Heinrich Heine
Universität Düsseldorf

Morpho-phonetic detail can be perceived:

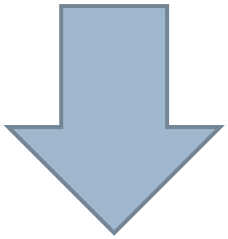
Evidence from stems and suffixes

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

MPP 2022, 8th February 2022

Motivation: Durational differences in production

- **stems**: real stems > pseudo-stems,
  e.g. *frees* > *freeze*
  (Seyfarth et al. 2017; Engemann & Plag 2021)
- **word-final /s/**: non-morphemic /s/ > suffix /s/ > clitic /s/,
  e.g. *corpse* > *books* > *book's*
  (e.g. Plag et al. 2017; Tomaschek et al. 2019; Plag et al. 2020; Schmitz et al. 2021)

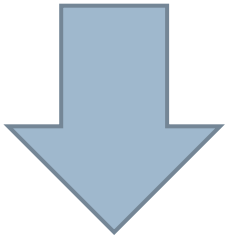


Can these durational differences in **stems** and **word-final /s/** be perceived?

Previous findings on perception

- listeners are able to distinguish *cap* and *cap* part of *captain*; *clue* and *clue* part of *clueless*

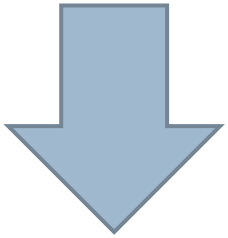
(Davis, Marslen-Wilson & Gaskell 2002; Blazej & Cohen-Goldberg 2015)



Would they be able to perceive differences between complex and simplex words?
(e.g. *frees* vs. *freeze*)

Research questions

- Can listeners perceive durational differences between the same strings of **stems** / **word-final /s/** in complex and simplex words?

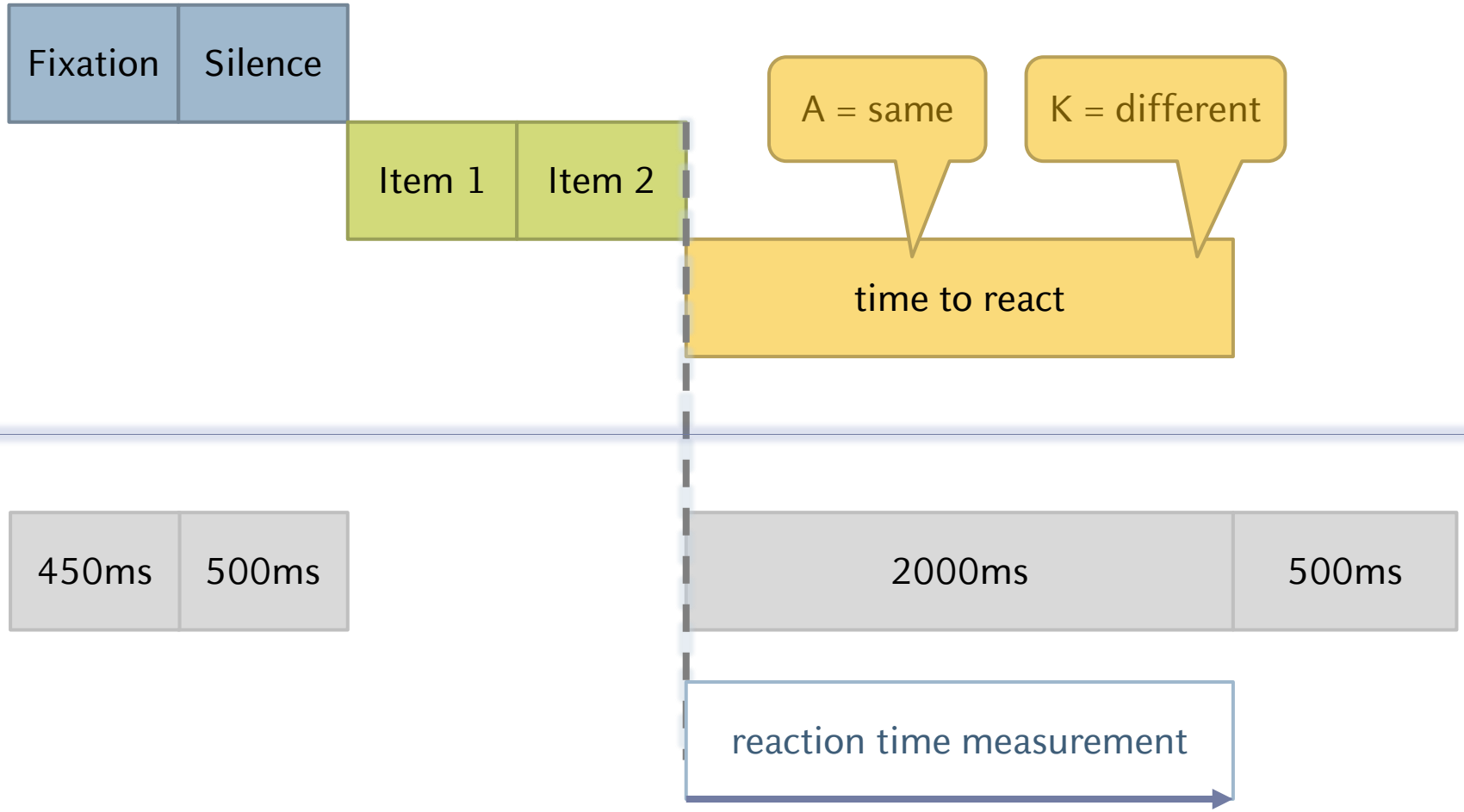


- Which differences can be perceived?
- Are there differences between speakers in their ability to perceive the durational difference?

Methodology

- two same-different tasks were used to measure the sensitivity of participants towards durational differences
- 39/40 participants; all native speakers of New Zealand English
- analyzed using R (signal detection theory & beta regression)

Same-different task



Durational manipulation

Durational manipulation of stems

- A unmanipulated, original length
- B stem duration +10 ms
- C stem duration +25 ms
- D stem duration +50 ms
- E stem duration +75 ms

Durational manipulation of /s/

- A prototypical length
- B non-morphemic /s/ 10 ms; plural /s/ +10ms
- C non-morphemic /s/ 20 ms; plural /s/ +20ms
- D non-morphemic /s/ 35 ms; plural /s/ +35ms
- E non-morphemic /s/ 75 ms; plural /s/ +75ms

Stimuli combinations for stems

Pair	Same or different	Durational difference
A + B	Different	+10ms
A + C	Different	+25ms
A + D	Different	+50ms
A + E	Different	+75ms
A + A	Same	none
B + B	Same	none
C + C	Same	none
D + D	Same	none
E + E	Same	none

Stimuli combinations for /s/

Pair	Same or different	Durational difference
A + B	Different	±10ms
A + C	Different	±20ms
A + D	Different	±35ms
A + E	Different	±75ms
A + A	Same	none
B + B	Same	none
C + C	Same	none
D + D	Same	none
E + E	Same	none

Items: (Pseudo-)Stems

monomorphemic	plural
ace	*bees*
buzz	*blues*
chess	*boys*
clause	*flaws*
goose	*foes*
house	*ways*

Items: word-final /s/

non-morphemic /s/		plural /s/	
box [bɒks]	*hoax* [həʊks]	*steps*	*parts*
coax [kəʊks]	*mix* [mɪks]	*points*	*rights*
corpse	*tax* [tæks]	*groups*	*books*

pseudowords					
bloups	*glaips*	*pleeps*	*glips*	*cloops*	*prups*
blouts	*glaits*	*pleets*	*glits*	*cloots*	*pruts*
blouks	*glaiks*	*pleeks*	*gliks*	*clooks*	*pruks*
bloufs	*glaifs*	*pleefs*	*glifs*	*cloofs*	*prufs*

same

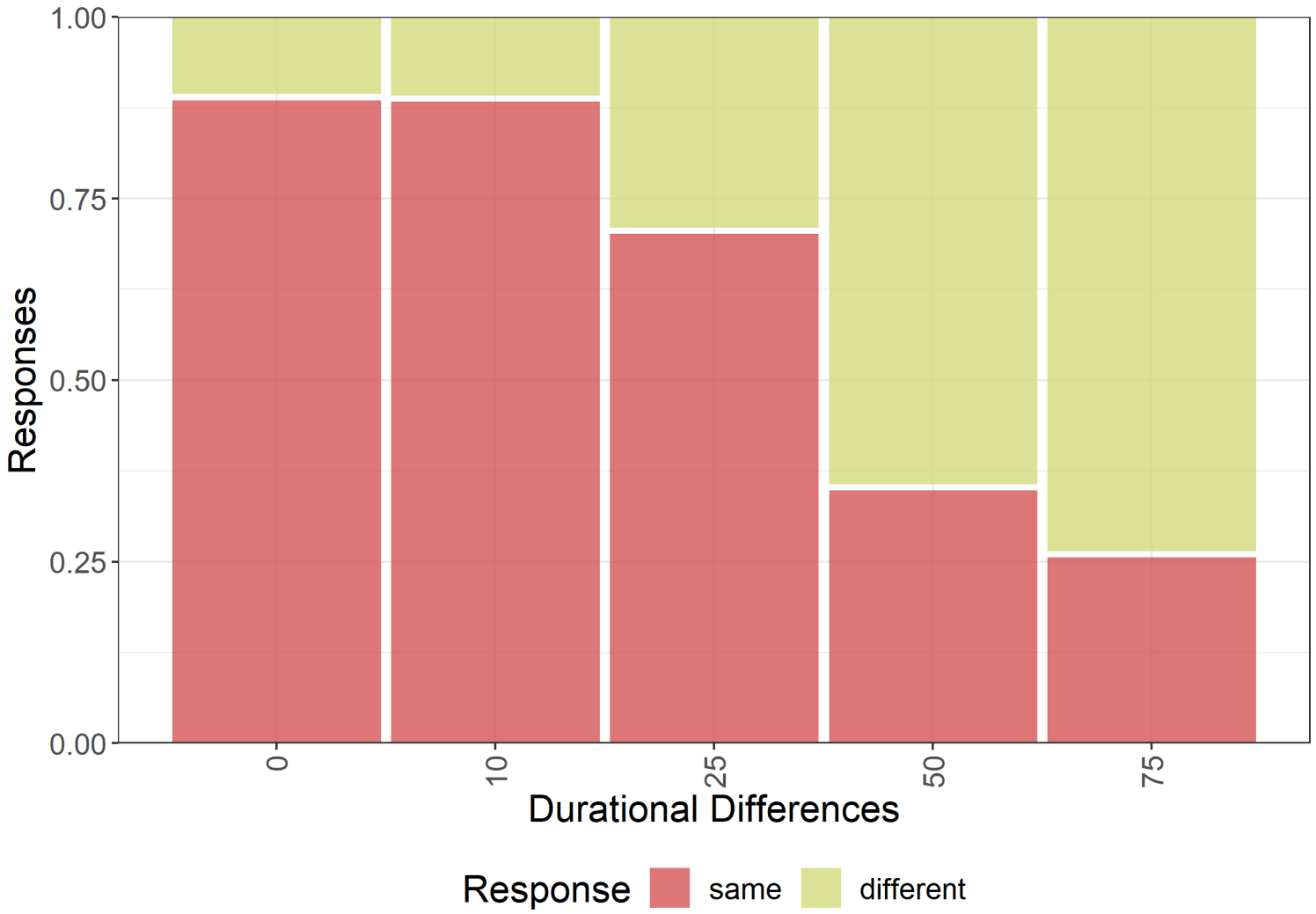
A

different

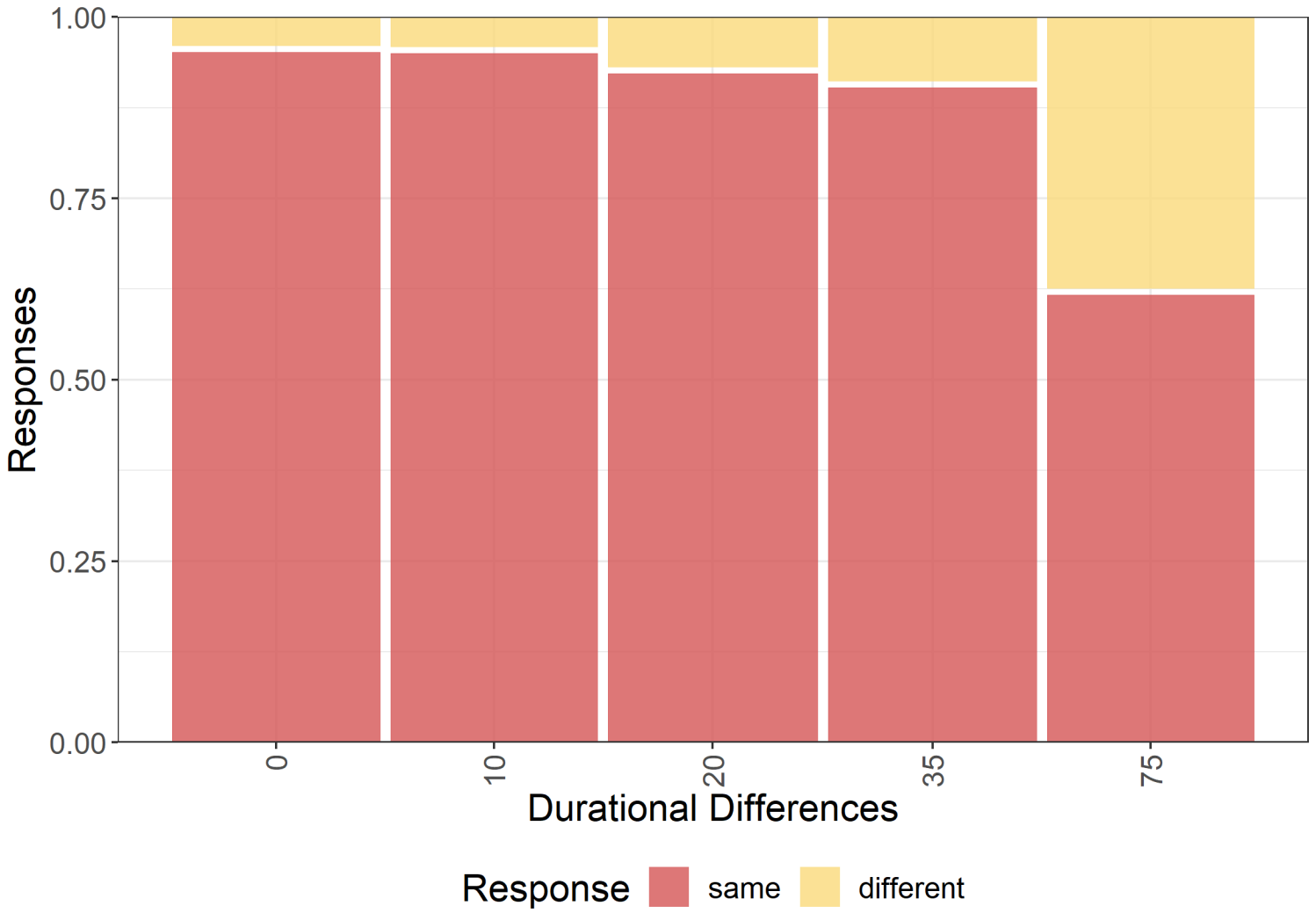
K

same	different
A	K

Overall results for stems



Overall results for word-final /s/



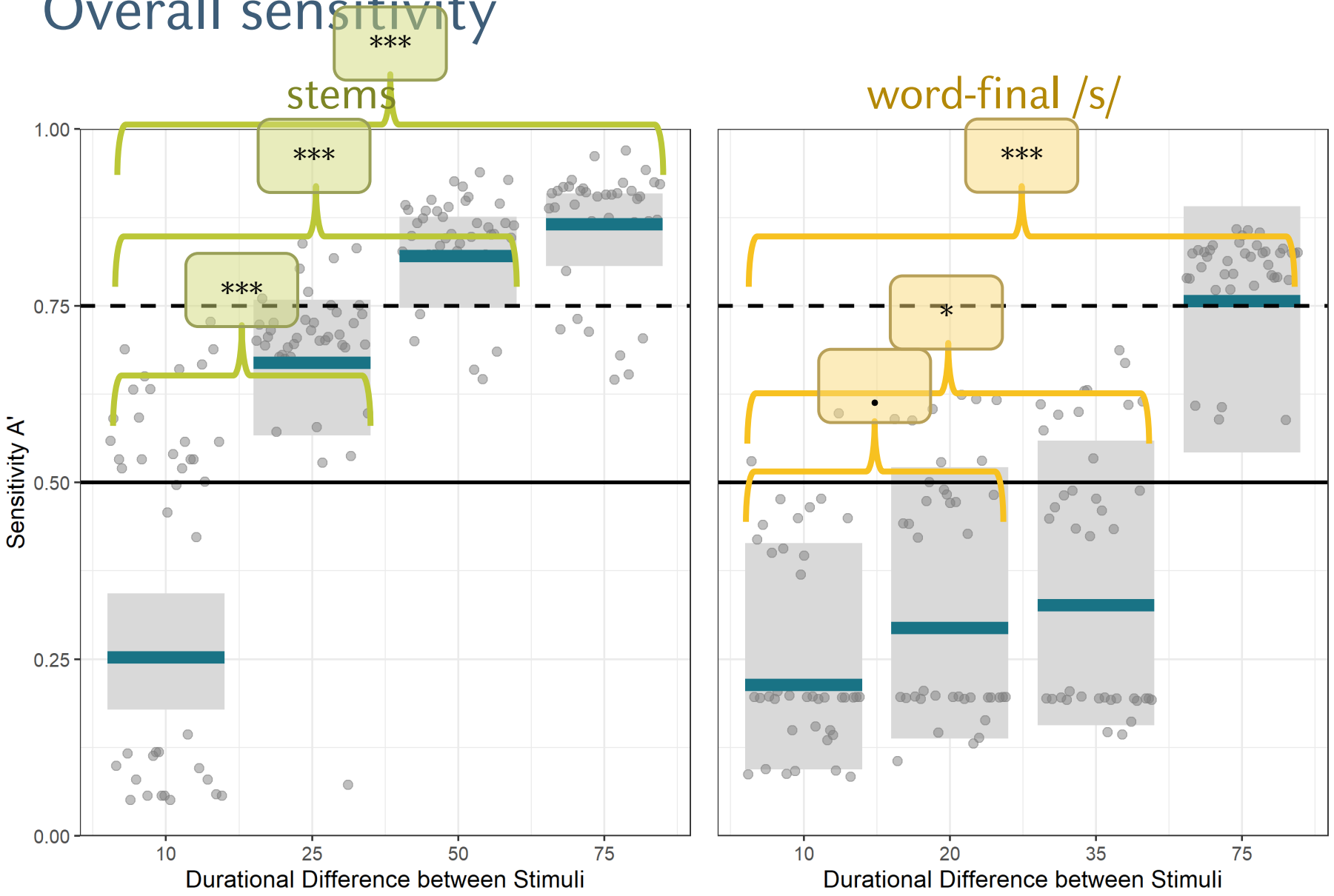
Signal Detection Theory

- Signal Detection Theory attributes responses to a combination of **sensitivity** and **bias** (Macmillan & Creelman 2005)
- **Sensitivity** is what we are interested in
  - How good is a participant in detecting differences between signals?
- **Bias** is what we have to take into account to recover sensitivity
  - How conservative is a participant overall?
  - more conservative = fewer 'different' responses, bias towards same
- Signal Detection Theory knows a number of different measures; we are interested in *A'* - the non-parametric estimate of sensitivity
- For *A'*, a value
  - near 1 indicates perfect sensitivity
  - below 0.5 participants are not so sensitive

Beta regression

- mixed effects beta regression modelling using R (Wood 2021)
- 2 models: **stems**; **word-final /s/**
- Response variable: *A'* (aprime)
- Fixed effects:
  - durational difference
    - levels for stems: 10ms, 25ms, 50ms, 75ms
    - levels for /s/: 10ms, 20ms, 35ms, 75ms
  - covariates
- Random intercepts:
  - subject (participant)

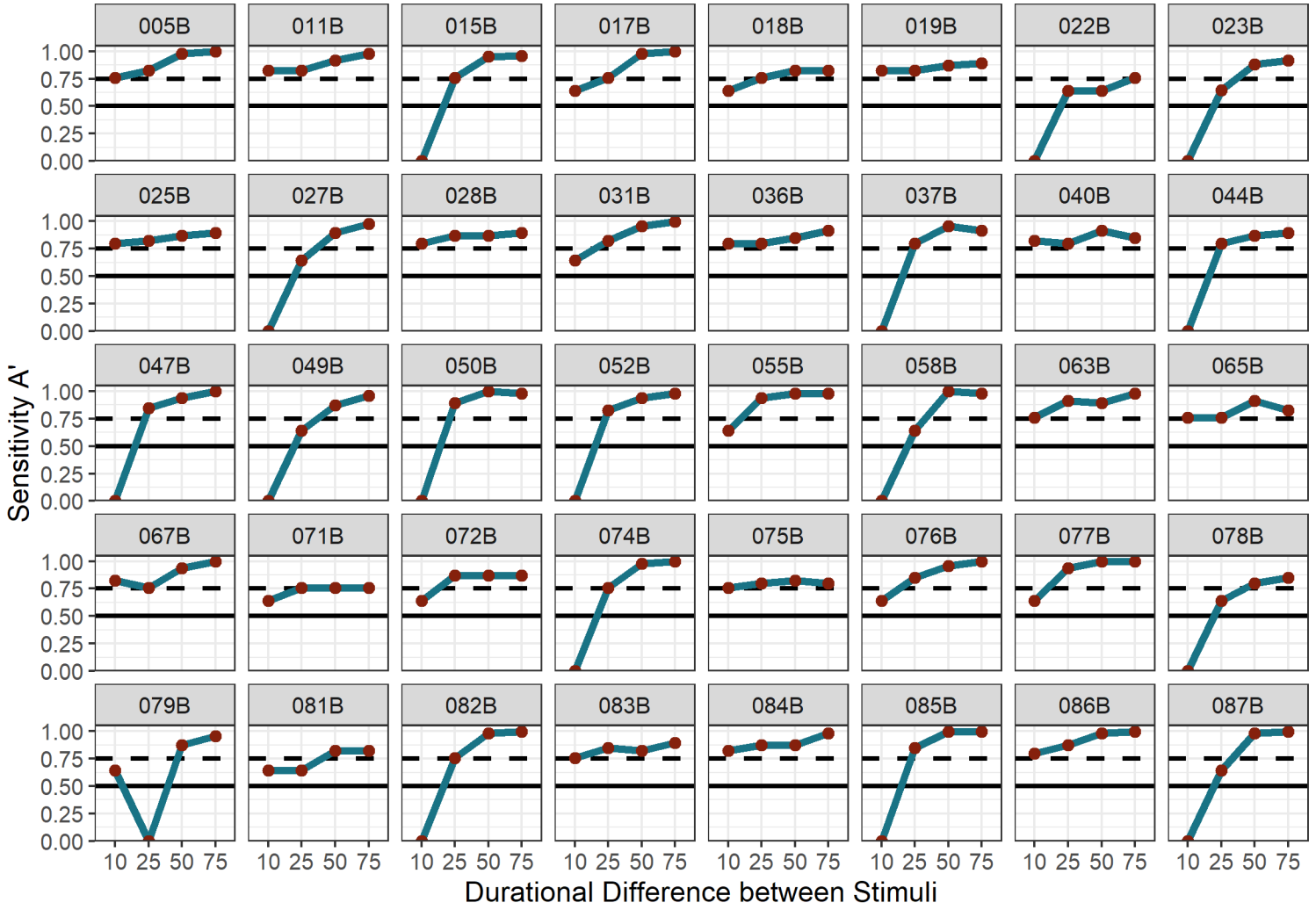
Overall sensitivity



Participant sensitivity

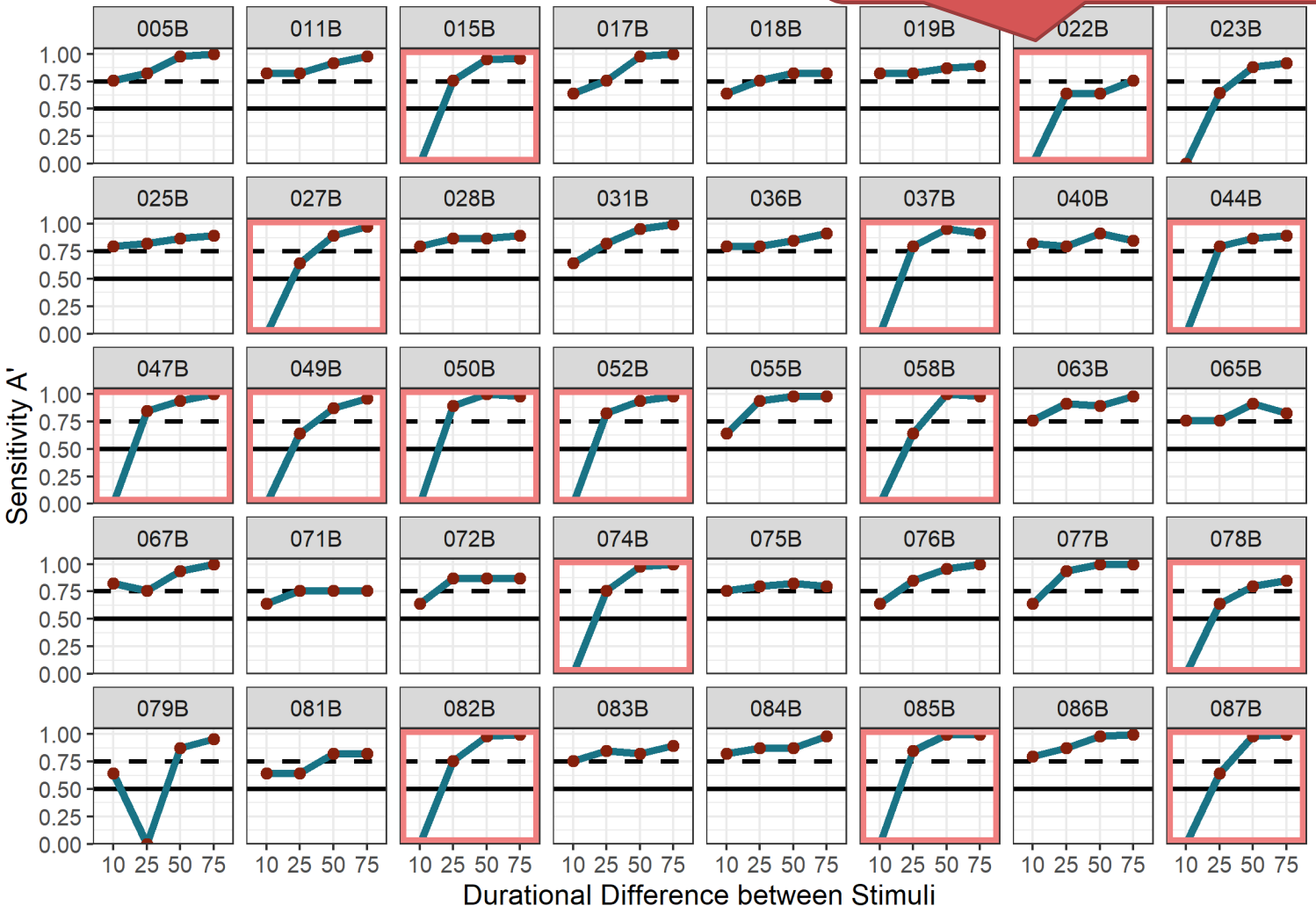
- Do listeners show a variable pattern in that some can perceive the difference and some cannot?

Participant sensitivity: Stems



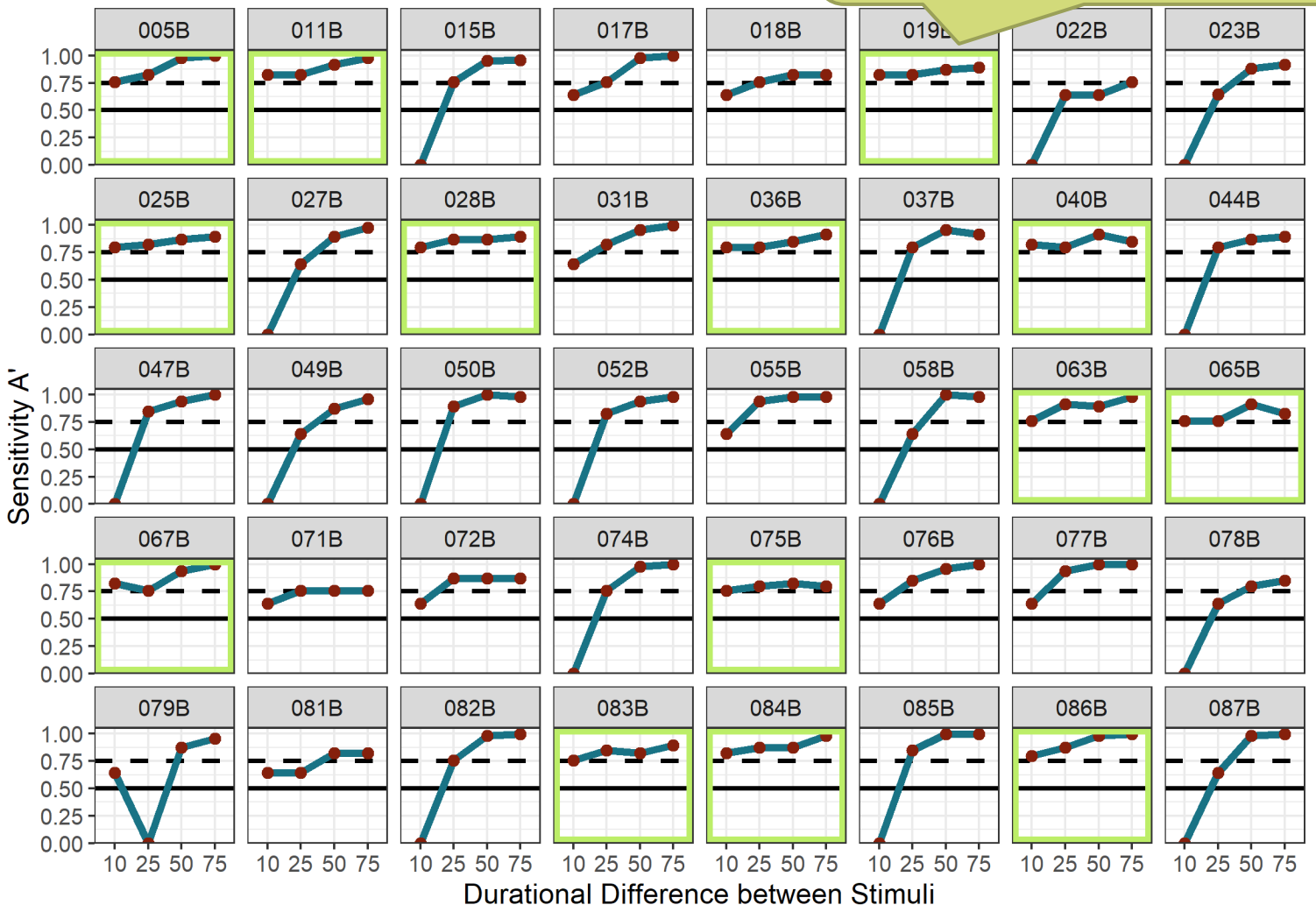
Participant sensitivity: Stems

participants who don't hear a difference at 10ms

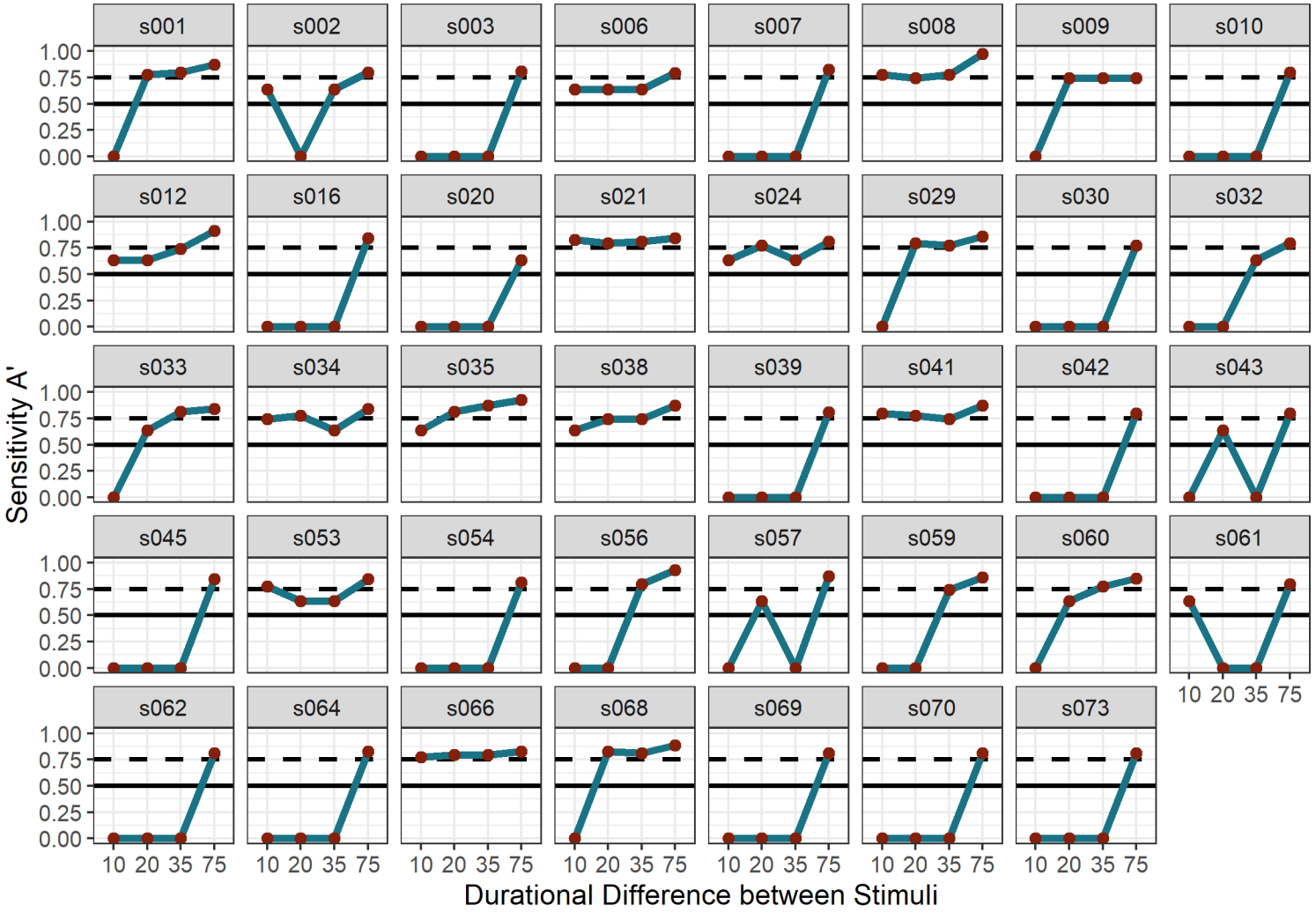


Participant sensitivity: Stems

participants who hear a difference at 10ms

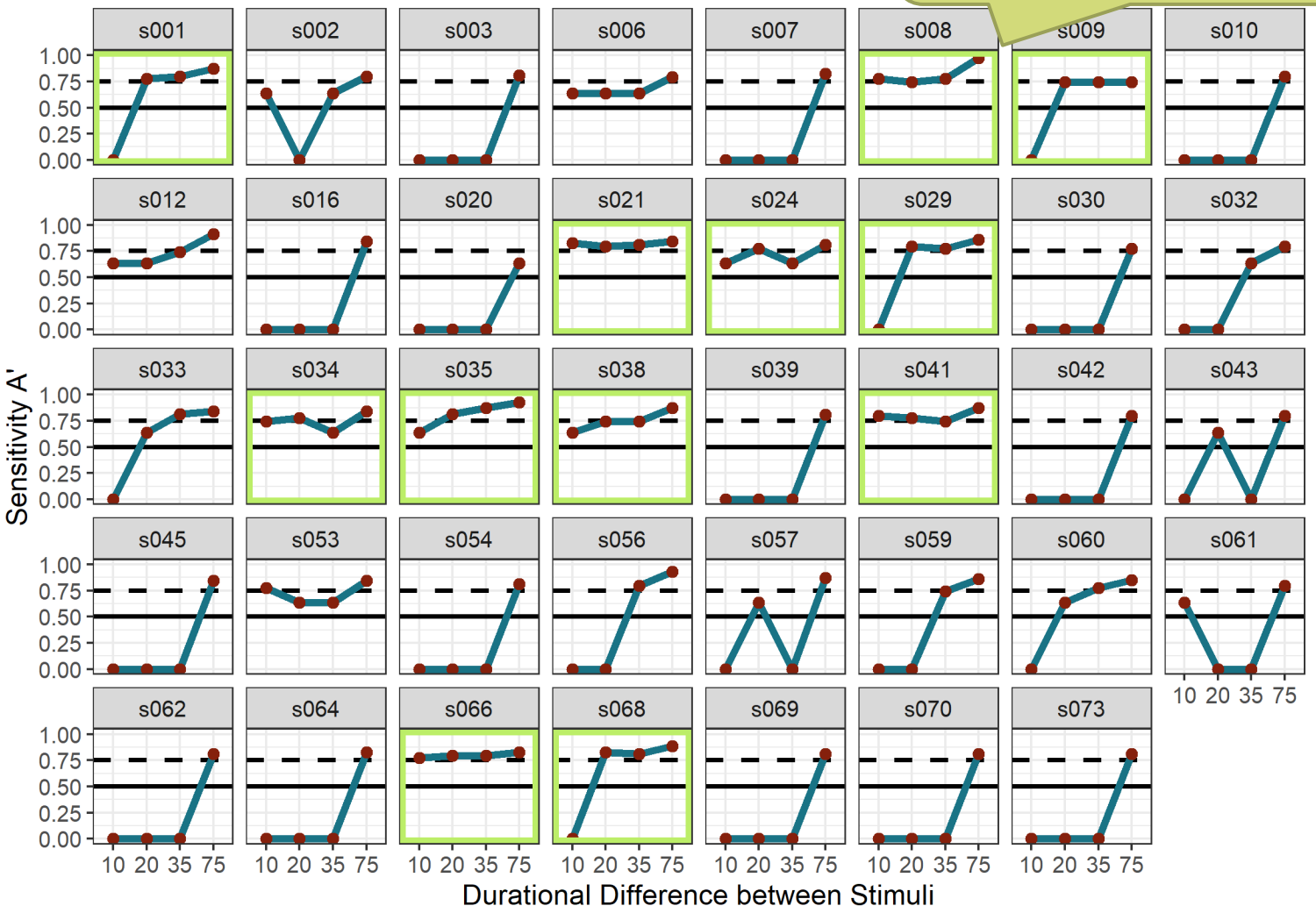


Participant sensitivity: Word-final /s/



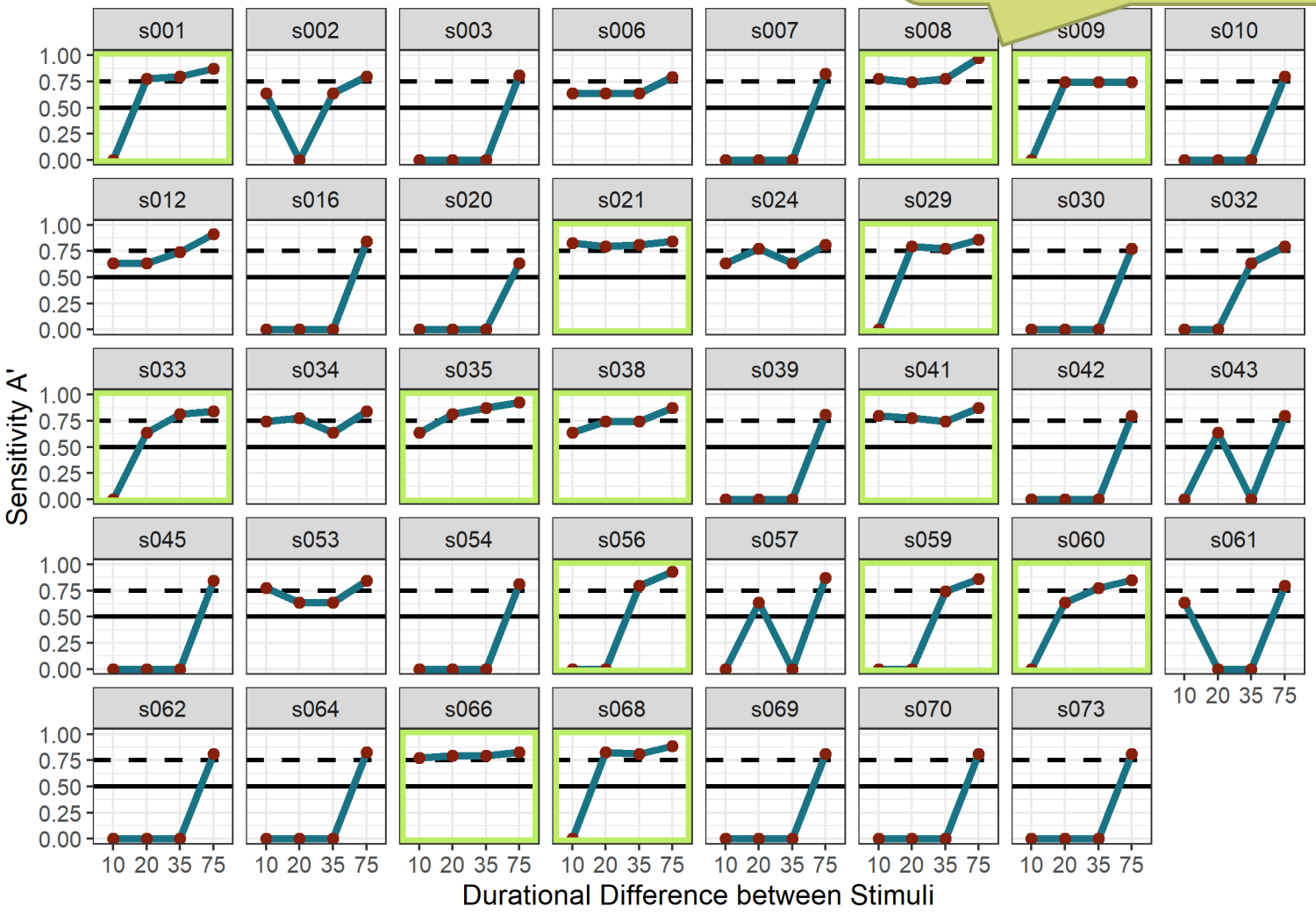
Participant sensitivity: Word-fina

participants who hear a difference for 20ms



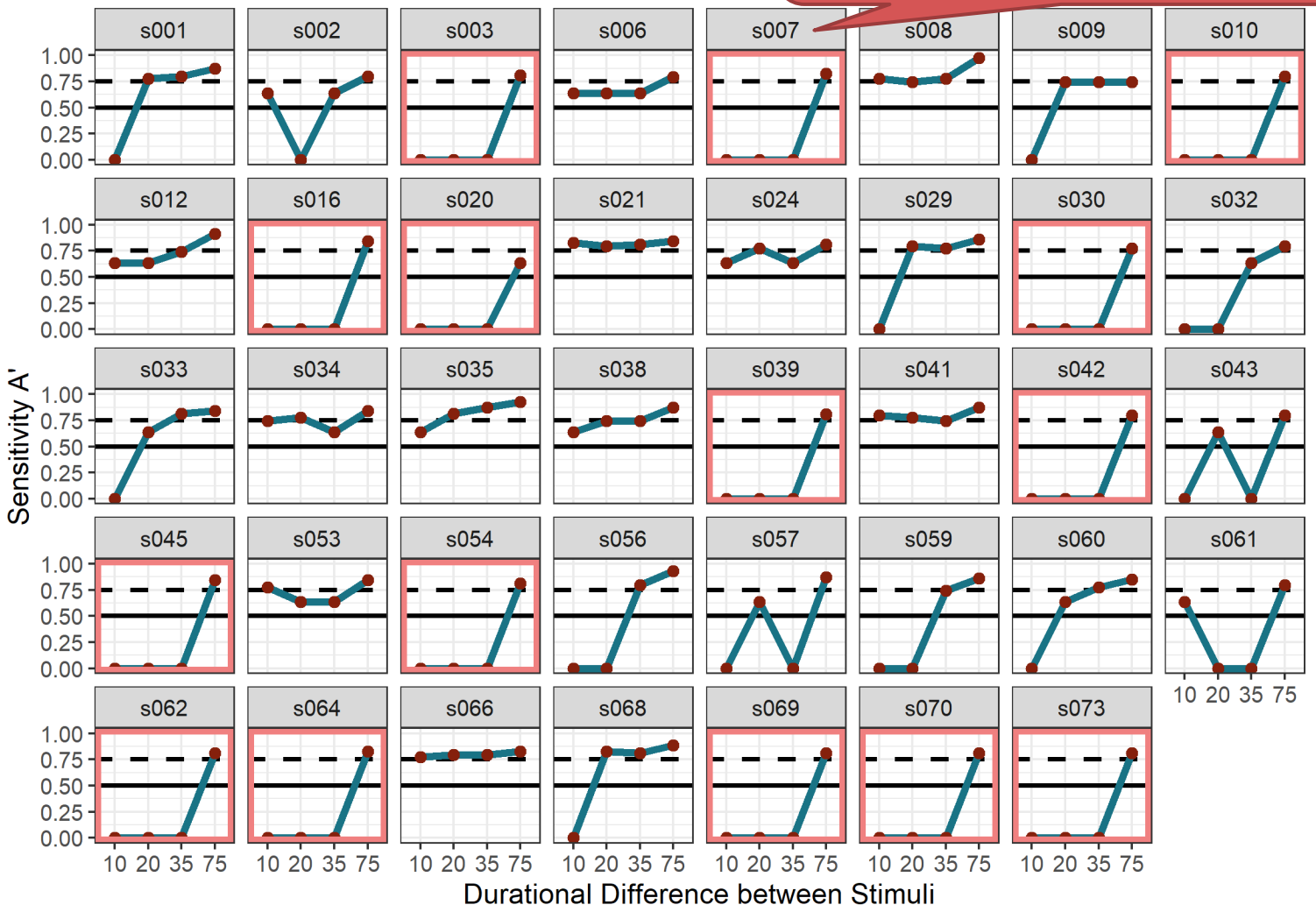
Participant sensitivity: Word-fina

participants who hear a difference for 35ms



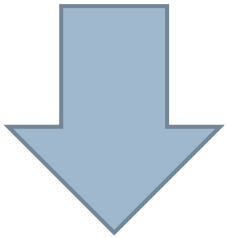
Participant sensitivity: Word

participants who don't hear a difference until 75ms



Conclusion

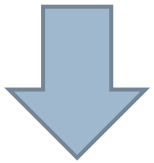
- Can listeners perceive durational differences between the same strings of **stems** / **word-final /s/** in complex and simplex words?



- listeners can perceive subtle durational differences in stems and word-final /s/
- type of morpheme was not significant in any of our analysis → doesn't seem to play a role

Conclusion

- Which differences can be perceived after accounting for bias?
  - stems: differences starting at 10ms
  - /s/: differences starting at 20ms
- Do listeners show a variable pattern in that some can perceive the differences and some cannot?
  - some hear differences earlier than others
  - differences seems more easily perceived in stems than word-final /s/



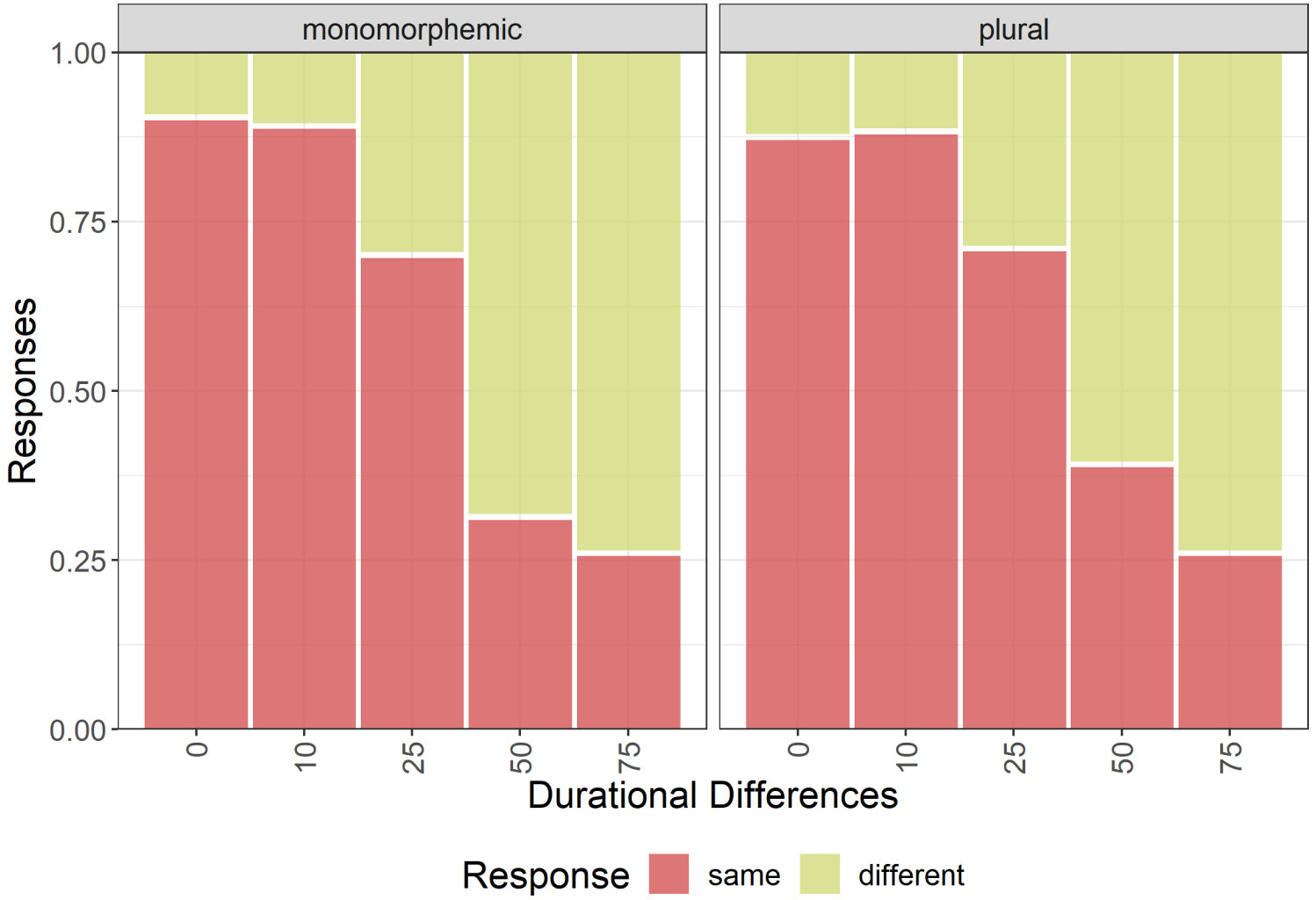
- Do sensitive listeners actually make use of durational differences? → next talk (Schmitz et al. 2022)

Thank you for your attention!

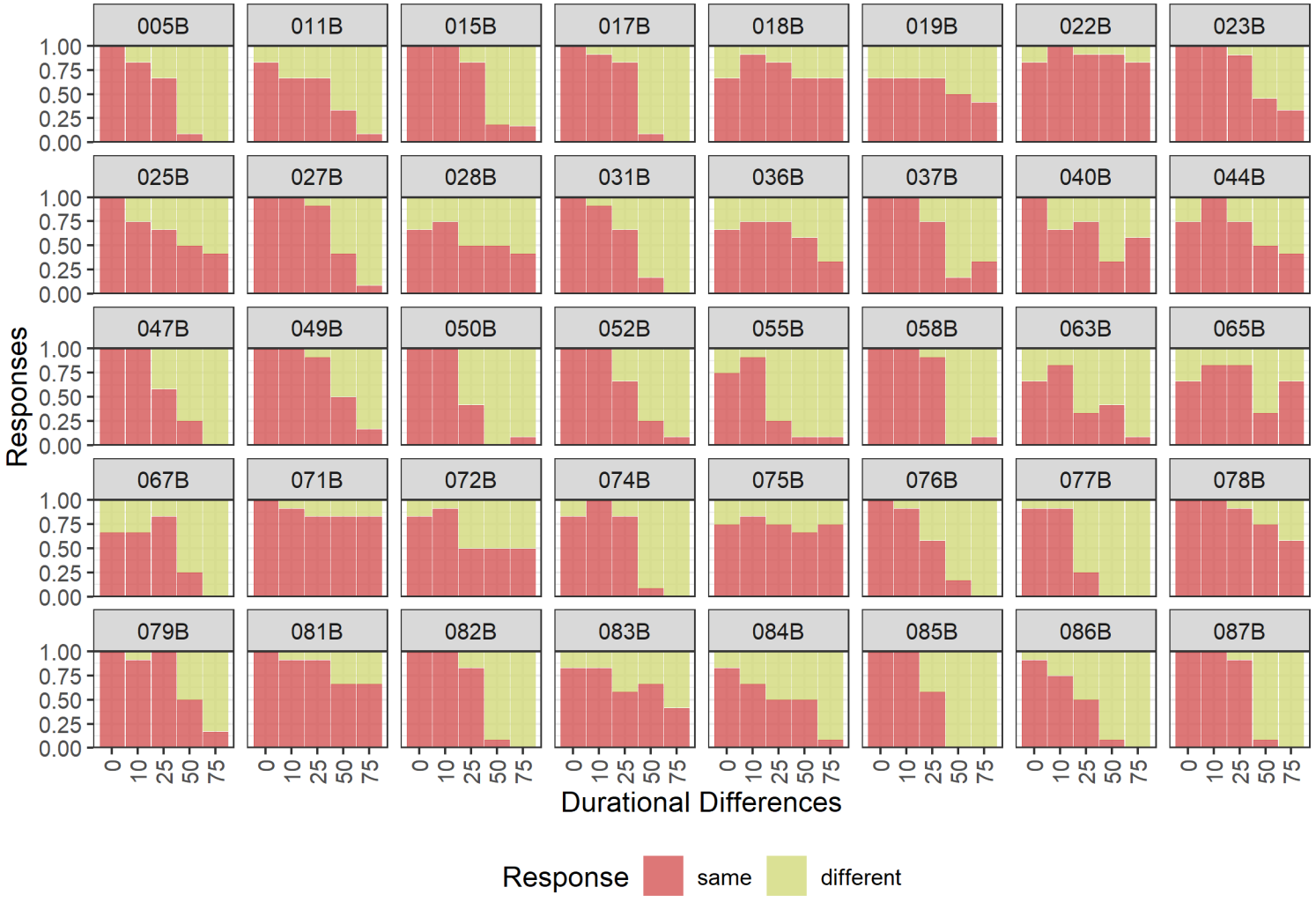
References

- Bates, D., Maechler, M.,Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, 67(1), 1-48. doi:10.18637/jss.v067.i01
- Blazej, Laura J. & Ariel M. Cohen-Goldberg. 2015. Can We Hear Morphological Complexity Before Words Are Complex? *Journal of Experimental Psychology: Human Perception and Performance* 41(1). 50–68. https://doi.org/10.1037/a0038509.
- Davis, M. H., Marslen-Wilson, W. D., & Gaskel, M. Gl. (2002). Leading up the lexical garden path: Segmentation and ambiguity in spoken word recognition. *Journal of Experimental Psychology: Human Perception and Performance* 28(1). 218–244.
- Engemann, M., & Plag, I. (2021). Paradigm uniformity effects in spontaneous speech. *The Mental Lexicon* 16(1).
- Macmillan, N. A., & Creelman, C. D. (2009). *Detection theory: a user's guide*. New York, London: Psychology Press.
- Plag, I., Homann, J., & Kunter, G. (2017). Homophony and morphology: The acoustics of word-final S in English. *Journal of Linguistics, 53(1)*, 181–216. https://doi.org/10.1017/S0022226715000183
- Plag, I., Lohmann, A., Ben Hedia, S., & Zimmermann, J. (2020). An <s> is an <s'>, or is it? Plural and genitive-plural are not homophonous. In L. Körtvélyessy & P. Štekauer (Eds.), *Complex Words*. Cambridge University Press.
- Plag, I., M.Engemann & Kunter, G. (2018a). The effect of morphological boundaries on stem vowel duration in English. In *40. Jahrestagung der Deutschen Gesellschaft für Sprachwissenschaft*. Stuttgart: Deutsche Gesellschaft für Sprachwissenschaft.
- Plag, I., M.Engemann & Kunter, G. (2018b). The effect of morphological boundaries on stem vowel duration in English. In *LabPhon 16 - Variation, development and impairment: Between phonetics and phonology*. Lisbon: Association for Laboratory Phonology.
- Plag, I., M.Engemann & Zimmermann, J. (2019). Morphological boundaries and stem duration in English: Replicating experimental results with corpus data. In *12th Mediterranean Morphology Meeting*. Ljubljana, Slovenia.
- Schmitz, D., Baer-Henney, D., & Plag, I. (2021). The duration of word-final /s/ differs across morphological categories in English: Evidence from pseudowords. To appear in *Phonetica*.
- Schmitz, Dominic, Marie Engemann, Ingo Plag & Dinah Baer-Henney. 2022. Subphonemic detail affects morphological processing. In. Heinrich-Heine-Universität Düsseldorf, Germany.
- Tomaschek, F., Plag, I., Ernestus, M., & Baayen, R. H. (2019). Phonetic effects of morphology and context: Modeling the duration of word-final S in English with naïve discriminative learning. *Journal of Linguistics*, 2019, 1–39. https://doi.org/10.1017/S0022226719000203
- Wood, Simon. 2021. *mgcv: Mixed GAM Computation Vehicle with Automatic Smoothness Estimation*. https://CRAN.R-project.org/package=mgcv (1 December, 2021).

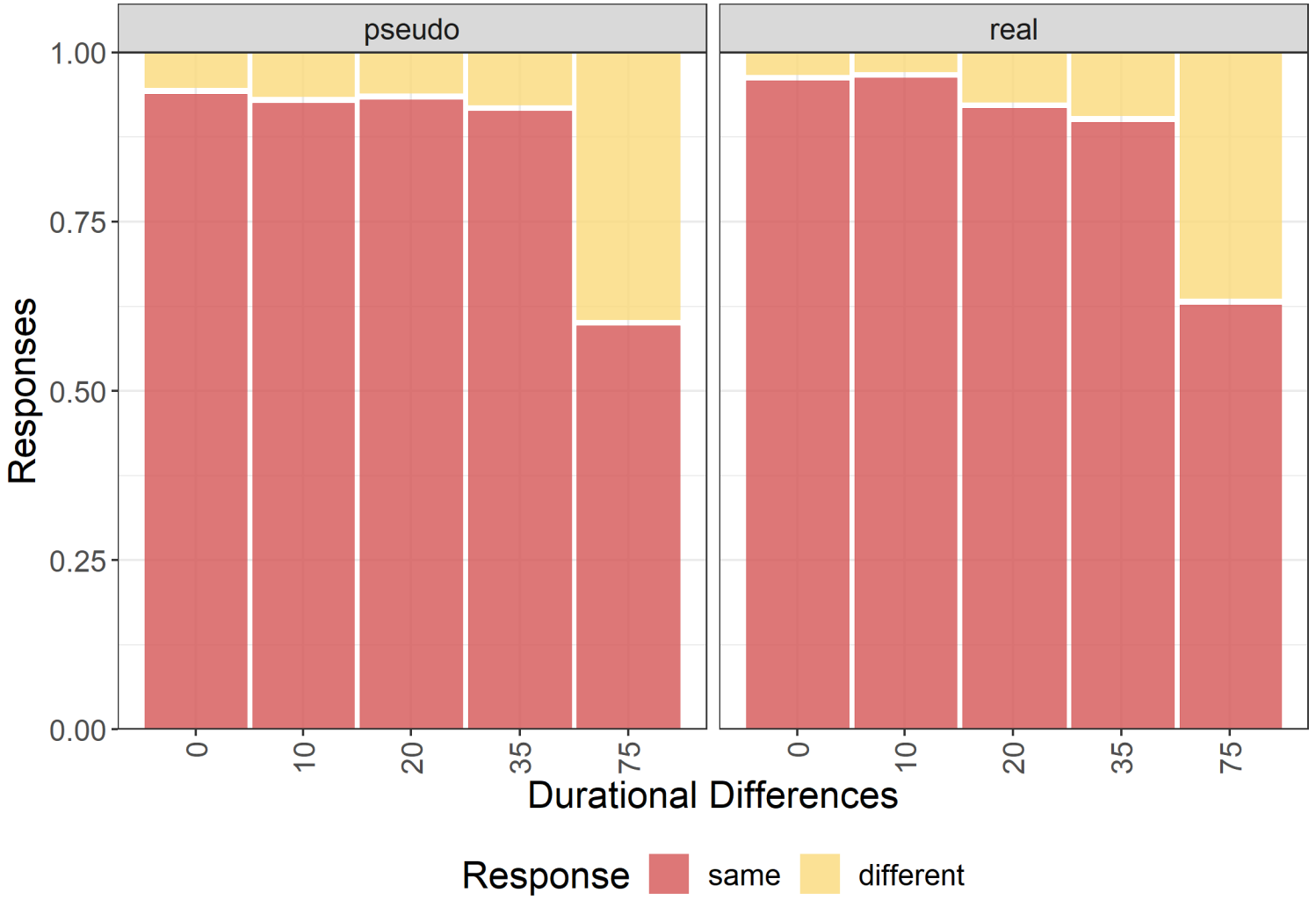
Stems: monomorphemic vs. plural



Stems: Raw participant data



Word-final /s/: Pseudo vs. real words



Word-final /s/: monomorphemic vs. plural

Word-final /s/: Raw participant data

Beta regression: Stems

Parametric coefficients:					
	Estimate	Std. Error	z value	Pr(>|t|)	
(Intercept)	-1.02549	0.11018	-9.307	<2e-16	***
DUR_DIF: 25	1.82626	0.06529	27.971	<2e-16	***
DUR_DIF: 50	2.74798	0.06600	41.636	<2e-16	***
DUR_DIF: 75	3.05100	0.06611	46.149	<2e-16	***
Approximate significance of smooth terms:					
	edf	Ref.df	Chi.sq	p-value	
s(PARTICIPANTID)	36.99	39	711.8	<2e-16	***

Beta regression: Word-final /s/

Parametric coefficients:					
	Estimate	Std. Error	z value	Pr(>|t|)	
(Intercept)	-1.5956	0.2168	-7.360	1.84e-13	***
DUR_DIF: 20	0.4301	0.2562	1.679	0.0932	.
DUR_DIF: 35	0.5802	0.2571	2.257	0.0240	*
DUR_DIF: 75	2.4389	0.2582	9.444	<2e-16	***
Approximate significance of smooth terms:					
	edf	Ref.df	Chi.sq	p-value	
s(PARTICIPANTID)	24.3	38	67.98	<2e-16	***