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Spoken Morphology: Phonetics and phonology of complex words

Morphological boundaries and stem duration in English

Paradigm uniformity effects in conversational speech

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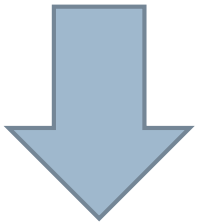
P&P Conference Düsseldorf, 27th September 2019

Introduction

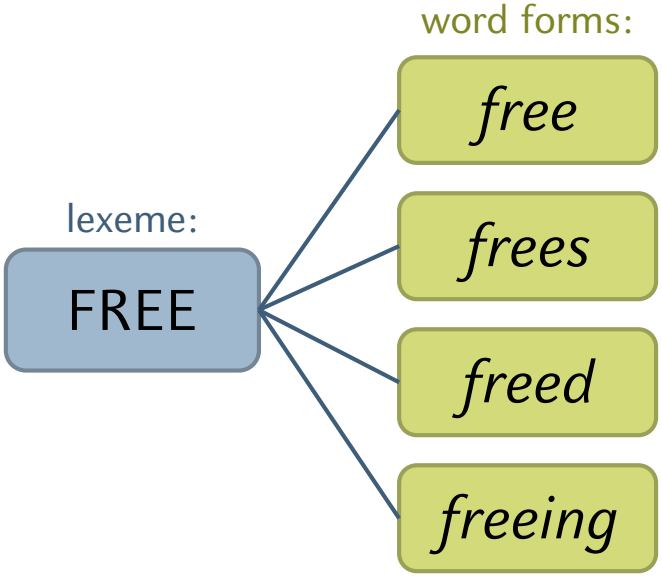
- phonetic duration may be affected by morphological structure
  - different types of word-final [s, z] have different durations (Plag, Homann & Kunter 2017; Seyfarth et al. 2017; Tomaschek et al. 2019; Plag et al. 2019)
  - stems of words ending in [s, z] also have longer durations if these are complex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



What is a possible cause of these differences?

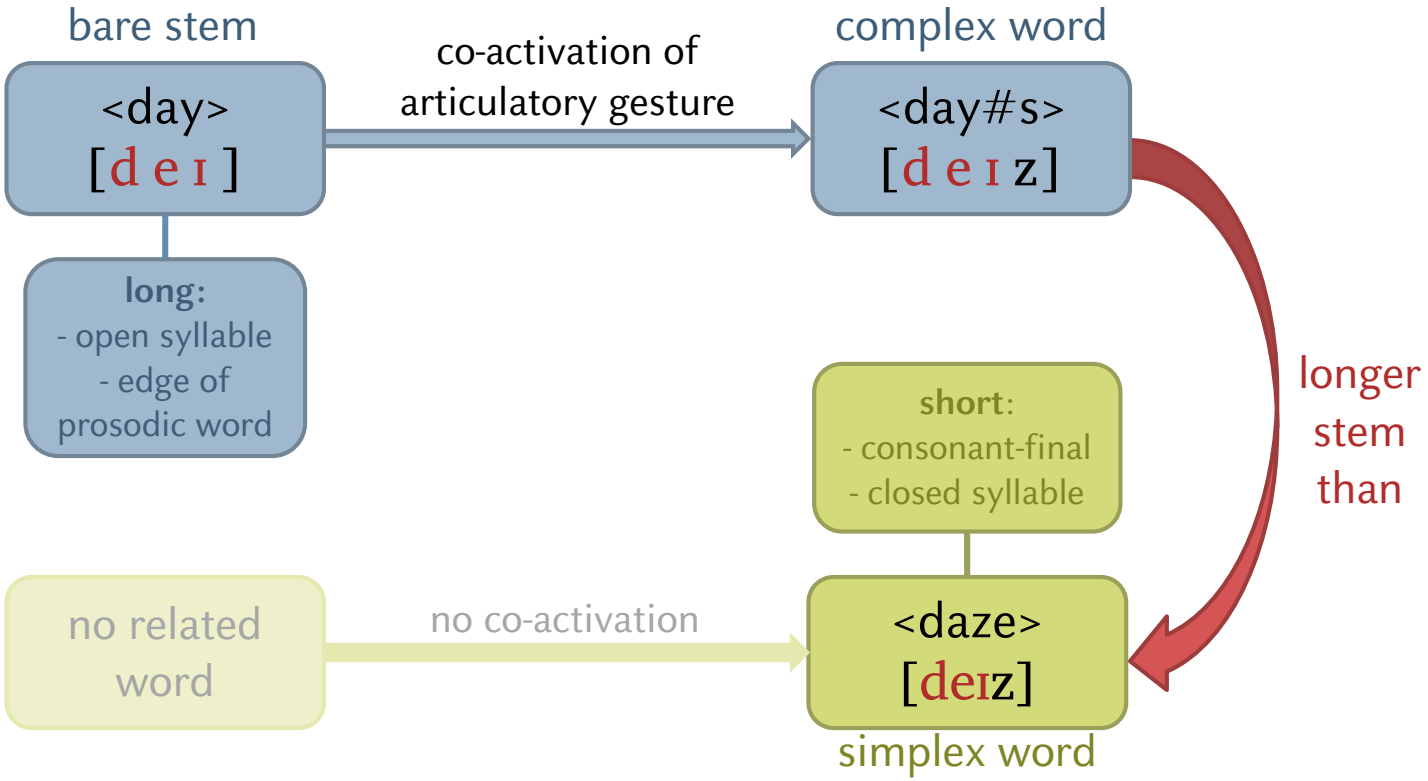
Paradigm uniformity (1/4)

- 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] pural stem
- we will refer to the corresponding string of sounds in monomorphemic words as ‘monomorphemic stem’
  - <daze> [deɪz] monomorphemic stem

Paradigm uniformity (4/4)

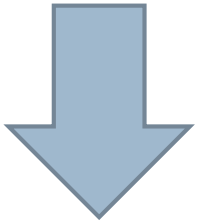
- Seyfarth et al. (2017) found that categorically, stems of complex words ending in [s, z] are longer than stems of simplex words
  - *days* is longer than *daze*
  - categorical paradigm uniformity
- they further predicted that a stronger representation (~higher frequency) of the stem leads to an even 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

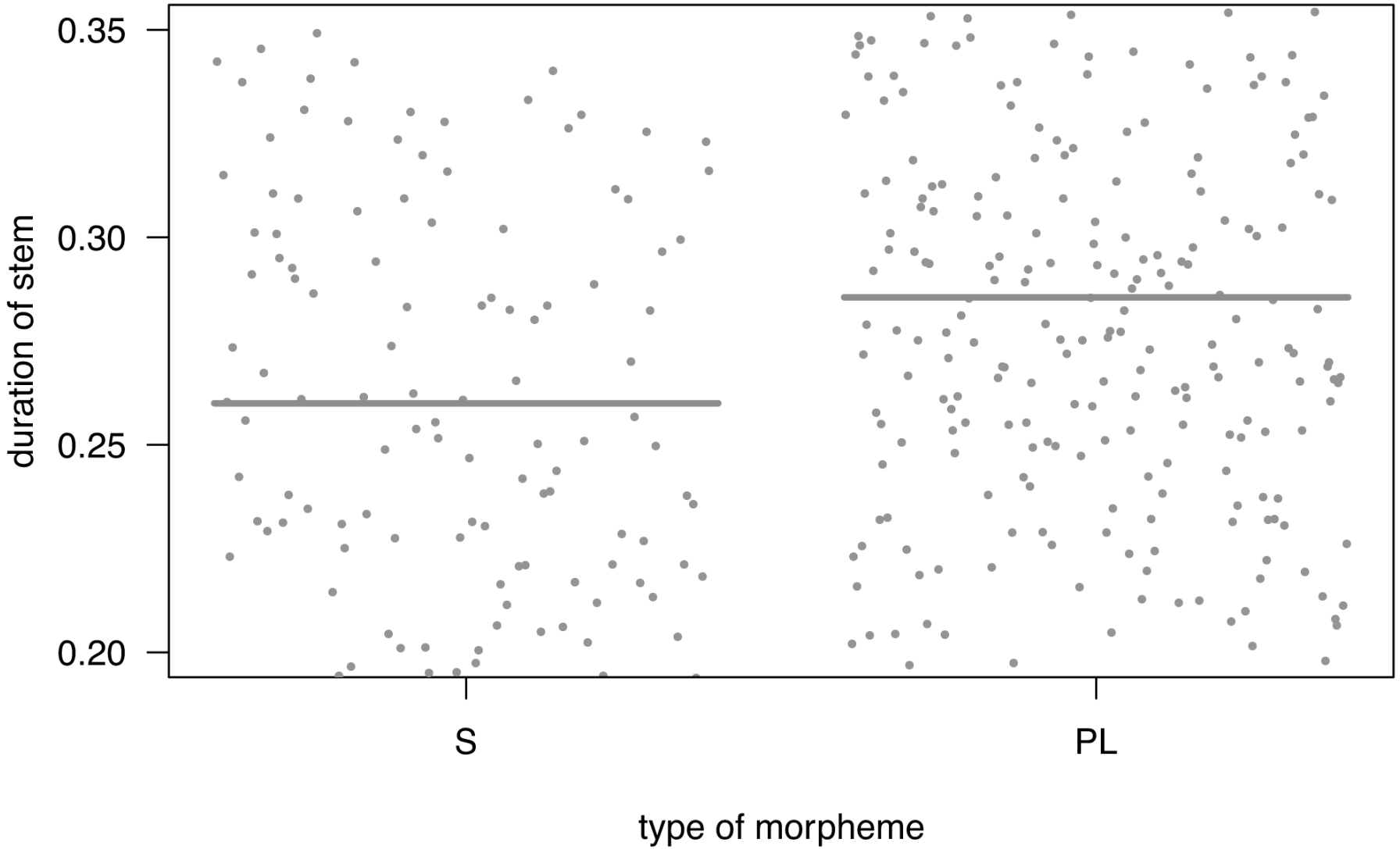
Statistical modeling (1/2)

- 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)

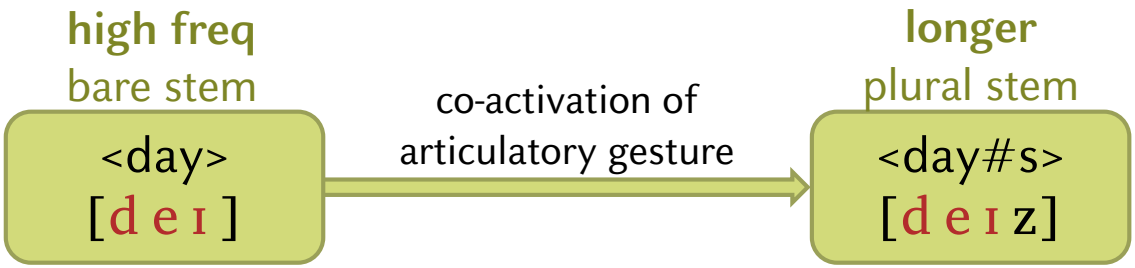
- covariates show significant effects and behave in expected direction
  - higher word form frequency = shorter stem
  - faster speech rate = shorter stem
  - higher number of phonemes = longer stem
  - higher voicing ratio = shorter stem
  - older speakers speak slower

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

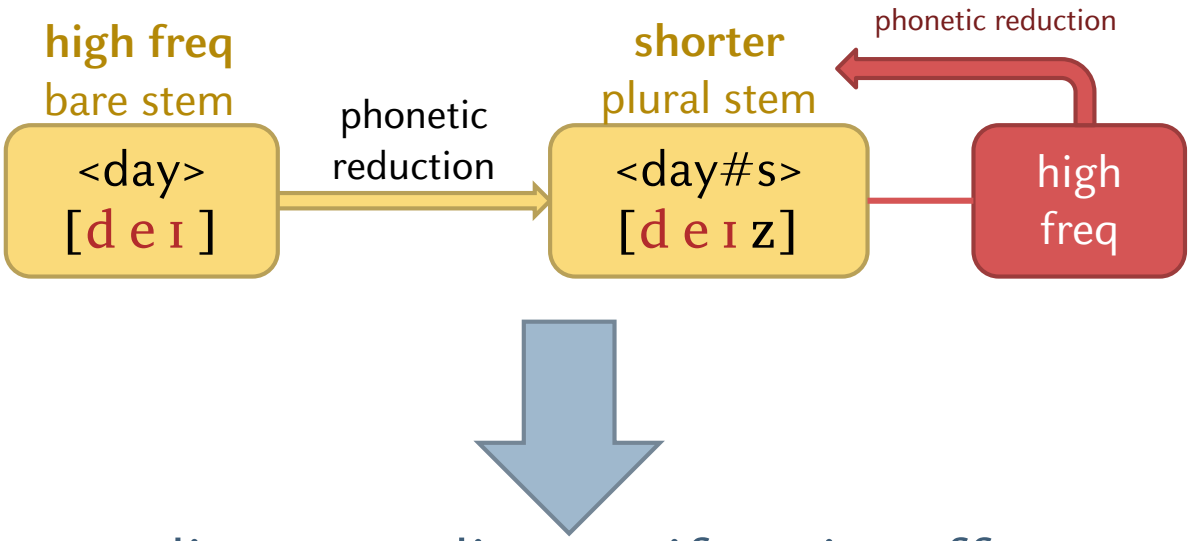
- higher frequency of bare stem leads to longer duration of plural stem



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



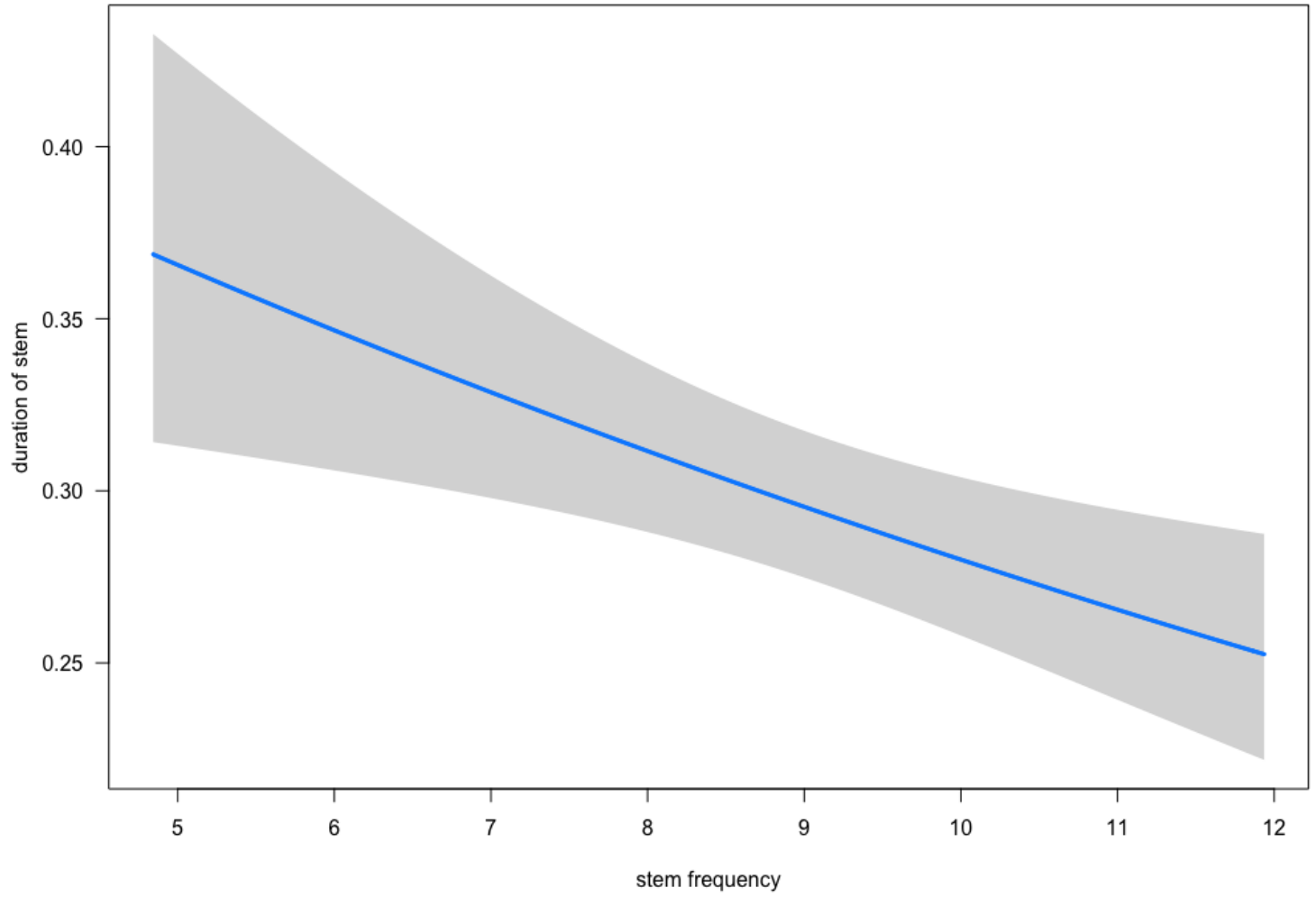
gradient paradigm uniformity effect
due to **phonetic reduction**

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**

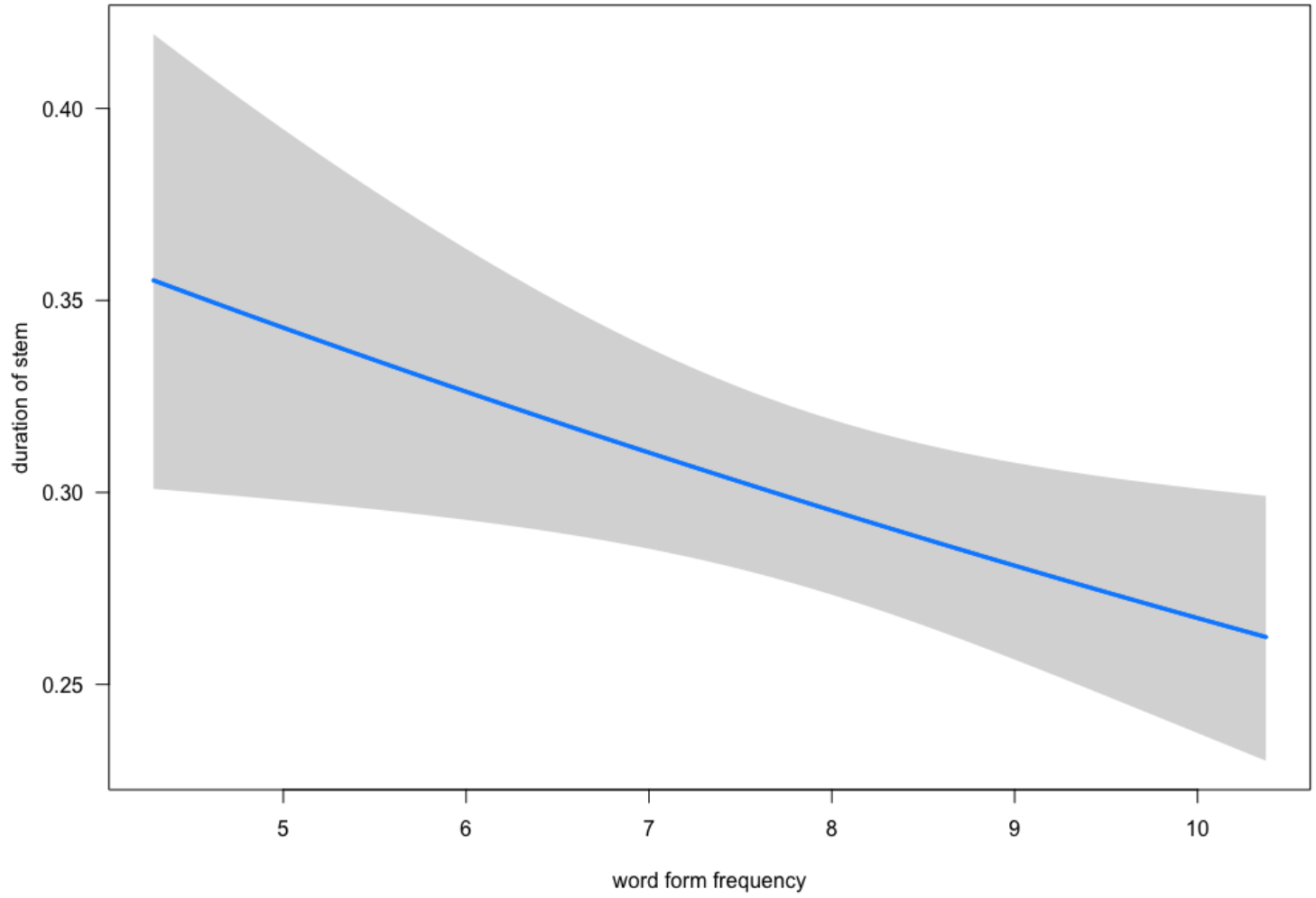
Results: Gradient Paradigm Uniformity (1/4)

- **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 ≠ 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)

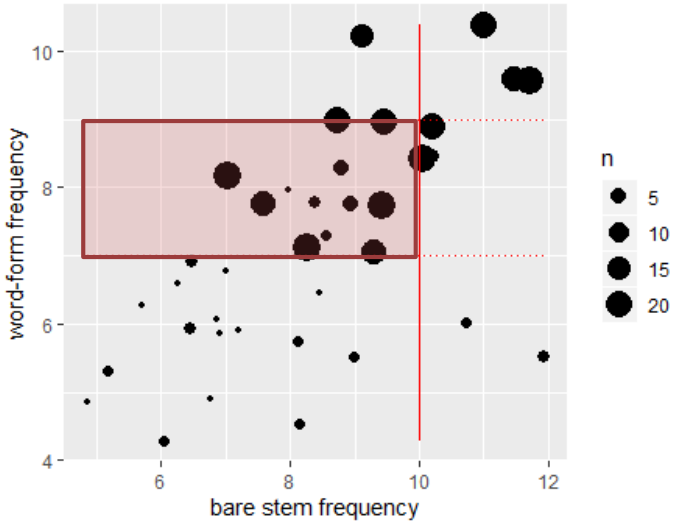
- we do not find evidence for gradient paradigm uniformity due to strength of activation
- we find evidence for gradient paradigm uniformity due to **phonetic reduction**

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

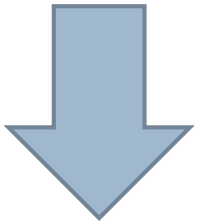
Unmasking word form frequency effects (1/2)

- 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

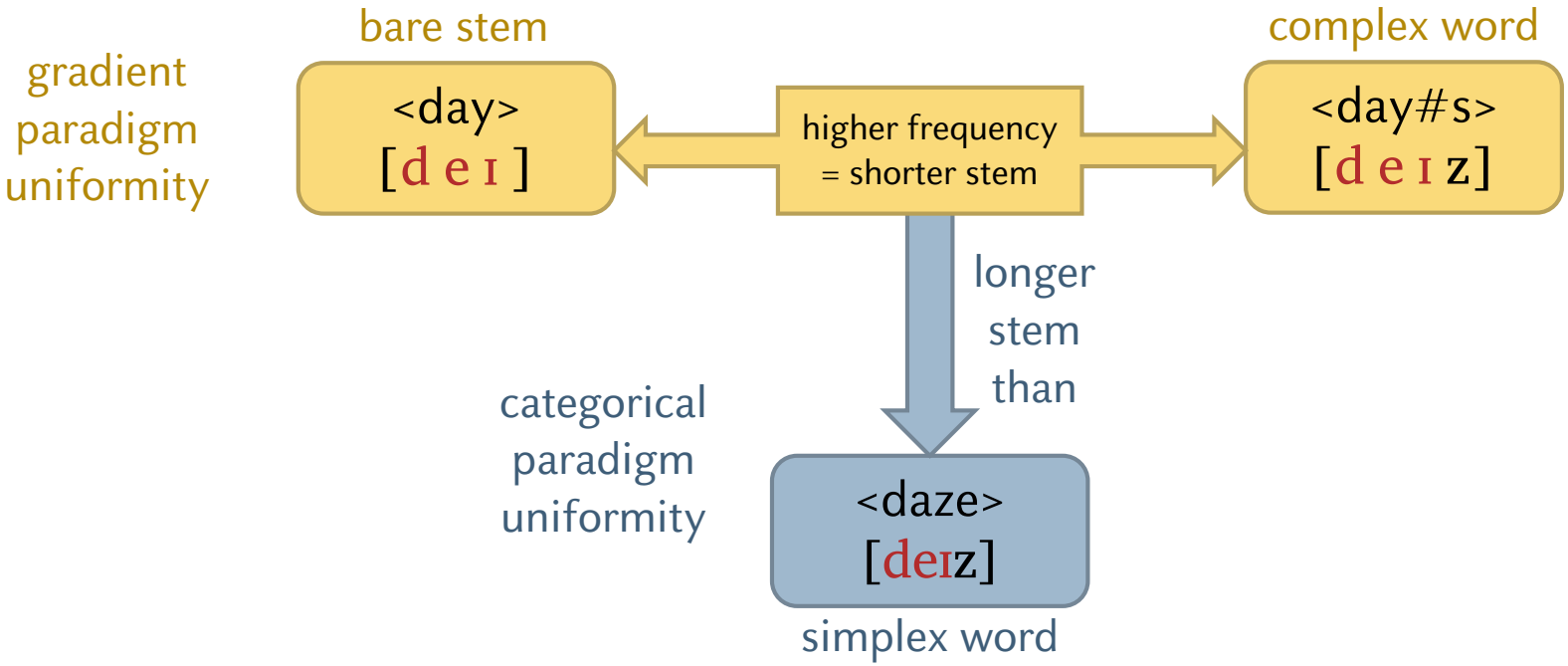
Conclusion (1/3)

- 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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