Subphonemic detail affects morphological processing

Dominic Schmitz, Marie Engemann, Ingo Plag, and Dinah Baer-Henney

MORPHOLOGY IN PRODUCTION AND PERCEPTION
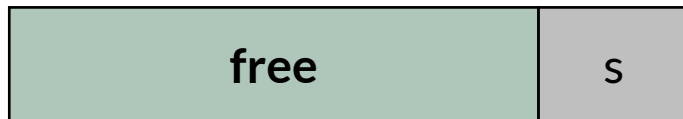Phonetics, phonology and spelling of complex words

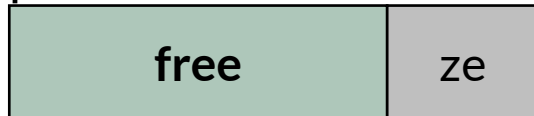Heinrich Heine Universität
Düsseldorf, Germany
7-9 February 2022

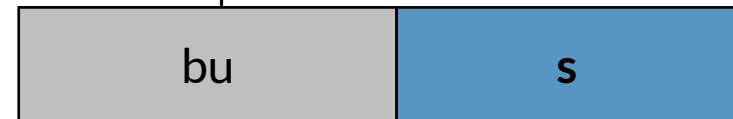# Background: Durational Differences in Production

Stems

real stems

free	s

pseudo-stems

free	ze

Word-Final /s/

non-morphemic /s/

bu	s

suffix /s/

cat	s

clitic /s/

cat	's

cf. Seyfarth et al., 2017; Engemann & Plag, 2021

cf. Plag et al., 2017; Plag et al., 2020; Tomaschek et al., 2020; Schmitz et al., 2021
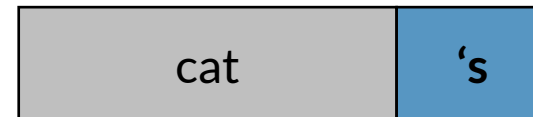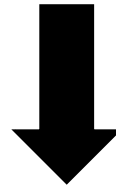
Research Question

durational differences are perceptible*

⬇

Can listeners make use of these differences in comprehension?

→ How can we test this?

- if durational information is used in comprehension,

  a mismatch of durations should show an effect on comprehension

- we investigated this in 2 mouse-tracking experiments

*Engemann et al., this conference

Method: Mouse-Tracking – Stems

frees

freeze

Method: Mouse-Tracking – Word-Final /s/

one

two or more

Method: Stimuli

Stimuli for stems

Condition	Example						/z/
matched	*daze* [deɪ]	+	*daze* [z]	→	[deɪz]		**mono-morphemic**
mismatched	*days* [deɪ]	+	*daze* [z]	→	[deɪz]		
matched	*days* [deɪ]	+	*days* [z]	→	[deɪz]		**plural**
mismatched	*daze* [deɪ]	+	*days* [z]	→	[deɪz]		

Stimuli for word-final /s/

Condition	Example						Stem
matched	*corpse* [kɔːp]	+	*corpse* [s]	→	[kɔːps]		**mono-morphemic**
mismatched	*corpse* [kɔːp]	+	*steps* [s]	→	[kɔːps]		
matched	*steps* [stɛp]	+	*steps* [s]	→	[stɛps]		**plural**
mismatched	*steps* [stɛp]	+	*corpse* [s]	→	[stɛps]		

Mouse-Tracks: Raw Data
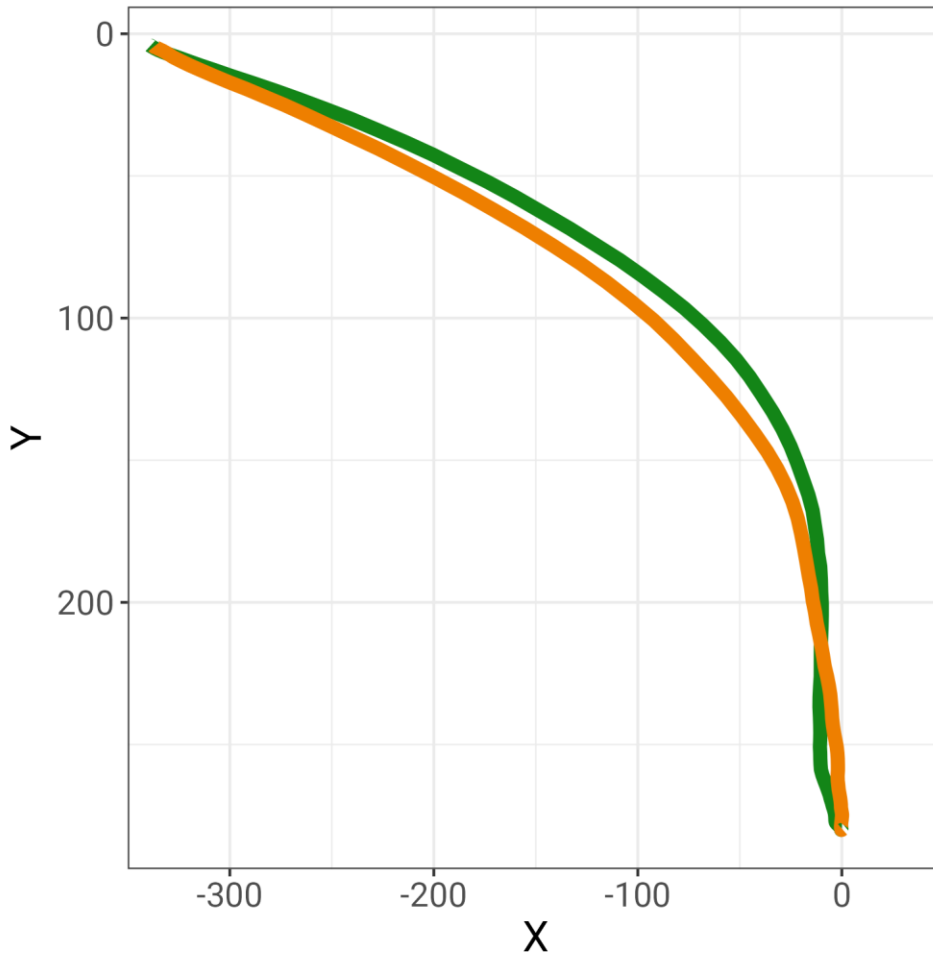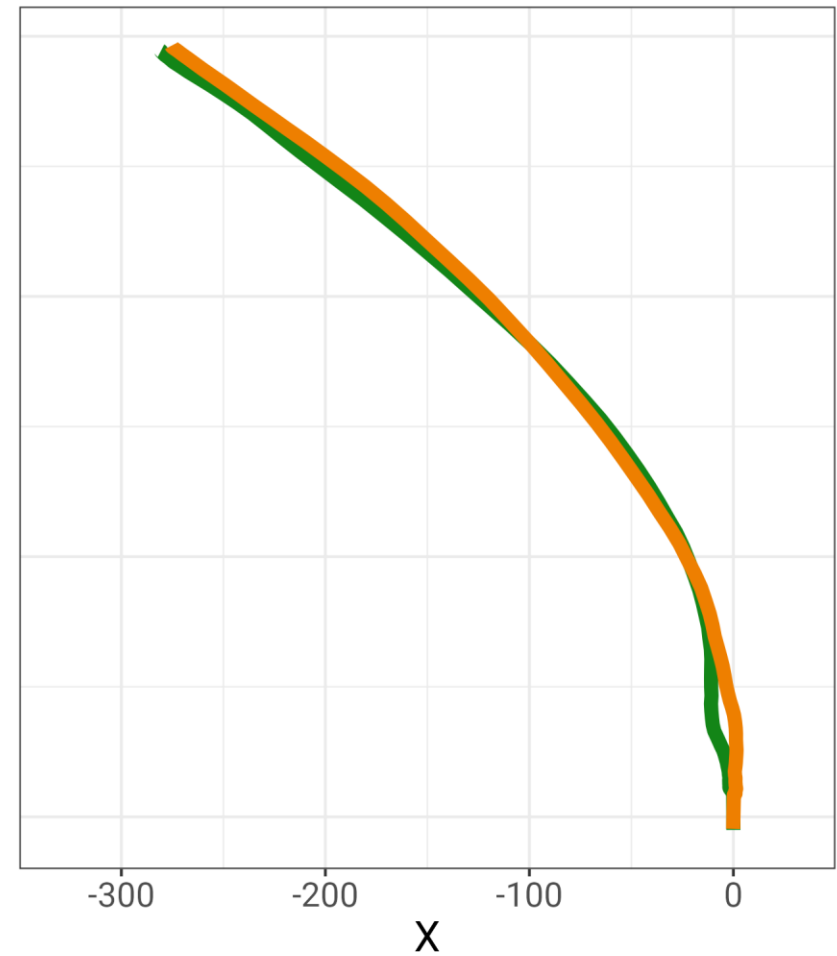
Analysis

- there are many ways to analyse mouse-track data
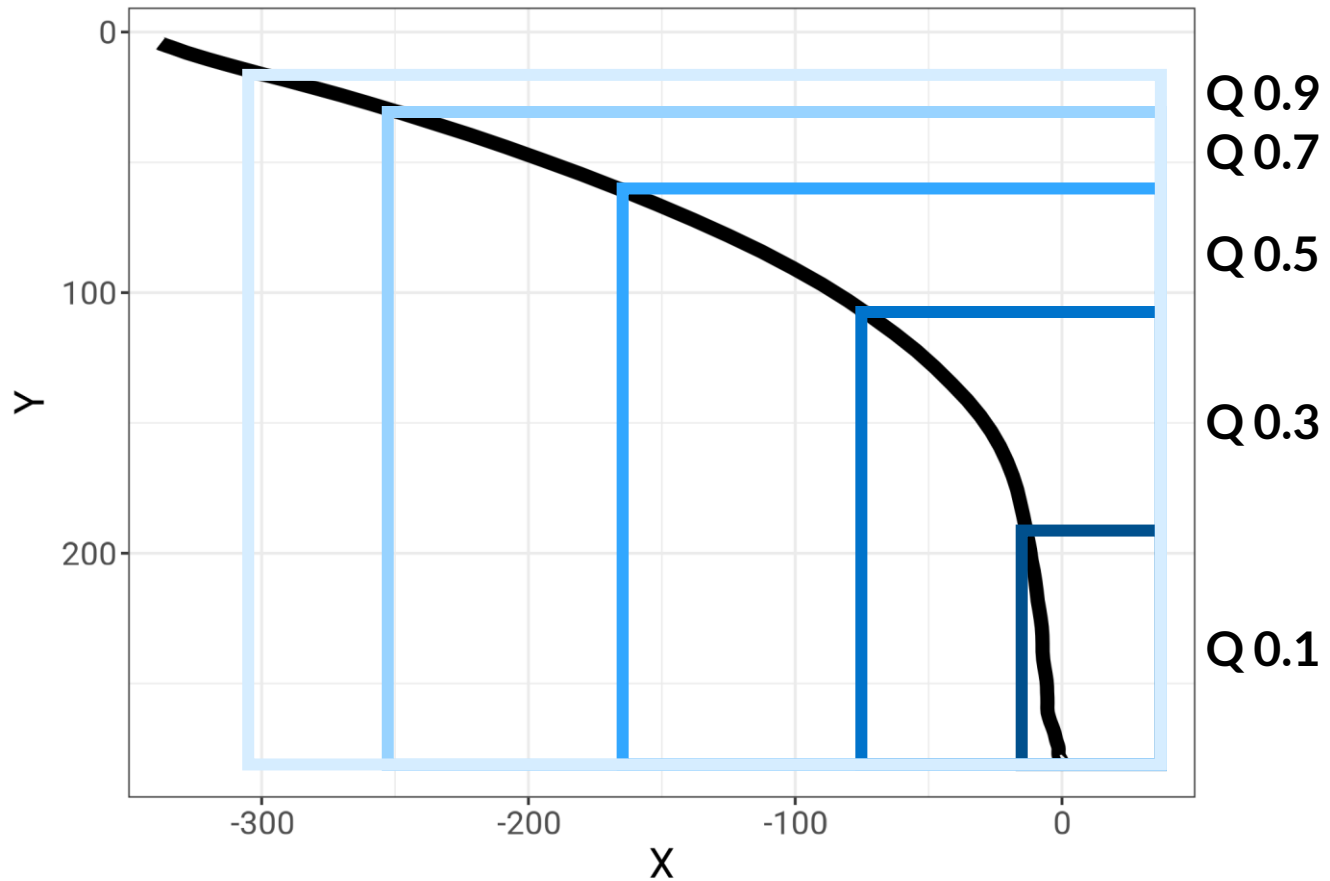
- we decided to use QGAMs – Quantile Generalized Additive Mixed models (Fasiolo et al., 2021)

- QGAMs are fitted to conditional quantiles of the dependent variable

Analysis: Conditional Quantiles

Analysis: Modelling

- QGAMs were fitted for quantiles 0.1, 0.3, 0.5, 0.7, 0.9 with

  - response variables

    XCOORDINATES & YCOORDINATES

  - smooth terms

    ORDER, AGE, SLIDENUMBER

  - parametric terms

    CONDITION, RESPONSETYPE

  - interaction

    CONDITION * RESPONSETYPE

  - random smooth terms

    ITEM, PARTICIPANT

Analysis: Modelling

- QGAMs were fitted for quantiles 0.1, 0.3, 0.5, 0.7, 0.9 with

  - response variables

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  - parametric terms

    CONDITION, RESPONSETYPE

  - interaction

    CONDITION * RESPONSETYPE

  - random smooth terms

    ITEM, PARTICIPANT

Analysis: Modelling

Stimuli for stems

Condition	Example						/z/	
matched	*da*ze [deɪ]	+	*da*ze [z]	→ [deɪz]			**mono-morphemic**	QGAMs for X and Y coordinates
mismatched	*day*s [deɪ]	+	*da*ze [z]	→ [deɪz]				
matched	*day*s [deɪ]	+	*day*s [z]	→ [deɪz]			**plural**	QGAMs for X and Y coordinates
mismatched	*da*ze [deɪ]	+	*day*s [z]	→ [deɪz]				

Stimuli for word-final /s/

Condition	Example						Stem	
matched	*corp*se [kɔːp]	+	*corp*se [s]	→ [kɔːps]			**mono-morphemic**	QGAMs for X and Y coordinates
mismatched	*corp*se [kɔːp]	+	*step*s [s]	→ [kɔːps]				
matched	*step*s [stɛp]	+	*step*s [s]	→ [stɛps]			**plural**	QGAMs for X and Y coordinates
mismatched	*step*s [stɛp]	+	*corp*se [s]	→ [stɛps]				

Results: All Models

- CONDITION shows significant effects across most QGAMs

stems: mono-morphemic /z/									
X 0.1	X 0.3	X 0.5	X 0.7	X 0.9	Y 0.1	Y 0.3	Y 0.5	Y 0.7	Y 0.9
***	***	***	***	n.s.	***	**	*	n.s.	*

stems: plural /z/									
X 0.1	X 0.3	X 0.5	X 0.7	X 0.9	Y 0.1	Y 0.3	Y 0.5	Y 0.7	Y 0.9
***	***	**	**	n.s.	*	n.s.	**	*	***

word-final /s/: mono-morphemic stem									
X 0.1	X 0.3	X 0.5	X 0.7	X 0.9	Y 0.1	Y 0.3	Y 0.5	Y 0.7	Y 0.9
***	***	n.s.	***	***	n.s.	n.s.	n.s.	*	***

word-final /s/: plural stem									
X 0.1	X 0.3	X 0.5	X 0.7	X 0.9	Y 0.1	Y 0.3	Y 0.5	Y 0.7	Y 0.9
*	***	n.s.	**	*	***	***	**	***	**

Results: Example of Stems

Q 0.1 mono-morphemic /z/, [deɪz] vs. [deɪz]

Q 0.3 plural stems, [stɛps] vs. [stɛps]
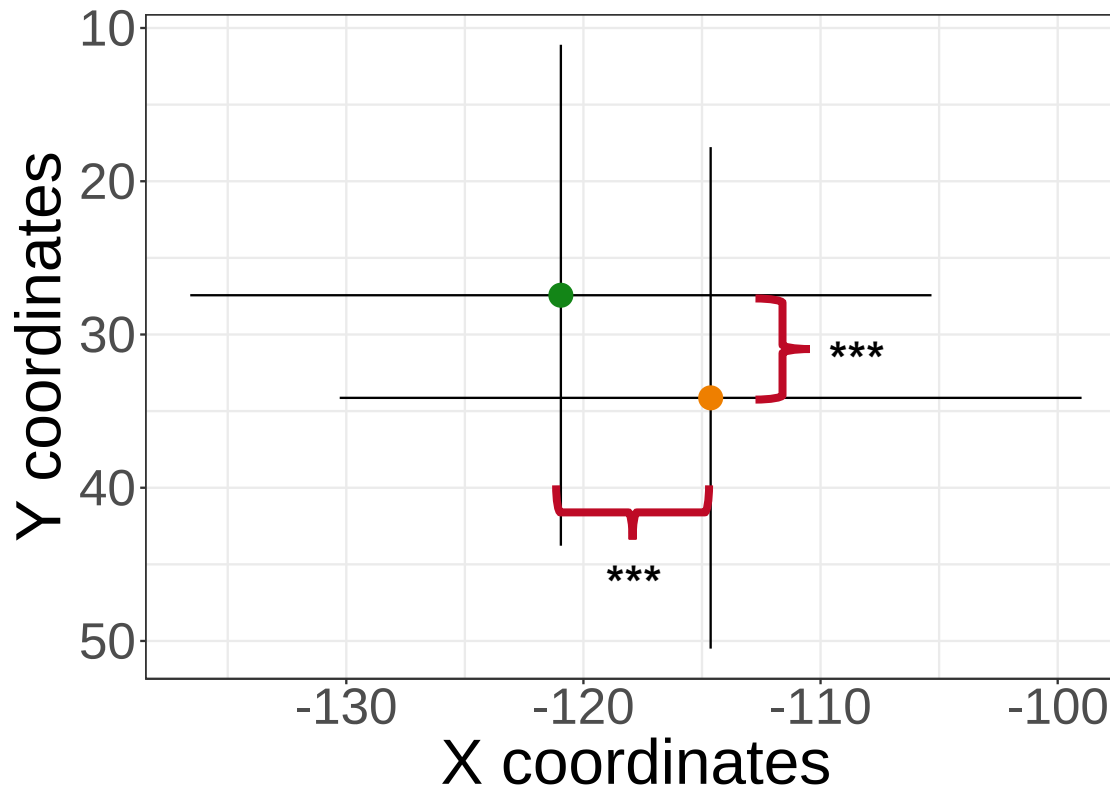
Summary

- CONDITION shows a significant effect across most quantiles and across all sets of QGAMs

- that is, participants overall show significantly different mouse-trajectories for **matched** vs. **mismatched** items

- this is clear evidence for an influence of stem & word-final /s/ duration on comprehension

Theoretical Implications

- abstractionist models assume abstract phonological representations to be the unit of comprehension (e.g. Klatt, 1979; McClelland & Elman, 1986; Norris, 1994; Norris & McQueen, 2008)

    → no subphonemic information is retained

- feature based models assume that only marked information is retained for comprehension (e.g. Massaro, 1987; Lahiri & Marslen-Wilson, 1991)

    → are subphonemic durational differences marked information?

- exemplar-based models can account for our findings as they assume fine phonetic detail to be stored in the lexicon (e.g. Goldinger, 1998)

    → however, they cannot account for the emergence of such

       differences in the first place (cf. Schmitz et al., 2021)

- in sum, our findings call for more adequate models of speech perception and comprehension

Thank you!

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