

The effect of morphological boundaries on stem vowel duration in English

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Introduction

- ▶ Recent research has found that morphology and phonetic detail may interact
 - ▶ Phonetic detail may be sensitive to morphological information; morphemic word-final /s/ is shorter than monomorphemic /s/ (Plag, Homann & Kunter 2017)
 - ▶ Segments **preceding** morphemic final /s/ are shorter (Zimmermann 2018)
 - ▶ Stem duration of morphemic & non-morphemic words differ; *free#s* vs. *freeze* (Seyfarth et al 2017)



- ▶ First indications that English vowel duration may be dependent on presence or absence of a following word-internal morphemic boundary: *need* vs. *knee#d*

Theoretical Background: Vowel duration in English

- ▶ Vowels are longer before final voiced consonants than before final voiceless consonants (Klatt & Cooper 1975; Klatt 1976; Chen 1970; House & Fairbanks 1953)
- ▶ Some varieties have phonological rules that interact with morphological boundaries
 - ▶ Canadian Raising: doesn't take place before class II suffixes (*eyeful* vs. *Eiffel*) (Bermúdez-Otero 2006:391)
 - ▶ Scottish Vowel Length Rule: vowels are lengthened before /r/, voiced fricatives, and before morphological boundaries (e.g. *brewed* [bru:d] vs. *brood* [brud]) (McMahon 1991; Giegerich 1992)
- ▶ Morphological relatives of a word may influence that word's phonetic realisation (paradigm uniformity; *free* may influence *free#d*) (Seyfarth et al. 2017)

Research Question

- ▶ Is there an effect of the presence or absence of a morpheme boundary on the duration of the vowel preceding final /z/ and /d/? How can we interpret such an effect?
 - ▶ Vowel lengthening rule interacting with morphological information
 - ▶ Paradigm uniformity (i.e. longer vowel before morphemic boundaries; *free* influencing *free#d*)

Methodology

- ▶ Monosyllabic words that end in /t, d, s, z/ in phonological representation
- ▶ Buckeye Corpus (Pitt et al. 2007)
- ▶ English Lexicon Project (Balota et al. 2007)
 - ▶ Data was extracted using corpus query tool Coquery (Kunter 2017)
- ▶ Example words:
 - ▶ Simplex: /z, s/ *jazz, juice* /d, t/ *glad, neat*
 - ▶ Complex: /z/ *keys* /d/ *tried*

Variables

- ▶ Predictor:
 - ▶ Vowel duration in seconds
- ▶ Fixed effects:
 - ▶ Voicing of final consonant
 - ▶ Boundary type
 - ▶ Number of phonemes
 - ▶ Following pause after word
 - ▶ Word form frequency (in Buckeye Corpus)
- ▶ Random effects:
 - ▶ Vowel
 - ▶ Speaker (ID from Buckeye Corpus)

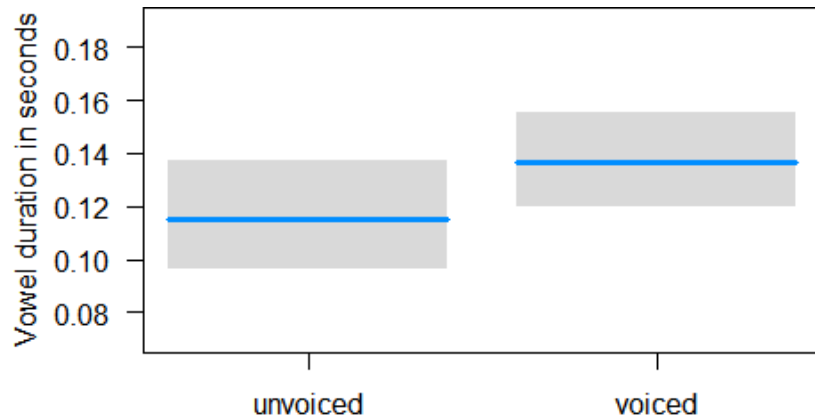
Statistical Analysis

- ▶ Mixed effects regression model using R & lme4 (R Core Team 2015; Bates et al. 2017)
- ▶ Separate models for different subsets
 - ▶ simplex words: /s/ vs /z/, $N=1554$; e.g. *jazz*, *juice*
 - ▶ simplex words: /t/ vs /d/, $N=4258$; e.g. *glad*, *neat*
 - ▶ complex vs. simplex words: /z/, $N=548$; e.g. *cruise*, *keys*
 - ▶ complex vs. simplex words: /d/, $N=369$; e.g. *trade*, *tried*

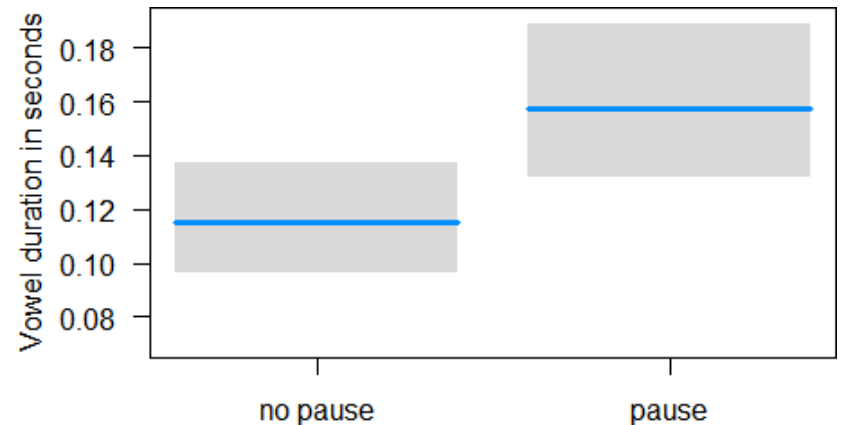
Statistical Analysis

- ▶ Simplex words: Vowel lengthening effect
 - ▶ Vowel duration predicted by voicing of final consonant
 - ▶ Interaction between voicing of final consonant and following pause
- ▶ Complex vs. simplex words: Boundary effects
 - ▶ Boundary type
 - ▶ Interaction between boundary type and following pause
- ▶ Random effects for vowel & speaker
- ▶ No random effect for word due to distribution

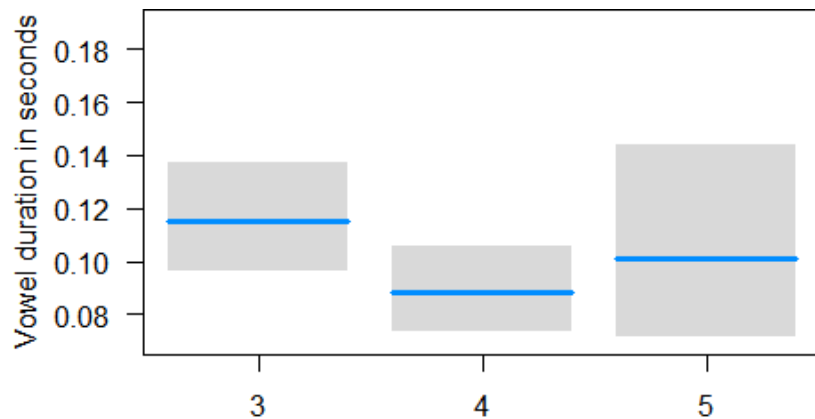
Results: Simplex words ending in /z, s/



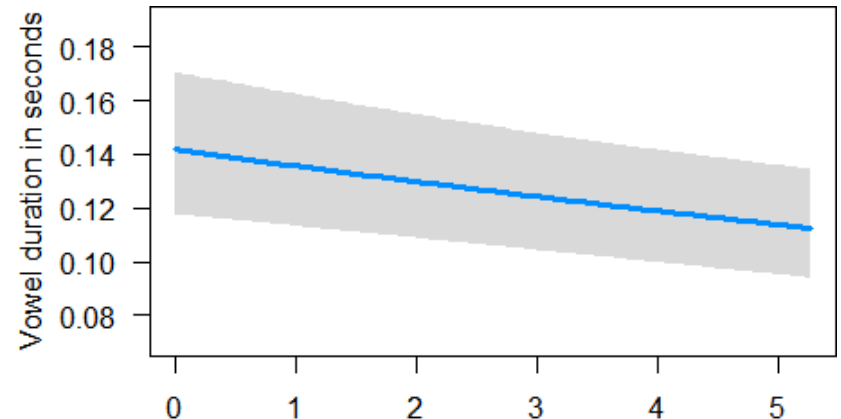
Voicing of final consonant



Following pause

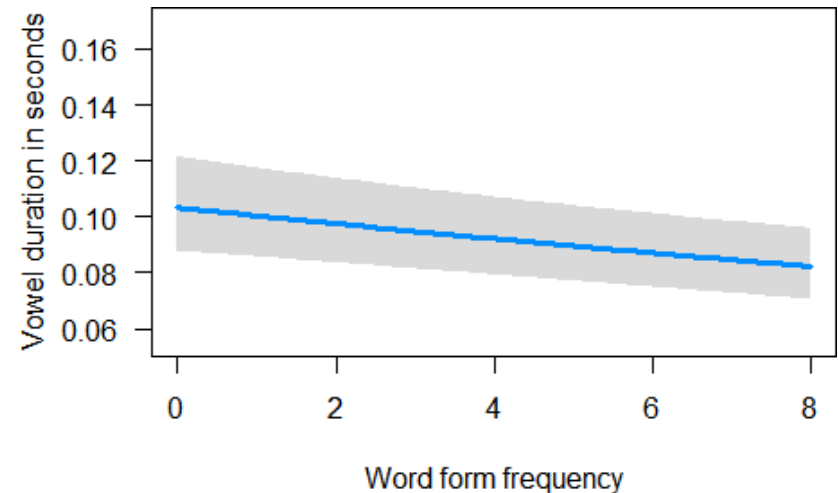
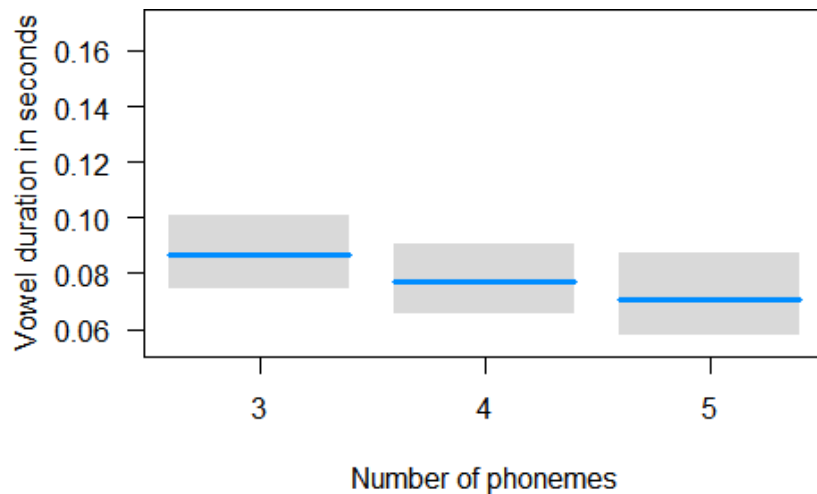
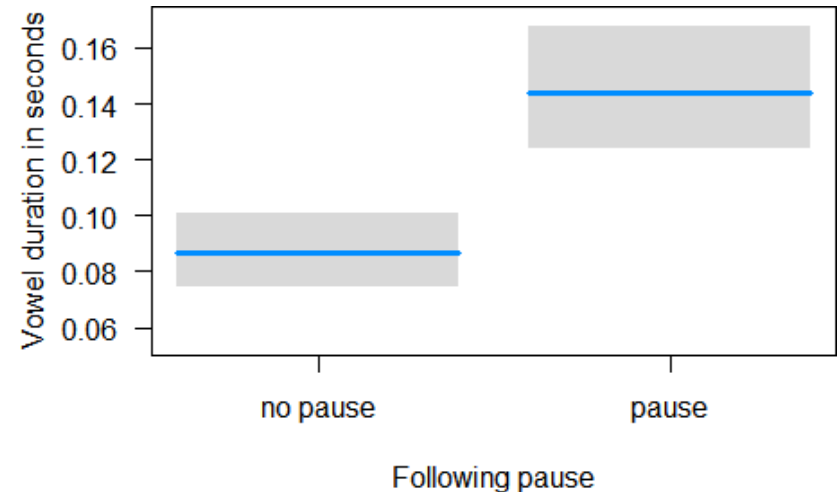
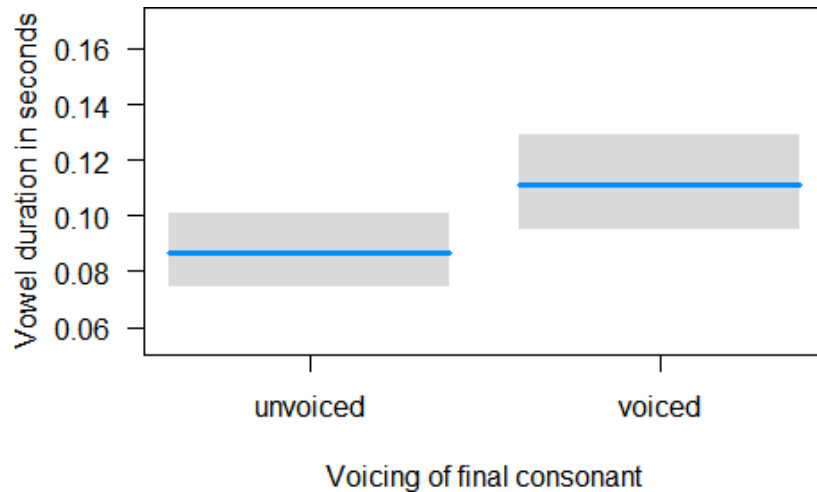


Number of phonemes

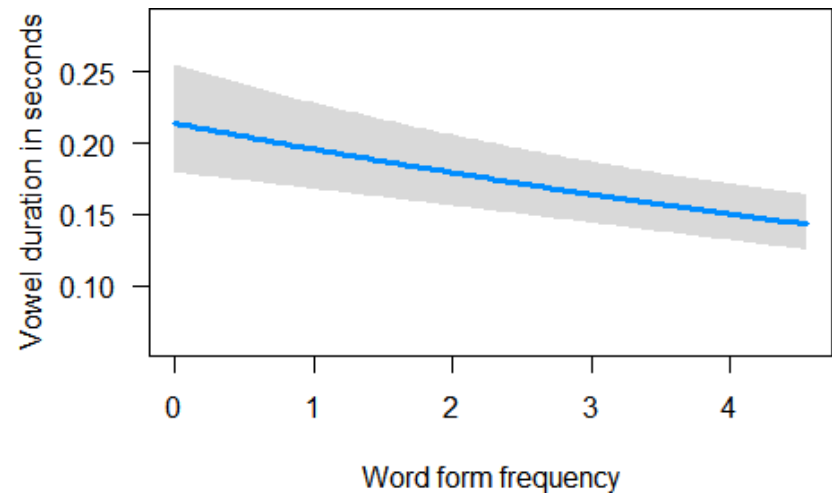
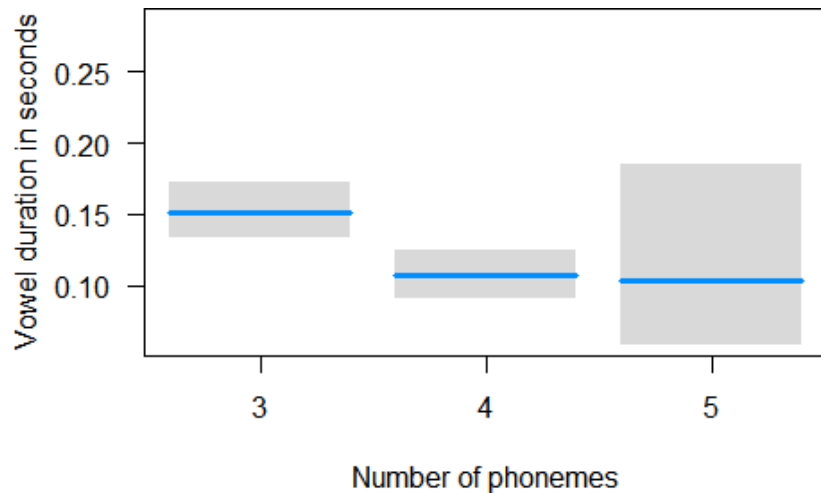
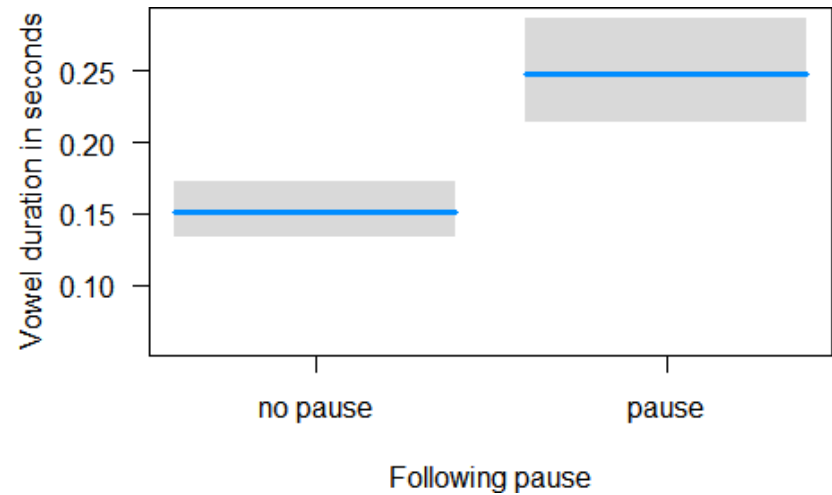
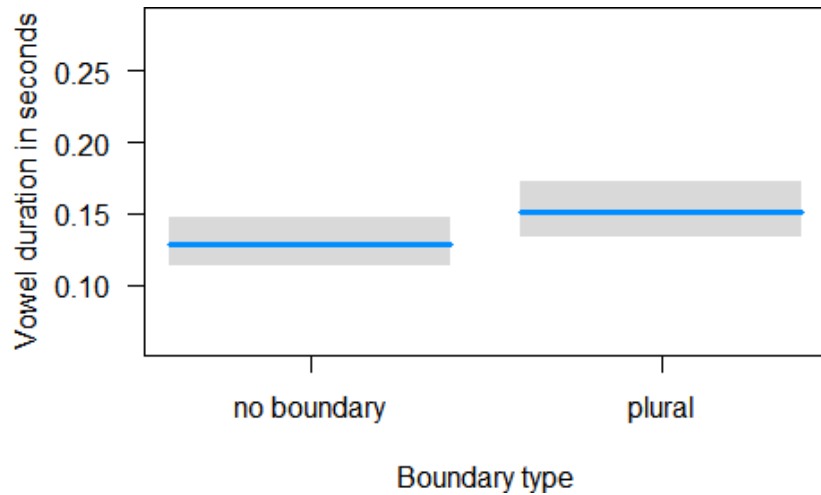


Word form frequency

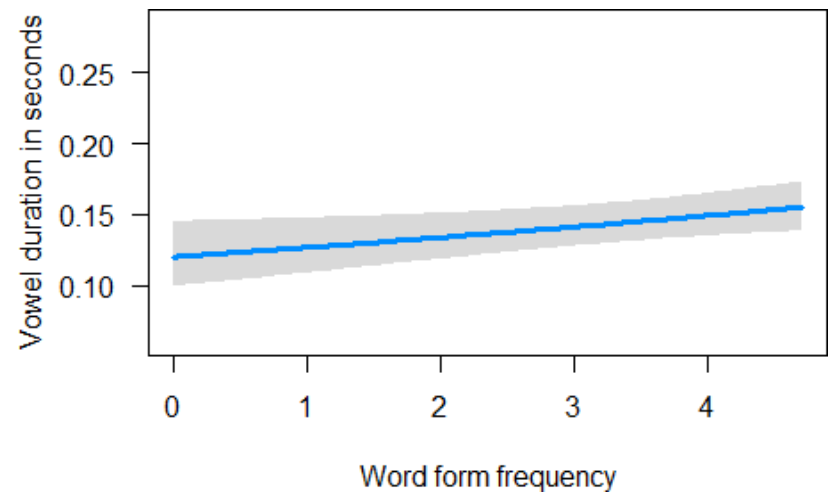
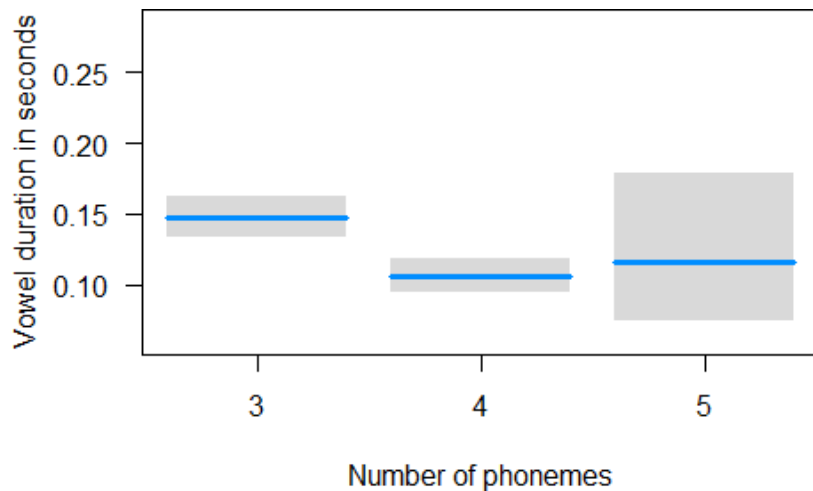
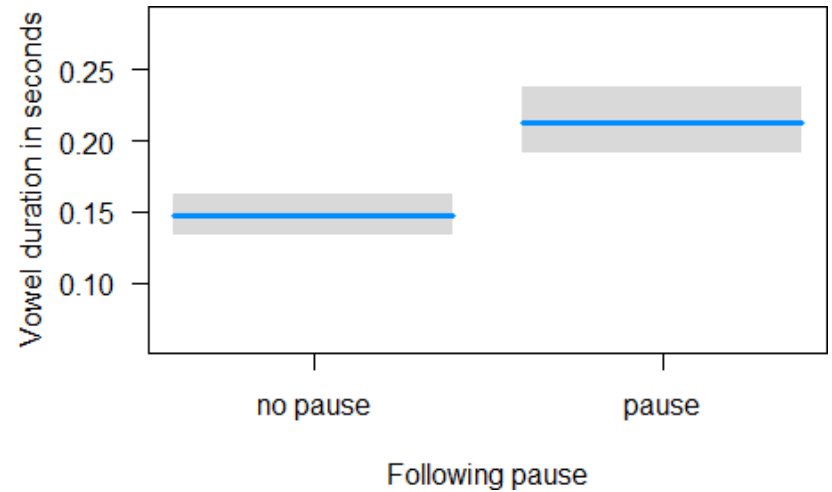
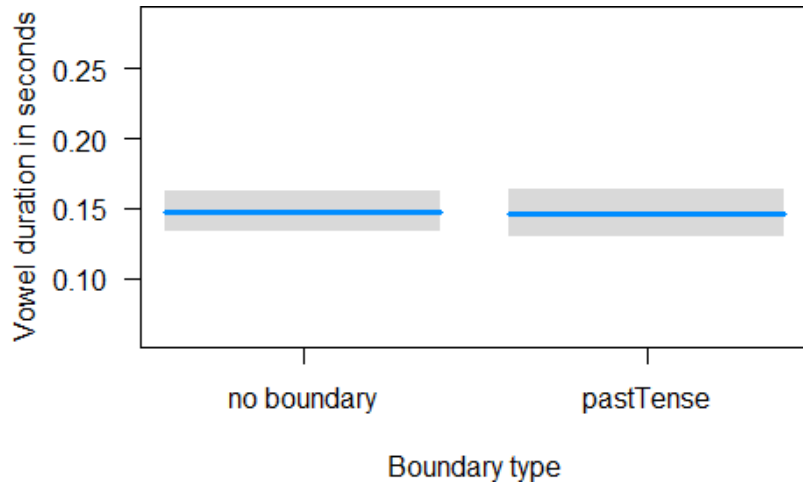
Results: Simplex words ending in /d, t/



Results: Boundary effects for /z/



Results: Boundary effects for /d/



Results: Boundary effects

/z/

- ▶ Vowel before plural /z/ is longer (20 ms) than before non-morphemic /z/.

/d/

- ▶ No effect of past tense morphological boundary on preceding vowel
- ▶ Potentially counter-intuitive effect of word-form frequency

Research Question

- ▶ Is there an effect of the presence or absence of a morpheme boundary on the duration of the vowel preceding final /z/ and /d/? How can we interpret such an effect?

Discussion /z/

- ▶ There is an effect of the boundary on the preceding vowel
- ▶ Results are similar to Seyfarth et al. (2017):
 - ▶ They: 18 ms longer stems
 - ▶ We: 20 ms longer vowels
- ▶ Interpretation 1: Vowel lengthening effect is sensitive to morphological boundary
- ▶ Interpretation 2: Paradigm uniformity

Discussion /d/

- ▶ There is no effect of the boundary on the duration of the vowel
- ▶ Results are in line with Seyfarth et al. (2017)
- ▶ Interpretation unclear
- ▶ Small and potentially skewed sample for /d/: controlled experiments needed

Further research

/z/

- ▶ Test the difference between vowels and consonants preceding the boundary (e.g. *bee#s* vs. *bean#s*)
 - ▶ Paradigm uniformity predicts same effect
 - ▶ Morpho-phonological rule predicts a difference

/d/

- ▶ Try to understand the null effects, or find effects by doing more studies or experiments

Thank you for your attention!

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Results: Simplex words ending in /z, s/

Linear mixed model fit by REML t-tests use Satterthwaite approximations to degrees of freedom [lmerMod]

Formula: LogVowelLength ~ FinalConsVoicingUR + PauseFollows + NumPhonCat + LogFreqBuckeye + (1 + FinalConsVoicingUR | Vowel) + (1 | Speaker)
Data: mmsF

REML criterion at convergence: 1359.6

Scaled residuals:

Min	1Q	Median	3Q	Max
-3.5417	-0.6329	0.0057	0.6327	3.4071

Random effects:

Groups	Name	Variance	Std.Dev.	Corr
Speaker	(Intercept)	0.02743	0.1656	
Vowel	(Intercept)	0.07872	0.2806	
	FinalConsVoicingURvoiced	0.03215	0.1793	-0.88
Residual		0.12714	0.3566	

Number of obs: 1554, groups: Speaker, 40; Vowel, 12

Fixed effects:

	Estimate	Std. Error	df	t value	Pr(> t)	
(Intercept)	-1.954e+00	9.489e-02	1.720e+01	-20.589	1.47e-13	***
FinalConsVoicingURvoiced	1.715e-01	7.124e-02	9.200e+00	2.408	0.0389	*
PauseFollowspause	3.138e-01	2.158e-02	1.512e+03	14.540	< 2e-16	***
NumPhonCat4	-2.675e-01	2.724e-02	1.233e+03	-9.818	< 2e-16	***
NumPhonCat5	-1.276e-01	1.512e-01	1.504e+03	-0.843	0.3991	
LogFreqBuckeye	-4.387e-02	9.949e-03	5.394e+02	-4.409	1.25e-05	***

Results: Simplex words ending in /d, t/

Linear mixed model fit by REML t-tests use Satterthwaite approximations to degrees of freedom [lmerMod]

Formula: LogVowelLength ~ FinalConsVoicingUR + PauseFollows + NumPhonCat + LogFreqBuckeye + (1 | Vowel) + (1 | Speaker)

Data: mmtF

REML criterion at convergence: 5033.9

Scaled residuals:

Min	1Q	Median	3Q	Max
-4.2126	-0.6213	0.0089	0.6149	3.7391

Random effects:

Groups	Name	Variance	Std.Dev.
Speaker	(Intercept)	0.02040	0.1428
Vowel	(Intercept)	0.06091	0.2468
Residual		0.18325	0.4281

Number of obs: 4258, groups: Speaker, 40; Vowel, 12

Fixed effects:

	Estimate	Std. Error	df	t value	Pr(> t)	
(Intercept)	-2.270e+00	8.262e-02	1.900e+01	-27.478	< 2e-16	***
FinalConsVoicingURvoiced	2.446e-01	2.045e-02	4.218e+03	11.960	< 2e-16	***
PauseFollowspause	5.065e-01	1.549e-02	4.223e+03	32.693	< 2e-16	***
NumPhonCat4	-1.172e-01	3.143e-02	4.219e+03	-3.730	0.000194	***
NumPhonCat5	-2.042e-01	7.466e-02	4.221e+03	-2.735	0.006265	**
LogFreqBuckeye	-2.843e-02	6.122e-03	4.057e+03	-4.644	3.52e-06	***

Results: Boundary effects for /z/

Linear mixed model fit by REML t-tests use Satterthwaite approximations to degrees of freedom [lmerMod]

Formula: LogVowelLength ~ BoundaryType + PauseFollows + NumPhonCat + LogFreqBuckeye +
(1 | Speaker) + (1 | Vowel)

Data: monosylz

REML criterion at convergence: 599.9

Scaled residuals:

Min	1Q	Median	3Q	Max
-4.8752	-0.6285	0.0085	0.6113	3.2385

Random effects:

Groups	Name	Variance	Std.Dev.
Speaker	(Intercept)	0.02560	0.1600
Vowel	(Intercept)	0.01325	0.1151
Residual		0.15317	0.3914

Number of obs: 548, groups: Speaker, 40; Vowel, 5

Fixed effects:

	Estimate	Std. Error	df	t value	Pr(> t)	
(Intercept)	-1.70590	0.08923	26.20000	-19.117	< 2e-16	***
BoundaryTypeplural	0.16316	0.04218	479.50000	3.868	0.000125	***
PauseFollowspause	0.49022	0.04412	514.90000	11.111	< 2e-16	***
NumPhonCat4	-0.35390	0.05756	377.20000	-6.149	1.99e-09	***
NumPhonCat5	-0.38319	0.28949	511.60000	-1.324	0.186200	
LogFreqBuckeye	-0.08829	0.01737	456.30000	-5.084	5.41e-07	***

Results: Boundary effects for /d/

Linear mixed model fit by REML t-tests use Satterthwaite approximations to degrees of freedom [lmerMod]

Formula: LogVowelLength ~ BoundaryType + LogFreqBuckeye + NumPhonCat +
PauseFollows + (1 | Speaker) + (1 | Vowel)

Data: monosyld

REML criterion at convergence: 347.2

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.8511	-0.6498	-0.0075	0.7038	2.5841

Random effects:

Groups	Name	Variance	Std.Dev.
Speaker	(Intercept)	0.033935	0.18422
Vowel	(Intercept)	0.001929	0.04393
Residual		0.125116	0.35372

Number of obs: 369, groups: Speaker, 40; Vowel, 4

Fixed effects:

	Estimate	Std. Error	df	t value	Pr(> t)	
(Intercept)	-2.12016	0.09694	129.60000	-21.872	< 2e-16	***
BoundaryTypepastTense	-0.01030	0.04625	266.50000	-0.223	0.8240	
LogFreqBuckeye	0.05432	0.02373	338.50000	2.289	0.0227	*
NumPhonCat4	-0.32554	0.04642	110.80000	-7.013	1.94e-10	***
NumPhonCat5	-0.23950	0.21784	309.90000	-1.099	0.2724	
PauseFollowspause	0.37026	0.04422	343.30000	8.372	1.33e-15	***