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

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Presented at Writing Words Workshop (Oxford Brookes)

Slides: github.com/jensroes/slides

July 4, 2025

Writers pause to plan what to say next!

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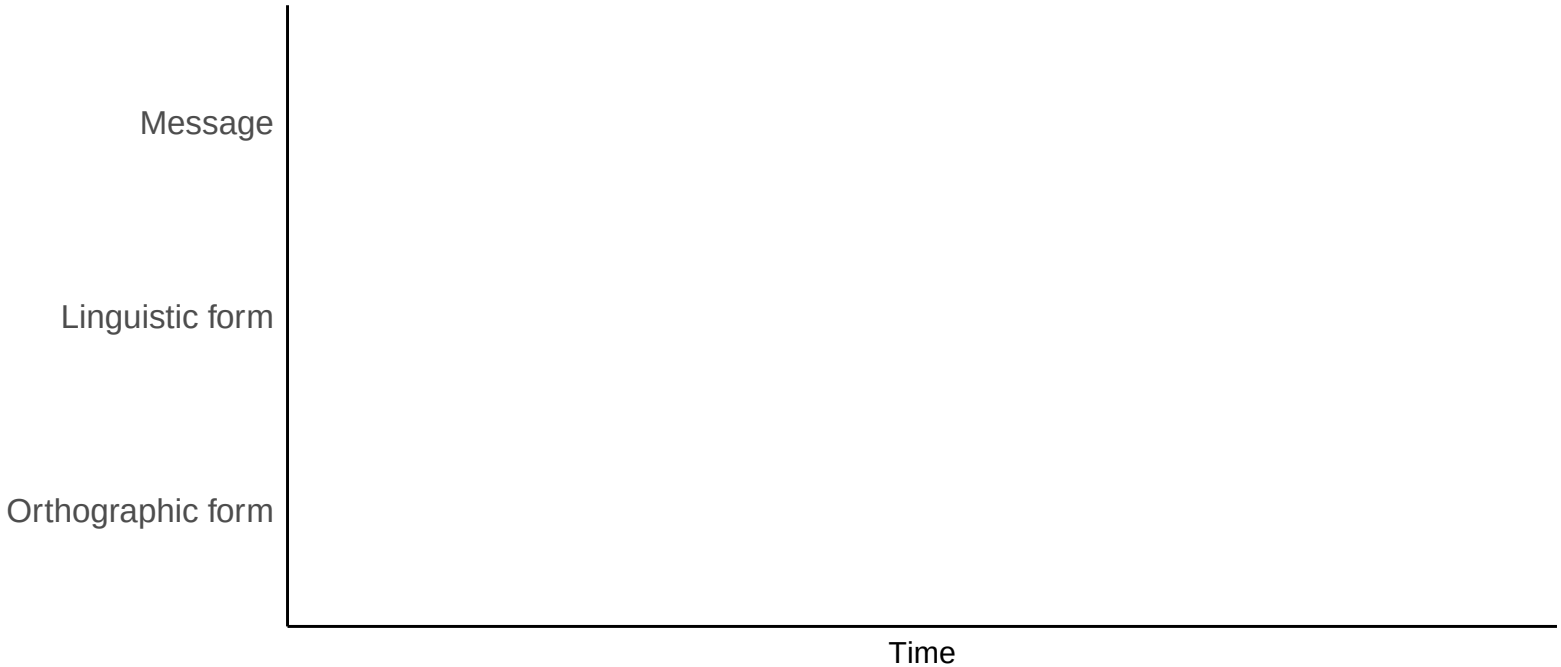

Planning happens at linguistic edges and unfolds in a serial fashion.

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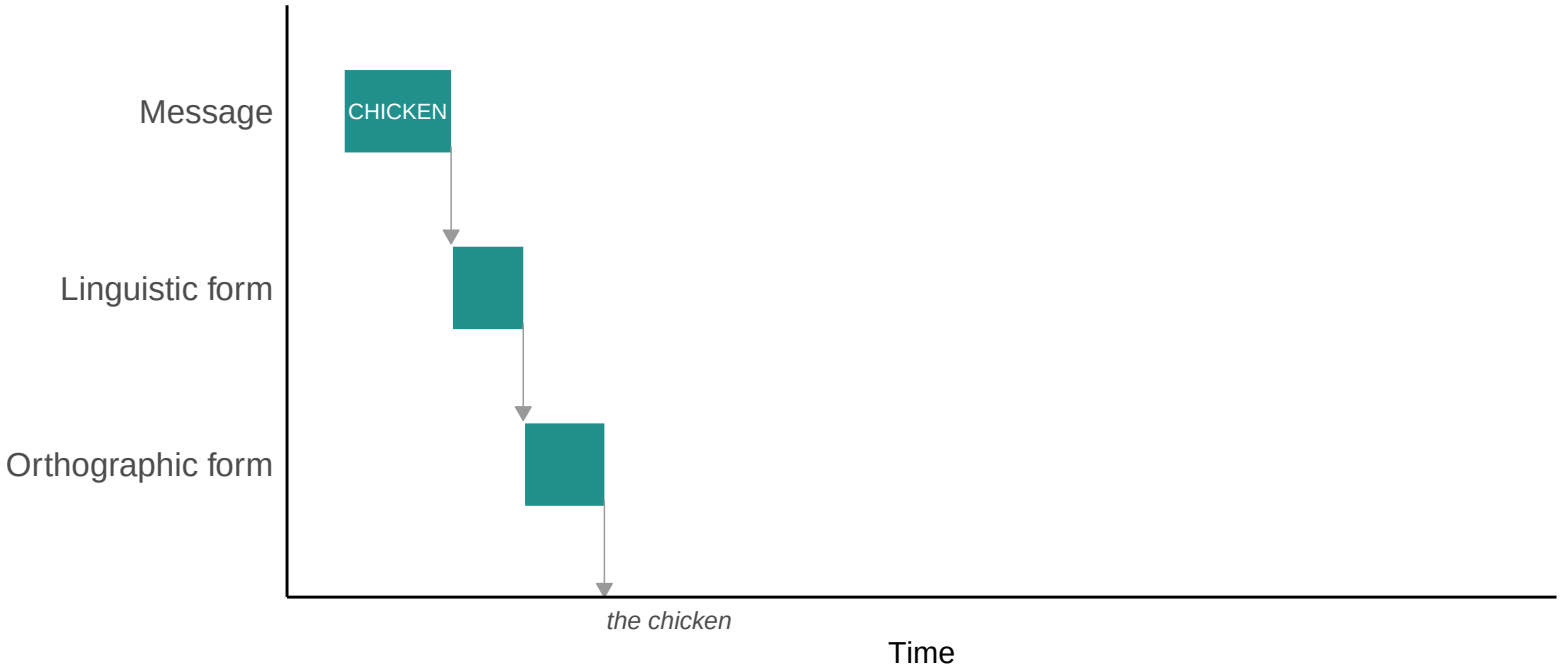

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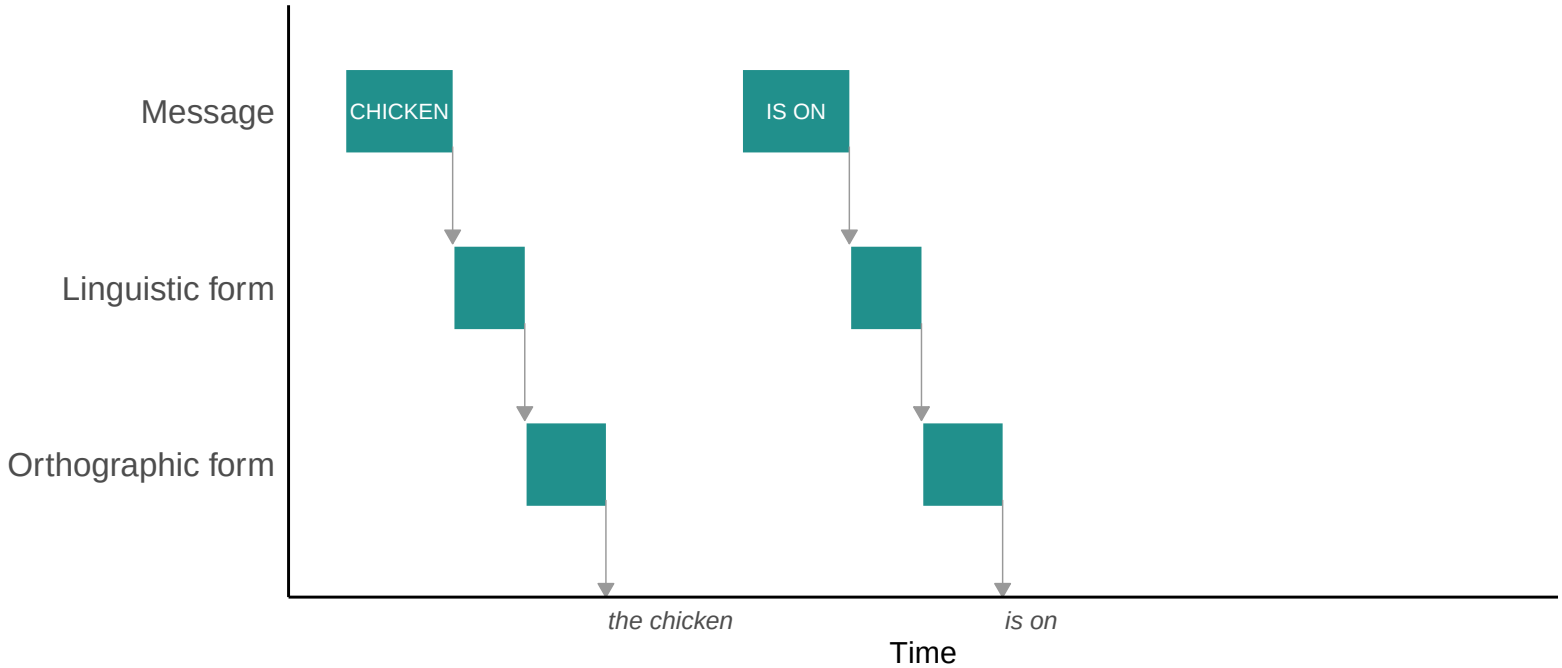

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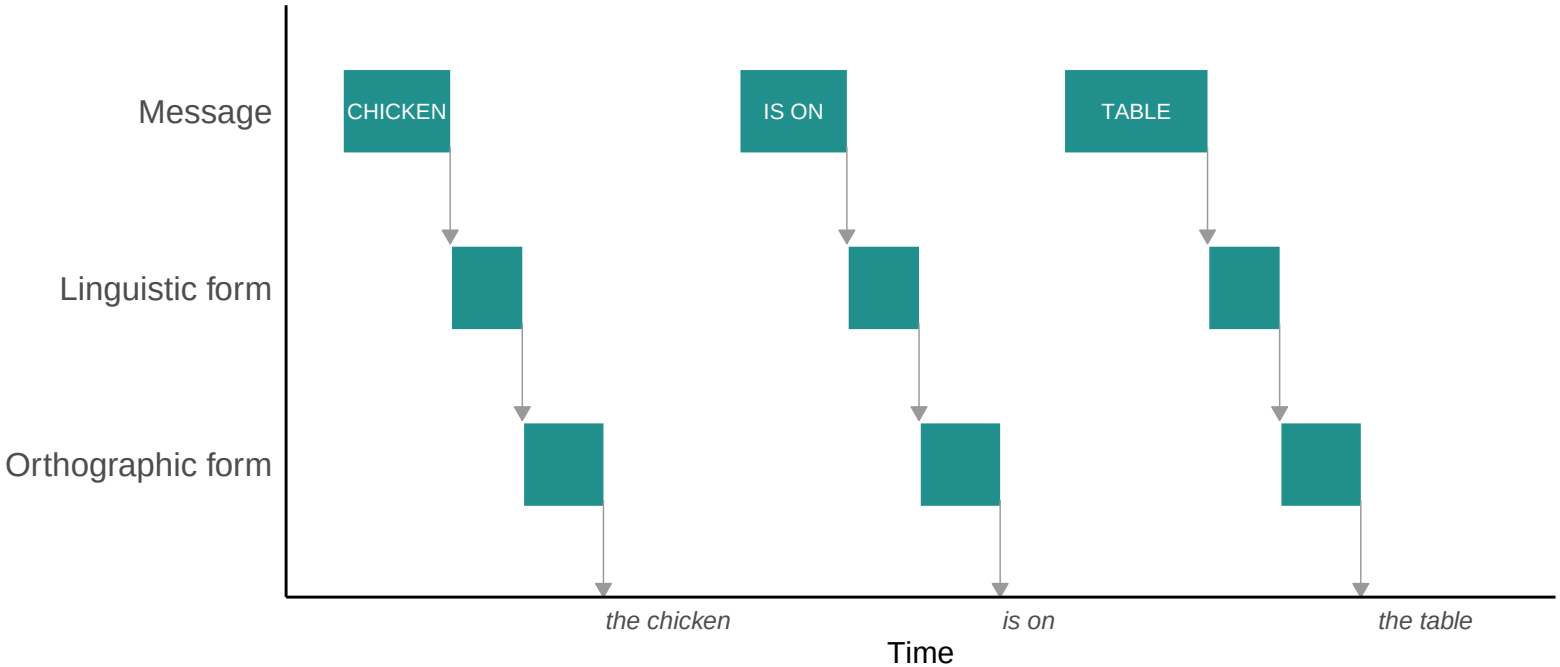
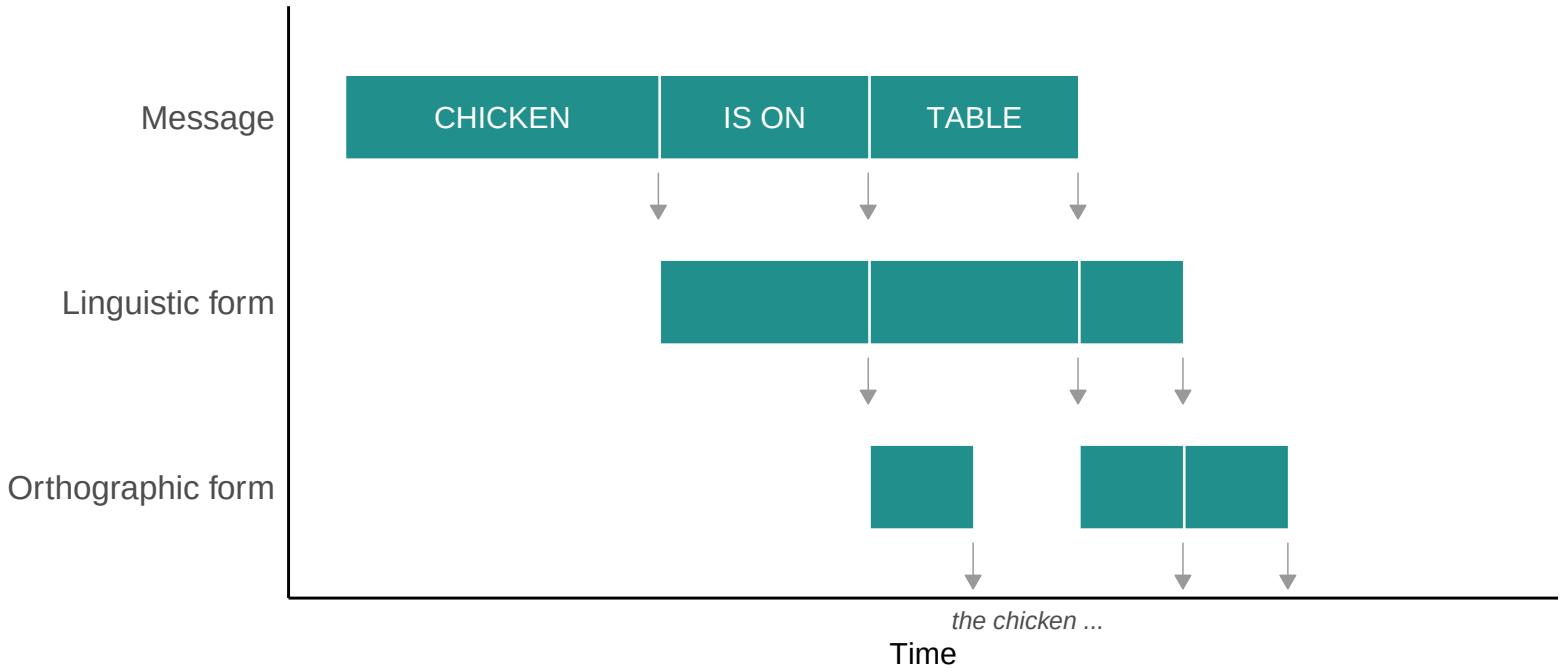


Planning happens at linguistic edges and unfolds in a serial fashion.

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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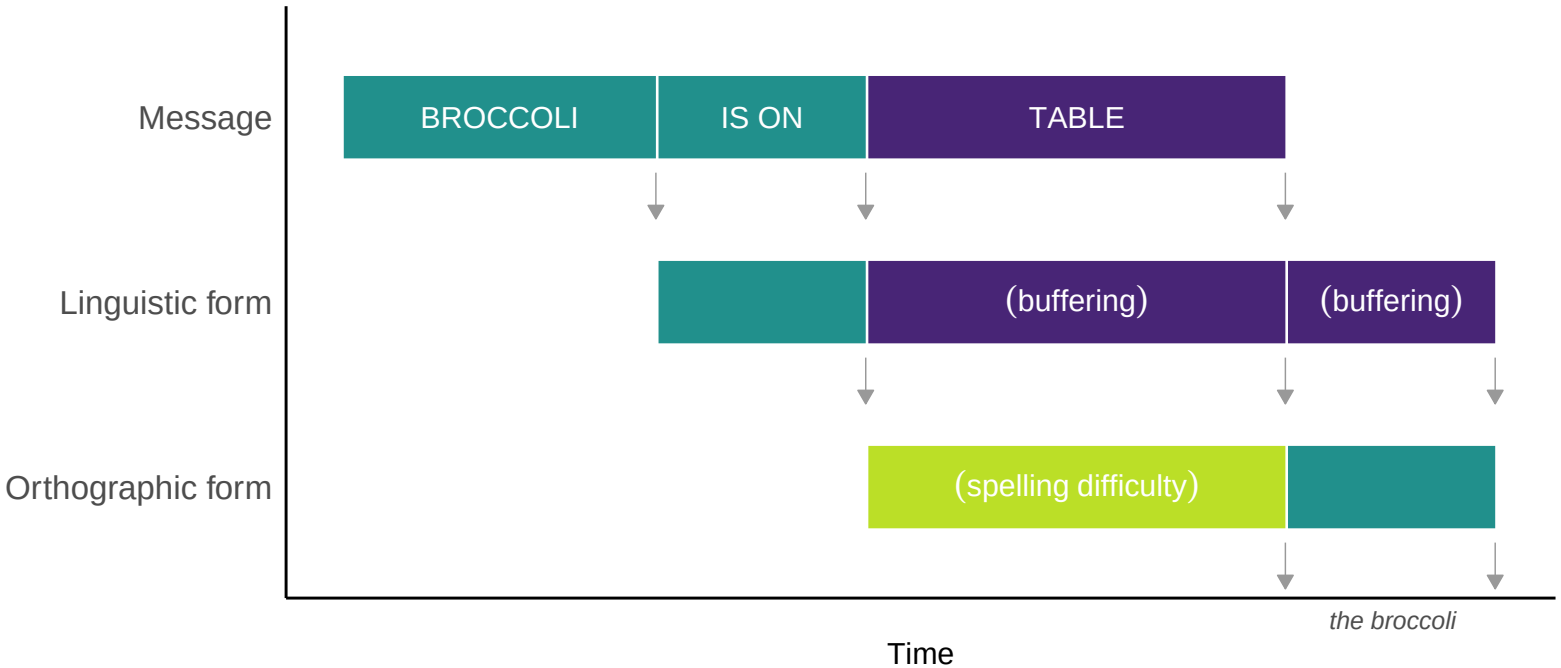

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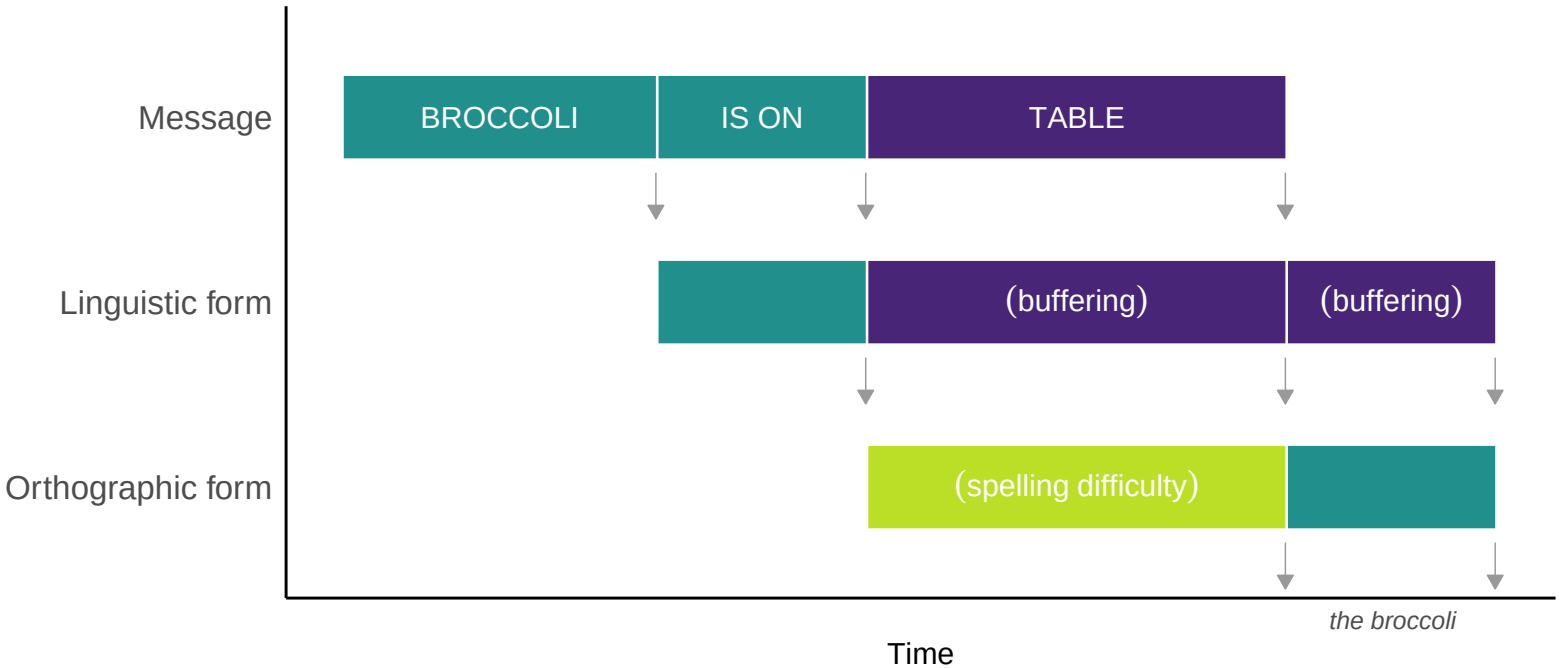

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Research Question & Aims

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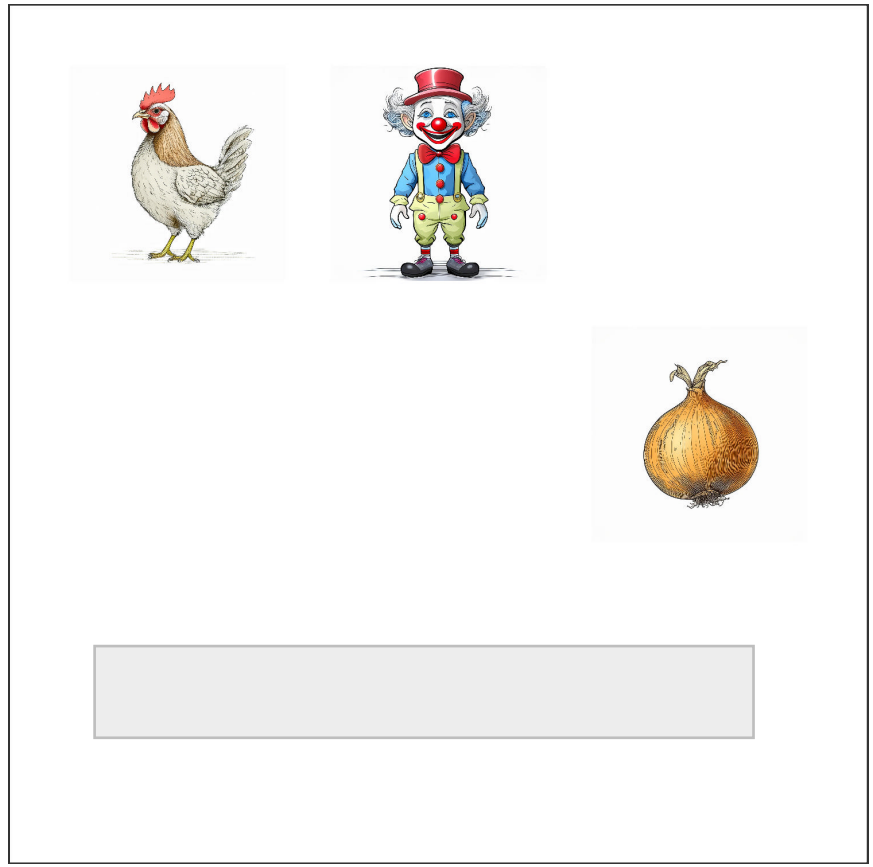
To what extent does difficulty with word spelling affect our ability to convey ideas in writing? In particular, this research aims to …

- 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)

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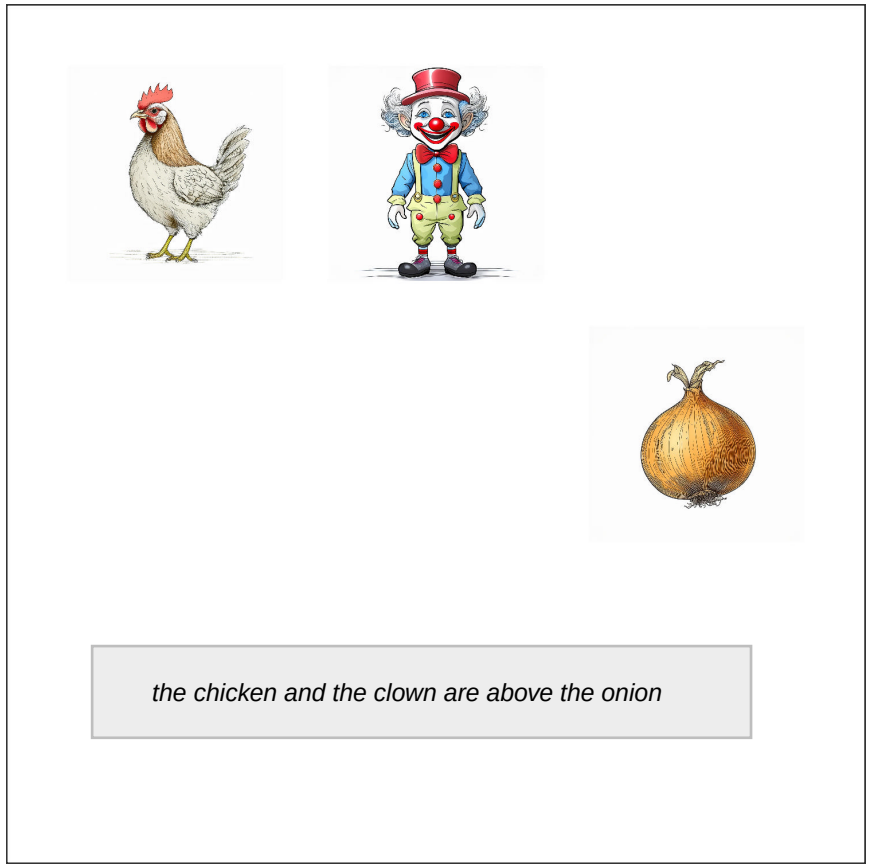

Example screen (Roeser et al., 2019; Smith & Wheeldon, 1999)

Design: Example item set

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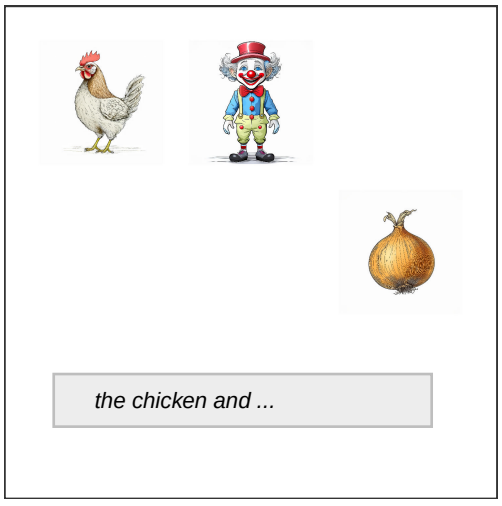
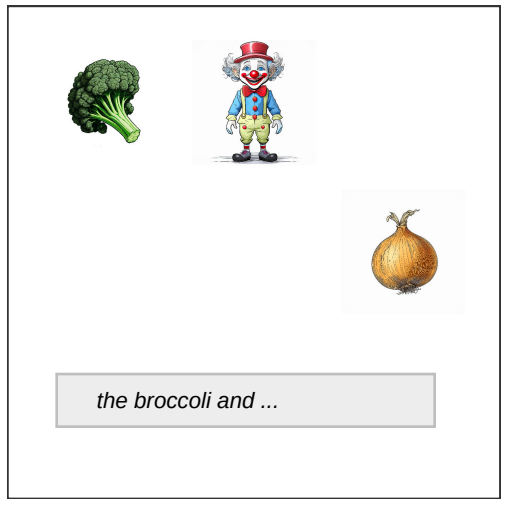
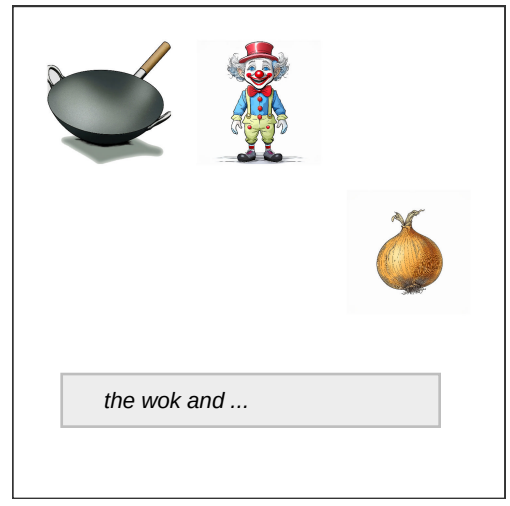
N1: easy spelling / long



N1 difficult spelling / long

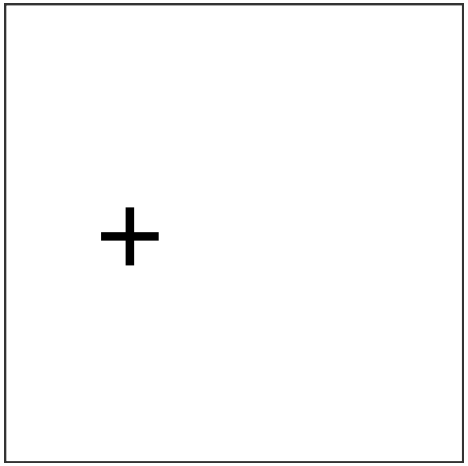


N1: easy spelling / short



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



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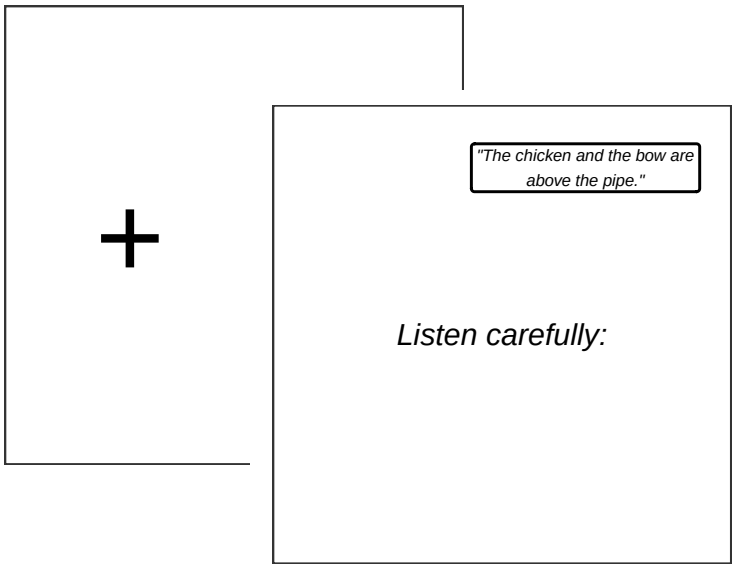

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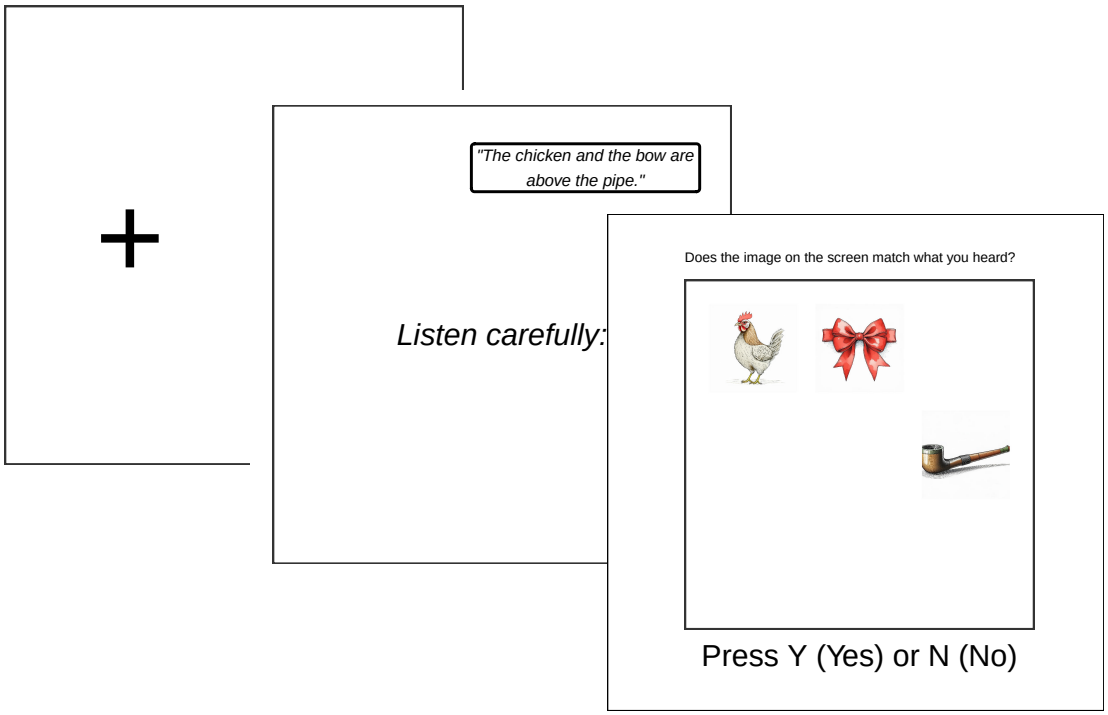

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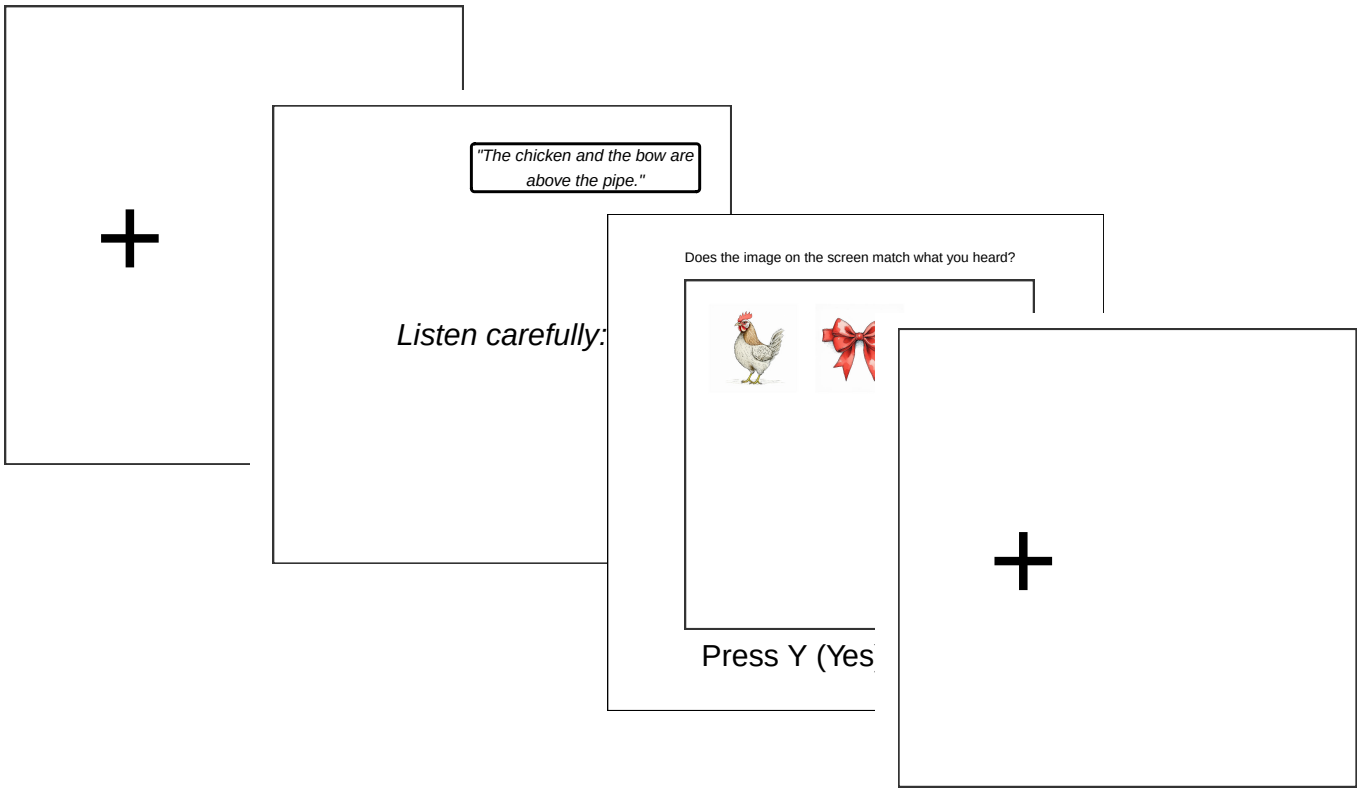

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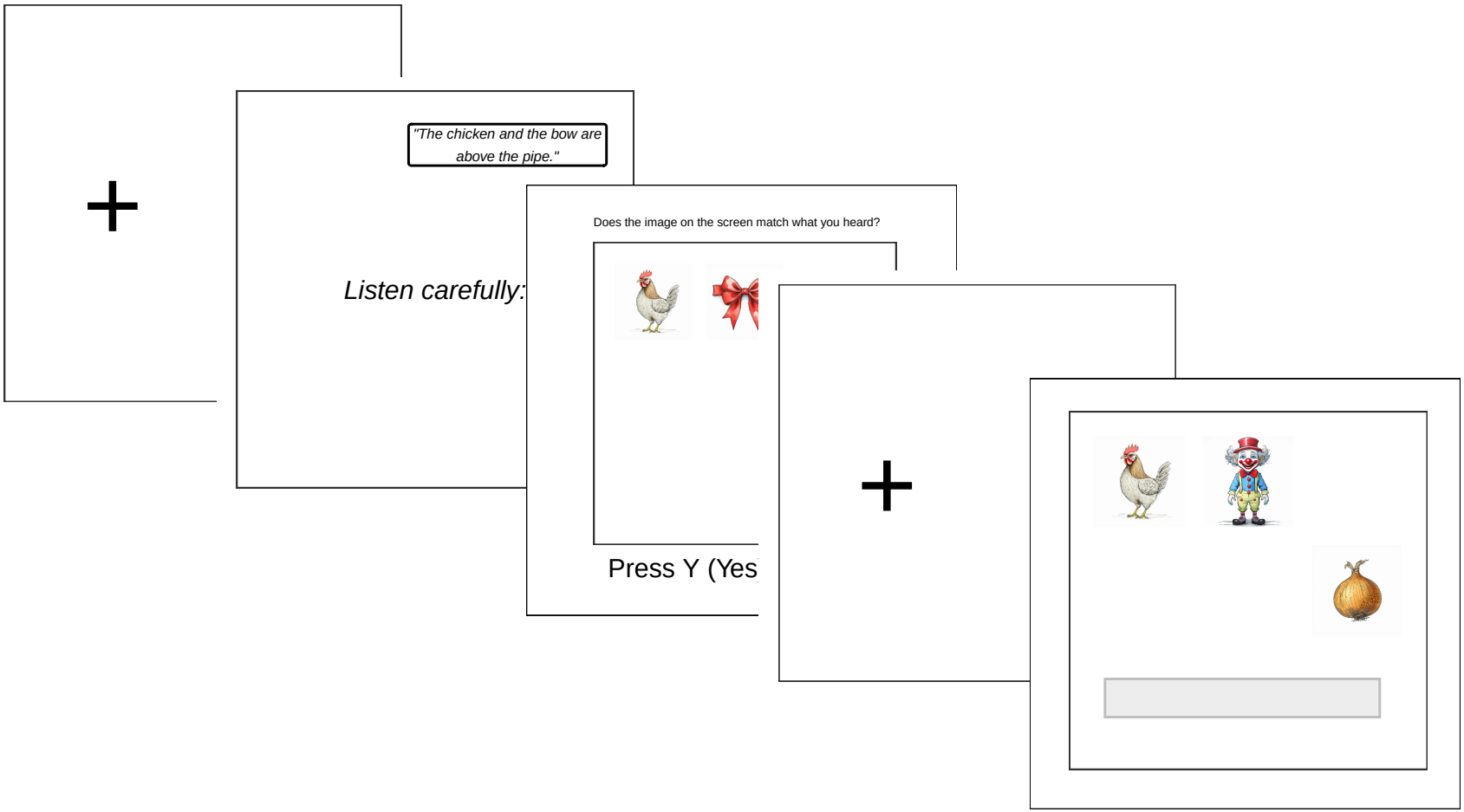

Materials I

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- 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: $\geqslant 2$ 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 form 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):

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

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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Write the name of what you see!

Spelling diversity

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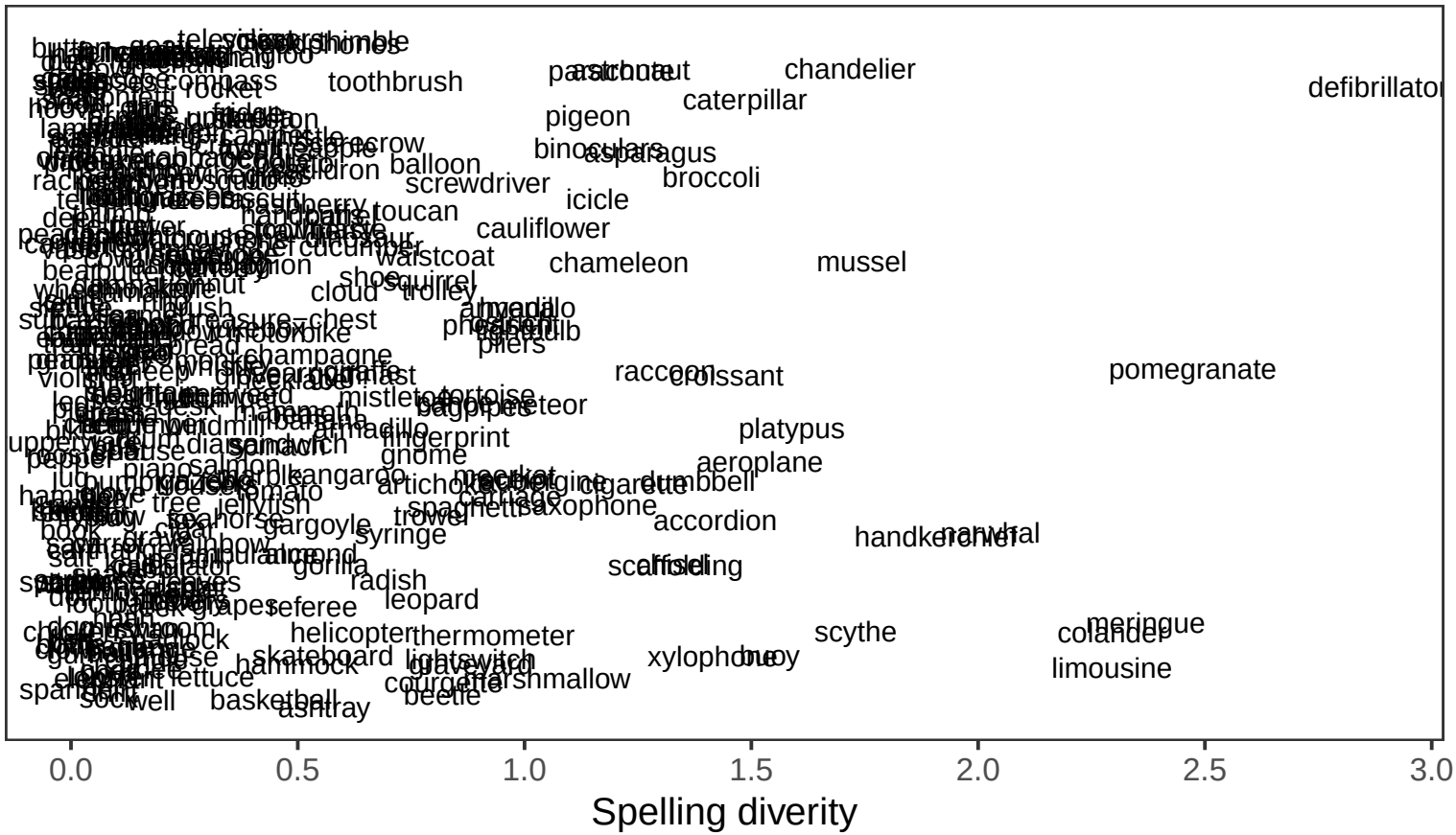
Example summary for "raccoon".

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



N of pics: 383

See poster presentation Aros Muñoz et al.

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- 36 items counterbalanced for prime structure and N1 word type.
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Participants

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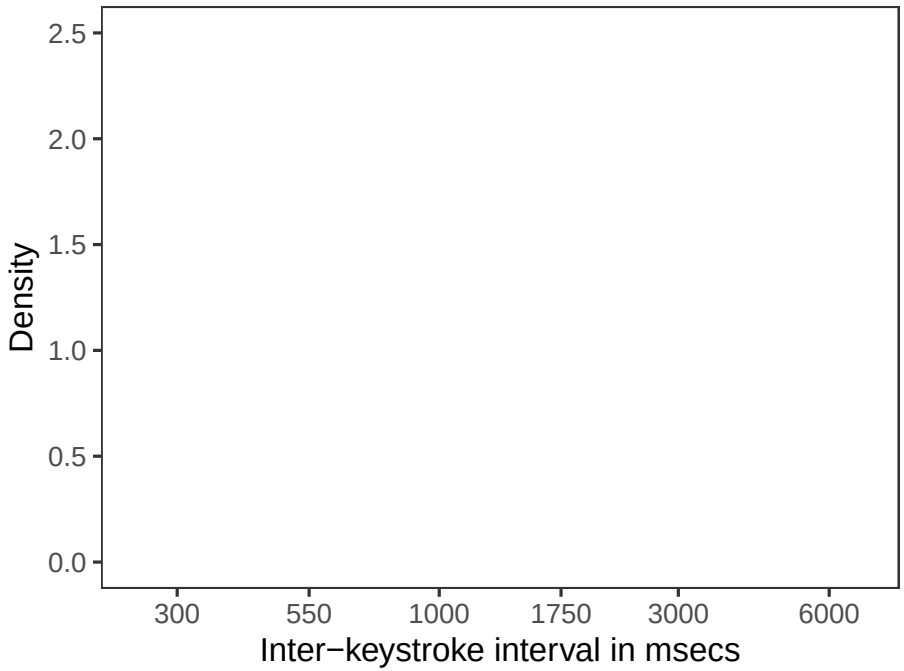
Ten ppts per counterbalancing list. After data cleaning:

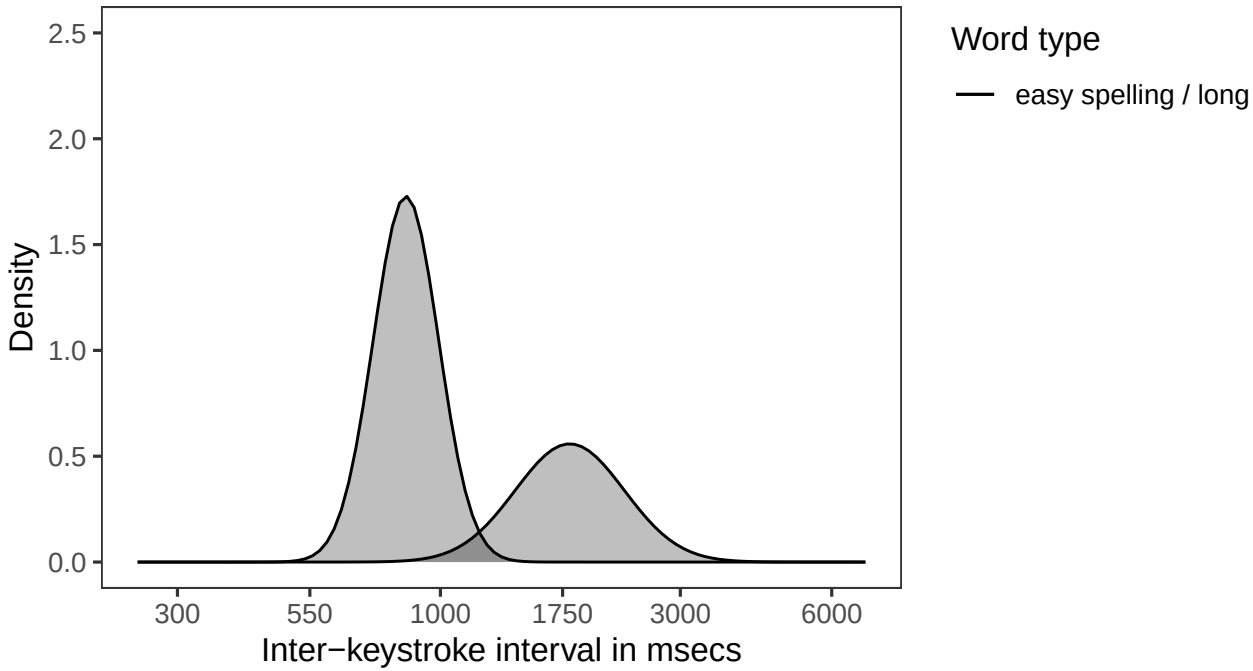
- Experiment 1: 56 ppts (6 lists)
- Experiment 2: 80 ppts (9 lists)
- Experiment 3: 96 ppts (12 lists)

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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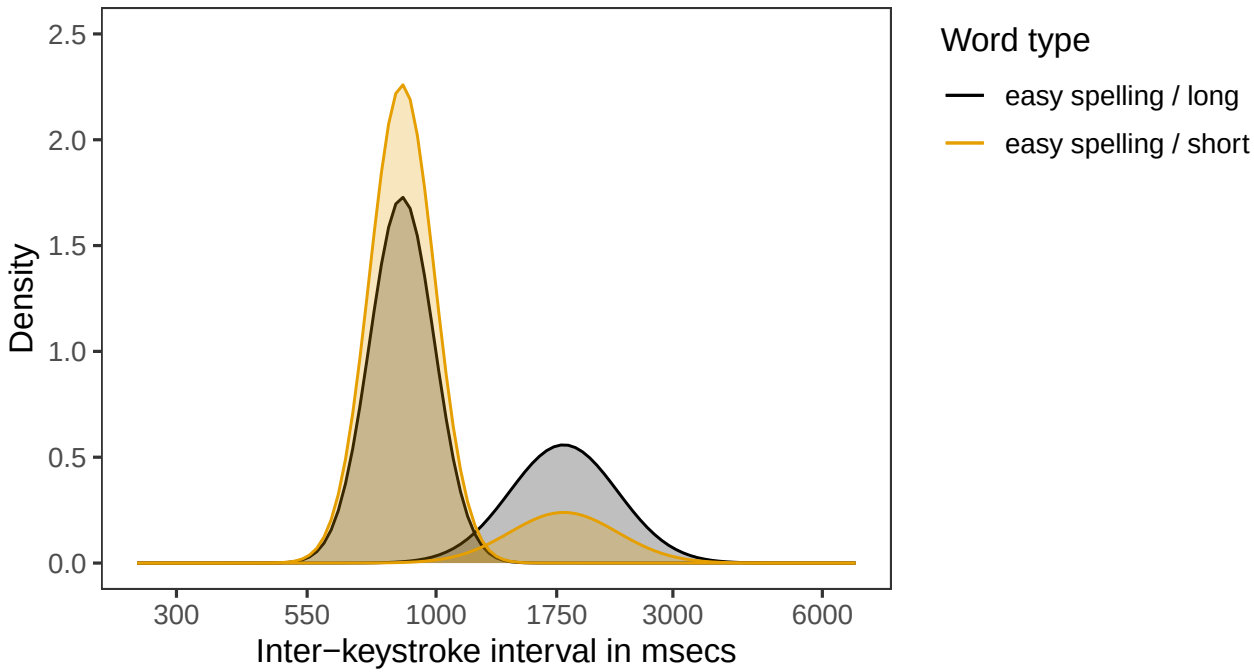

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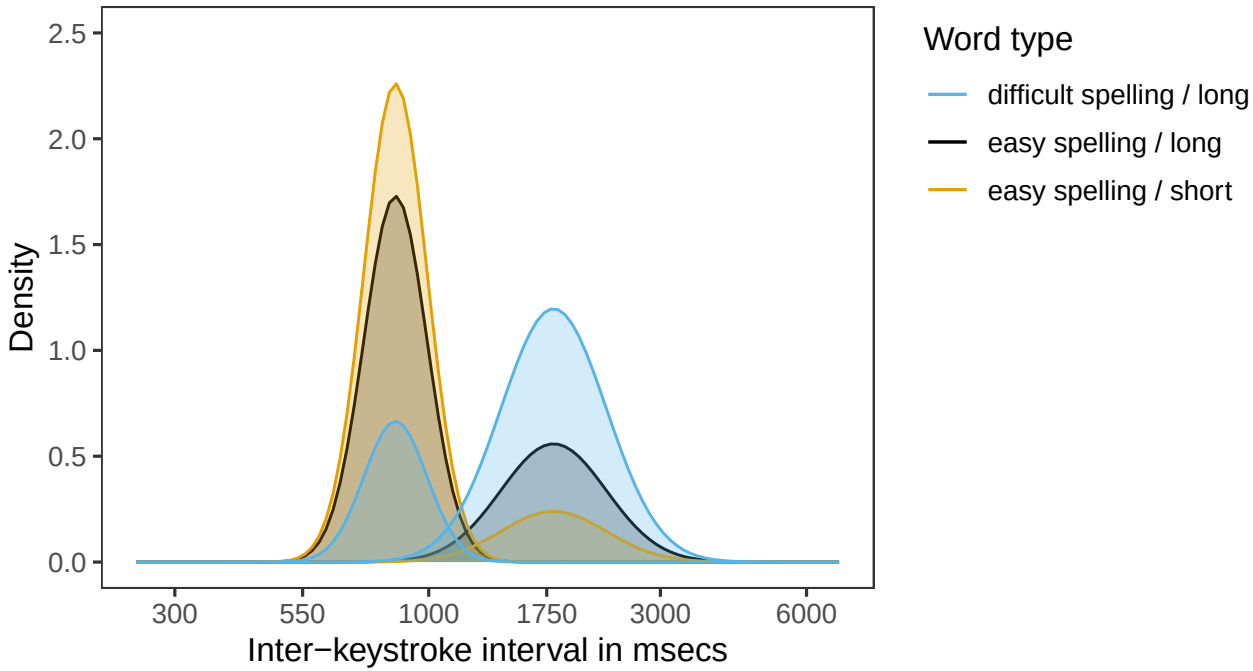

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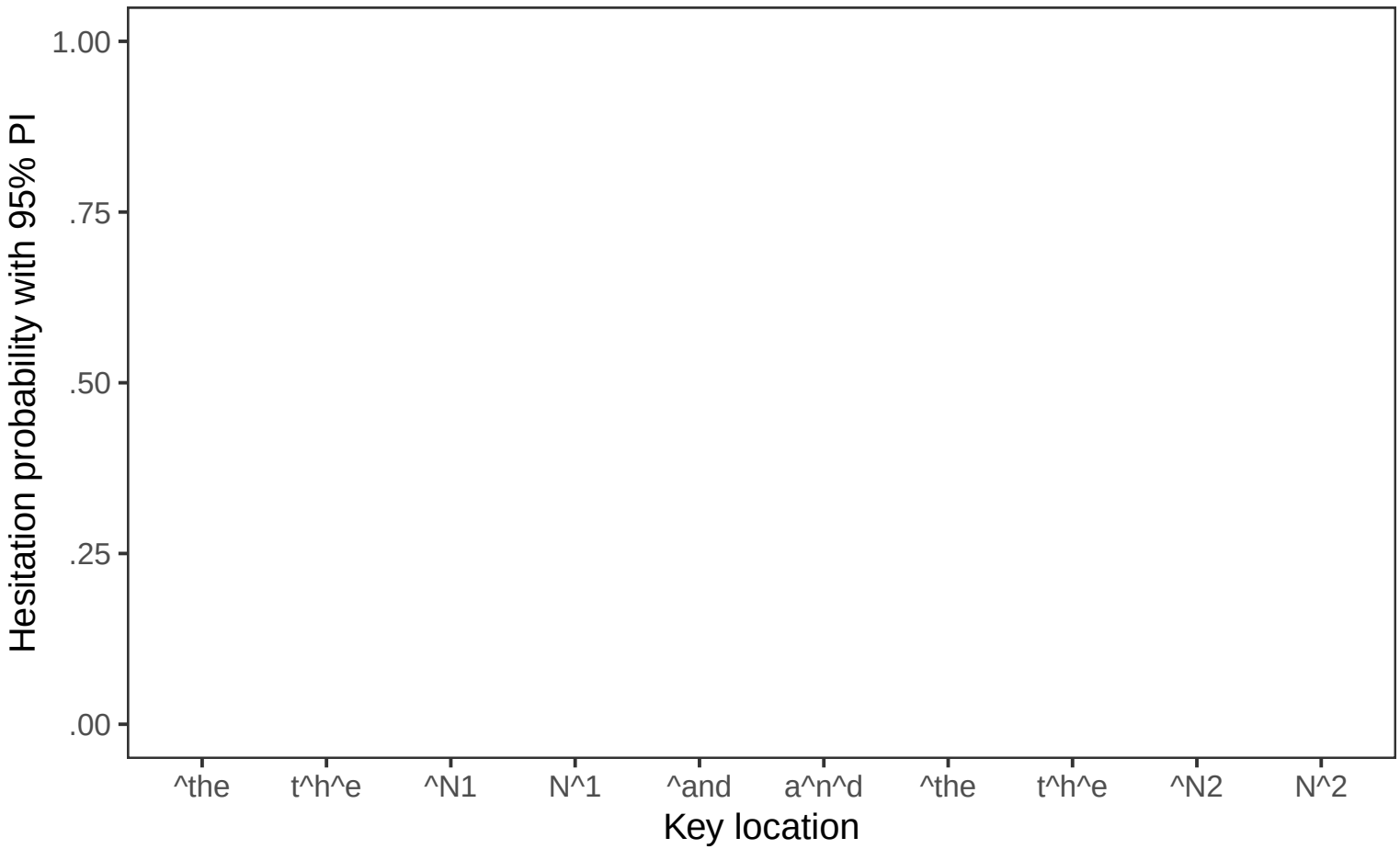

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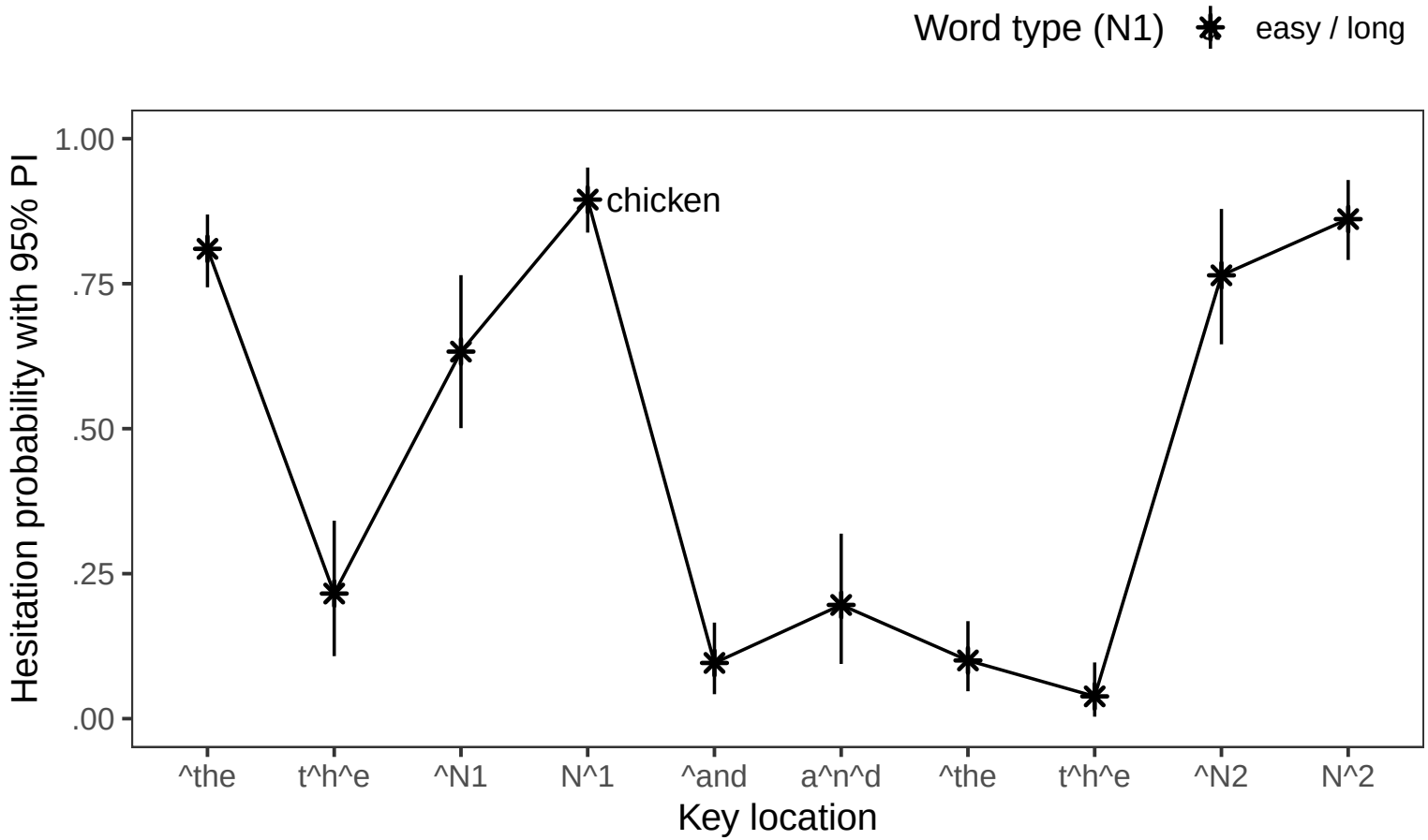

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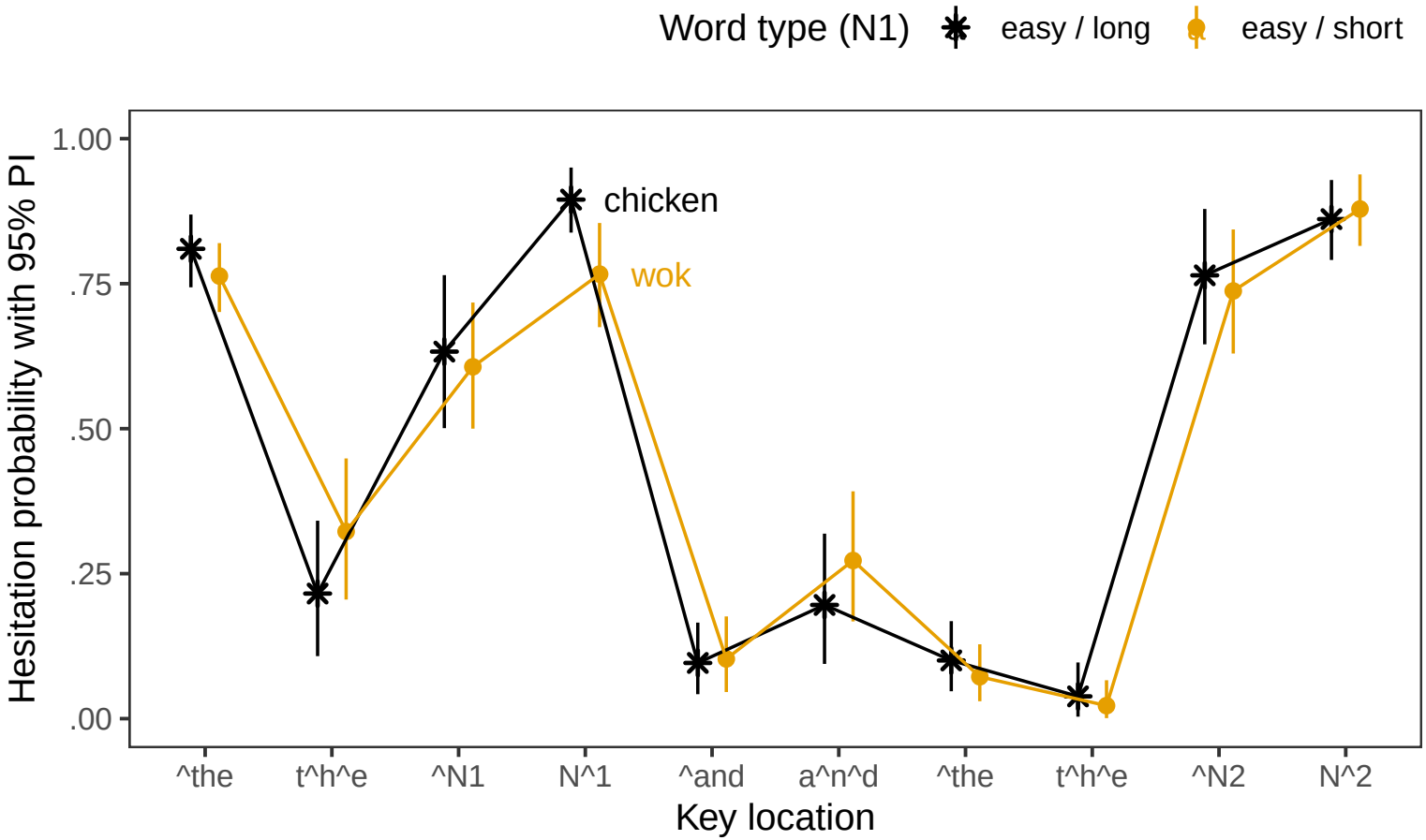

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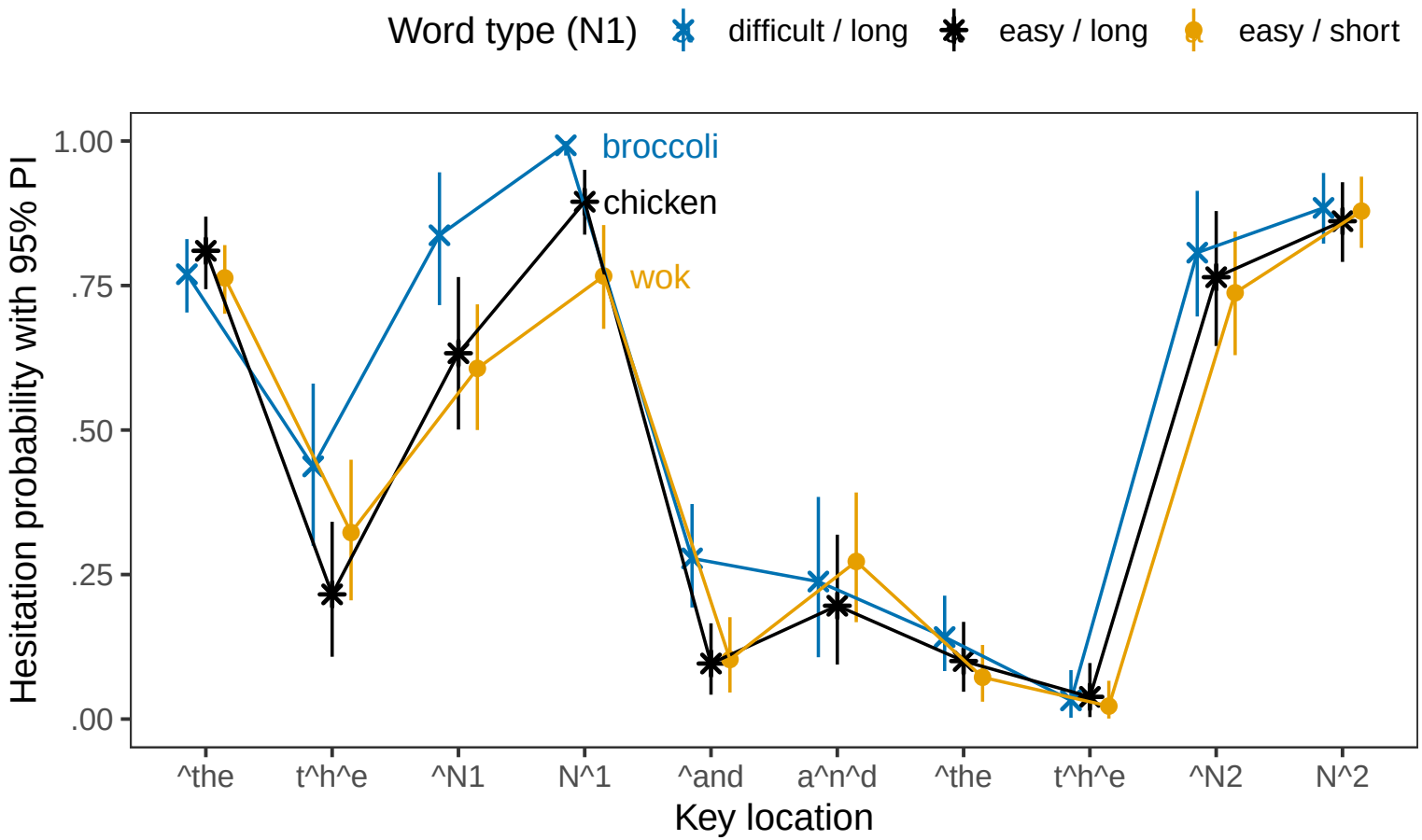

Experiment 2

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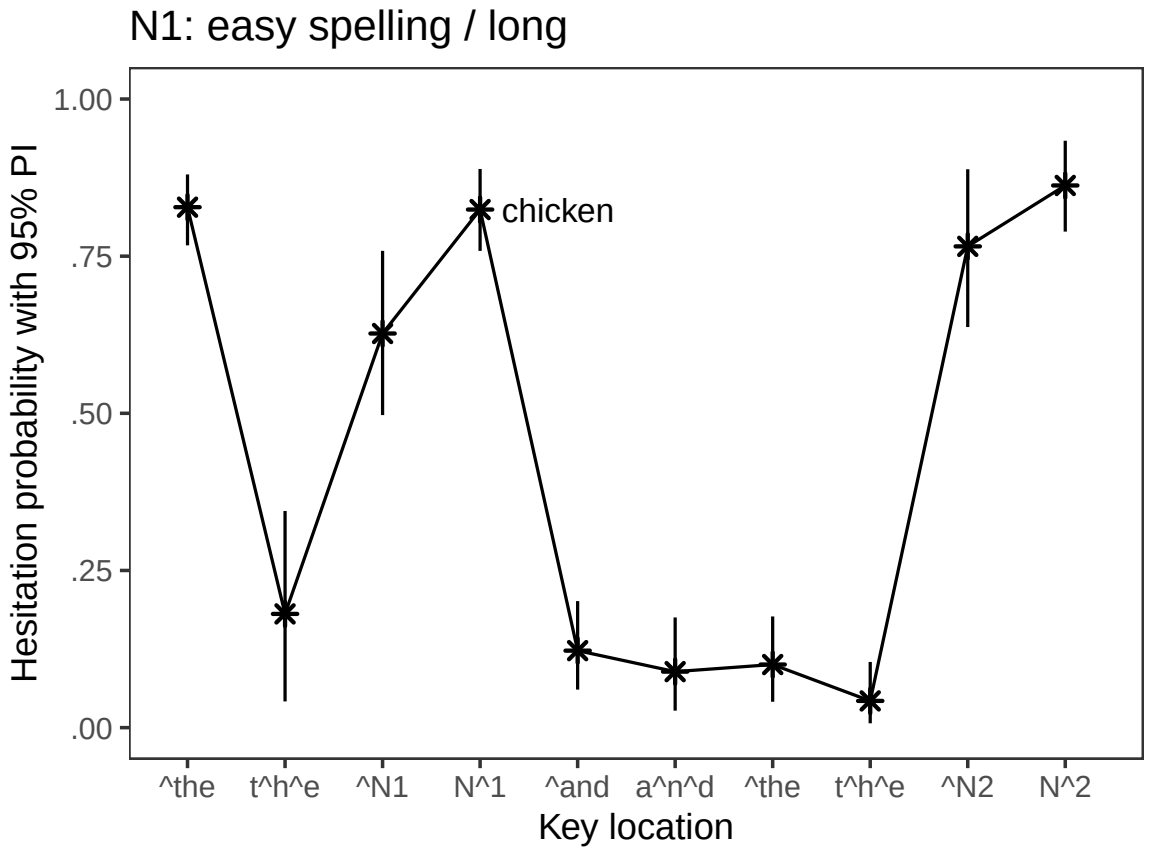
Distance between N1 and N2 might mediate spelling hesitations: Does *and the* buy writers enough time to avoid intra-sentence hesitations?

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 distance between nouns constraints parallel planning, we expect more hesitations before N2 for *the* omissions.

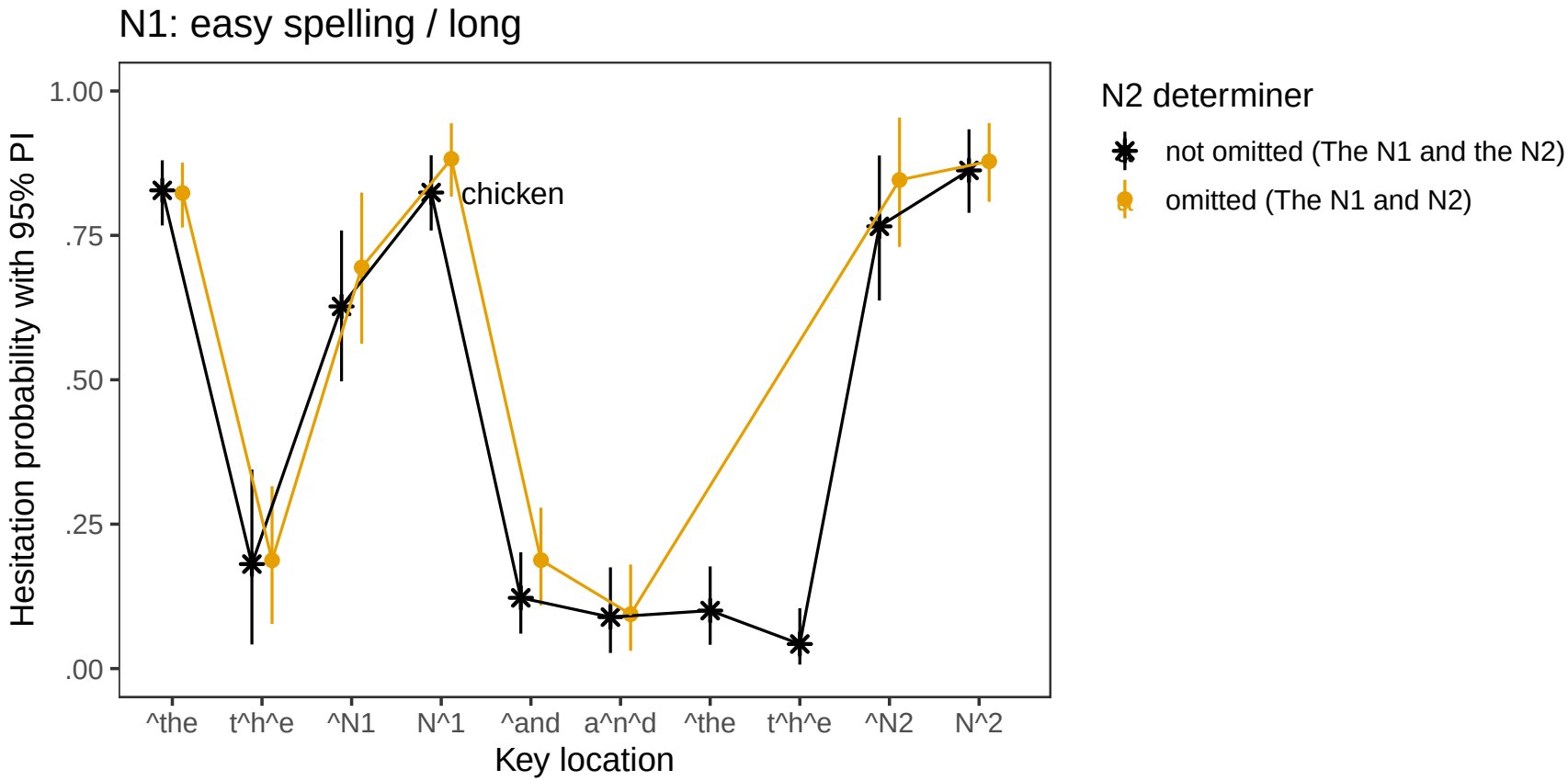
Experiment 2: typing timecourse



N2 determiner

not omitted (The N1 and the N2)

Experiment 2: typing timecourse



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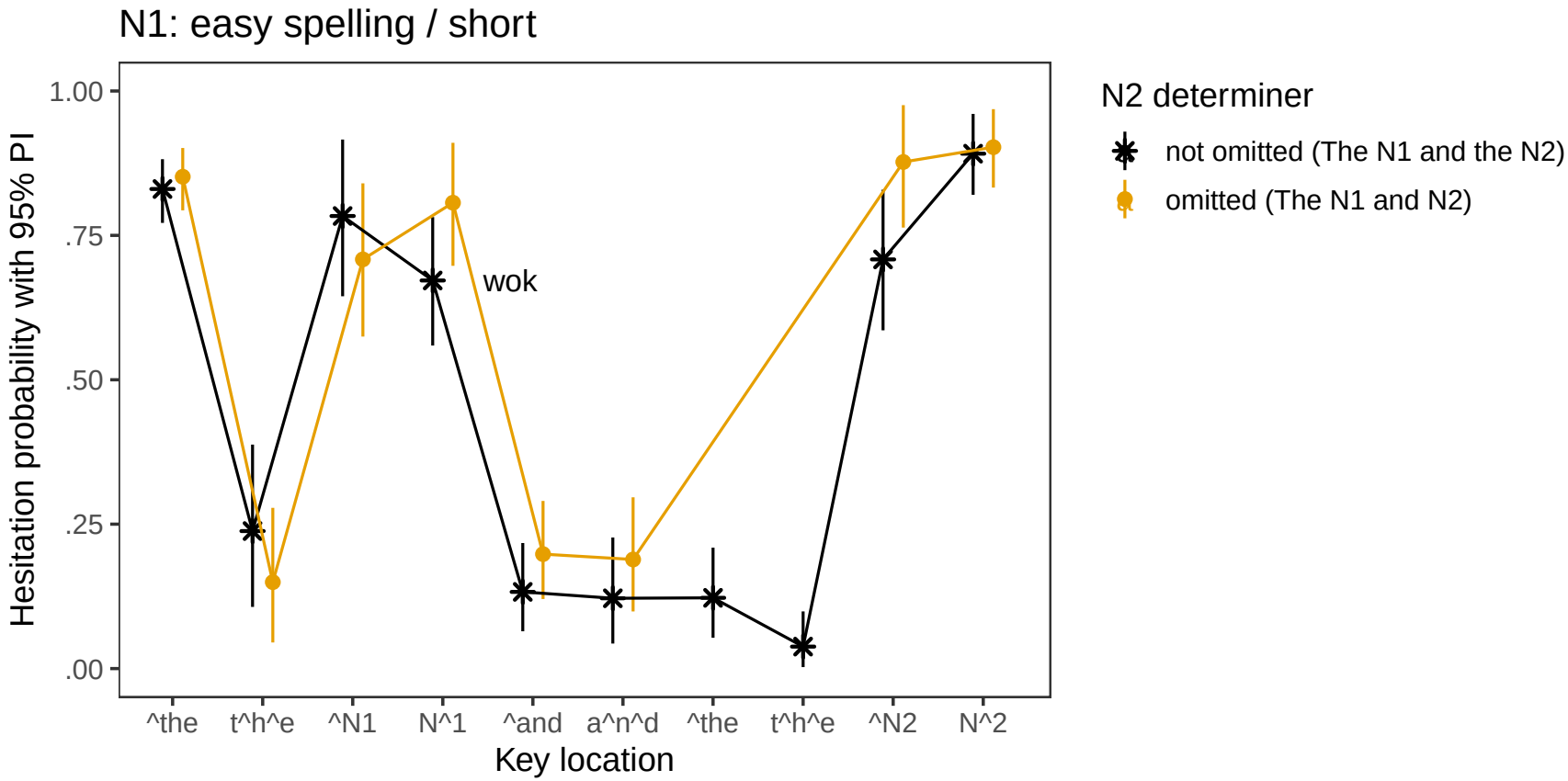

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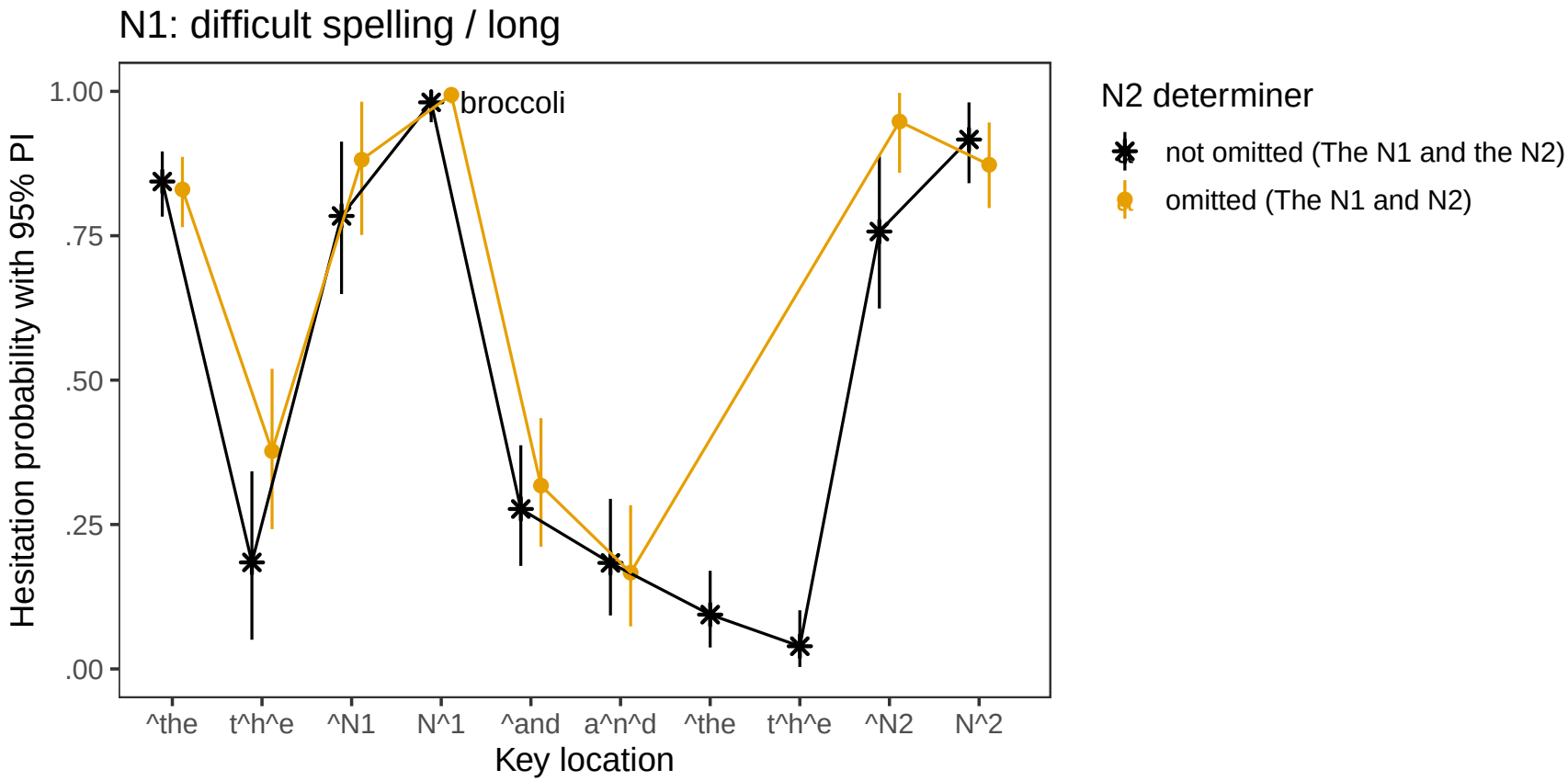

Experiment 3

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

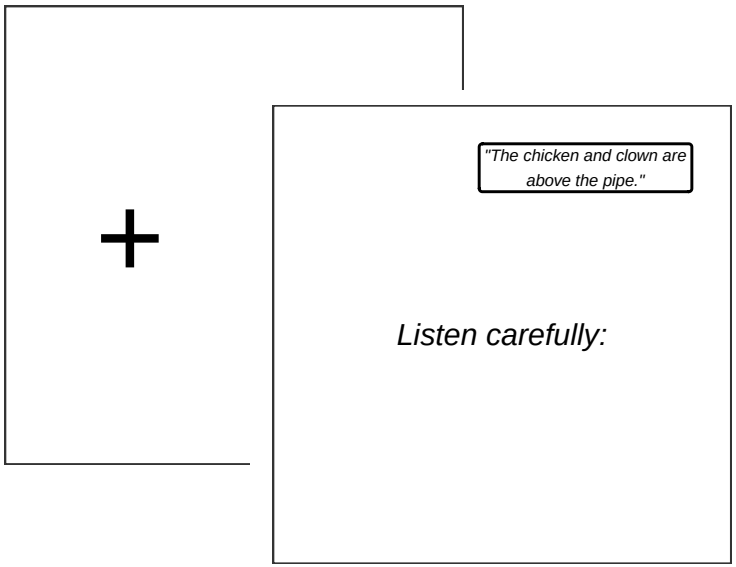
Prime with (auditory) N2 preview:

- 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 the planning bottleneck delayed N2 retrieval, preview will reduce associated hesitations.

Experiment 3: N2 preview



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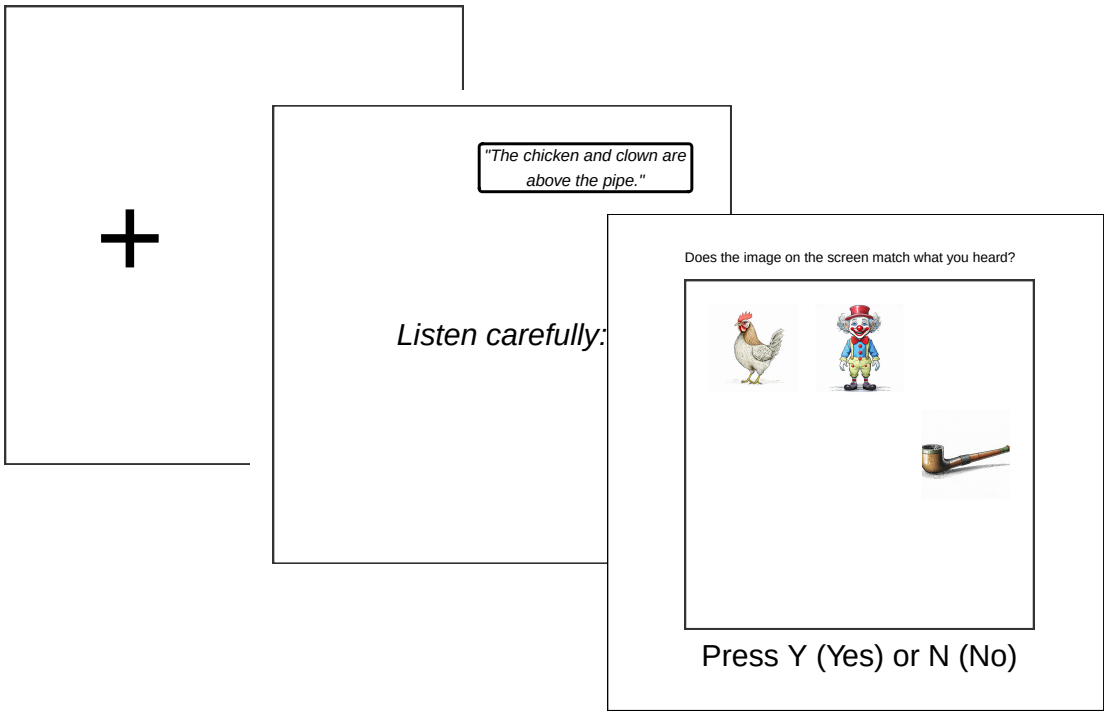

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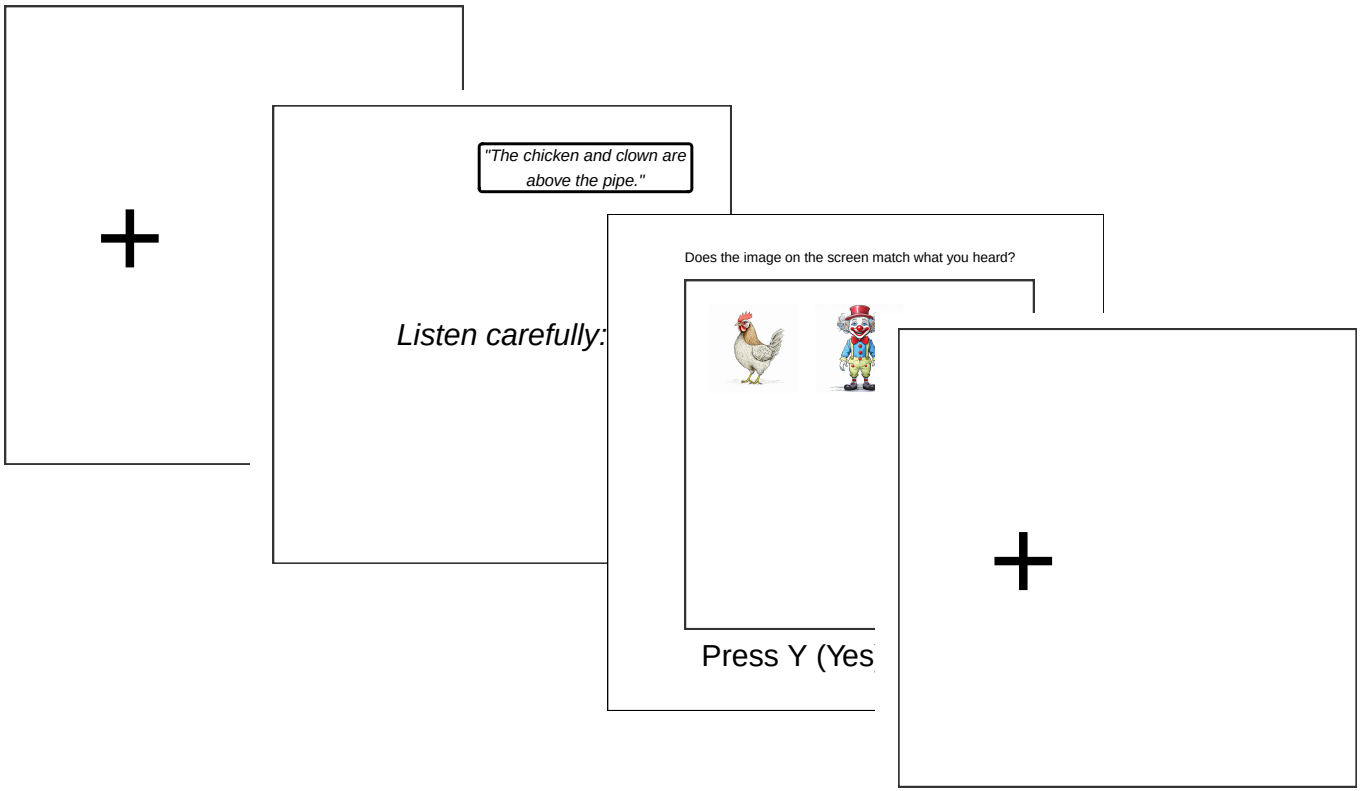

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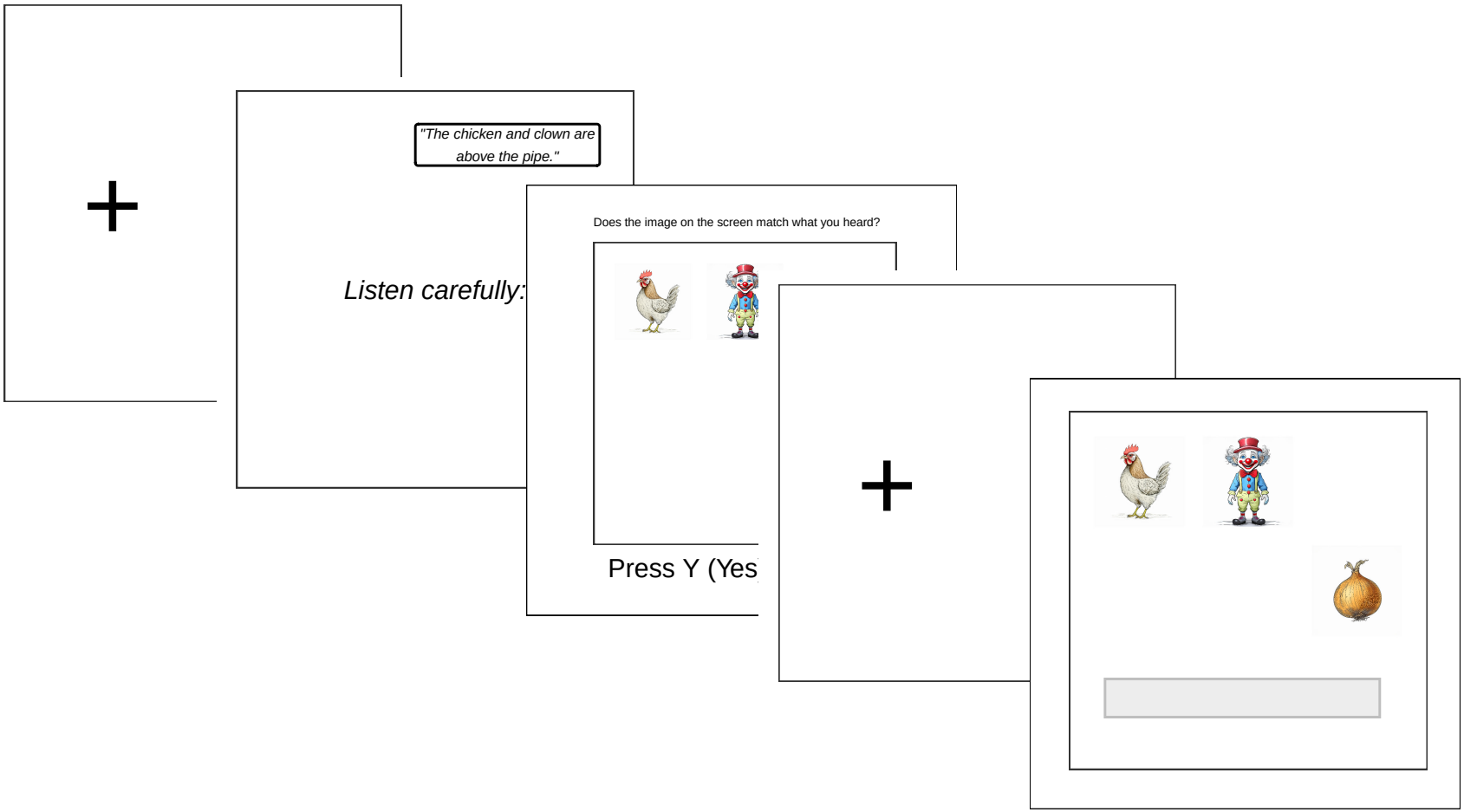

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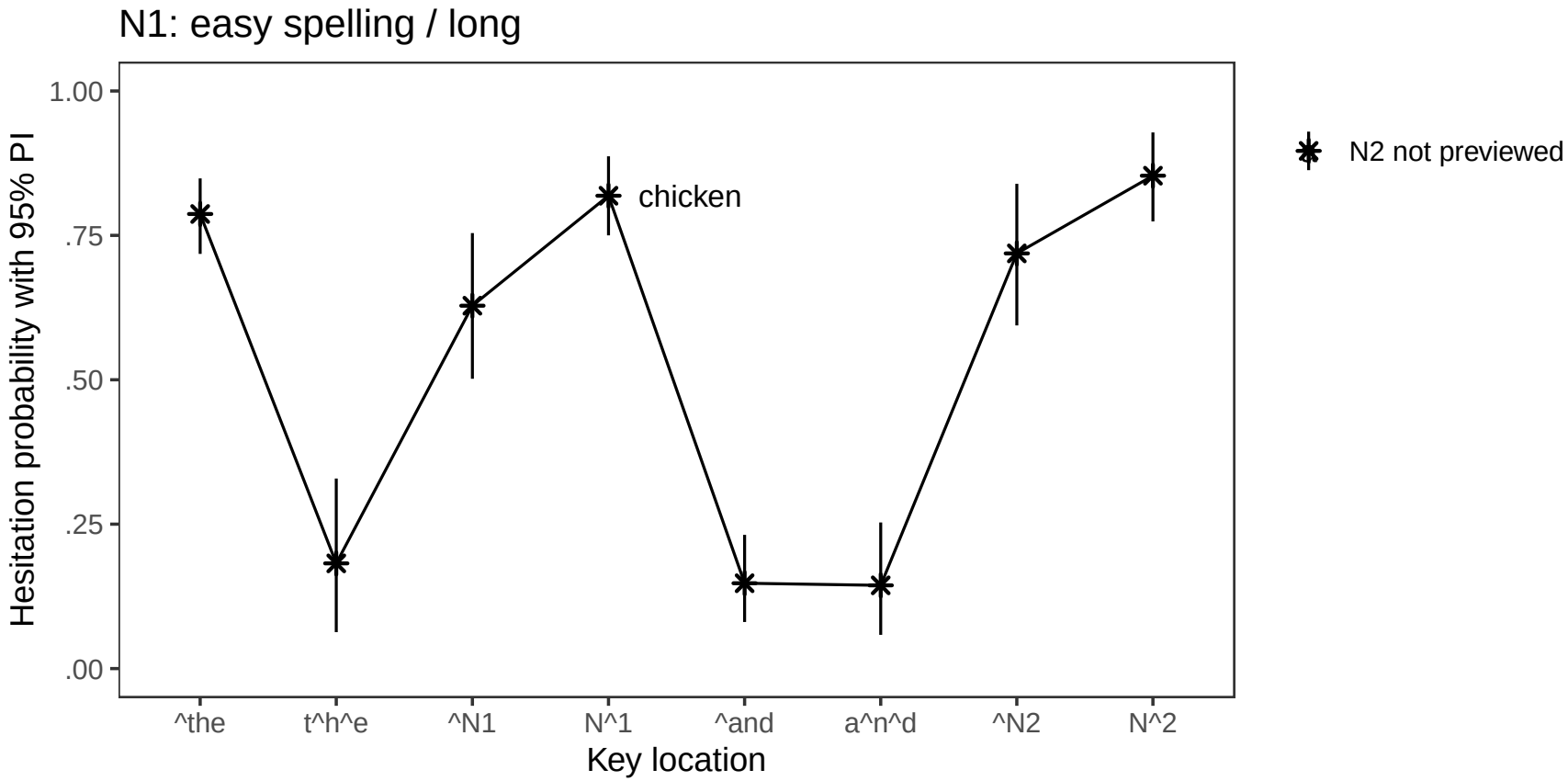

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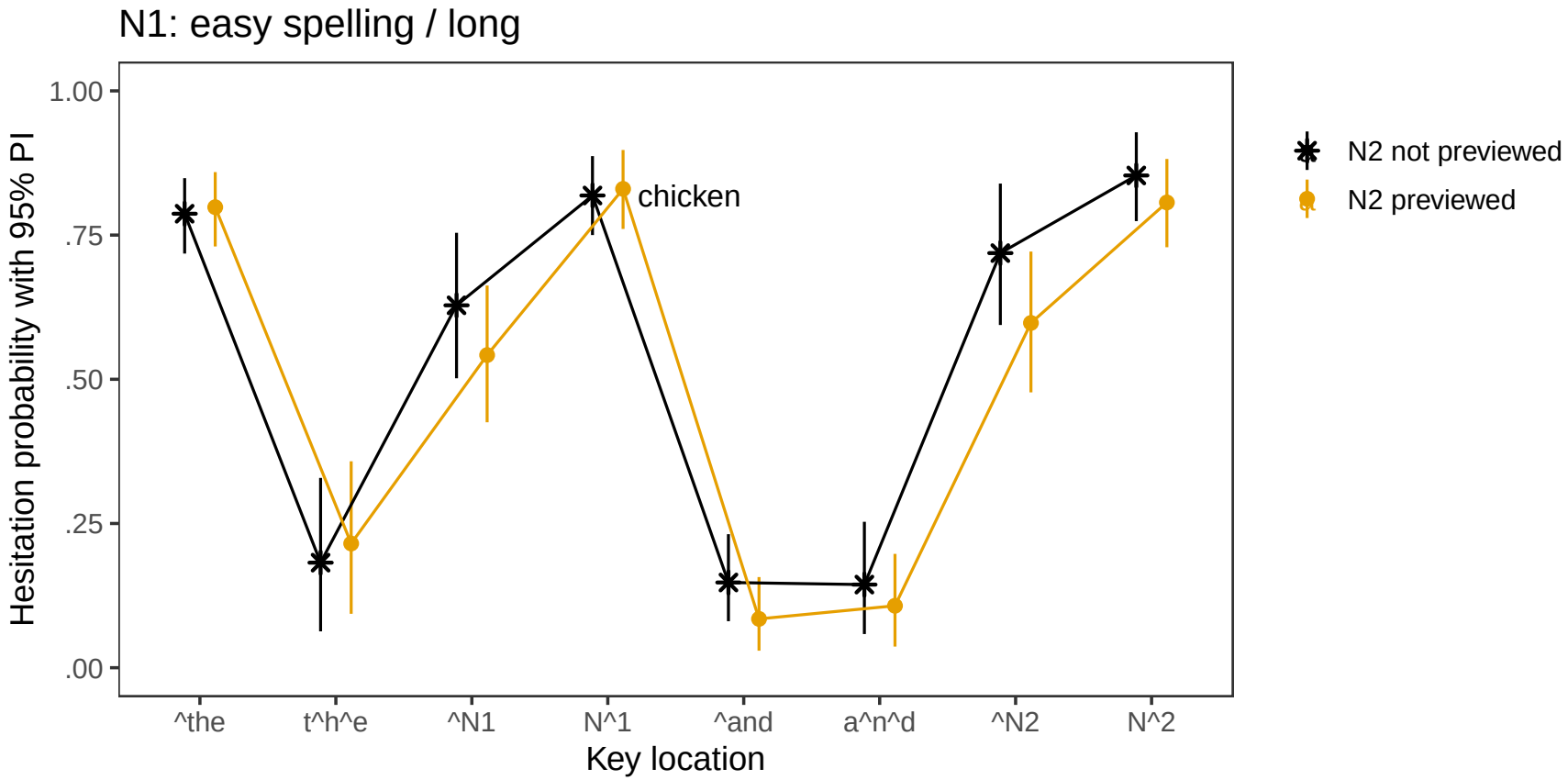

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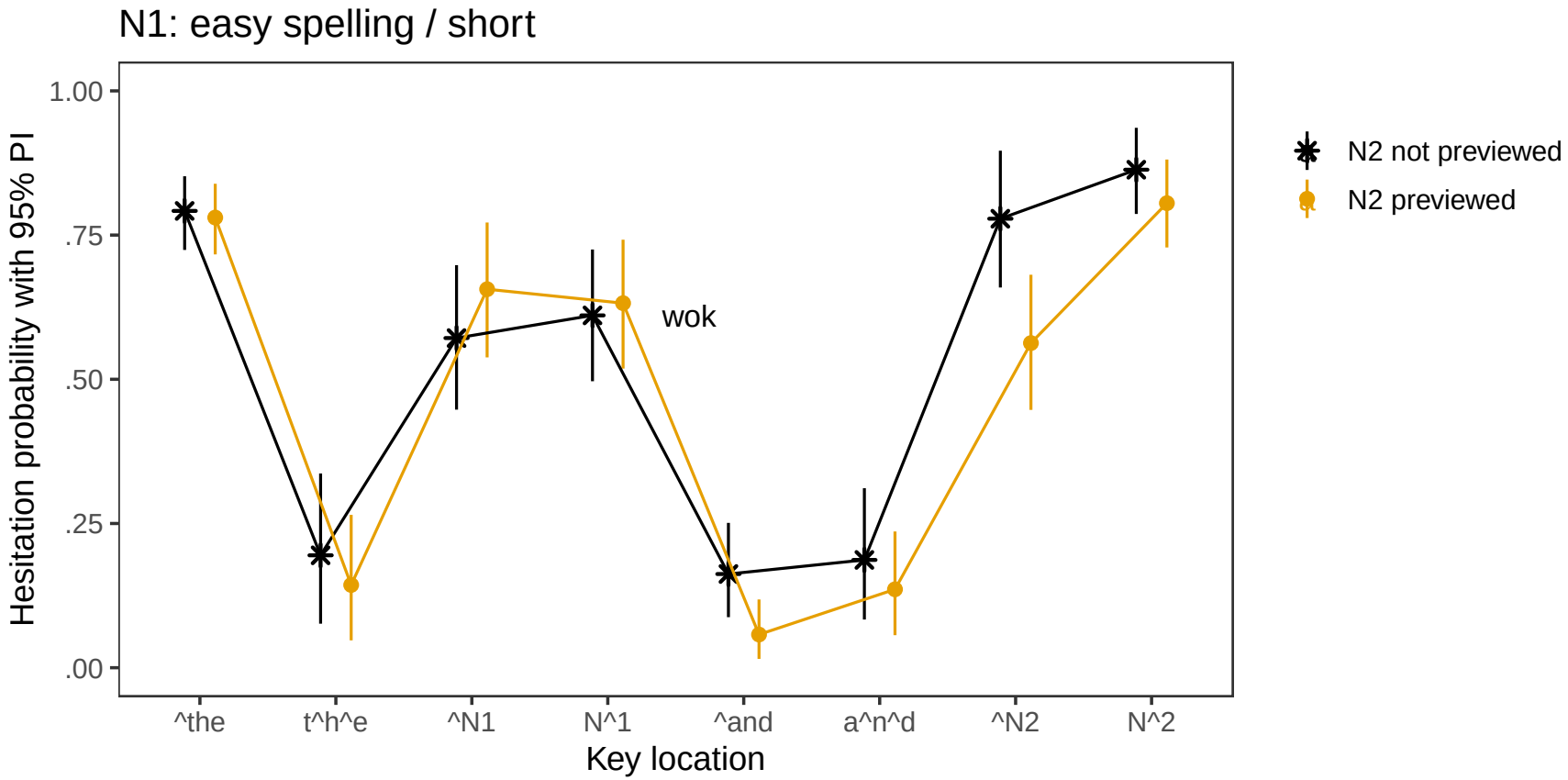

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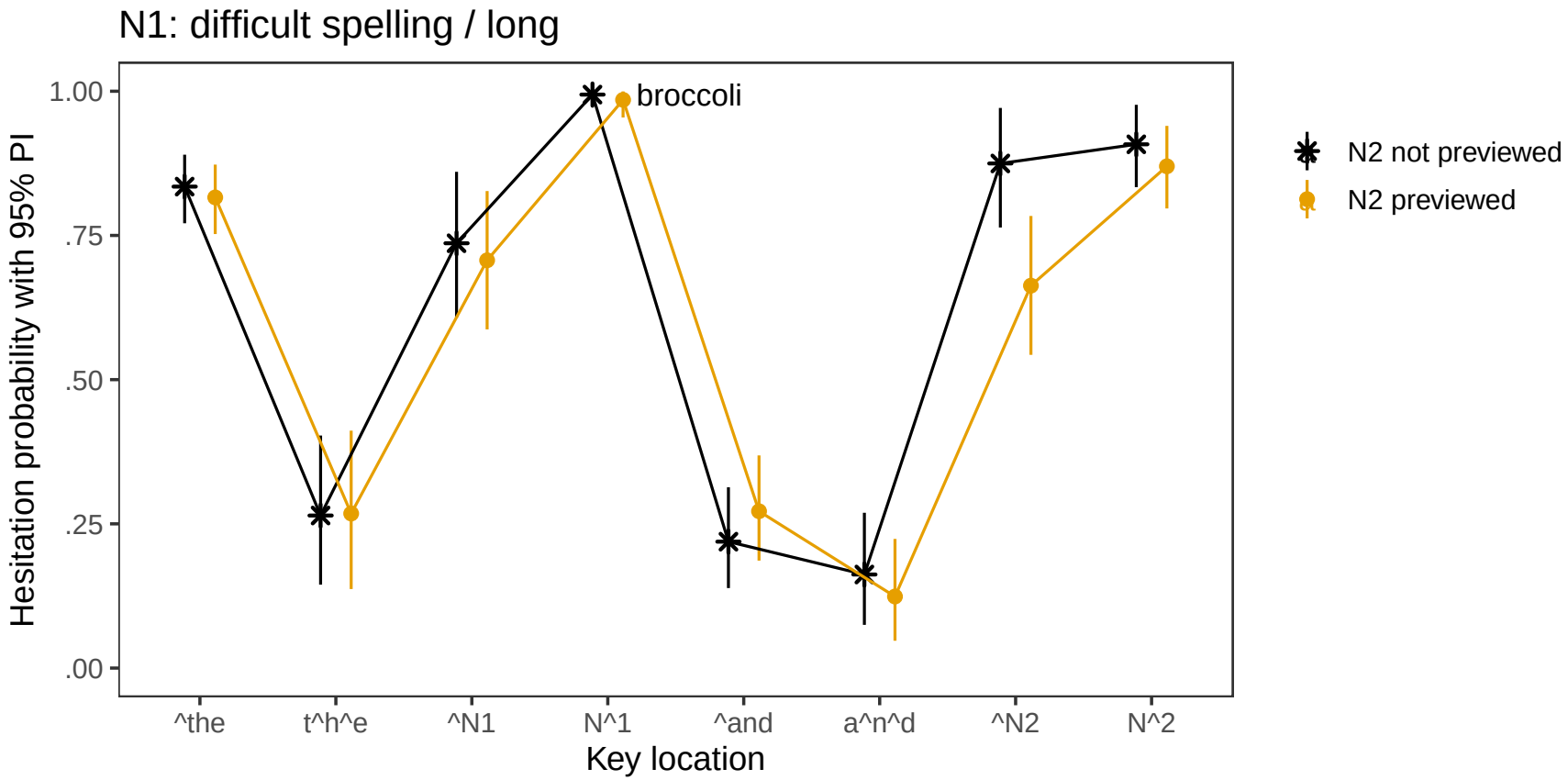

Conclusion

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- Writers plan text in parallel to production.
- Hesitations occur if information couldn't be retrieved in time because of ...

1. Difficulty orthographic encoding before / after word onset.
2. Not enough time for lexical retrieval: long and / or functional words – e.g. *and the* – allow time for parallel lexical retrieval (Griffin, 2003).
3. Error monitoring: more hesitations after critical word.

Thanks for listening!

email: 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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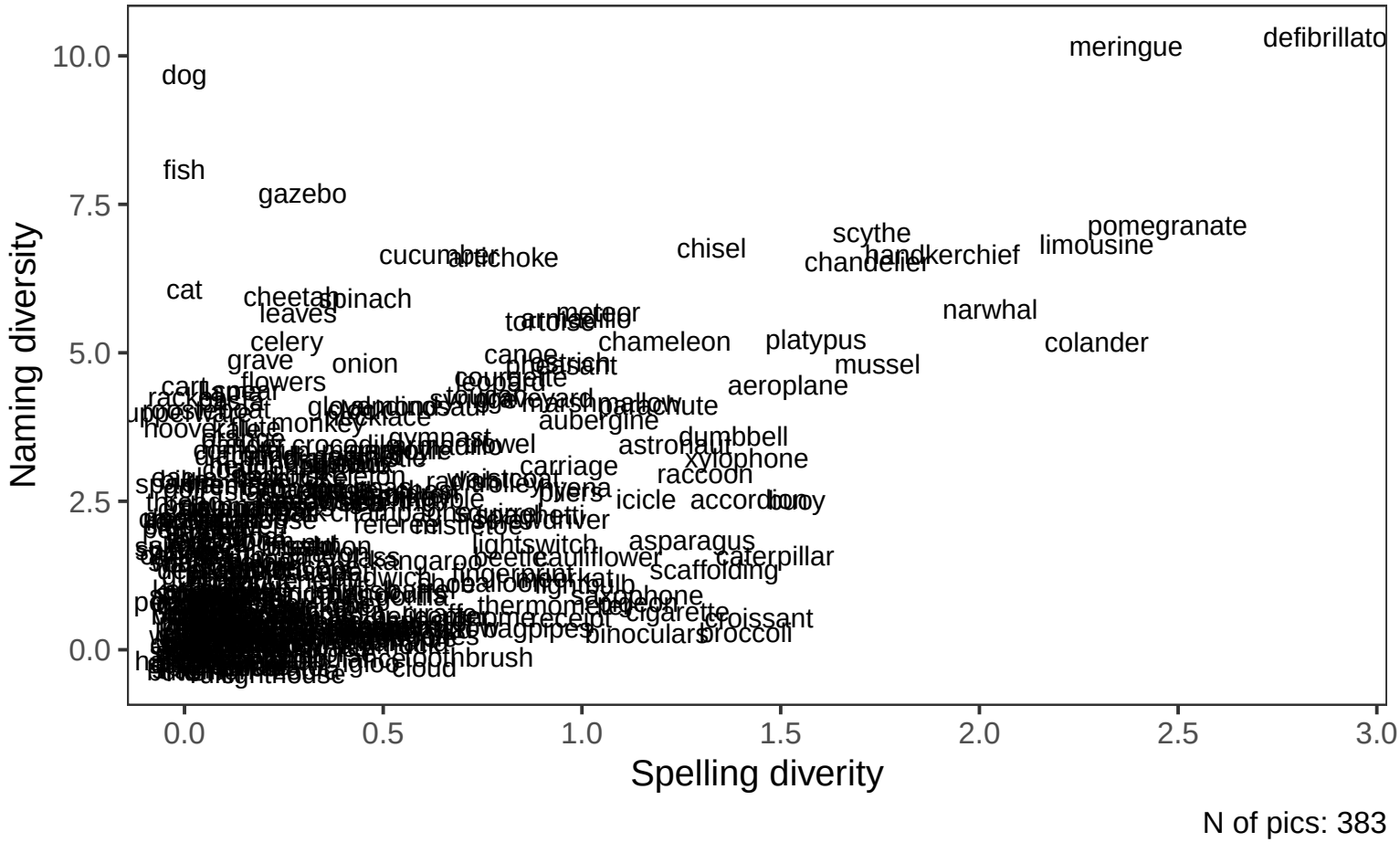
Spelling and naming diversity



N of pics: 383

See poster presentation Aros Muñoz et al.

Typing as mixture process

Economic and Social Research Council

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

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

where:

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

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

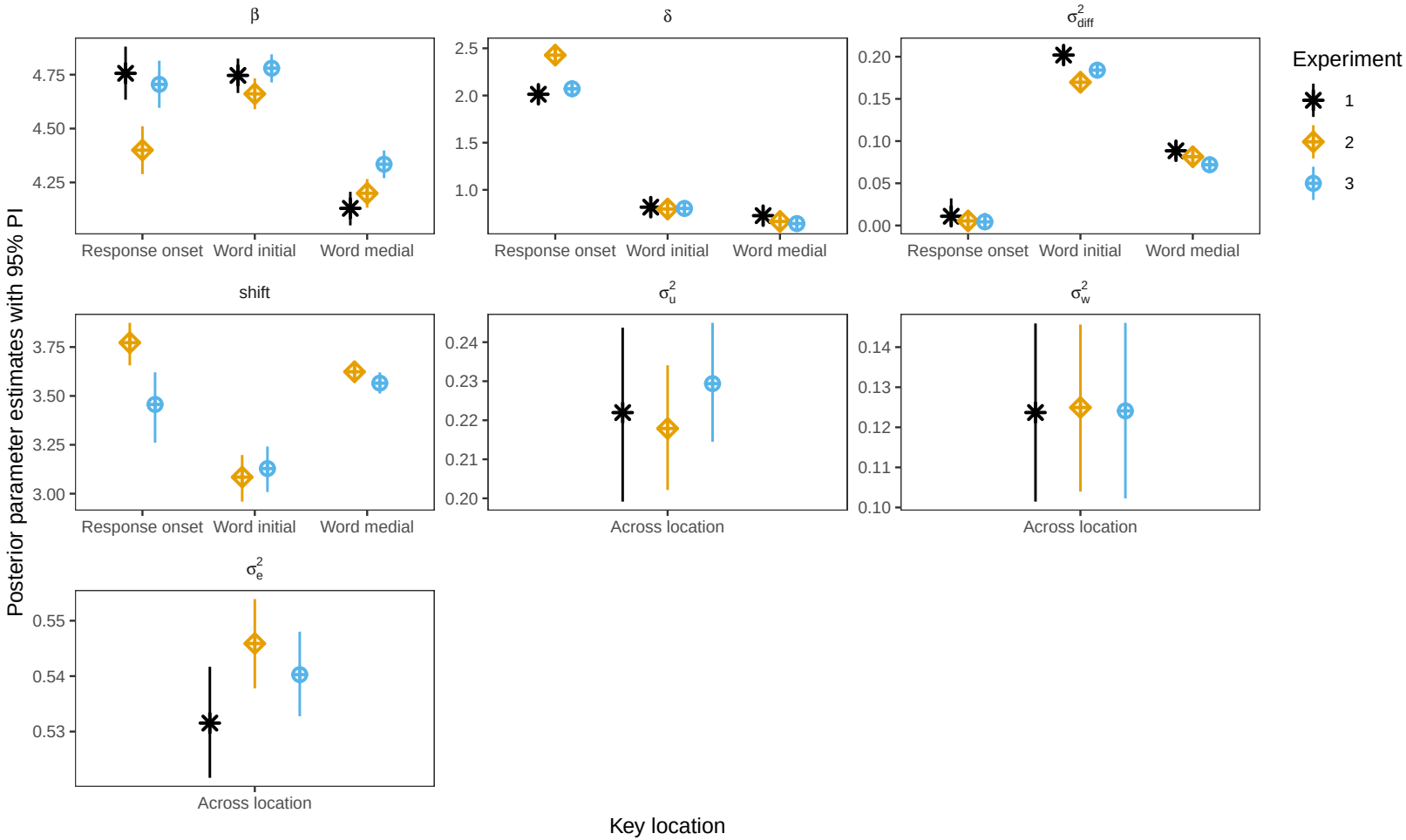
constraints:

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

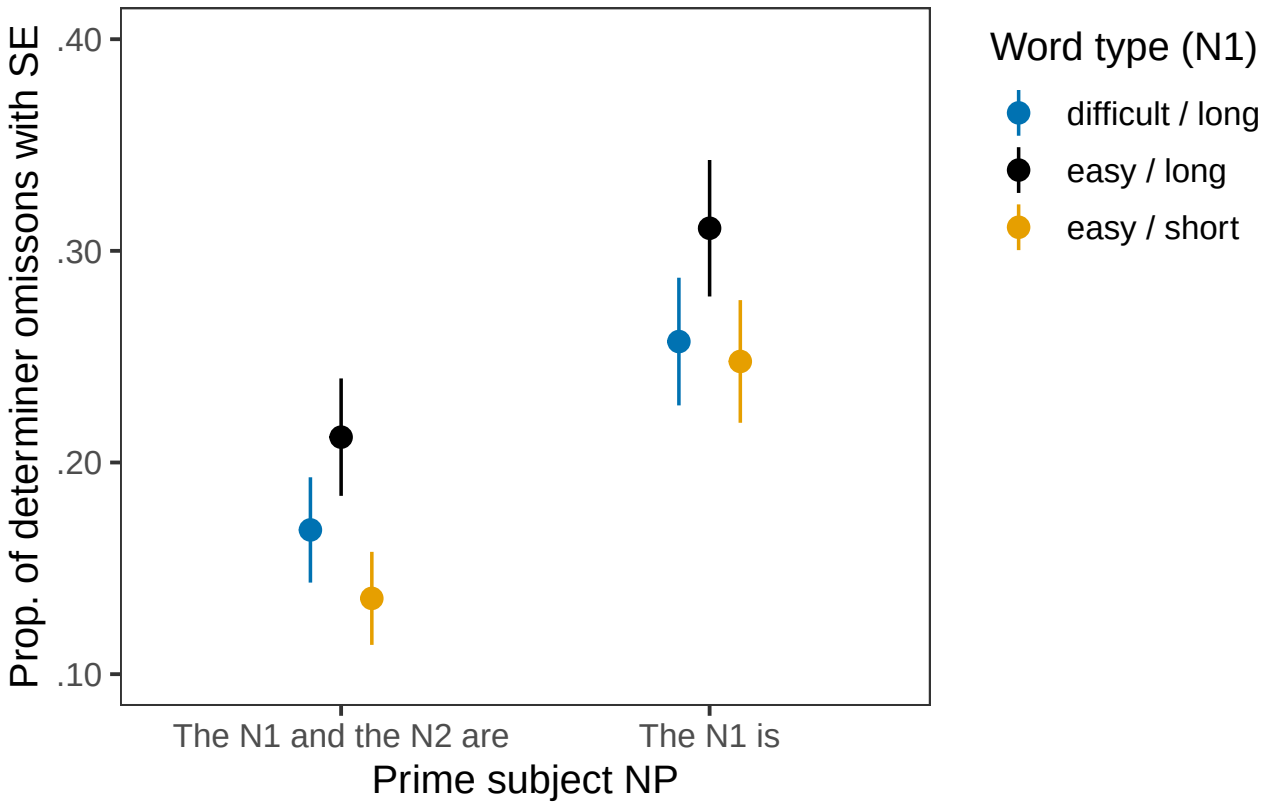
$$\sigma^2_{e'} > \sigma^2_e$$

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

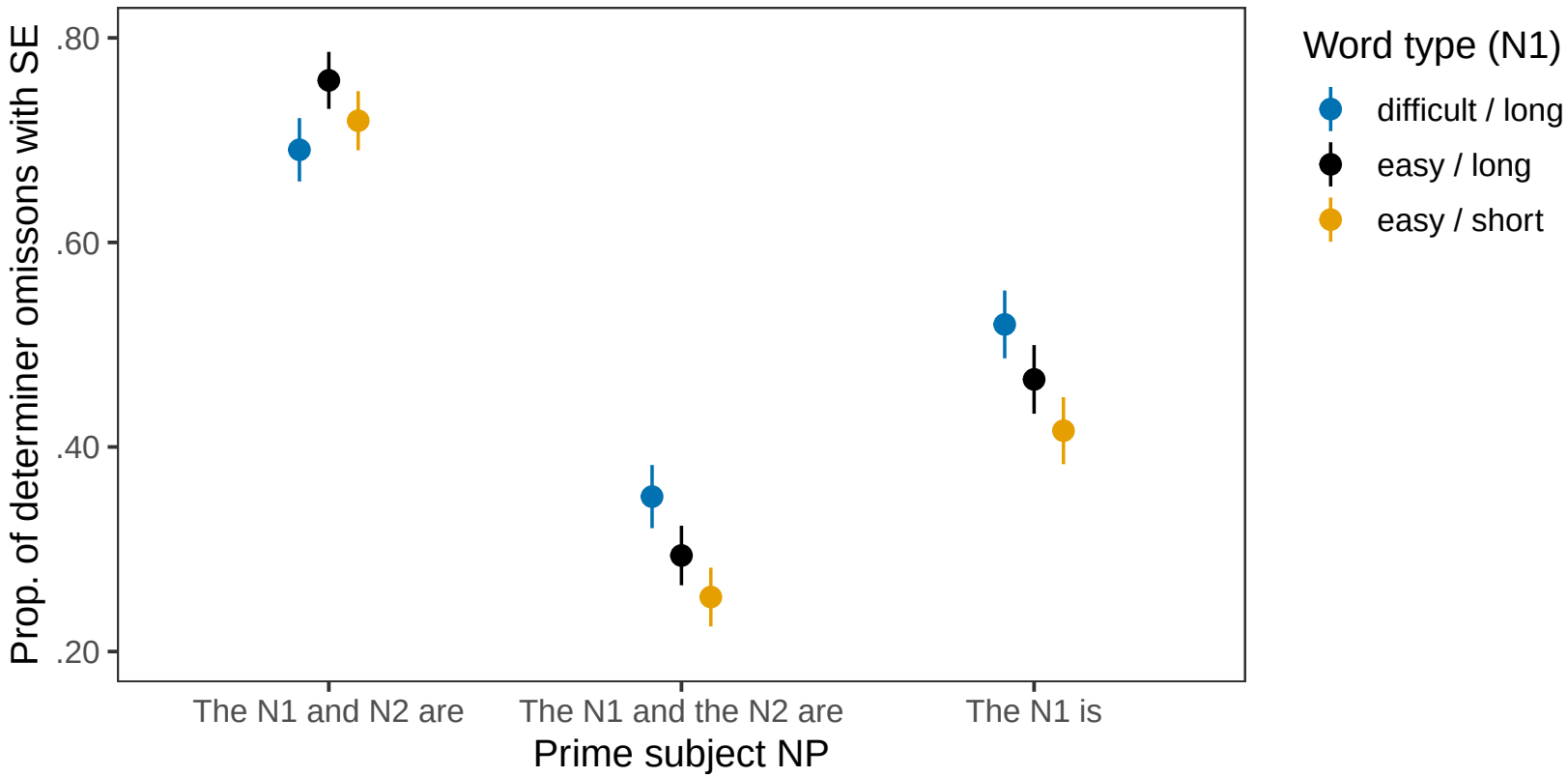
Most other mixture model parameter estimates



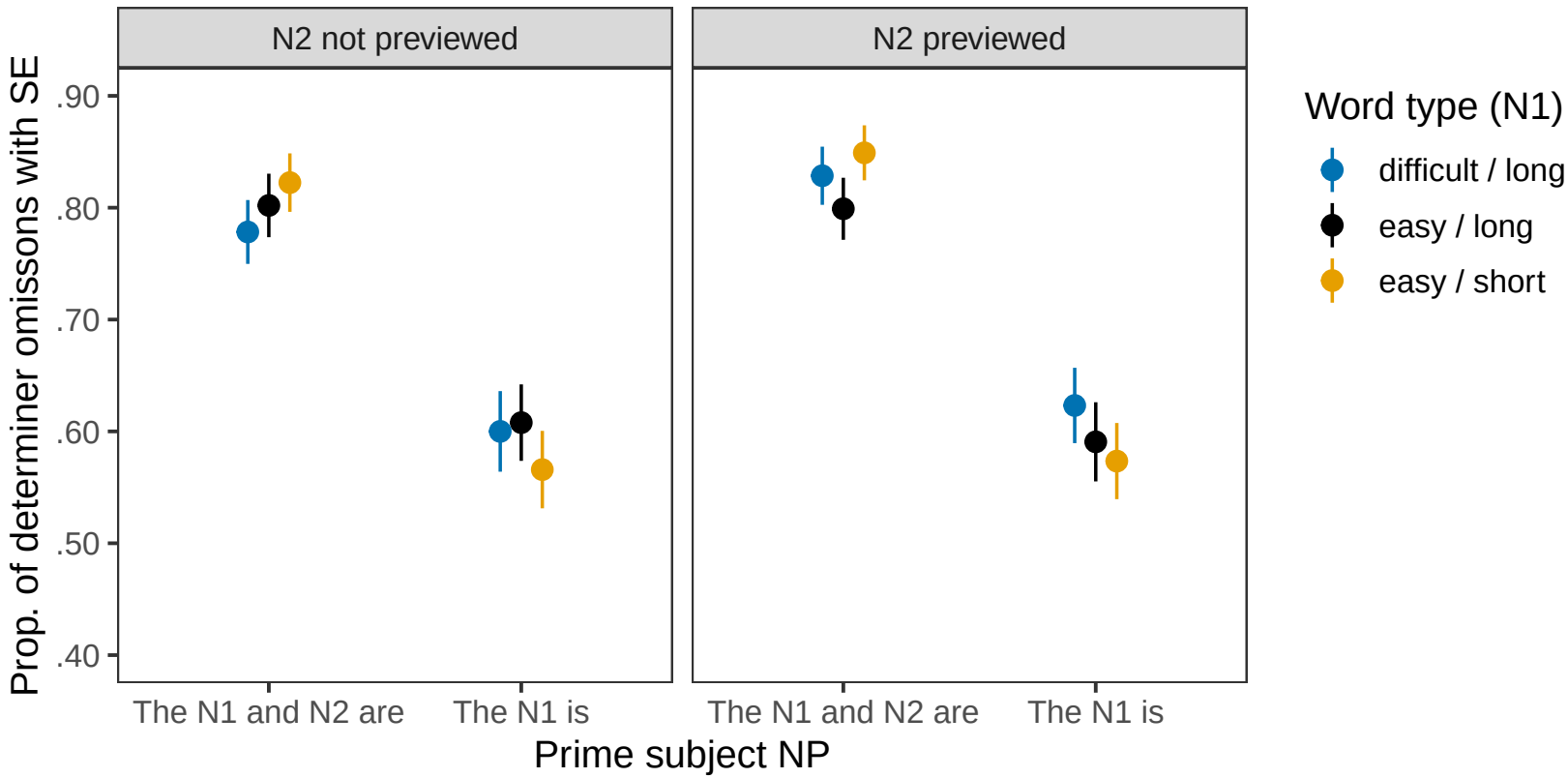
Experiment 1: determiner omissions before N2



Experiment 2: determiner omissions before N2



Experiment 3: determiner omissions before N2



Experiment 3: N2-initial hesitations