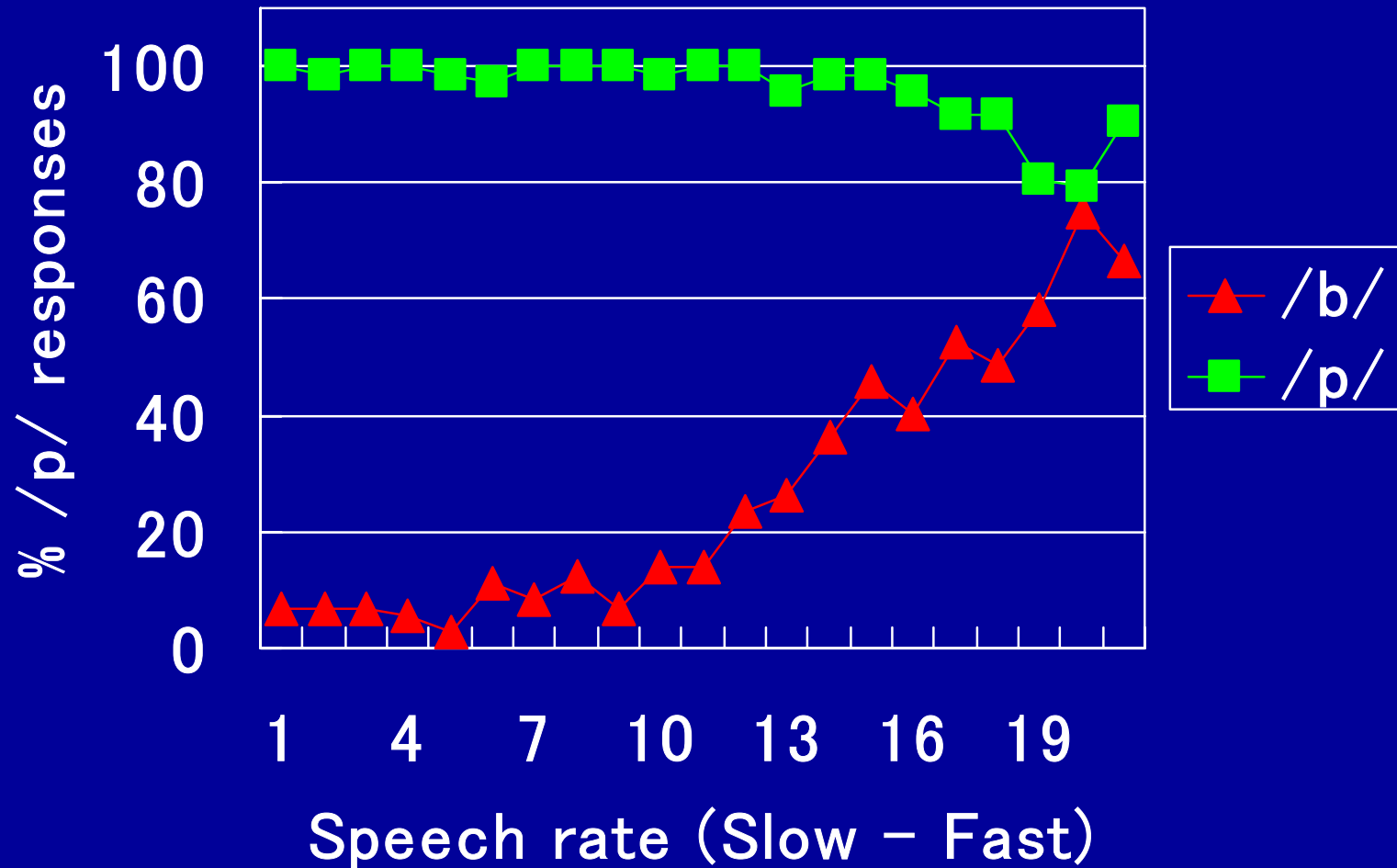
Onsets:

- /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



Codas: Bias toward voicedness

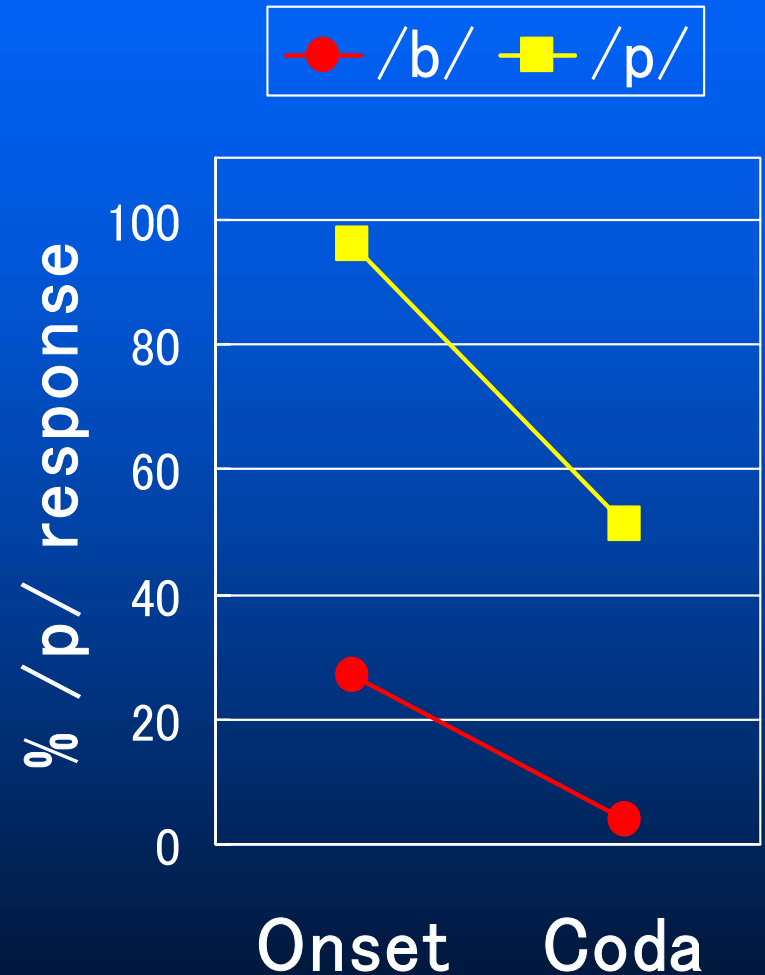


JFH

Phoneme	Position	
	Strong	Weak
Strong /t/	t	
Weak /d/	d	d
		ð

[Reproduced from JFH, 1952, p.6]

Data



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.

Summary: Voicing

- 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.

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