



F0 EFFECTS ON PERCEIVED VOWEL DURATION

CHELSEA SANKER CHELSEA_SANKER@BROWN.EDU
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BROWN

Introduction

- Previous work finds that vowels with dynamic F0 or higher F0 are perceived as longer (e.g. Lehiste 1976; Yu 2010); non-linguistic tones behave similarly (e.g. Brigner 1988)

- Task design:

Often based on multi-step duration ratings
Usually based on synthetic stimuli

- May interact with the voicing effect of longer vowels before voiced codas (Chen 1970)

This study:

- Two experiments on how F0 mean and contour in natural speech affect English speakers' categorization of vowel duration

- And how they interact with influences of coda voicing on the vowel

- *Higher F0 and falling contours make vowels sound longer, but rising contours don't*

Methodology

- **Study 1:** Categorization of isolated vowels as 'long' or 'short' (24 native English listeners)

Extracted from VC nonce words, with codas and transitions into them removed

Blocks based on vowel quality (/a/, /i/, /u/)

10-step vowel duration continuum

(129 ms to 252 ms)

Three F0 contour manipulations:

30 Hz rise, 30 Hz fall, and flat F0

- **Study 2:** Categorization of isolated vowels as 'long' or 'short' (24 native English listeners)

Extracted from VC nonce words, with codas and transitions into them removed

All /i/ vowel quality

10-step vowel duration continuum

(129 ms to 252 ms)

Three F0 mean manipulations:

235 Hz, 205 Hz, and 175 Hz

Summary of results: Regression models

	Estimate	Std. Error	t value	p value
(Intercept)	-2.92	0.124	-23.5	< 0.0001***
DurationStep	0.521	0.0113	46.1	< 0.0001***
Pitch-Fall	0.223	0.0653	3.41	< 0.0001***
Pitch-Rise	-0.0202	0.0653	-0.31	0.757
OrigCodaVoicing-Voiceless	-0.0641	0.0533	-1.20	0.229
Vowel-i	-0.0178	0.0653	-0.27	0.785
Vowel-u	-0.0717	0.0653	-1.10	0.272

Table 1: Generalized linear mixed effects model for 'long' responses in Study 1
Intercept: OrigCoda Voicing = Voiced, Vowel = a, Pitch = Flat

	Estimate	Std. Error	t value	p value
(Intercept)	-1.70	0.211	-8.09	< 0.0001***
DurationStep	0.376	0.0101	37.4	< 0.0001***
Pitch-High	0.223	0.0629	3.55	< 0.0001***
Pitch-Low	-0.124	0.0628	-1.98	0.0475*
OrigCodaVoicing-Voiceless	-0.774	0.0520	-14.9	< 0.0001***

Table 2: Generalized linear mixed effects model for 'long' responses in Study 2
Intercept: OrigCoda Voicing = Voiced, Pitch = Mid

Study 1: F0 contour manipulations

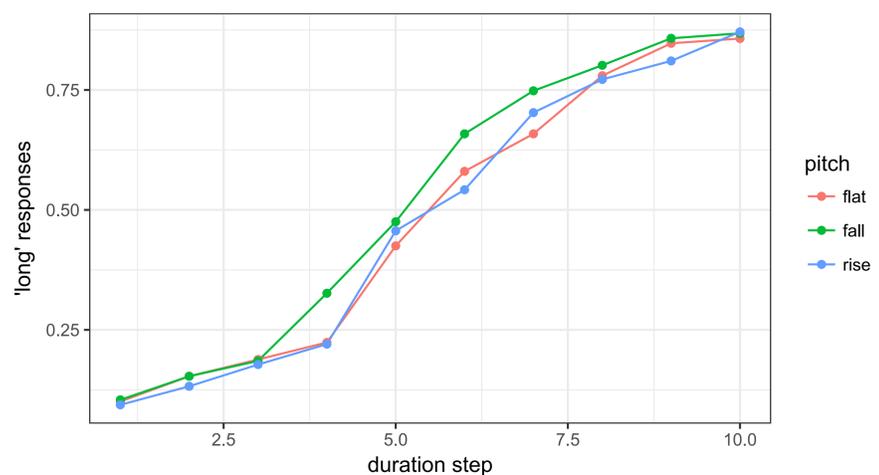


Figure 1: 'long' responses, by coda voicing

More 'long' responses to vowels with falling F0 than other vowels, primarily apparent in the middle of the duration continuum

The voicing of the original coda had no significant effect (Table 1)

Study 2: Mean F0 manipulations

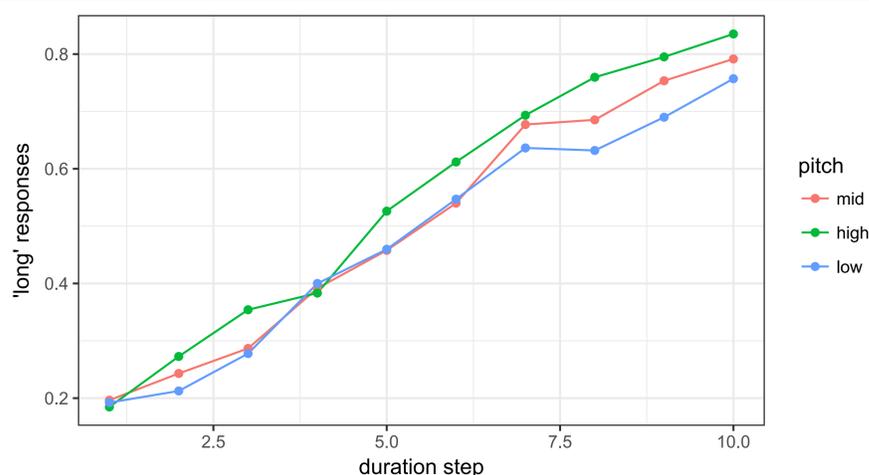


Figure 2: 'long' responses, by original coda voicing

More 'long' responses to vowels with higher F0; mostly a separation between high F0 and lower F0s
Vowels extracted from syllables where they preceded voiced stops were perceived as longer than vowels from before voiceless stops (Table 2)

Conclusions

Effects of absolute F0

- Vowels with high F0 were identified as long more often than those with low or moderate F0
- F0 and duration increase prominence; they may be perceptually conflated

Effects of F0 contour

- Vowels with falling F0 were identified as long more often than those with flat or rising F0
- Correlation between falling F0 and longer duration in other domains may lead to cue mixing

Effects of coda voicing

- Greater perceived duration of vowels produced with voiced codas in Study 2 but not in Study 1
- Voicing can lower F0; contour perception may be a pathway to voicing-conditioned duration

Selected References

- Brigner, W. (1988). Perceived duration as a function of pitch. *Perceptual and Motor Skills*, 67, 301–302.
 Chen, M. (1970). Vowel length variation as a function of the voicing of the consonant environment. *Phonetica*, 22, 129–159.
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 Yu, A.C.L. (2010). Tonal effects on perceived vowel duration. In C. Fougeron, B., Kuehnert, M., D'Imperio, M. and N. Vallée, editors, *Laboratory Phonology 10*, 151–168, Mouton de Gruyter.