

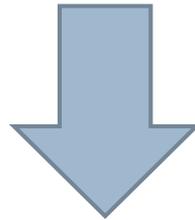
Morphological boundaries and stem duration in English

Paradigm uniformity effects
in conversational speech

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Introduction

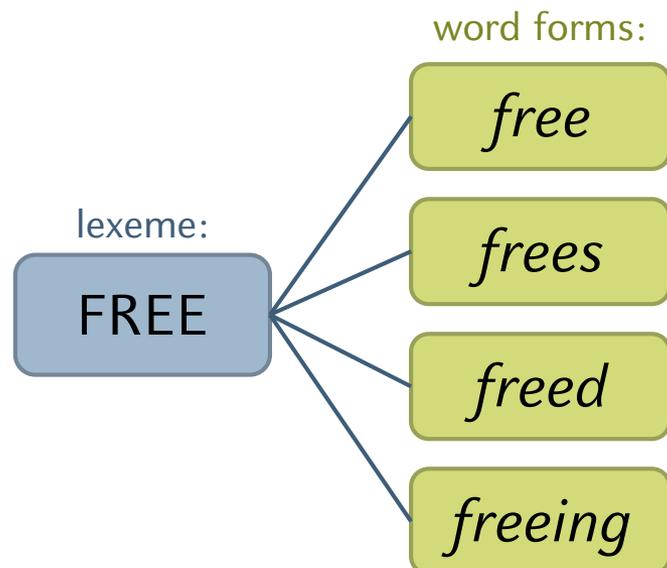
- ▶ phonetic duration may be affected by morphological structure
 - ▶ different types of word-final [s, z] have different durations (Plag, Homann & Kunter 2017; Seyfarth et al. 2017; Tomaschek et al. 2019; Plag et al. 2019)
 - ▶ stems of words ending in [s, z] also have longer durations if these are complex words (Seyfarth et al. 2017)



What is a possible cause of these differences?

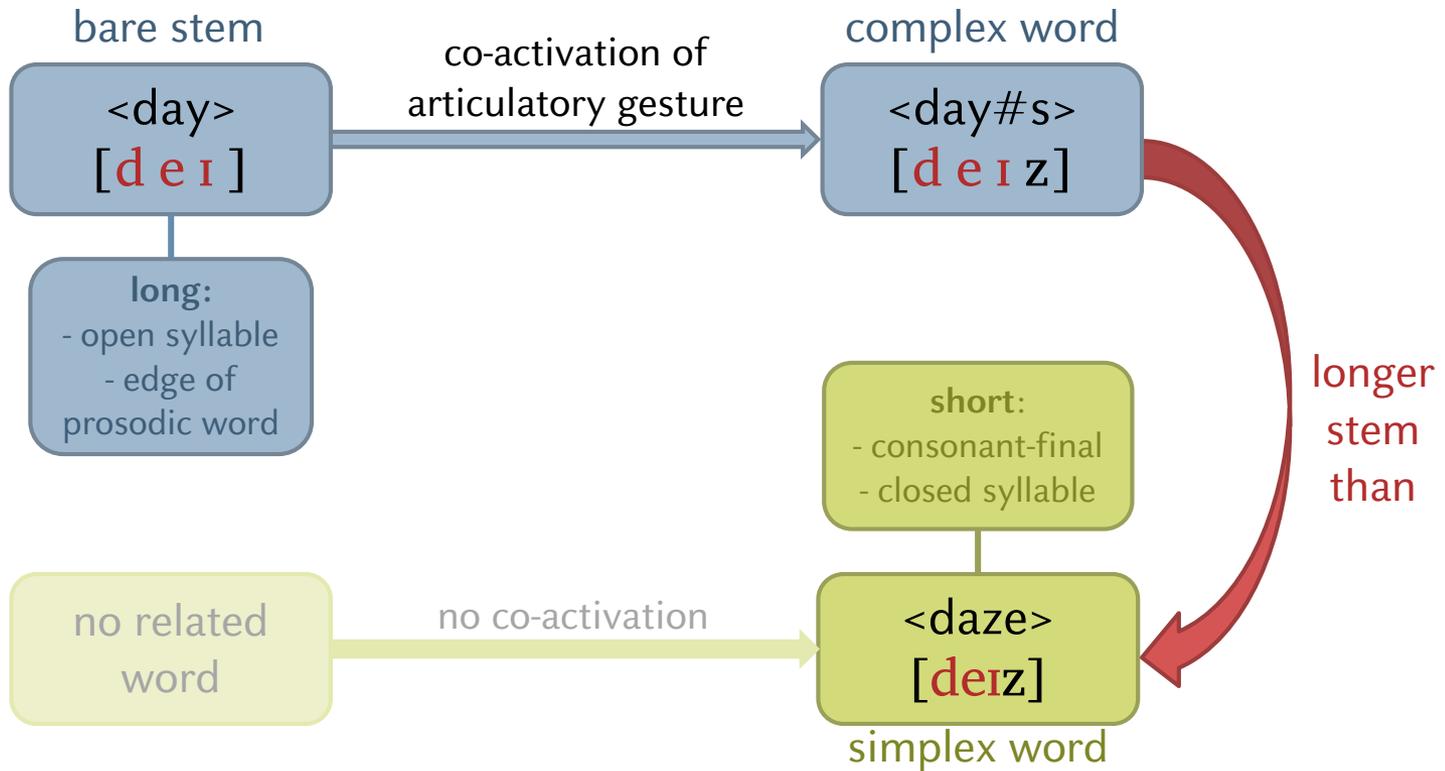
Paradigm uniformity (1/4)

- ▶ paradigm uniformity effect may cause lengthening of complex stems (Seyfarth et al. 2017)
- ▶ What is paradigm uniformity?
- ▶ morphological paradigm consists of set of morphologically related forms
 - ▶ e.g. inflectional paradigms contain all word forms of a lexeme



Paradigm uniformity (2/4)

- ▶ paradigm uniformity effects arise if morphologically complex form is influenced by paradigm members



Paradigm uniformity (3/4)

- ▶ note on terminology:
 - ▶ <day> [d e ɪ] bare stem
 - ▶ <day#s> [d e ɪ z] plural stem
- ▶ we will refer to the corresponding string of sounds in monomorphemic words as ‘monomorphemic stem’
 - ▶ <daze> [deɪz] monomorphemic stem

Paradigm uniformity (4/4)

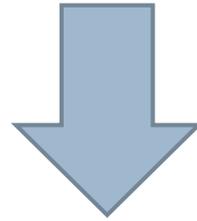
- ▶ Seyfarth et al. (2017) found that categorically, stems of complex words ending in [s, z] are longer than stems of simplex words
 - ▶ *days* is longer than *daze*
 - ▶ categorical paradigm uniformity
- ▶ they further predicted that a stronger representation (~higher frequency) of the stem leads to an even longer duration
 - ▶ found no relation between frequency and duration
 - ▶ gradient paradigm uniformity

The present study

- ▶ we expand Seyfarth et al. (2017) because:
 - ▶ their results only partly confirm paradigm uniformity
 - ▶ they did not discuss their null results for **gradient paradigm uniformity**
- ▶ additionally, we address these problems:
 - ▶ they used phonetically matched dialogues with embedded homophones to emulate natural speech
 - ▶ we use natural speech from a corpus
 - ▶ they recruited speakers of North American English
 - ▶ we use New Zealand English

Hypothesis

- ▶ stems of plural words are longer than stems of non-morphemic words before [z]
 - ▶ a) in corpus data
 - ▶ b) for New Zealand English



categorical paradigm uniformity effect

Data

- ▶ **QuakeBox Corpus** (Walsh et al. 2013) recorded in Christchurch, New Zealand
 - ▶ monologues in which speakers share their experiences in the earthquakes in 2010/2011
- ▶ dataset was originally used for the study of the durations of word-final S (Zimmermann 2016)
- ▶ we use subset to investigate paradigm uniformity (487 tokens, 74 types)
 - ▶ included only words that are
 - ▶ monosyllabic and ending in /z/
 - ▶ monomorphemic or plural
 - ▶ have final /z/ preceded by vowel

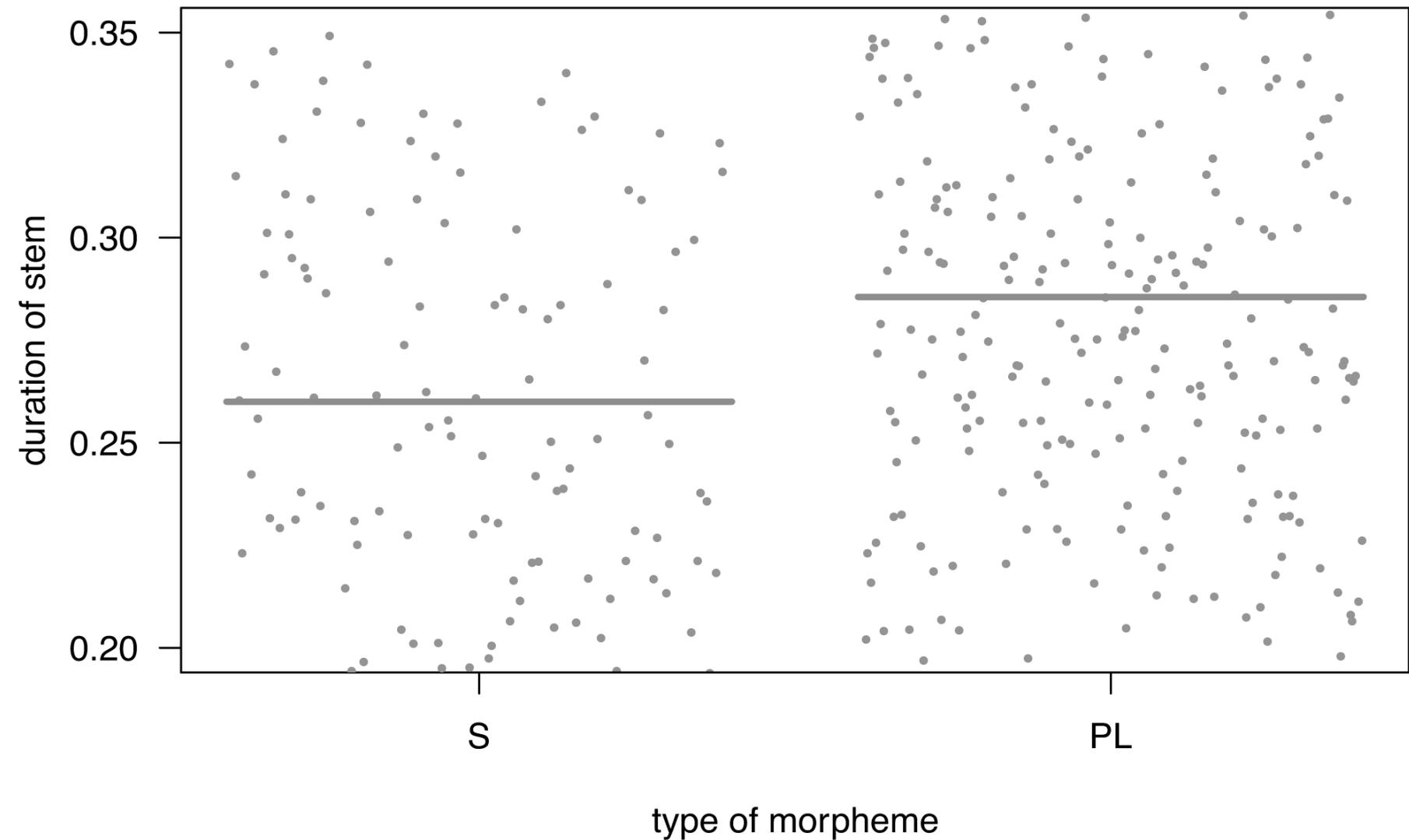
Statistical modeling (1/2)

- ▶ multiple linear regression modeling in R (R Core Team 2015)
- ▶ response variable: **stem duration**
- ▶ predictor variable: **type of morpheme**
 - ▶ monomorphemic or plural
- ▶ 6 covariates:
 - ▶ number of phonemes
 - ▶ word form frequency
 - ▶ speech rate
 - ▶ position within sentence
 - ▶ voicing ratio
 - ▶ age of speaker

Results: Categorical Paradigm Uniformity (1/4)

- ▶ significant effect of type of morpheme on duration of the stem in the expected direction ($p < 0.0005$)
- ▶ plural stems are about 25 milliseconds longer than stems of monomorphemic words

Results: Categorical Paradigm Uniformity (2/4)



Results: Categorical Paradigm Uniformity (3/4)

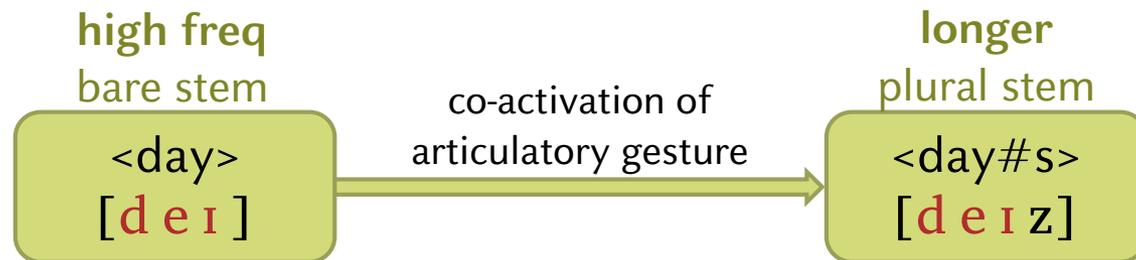
- ▶ covariates show significant effects and behave in expected direction
 - ▶ higher word form frequency = shorter stem
 - ▶ faster speech rate = shorter stem
 - ▶ higher number of phonemes = longer stem
 - ▶ higher voicing ratio = shorter stem
 - ▶ older speakers speak slower

Results: Categorical Paradigm Uniformity (4/4)

- ▶ we find support for categorical paradigm uniformity
- ▶ What is the relation between frequency and duration?
 - ▶ our results: higher word form frequency = shorter duration
 - ▶ Seyfarth et al. (2017) predicted: stronger representation (~higher frequency) of stem leads to even longer duration

Hypothesis 2

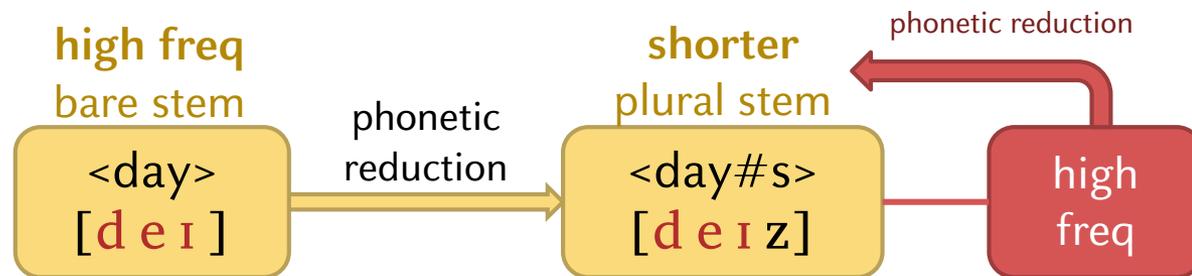
- ▶ higher frequency of bare stem leads to longer duration of plural stem



gradient paradigm uniformity effect
due to **strength of activation**

Alternative: Hypotheses 3

- ▶ a) higher frequency of bare stem leads to shorter duration of plural stem
- ▶ b) higher frequency of plural word-form leads to shorter duration of plural stem



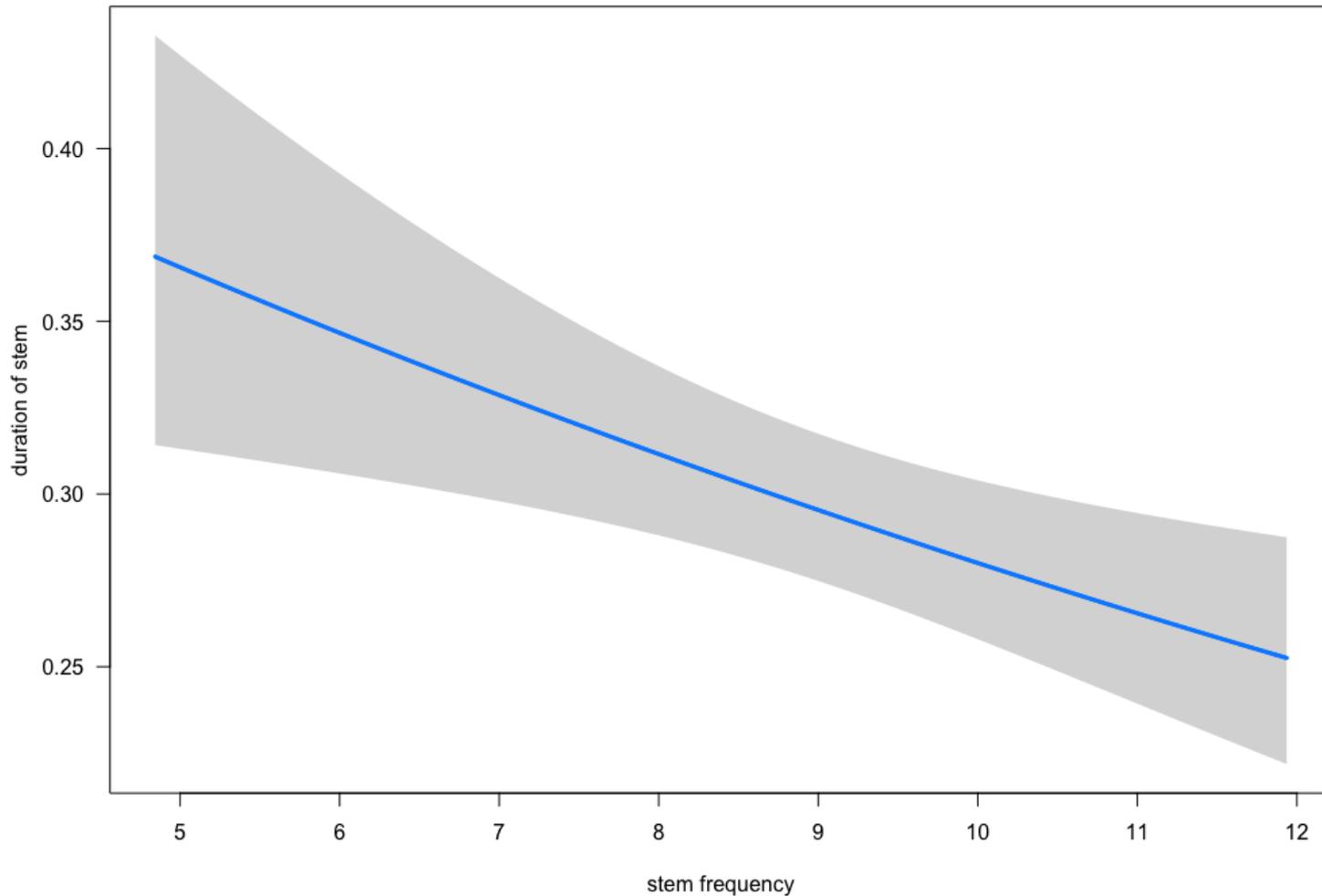
gradient paradigm uniformity effect
due to **phonetic reduction**

Methodology

- ▶ sub-dataset with only plural words (324 tokens, 40 types)
- ▶ response variable: **stem duration**
- ▶ 2 different models with predictor variables: **stem frequency, word form frequency**

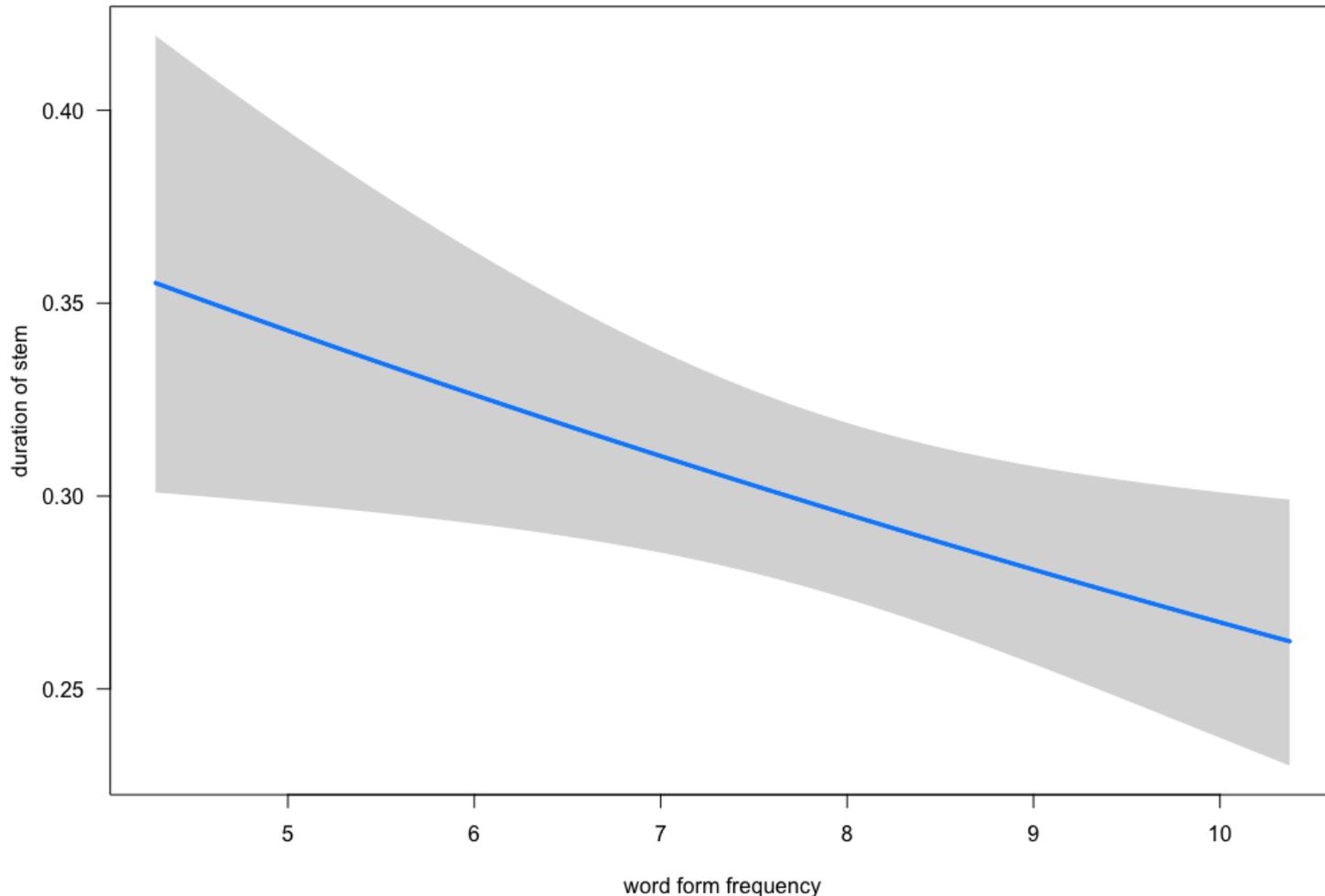
Results: Gradient Paradigm Uniformity (1/4)

- ▶ **stem frequency**: more frequent bare stem causes shorter duration of plural stem



Results: Gradient Paradigm Uniformity (3/4)

- ▶ **word form frequency:** higher frequency of the plural form causes shorter plural stem durations



Results: Gradient Paradigm Uniformity (3/4)

- ▶ our results **refute** hypothesis 2 and **confirm** hypotheses 3:
 - ▶ H2: **higher bare stem frequency \neq longer plural stem duration**
 - ▶ H3a: **higher bare stem frequency = shorter plural stem duration**
 - ▶ H3b: **higher word form frequency = shorter plural stem duration**

Results: Gradient Paradigm Uniformity (4/4)

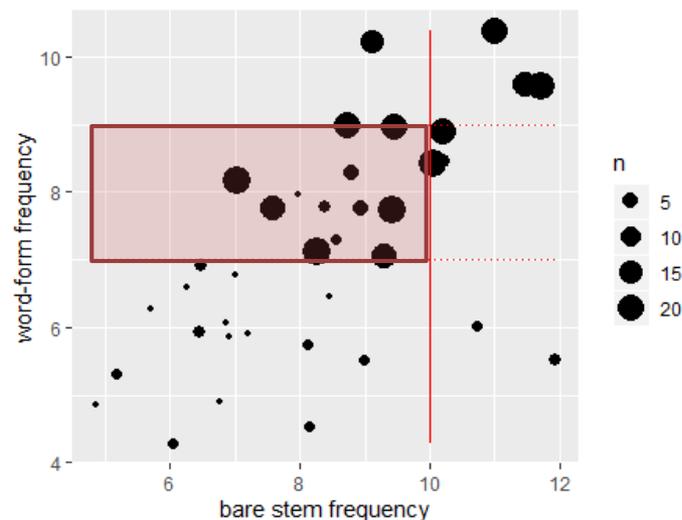
- ▶ we do not find evidence for gradient paradigm uniformity due to **strength of activation**
- ▶ we find evidence for gradient paradigm uniformity due to **phonetic reduction**

Correlation of frequencies

- ▶ word form frequency and bare stem frequency correlate positively in our data set ($\rho=0.61$, $p<0.001$, Spearman test)
- ▶ both correlate negatively with duration
- ▶ shorter plural forms with rising stem frequency might be a masked word-form frequency effect

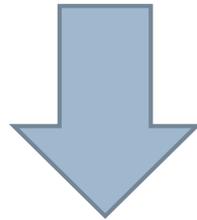
Unmasking word form frequency effects (1/2)

- ▶ we created a model in which frequencies do not correlate
 - ▶ we chose a narrow word-form frequency band in the middle of the distribution that had many observations
- ▶ observations with log word-form frequencies between 7 and 9, and log bare stem frequency of less than 10
- ▶ 164 observations (against 314 in the previous analysis)



Unmasking word form frequency effects (2/2)

- ▶ significant effect of bare stem frequency on the duration of the plural stem
 - ▶ dataset without correlation of word form frequency
 - ▶ dataset without effect of word form frequency on duration



strong support for H3:
phonetic reduction

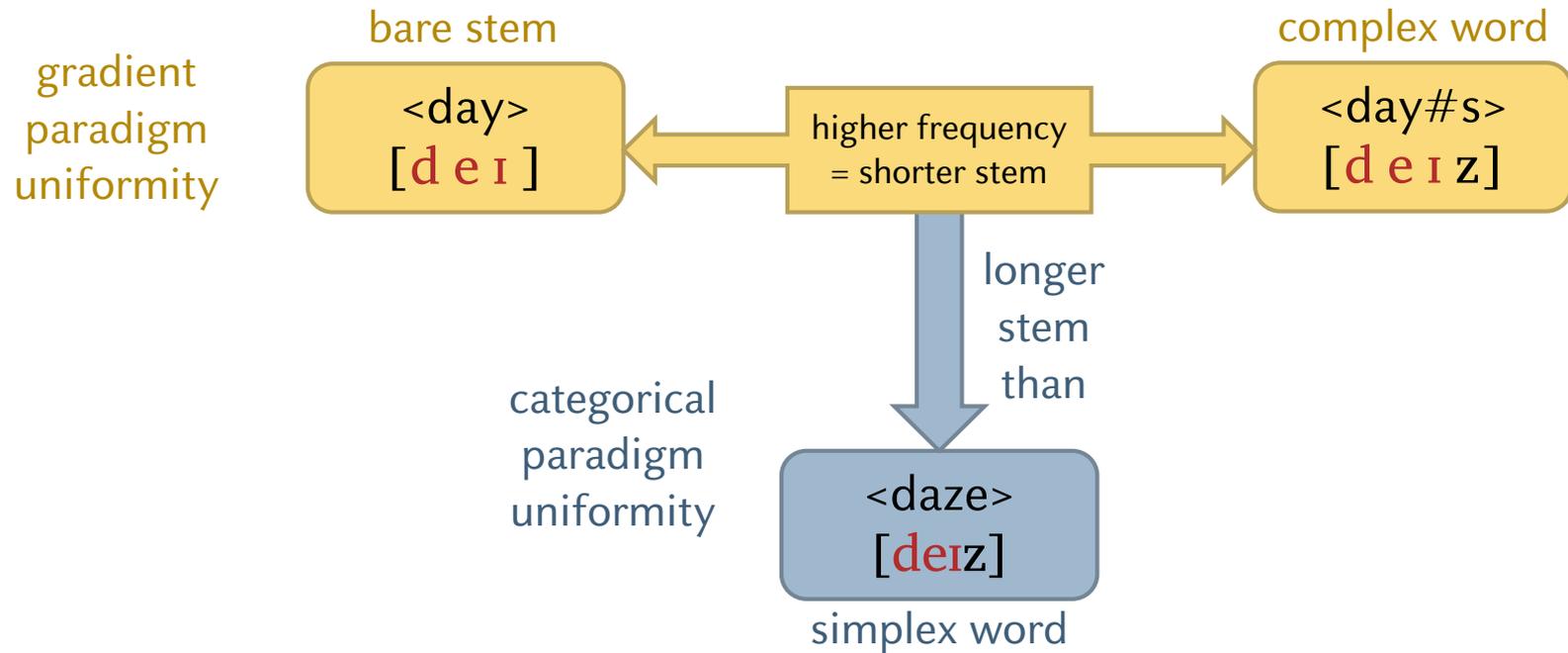
Conclusion (1/3)

- ▶ we tested three predictions following from work on paradigm uniformity on corpus data of New Zealand English (Seyfarth et al. 2017)
- ▶ support for hypothesis 1: **categorical paradigm uniformity**
 - ▶ plural stems are about 25 ms longer than monomorphemic stems
 - ▶ results are in line with Seyfarth et al. (2017) who found that complex stems are 18ms longer
 - ▶ robust effect across different types of data and varieties

Conclusion (2/3)

- ▶ no support for hypothesis 2: gradient paradigm uniformity due to **strength of activation**
 - ▶ contrary to what Seyfarth et al. predicted
- ▶ support for hypothesis 3: gradient paradigm uniformity due to **phonetic reduction**
 - ▶ general reduction effect of high frequency forms on paradigm members

Conclusion (3/3)



Thank you for your attention!

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