



(a) The Ohio State University

From Consonant Voicing to Vowel Length: Invariant and co-varying cues to final "voicing" in American English

Rebecca L. Morley (a), Bridget Smith (b), Björn Köhnlein (a), and Nohyong Kim (a)

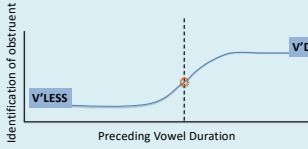


(b) North Carolina State University

INTRODUCTION

"Vowel lengthening" before voiced obstruents in English

Perception



[Denes 1955; Port & Dalby 1982; Raphael 1972, 1981; Luce & Luce 1985; Klatt 1976; Kluender 1988]

Production

Variable by speaker, vowel quality, consonant place, speaking rate, prosodic position; 13 ms – 150 ms difference

[Abdelli-Beruh 2004; House 1953, 1961; Peterson & Lehiste 1960; Mann 1992; Umeda 1975; Smith 2002; Mach 1982; et al.]

Source?

- Voiceless segments require more intraoral pressure → faster transition → shorter V (Chen 1970)
- (Partial) Temporal Compensation: constant syllable duration: longer C closure → shorter V duration (Chen 1970; Kozhevnikov & Chistovich 1967; Peterson & Lehiste 1960)
- Perceptual Enhancement: durational differences of vowel reinforce durational differences of consonants (Chen 1970; Kluender 1988)
- Auditory Contrast without enhancement

Cross-linguistic typology

- English has phonologized pattern while other languages have phonetic tendency? (Chen 1970)

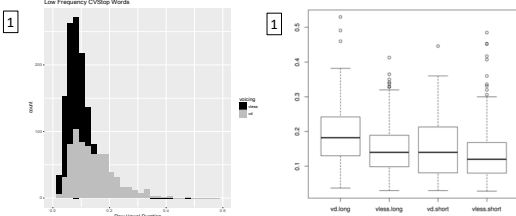
Problem

- Words in isolation not the same as conversational speech

Production Experiments

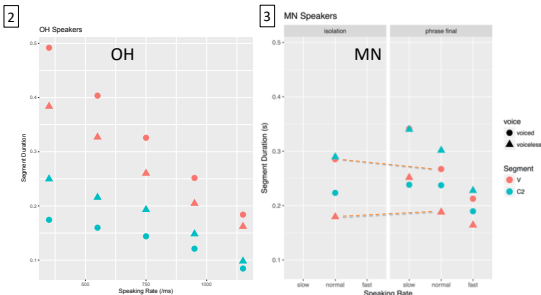
Methods:

1. Buckeye Speech Corpus: utterance-final and low-freq CVC
2. OH: metronome (flashing +) 300-1200 words per minute, single CVC word repetition
3. MN: three speaking rates (normal/slow/fast), 5-7 syllable sentences (92 CVC words in initial, medial, final, and isolation)



CVStop words from the lowest 2 log(freq) quartiles, excluding lax vowels {ə,ɪ,ɛ,ʊ}: 1321 tokens. Utterance-final only: 7814 voiced, 14795 voiceless

- "Vowel lengthening" effect only found primarily phrase-finally (and in isolation)
- Final lengthening of C greater for voiceless, much less for voiced
- Final lengthening of V much greater for pre-voiced, much less for pre-voiceless
- Largest duration difference at longest absolute durations: for both obstruents and vowels, esp. in isolation
- Dialect-specific V to C duration ratio, but phrase-final lengthening effect holds

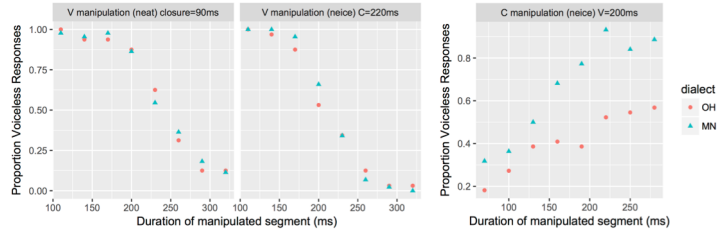


Perception Experiments

Methods:

- Exp A: Comparison OH and MN: isolated words, V manipulation before /t/ and /s/, C manipulation (/s/)
- Exp B: OH only, C manipulation: (2) randomized (word), (3) sequential (word) (4) carrier phrase
- Exp C: OH and MN, Constant CV: rate manipulation of carrier phrase (/pis/)

Exp A: Words in isolation



Replication: vowel duration effect

Consonant duration effect

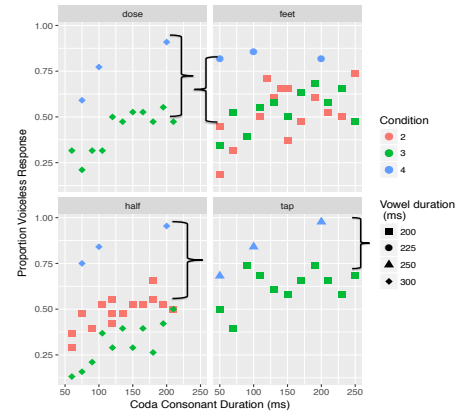
- Strong vowel duration effect for both dialects
- Greater consonant duration effect in dialect with final devoicing

Exp B [2,3,4]: C continua only

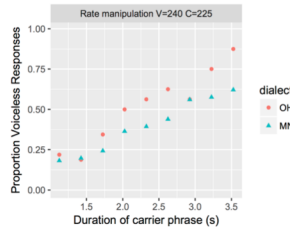
Cond 3 (sequential presentation)

Cond 4 (Carrier Phrase "Please say the word ___ to a stranger")

- Small C duration effect for Conds 2,3
- Strong effect of carrier phrase [Cond 4]
 - Perceived speaking rate
 - Prosodic effects
 - Recovery of C duration cues



Exp C: Speaking Rate



- Effect of speaking rate on cross-over point: voiceless proportion increases as rate decreases
- Perceived vowel duration affected more strongly than perceived fricative duration; steeper slope for OH listeners

Summary of Results

Production

- Significant vowel duration differences only at longest absolute durations, especially phrase-finally
 - Production Experiment (both dialects)
 - Corpus Data
- Final lengthening primarily affects vless C and pre-voiced V, creating a probabilistic split between voiced and vless

Perception

- Consonant duration affects voiced/voiceless judgments
- Perception is also affected by
 - Changes in speaking rate; whether words are heard in isolation or in carrier phrases
 - Whether or not participants hear varying vowel duration during test

Conclusions

- "Voicing" contrast on obstruent codas is cued by both C and V durations (as in word-medial position: Port & Dalby 1982; Denes 1955; Campbell & Isard 1991; Summerfield 1981; Fitch 1981)
- Vowel duration alone is only a sufficient cue in absolute phrase-final position, on inherently long (tense) vowels, in CVC words
- Vowel duration differences are potentially epiphenomenon of upper duration threshold for voiced obstruents, partial compensation on vowel, generalization from / exaggeration of phrase-final distribution of VC ratios

Acknowledgments: This research was partially supported by an OSU Targeted Ideas in Excellence grant. Thank you to Jessica Jelinger and Hannah Young for their assistance in data collection and preparation.