

# *"Write here, write now": real-time difficulty with word orthography delays language planning*

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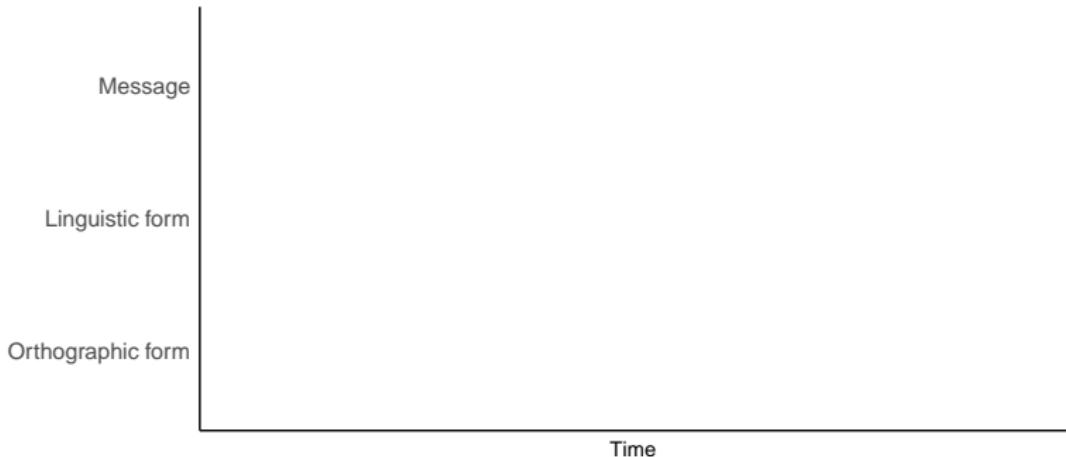
Nottingham Trent University

Presented at Writing Words Workshop (Oxford Brookes)

Slides: [github.com/jensroes/slides](https://github.com/jensroes/slides)

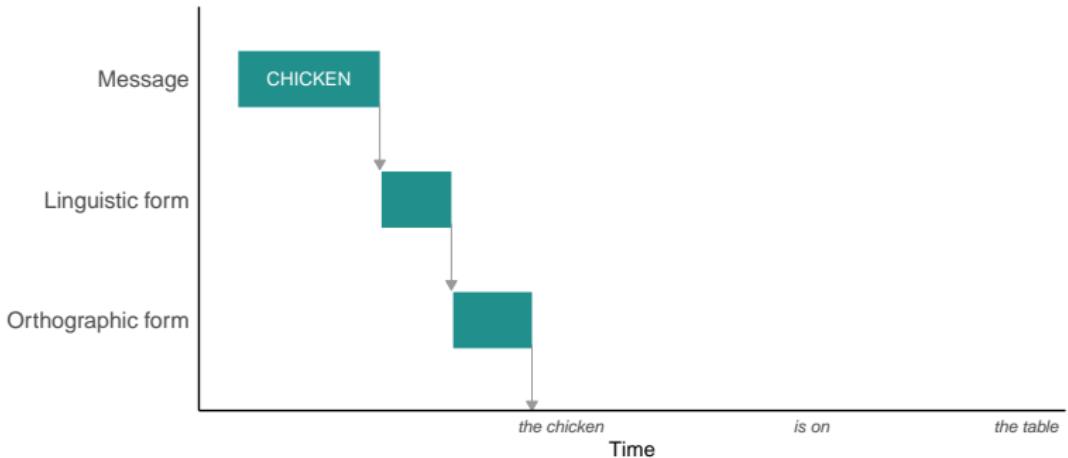
July 4, 2025

# *Writers pause to plan what to say next!*



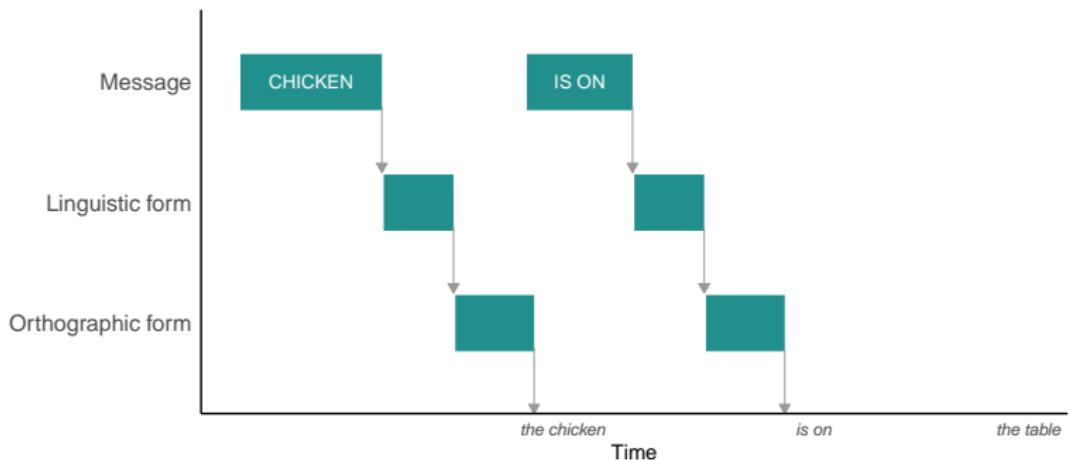
Planning happens at linguistic edges and unfolds in a serial fashion (Alves & Limpo, 2015; Hayes, 2012; Kaufer et al., 1986).

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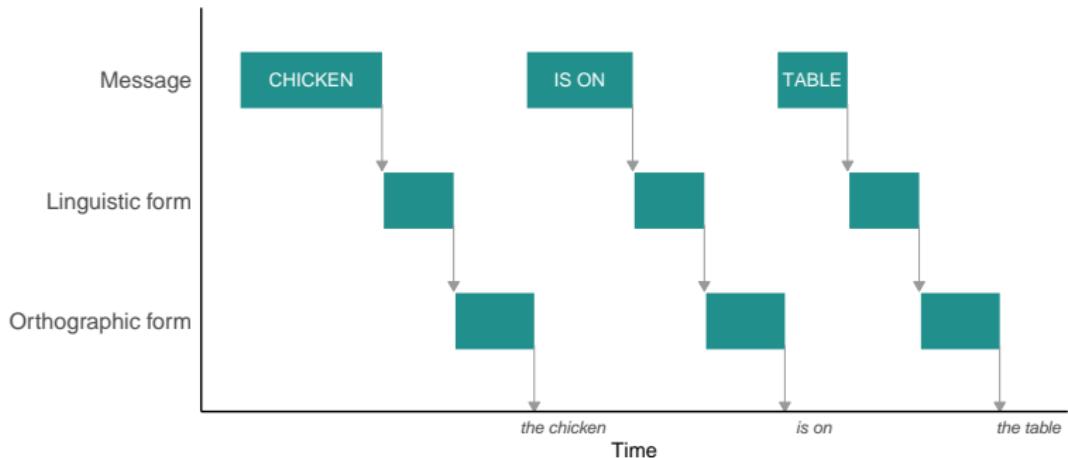
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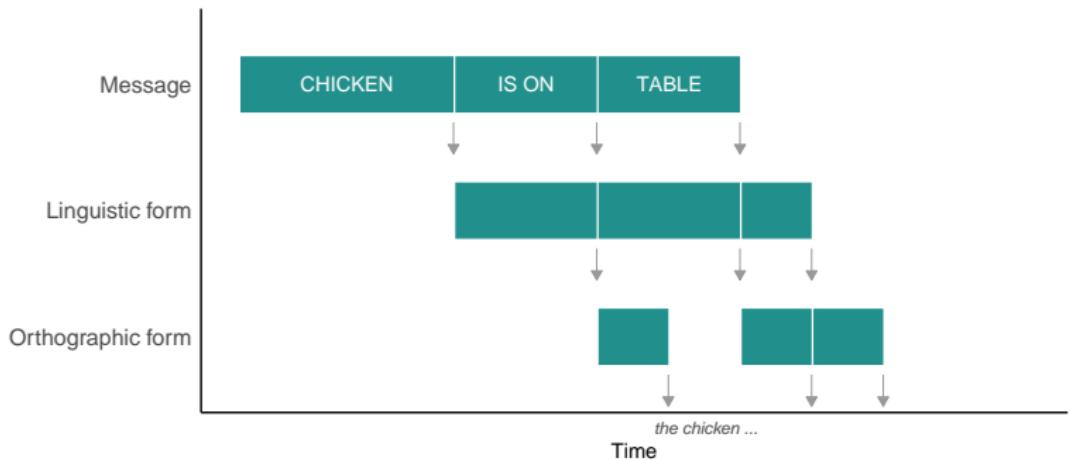
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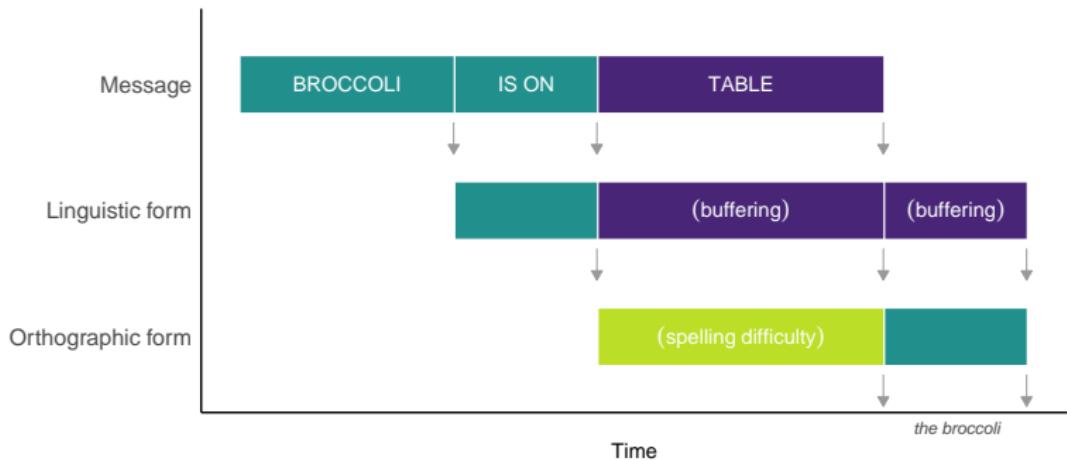
# *Pauses result from delays in information flow!*



Planning unfolds in parallel to output (Olive, 2014; Roeser et al., 2025; Van Galen, 1991).

**Prediction:** Processing bottleneck – e.g. orthographic retrieval – has knock-on effects for upstream processes.

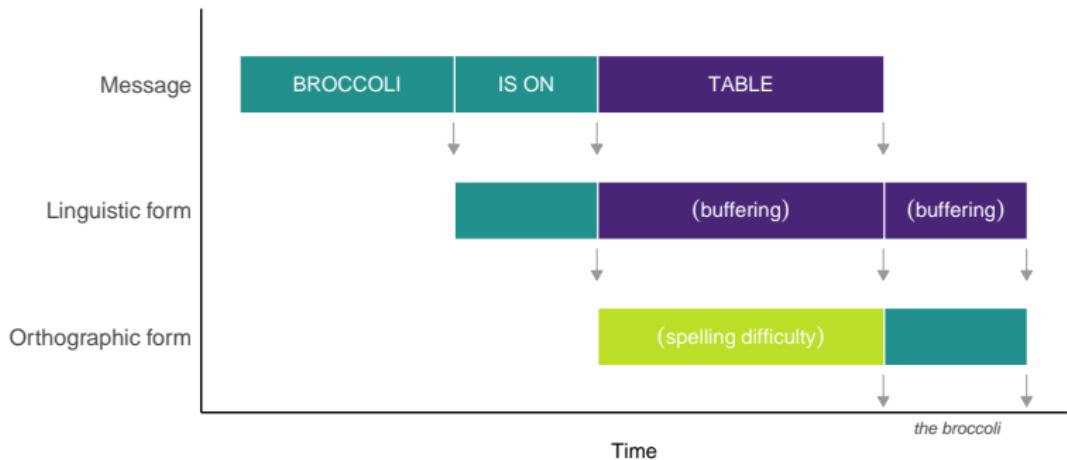
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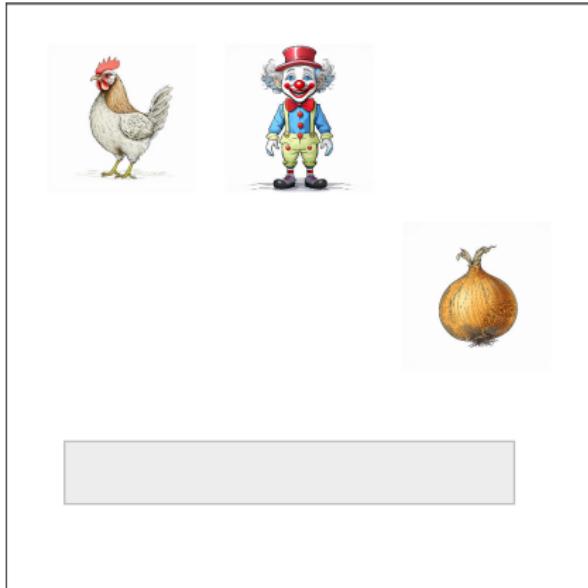
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# *Research Question & Aims*

To what extent does difficulty with word spelling affect our ability to convey ideas in writing? In particular, this research aims to ...

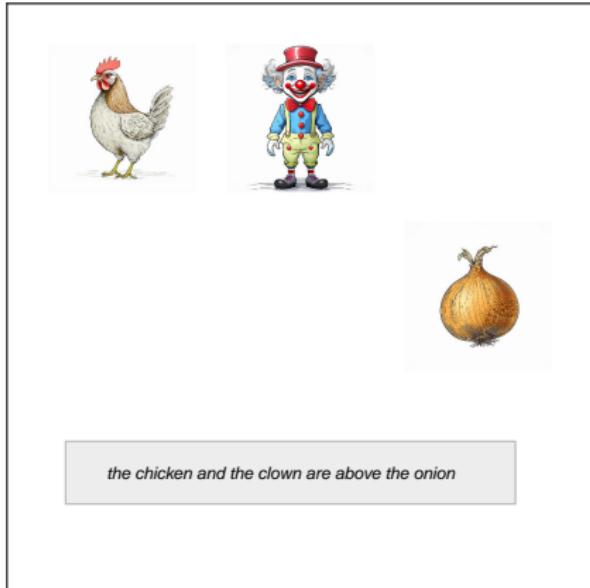
- ▶ establish timecourse of word retrieval in sentence production.
- ▶ evaluate how spelling difficulty affect parallel planning.

*Describe the arrangement from left to right!*



Example screen (Roeser et al., 2019; Smith & Wheeldon, 1999)

# *Describe the arrangement from left to right!*



Example screen (Roeser et al., 2019; Smith & Wheeldon, 1999)

# Design: Example item set

N1: easy spelling / long



*the chicken and ...*

N1 difficult spelling / long



*the broccoli and ...*

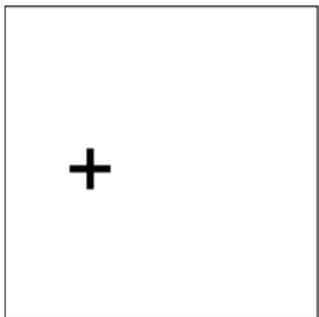
N1: easy spelling / short



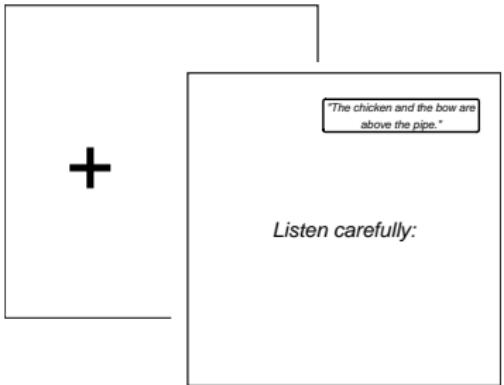
*the wok and ...*

**Prediction:** Hesitations for N2 (*clown*) result from (1) when properties of N1 (*broccoli*) couldn't be retrieved in time and (2) when N1 length (*wok*) didn't allow for parallel planning.

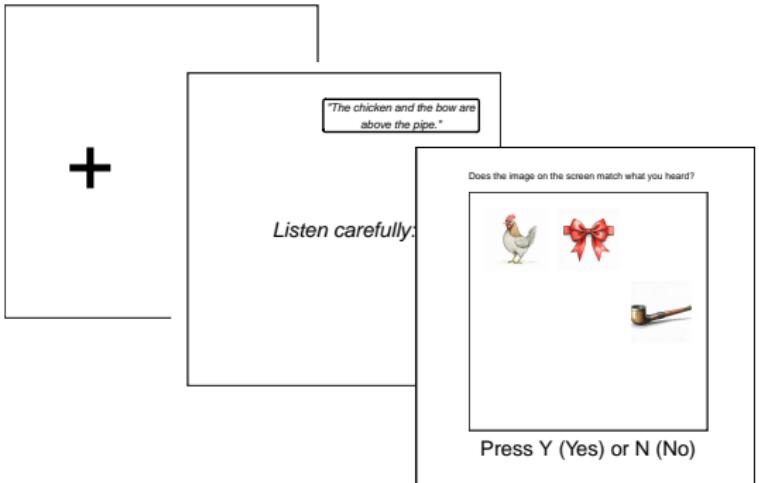
# *Window sequence*



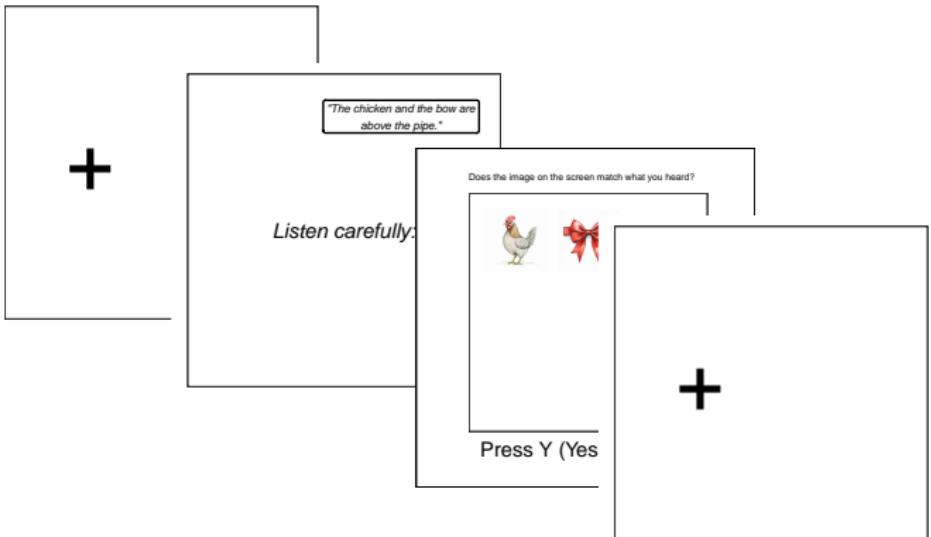
# Window sequence



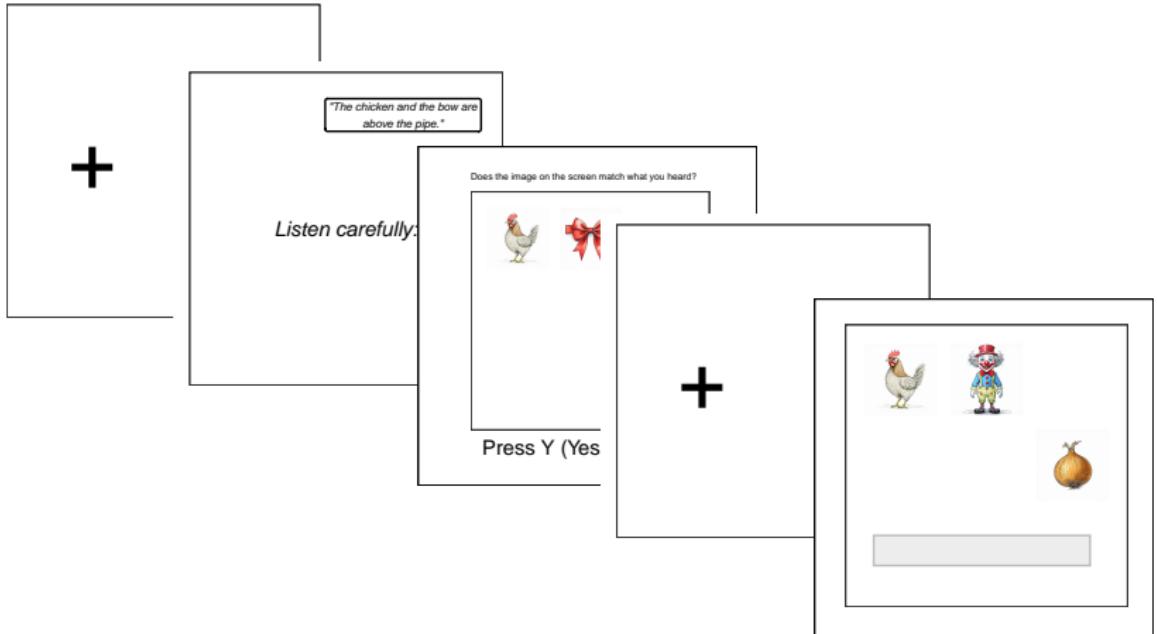
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# Window sequence



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# Materials I

- ▶ Prime-target design controls for syntax (Konopka, 2012).
- ▶ N1 repetition in prime and target controls for lexical retrieval.
- ▶ N1 word type manipulation: easy spelling (long), easy spelling (short), difficult spelling (long):
  - ▶ Long:  $\geq 2$  syllables
  - ▶ Difficult: spelling diversity  $H > 0.5$
- ▶ Sentence-picture match: YES for items; NO for filler trials.
- ▶ 36 items counterbalanced for prime structure and N1 word type.
- ▶ 24 fillers with structures different from items.

## *Spelling diversity*

Images were based on Rossion and Pourtois (2004) and Snodgrass and Vanderwart (1980).

Spelling diversity was calculated using (Lachman, 1973; Torrance et al., 2018):

$$H = \sum_{i=1}^K p_i \times \log_2\left(\frac{1}{p_i}\right) \quad (1)$$

where  $k$  is the number of spellings for a picture name and  $p_i$  is the proportion of participants producing the  $i^{th}$  spelling.

*Write the name of what you see!*

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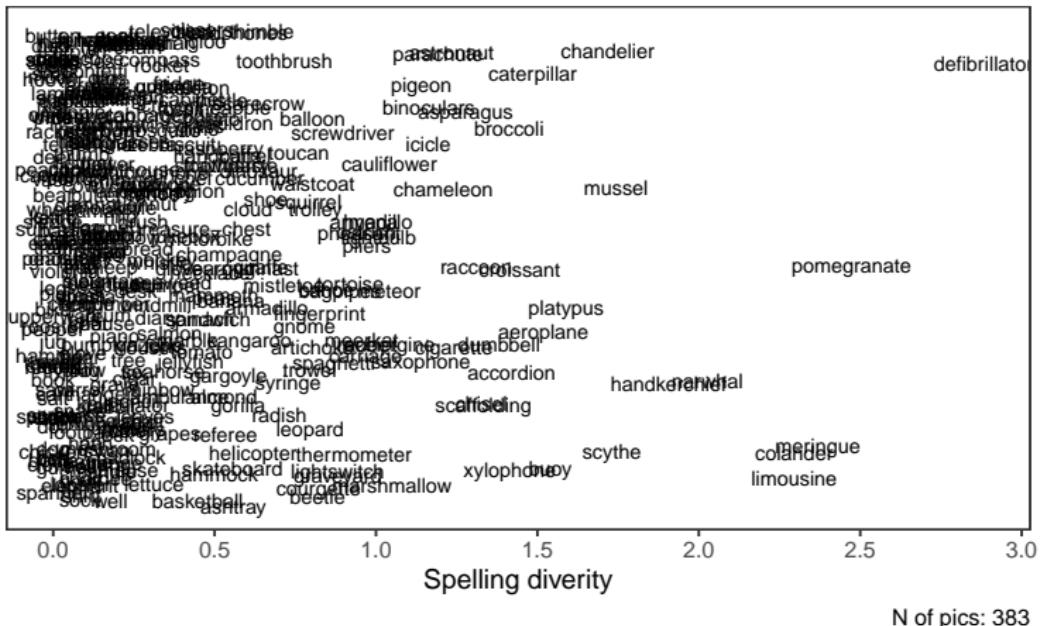
# *Spelling diversity*

Example summary for “raccoon”.

response	$N_{resp}$	$N_{name}$	$N_{ppts}$	$Pr_{name}$	$H_{name}$	$Pr_{spell}$	$H_{spell}$
raccoon	41	75	97	.77	2.48	.55	1.31
racoon	30	75	97	.77	2.48	.40	1.31
raccon	2	75	97	.77	2.48	.03	1.31
raccoo	1	75	97	.77	2.48	.01	1.31
racoo	1	75	97	.77	2.48	.01	1.31
skunk	8	8	97	.08	2.48	1.00	–
badger	6	6	97	.06	2.48	1.00	–
lemur	2	2	97	.02	2.48	1.00	–
animal	2	2	97	.02	2.48	1.00	–
red panda	1	1	97	.01	2.48	1.00	–
possum	1	1	97	.01	2.48	1.00	–
cougar	1	1	97	.01	2.48	1.00	–
meer kat	1	1	97	.01	2.48	1.00	–

*Note.* H indicates the diversity statistic; Pr is the proportion of responses.

# Spelling diversity



See poster presentation Aros Muñoz et al.

## Materials II

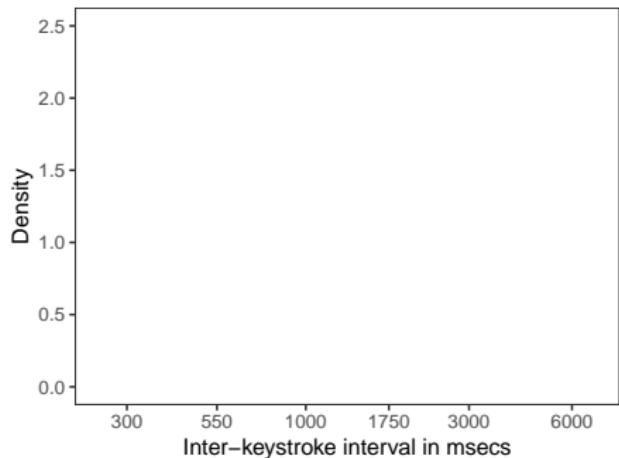
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# Participants

Ten ppts per counterbalancing list. After data cleaning:

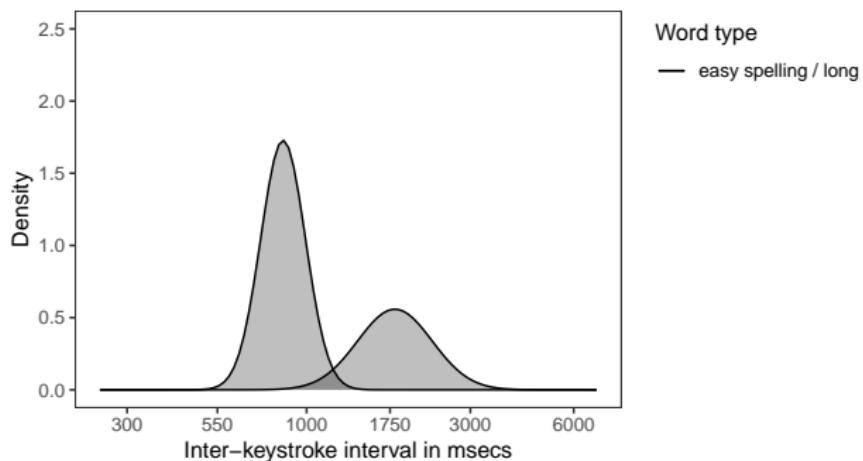
- ▶ Experiment 1: 56 ppts (6 lists)
- ▶ Experiment 2: 80 ppts (9 lists)
- ▶ Experiment 3: 96 ppts (12 lists)

# *Data analysis: typing as mixture process*



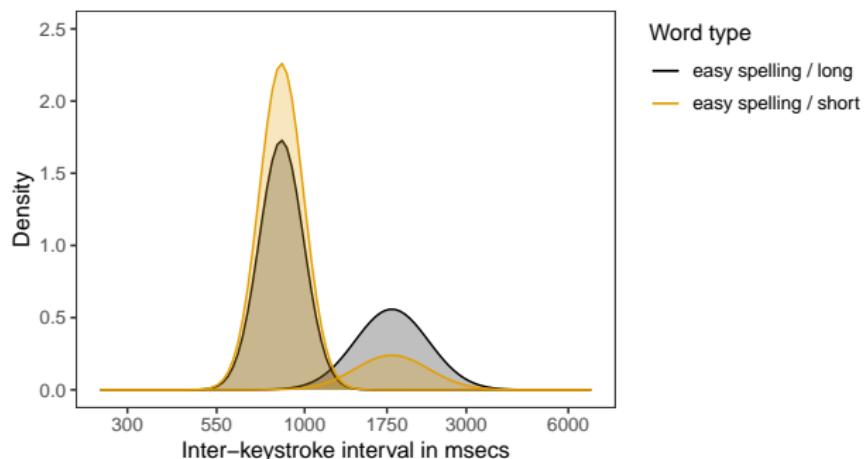
Inter-keystroke intervals were modelled as Bayesian mixed-effects mixture model (Roeser et al., 2024, 2025). For a tutorial see:  
<https://rpubs.com/jensroes/mixture-models-tutorial>.

# Data analysis: typing as mixture process



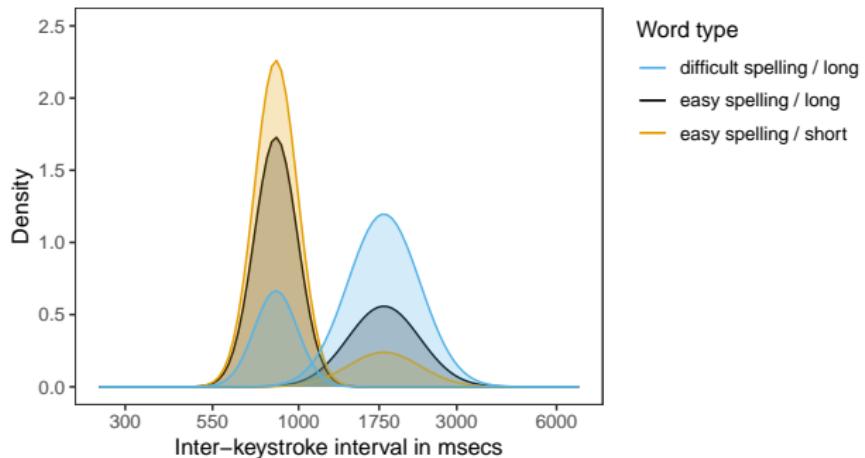
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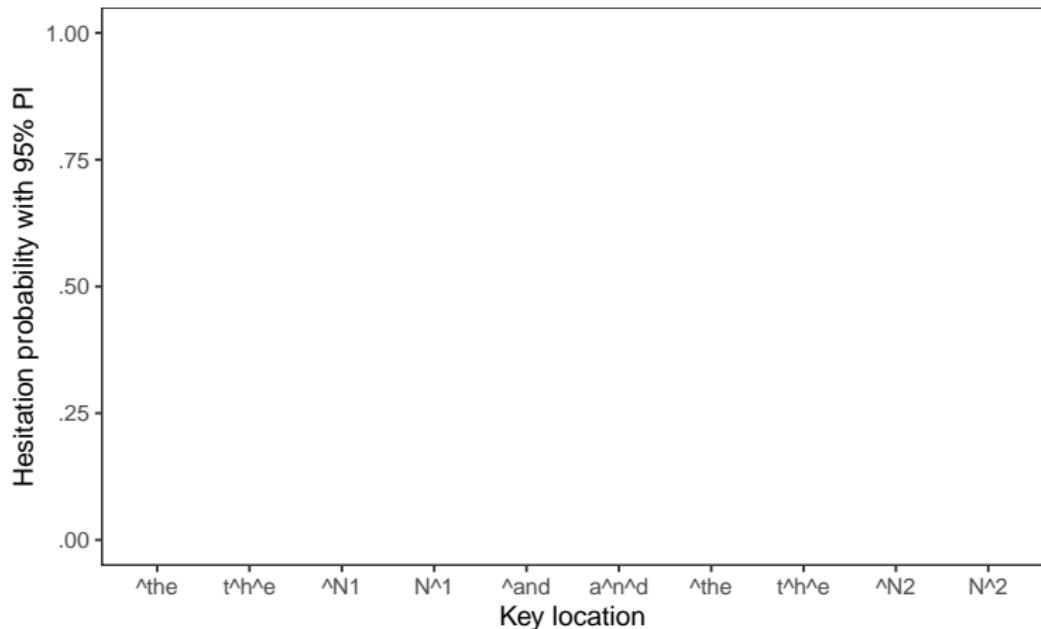
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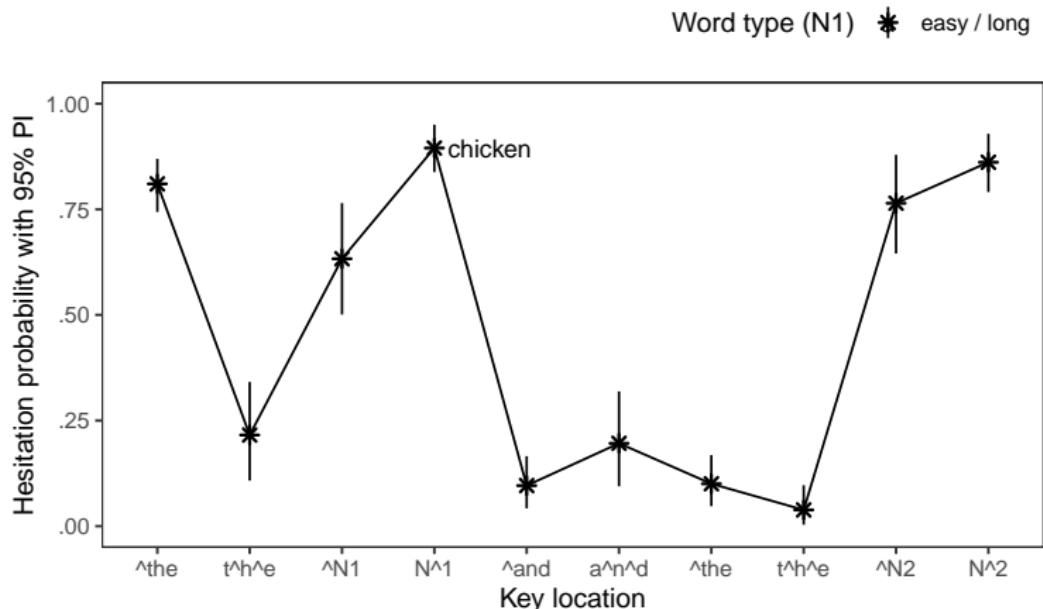


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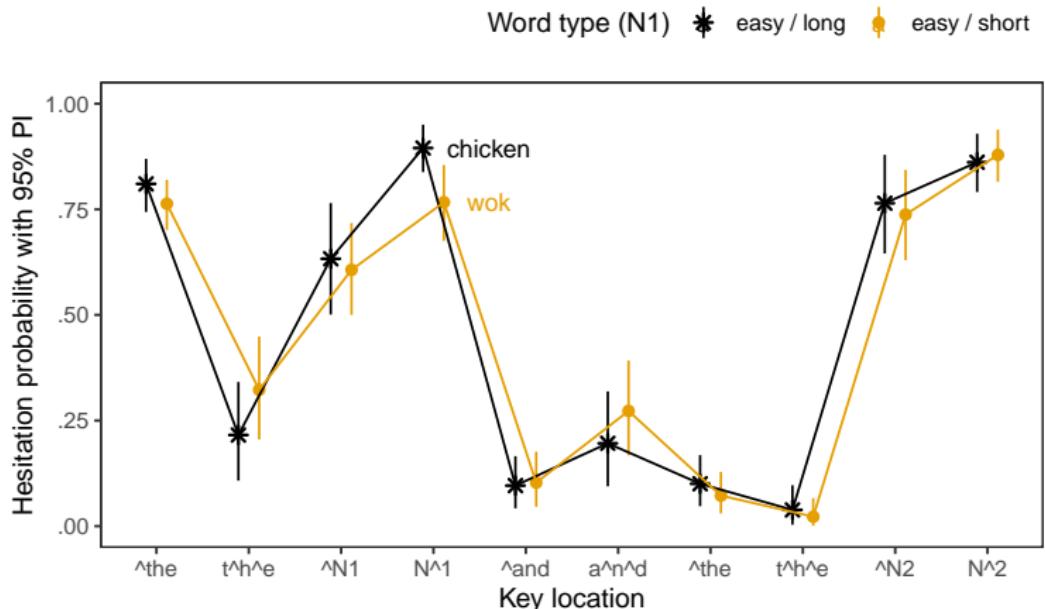
# *Experiment 1: typing timecourse*



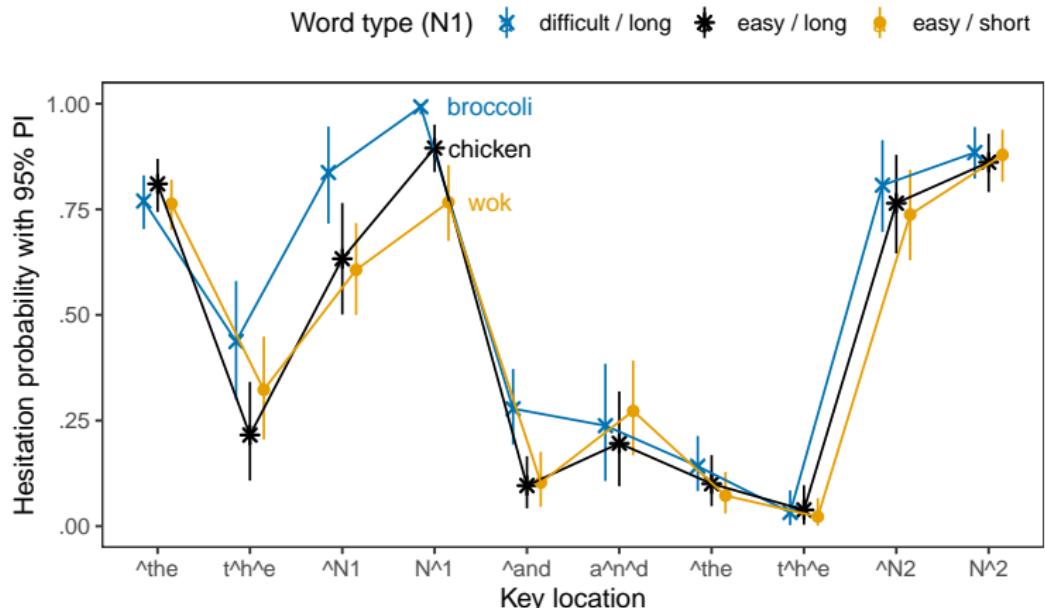
# Experiment 1: typing timecourse



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## *Experiment 2*

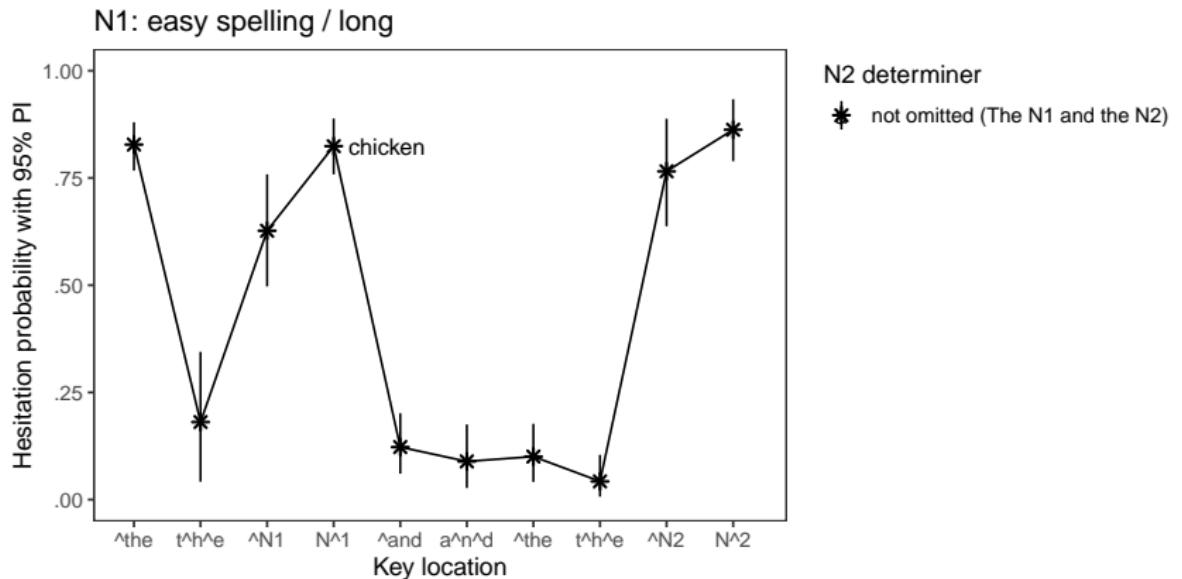
Function words might mediate spelling hesitations: Does *and the* buy enough time to avoid intra-sentence hesitations?

Additional prime condition and thus two target structures:

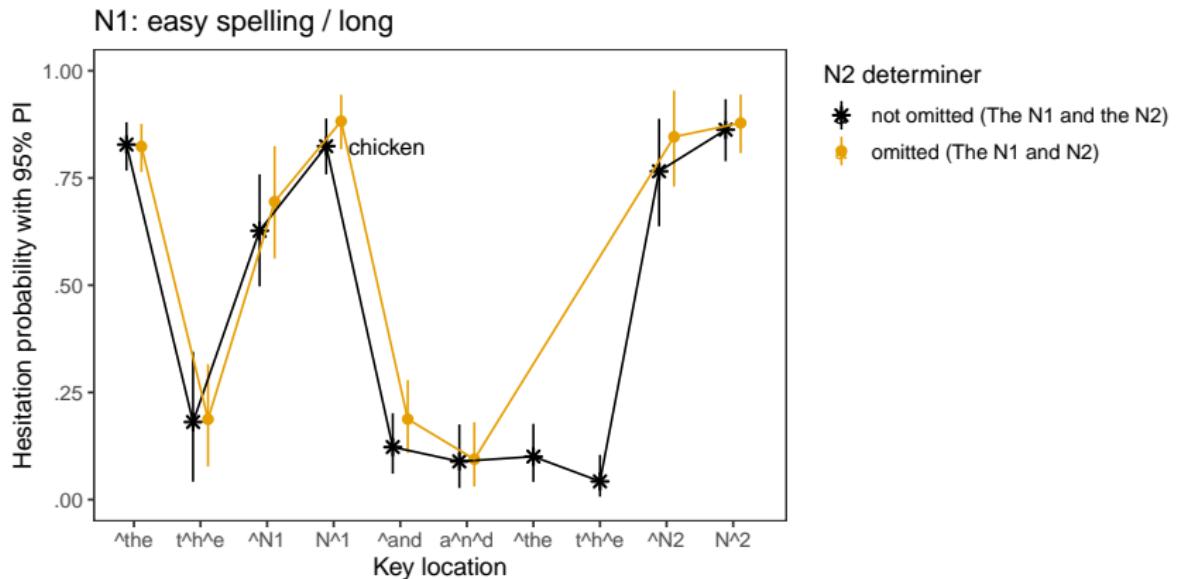
- ▶ With N2 determiner: *The N1 and the N2 are above the N3*
- ▶ Without N2 determiner: *The N1 and N2 are above the N3*

**Prediction:** If the omission of non-lexical functional words constraints parallel planning, we expect more hesitations before N2.

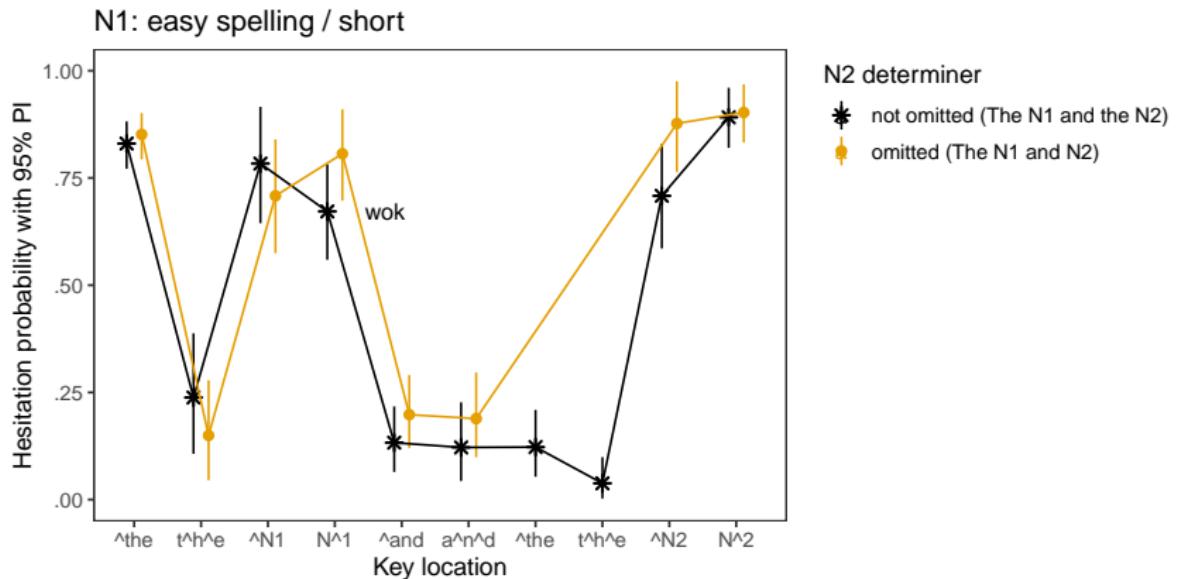
## Experiment 2: typing timecourse



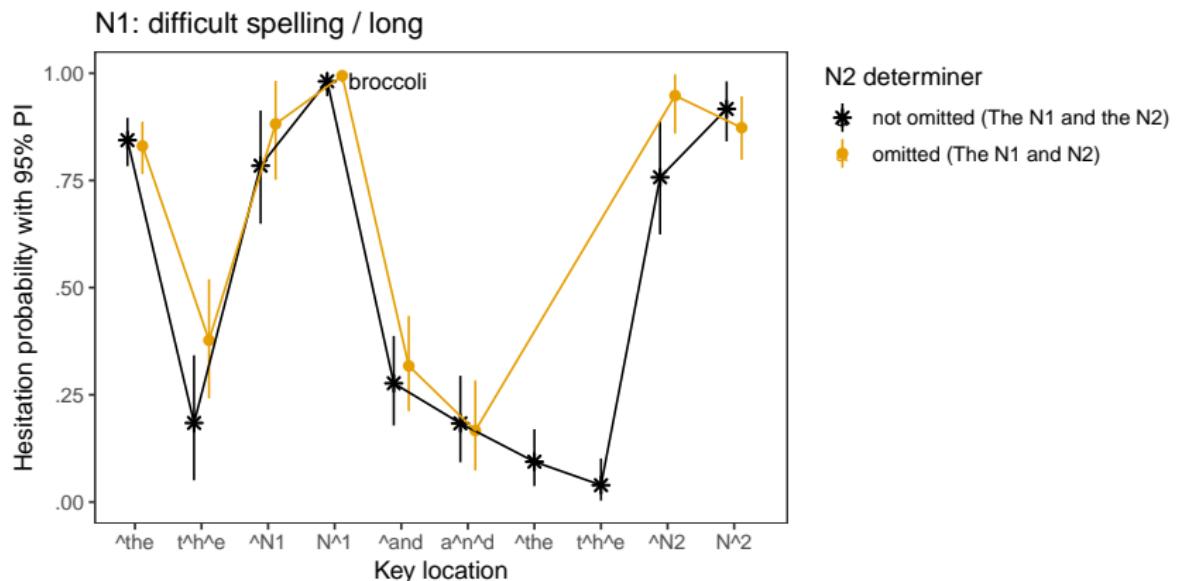
# Experiment 2: typing timecourse



# Experiment 2: typing timecourse



# Experiment 2: typing timecourse



## Experiment 3

Post-N1 hesitations can be explained by N2 retrieval or N1 error monitoring.

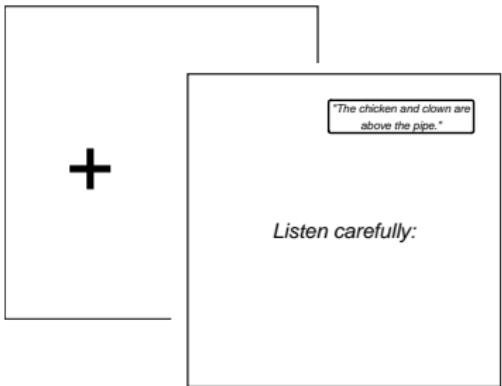
Prime with (auditory) N2 preview:

- ▶ N2 not previewed: *The N1 and bow are above the pipe*
- ▶ N2 previewed: *The N1 and clown are above the pipe*

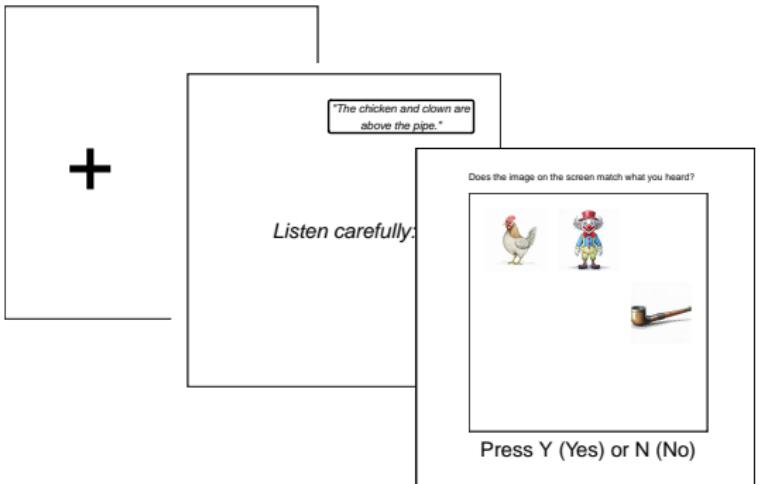
Target: *The N1 and clown are above the onion*

**Prediction:** If planning bottlenecks delay lexical retrieval of N2, preview will reduce associated hesitations.

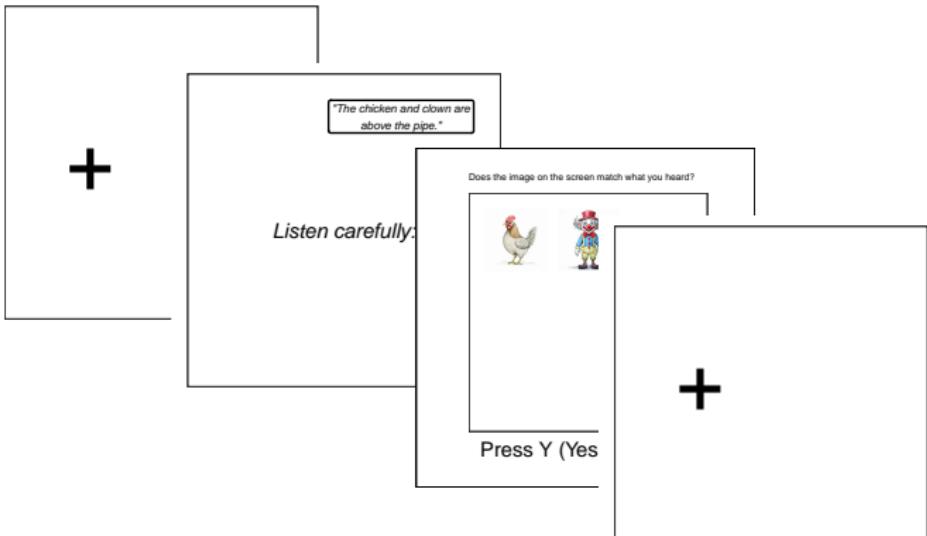
# *Experiment 3: N2 preview*



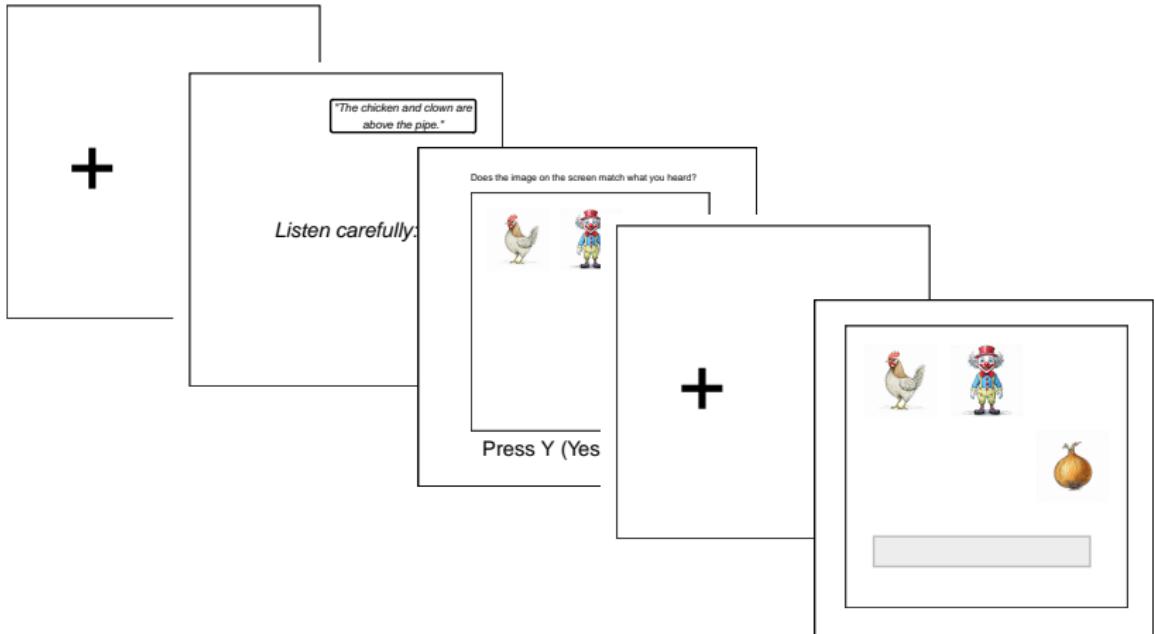
# Experiment 3: N2 preview



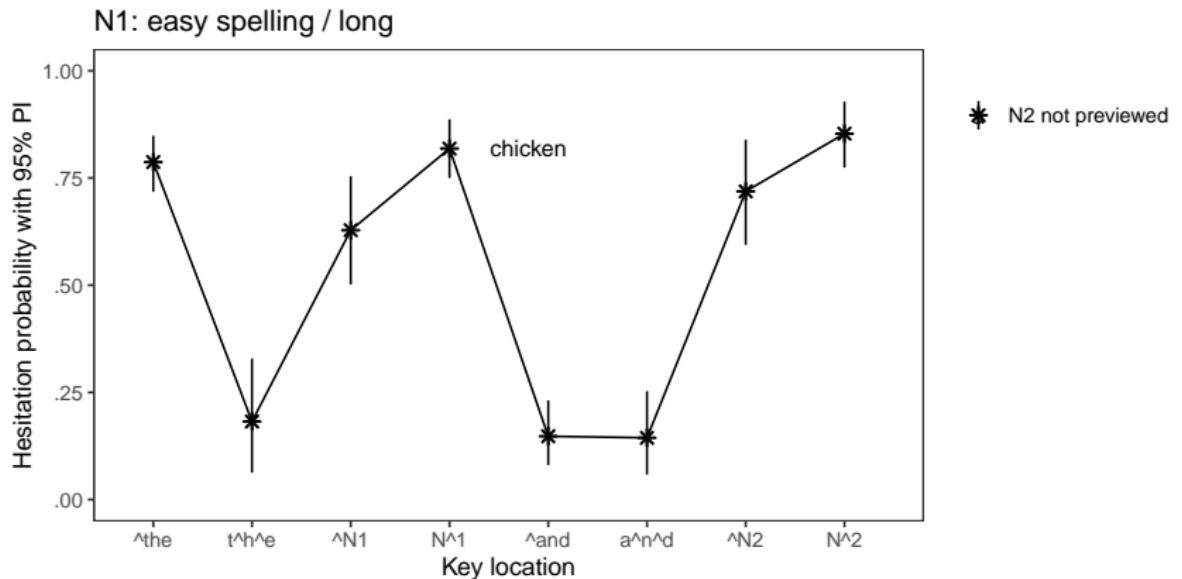
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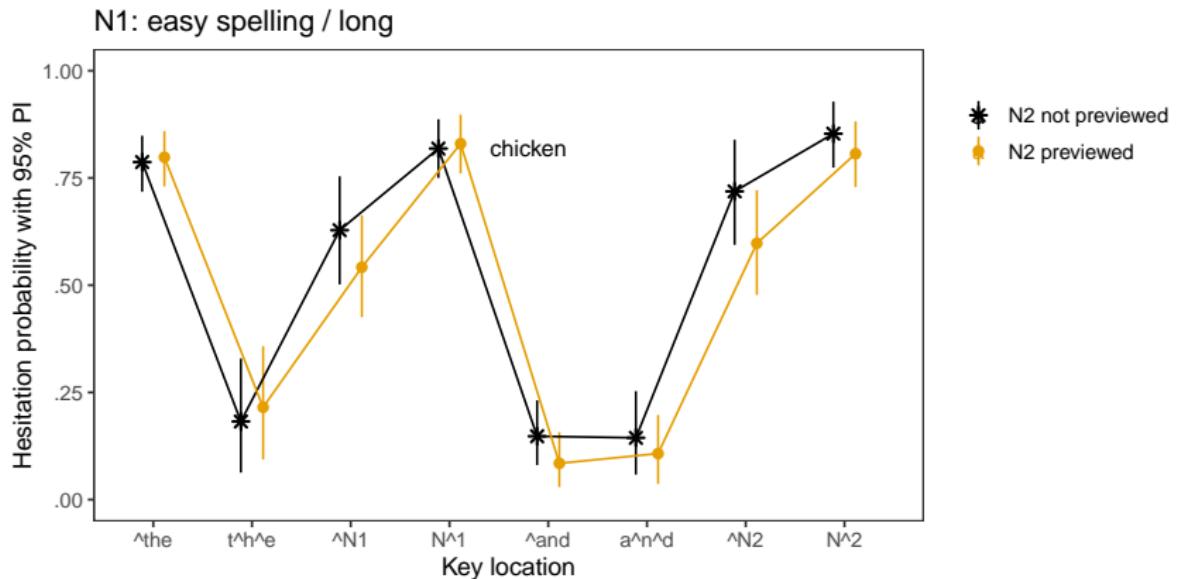
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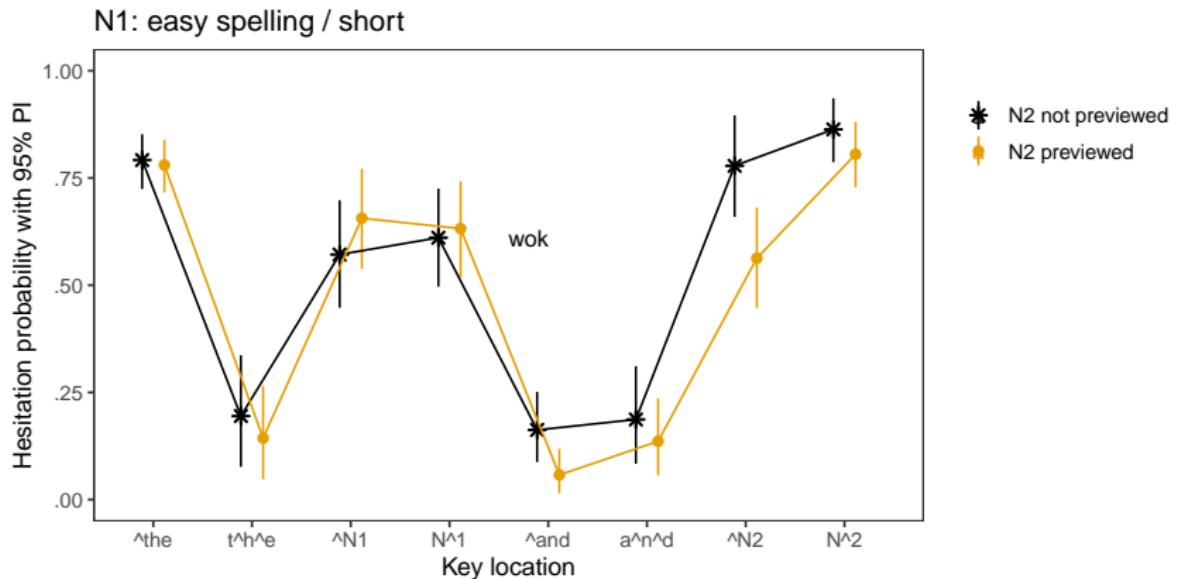
# Experiment 3: typing timecourse



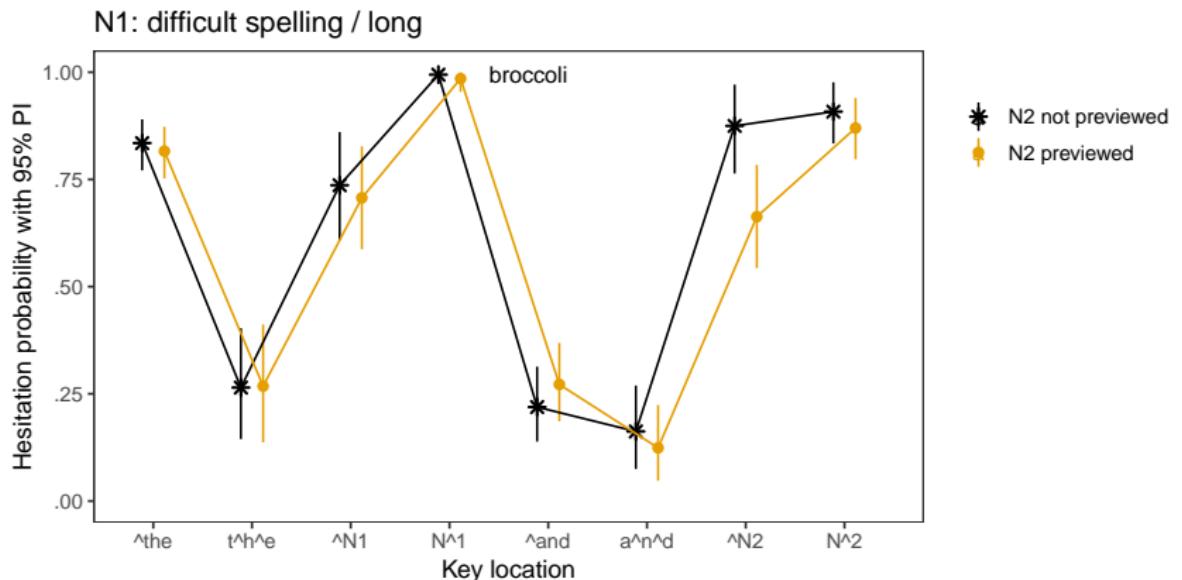
# Experiment 3: typing timecourse



# Experiment 3: typing timecourse



# Experiment 3: typing timecourse



# Conclusion

- ▶ Writers plan text in parallel to production when possible.
- ▶ Hesitations occur if information couldn't be retrieved in time because of ...
  1. Difficulty orthographic encoding before / after word onset: planning unit smaller than word (Kandel, [2023](#)).
  2. Not enough time for lexical retrieval: function words – e.g. *and the* – provide time for parallel lexical retrieval (Allum & Wheeldon, [2007](#); Griffin, [2003](#)).
  3. Error monitoring: more hesitations after critical word.

# Thanks for listening!

email: [jens.roeser@ntu.ac.uk](mailto:jens.roeser@ntu.ac.uk)

slides are here: <https://github.com/jensroes/slides>

Funded by UKRI ESRC (ES/W011832/1) – Project title: "Can you use it in a sentence?": Establishing how word-production difficulties shape text formation

# References I

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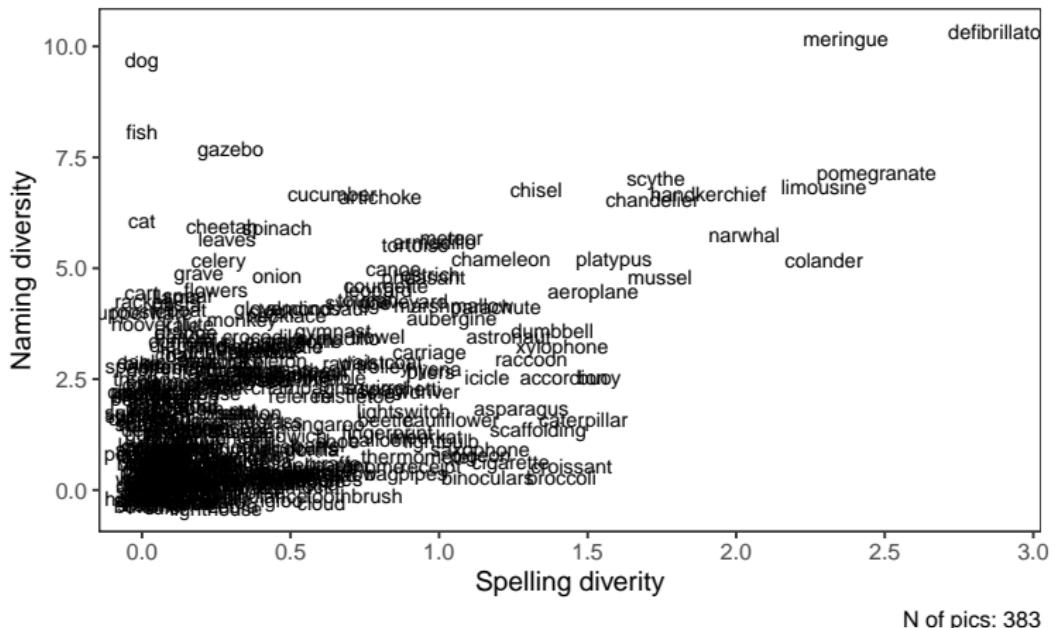
# References II

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# References III

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# Spelling and naming diversity



See poster presentation Aros Muñoz et al.

# Typing as mixture process

Inter-keystroke intervals were analysed in mixture models with shifted-lognormal distributions (Roeser et al., 2024, 2025).

$$(\log(iki_{ij}) - shift_i) \sim \theta_{condition} \times \mathcal{N}(\beta_{location} + \delta_{location} + u_i + w_j, \sigma_{e'}^2) + \\ (1 - \theta_{condition}) \times \mathcal{N}(\beta_{location} + u_i + w_j, \sigma_e^2)$$

where:

$$u_i \sim \mathcal{N}(0, \sigma_u^2)$$

$$w_j \sim \mathcal{N}(0, \sigma_w^2)$$

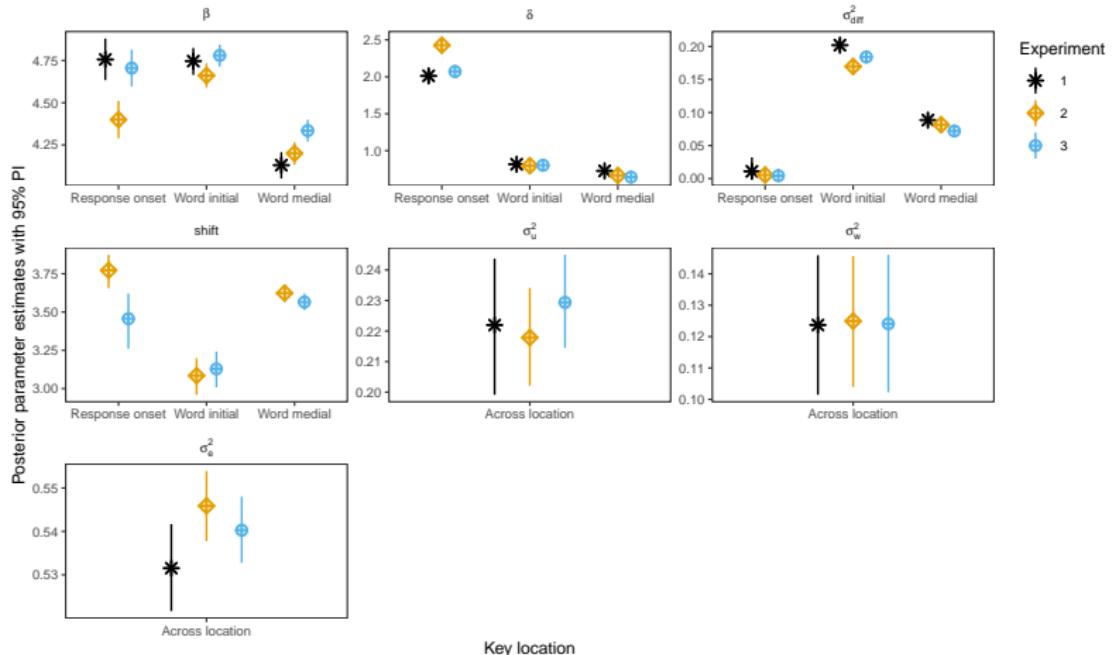
constraints:

$$\delta, \text{ (and all } \sigma\text{s)} > 0$$

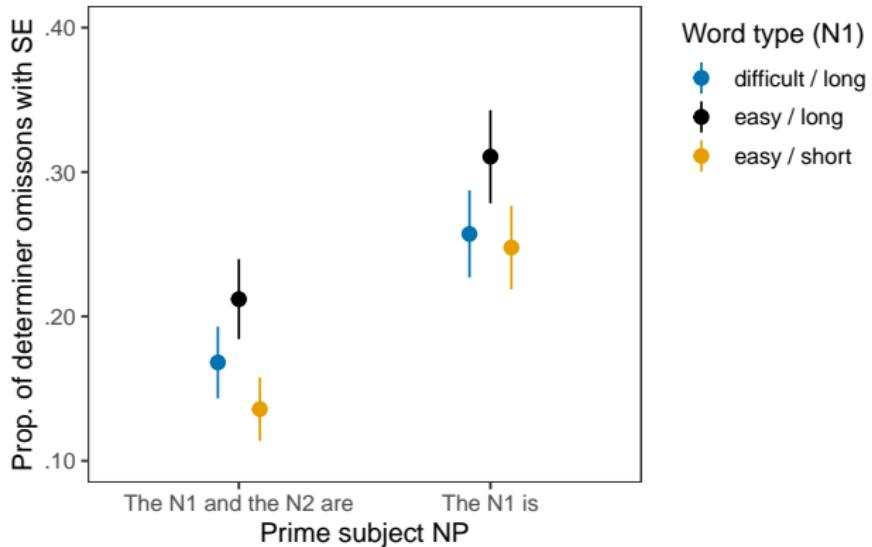
$$\sigma_{e'}^2 > \sigma_e^2$$

$\theta$  returns the proportion of hesitant inter-keystroke intervals for each key-location, prime and N1 condition.

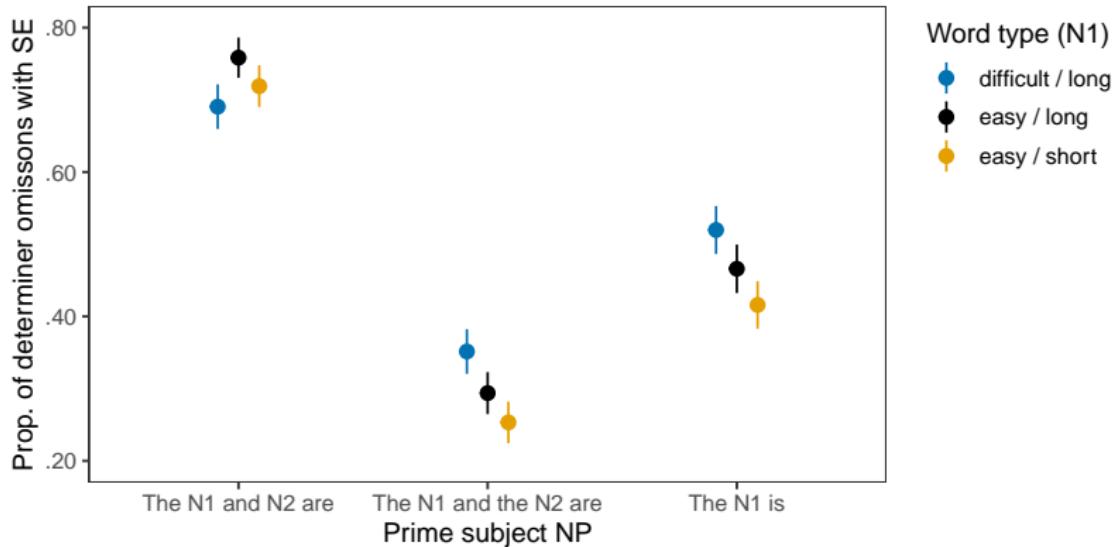
# Most other mixture model parameter estimates



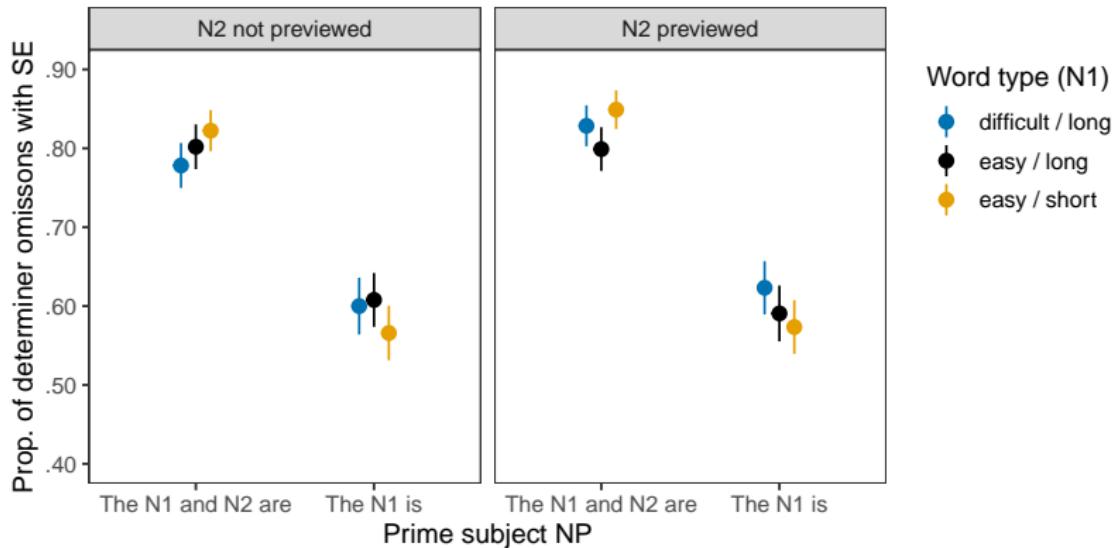
# *Experiment 1: determiner omissions before N2*



## *Experiment 2: determiner omissions before N2*



# *Experiment 3: determiner omissions before N2*



# *Experiment 3: N2-initial hesitations*

