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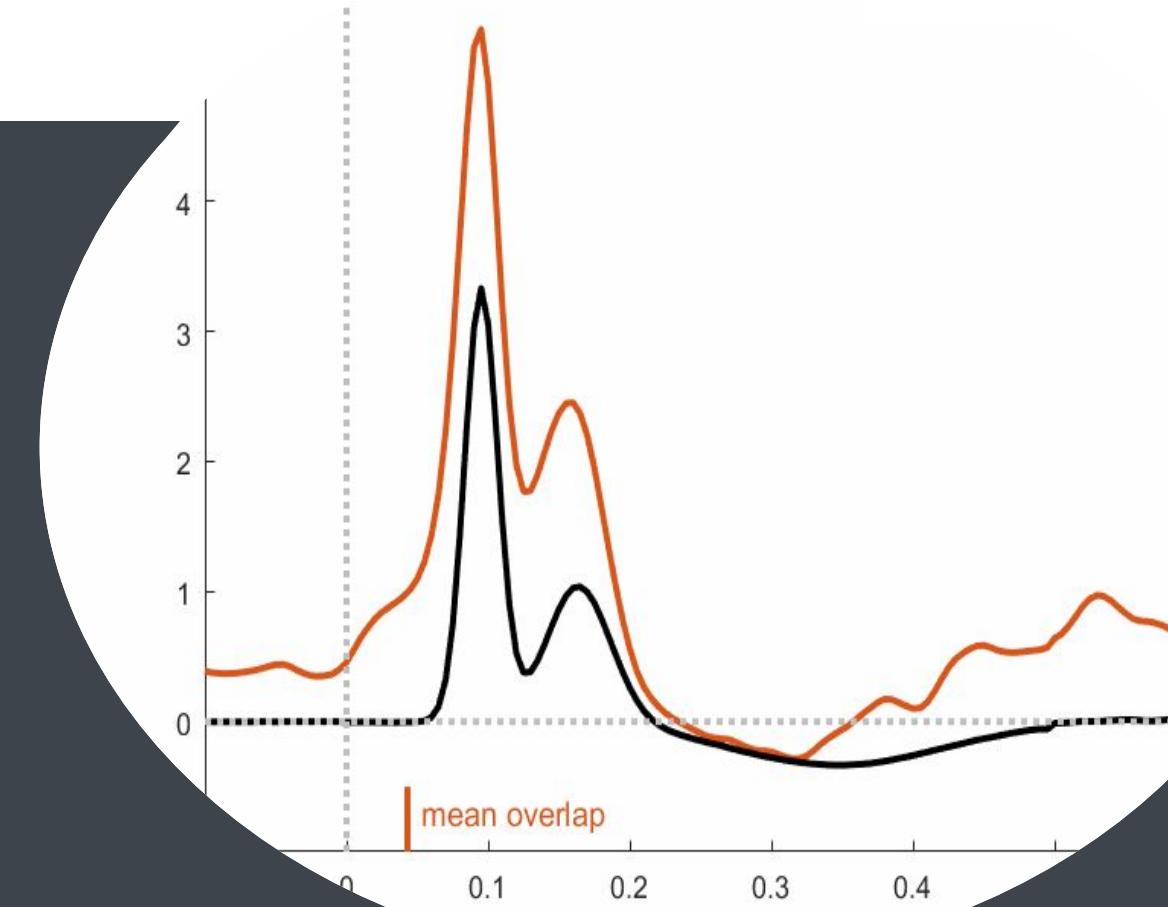


# Investigating the effects of overlap and event durations on neural responses

Master thesis - final presentation

25.11.2022

Martin Geiger



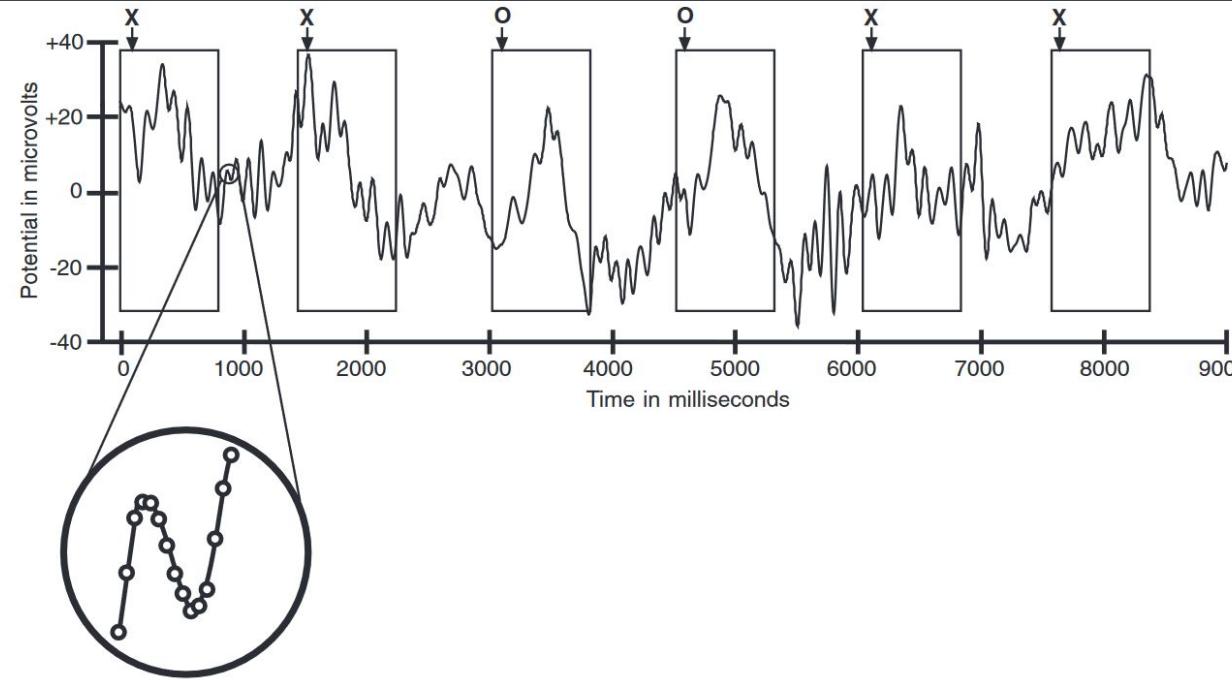
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# Introduction

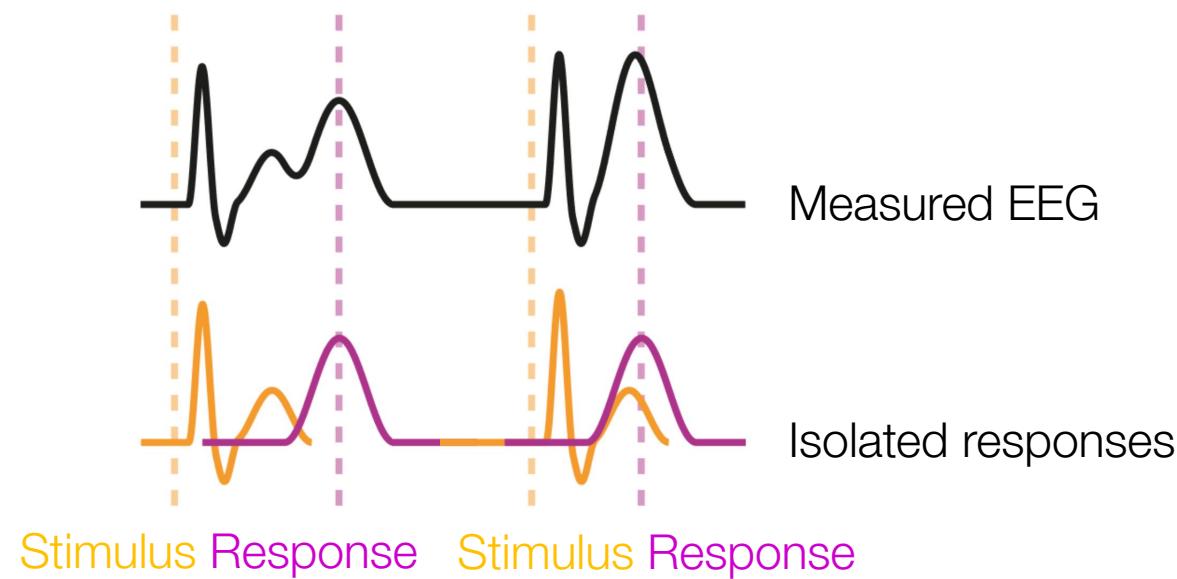
# ERP AVERAGING



Stimulus-locked ERPs

# ASSUMPTIONS

- 1) Linear summation
- 2) Linear time-invariant (LTI) system



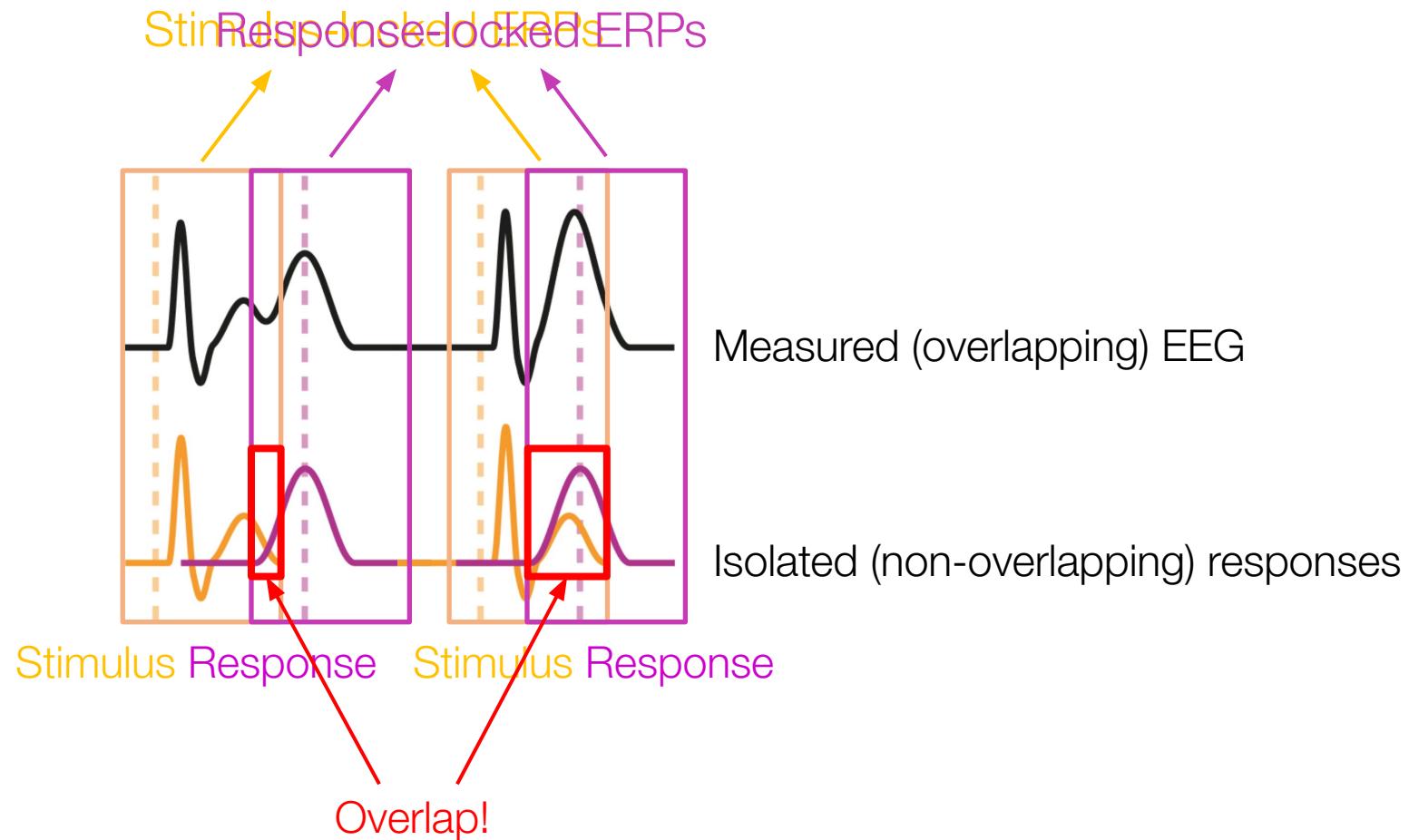
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## Challenges

Overlap

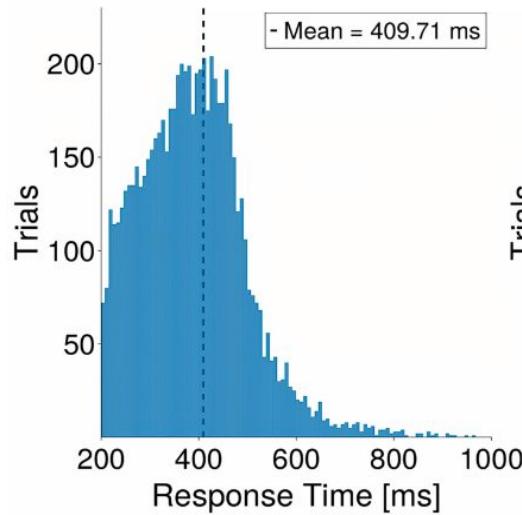
Varying event durations

# OVERLAP

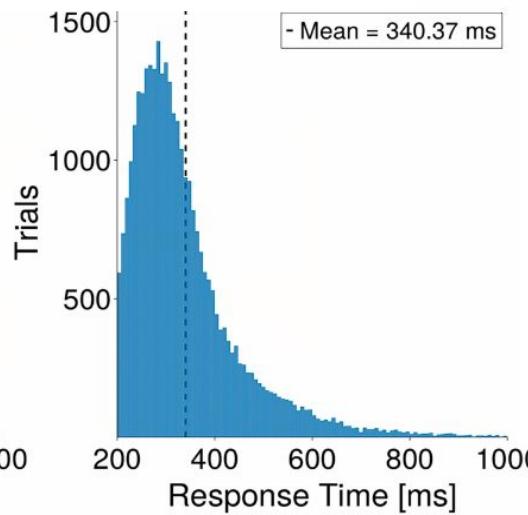


# VARYING EVENT DURATIONS

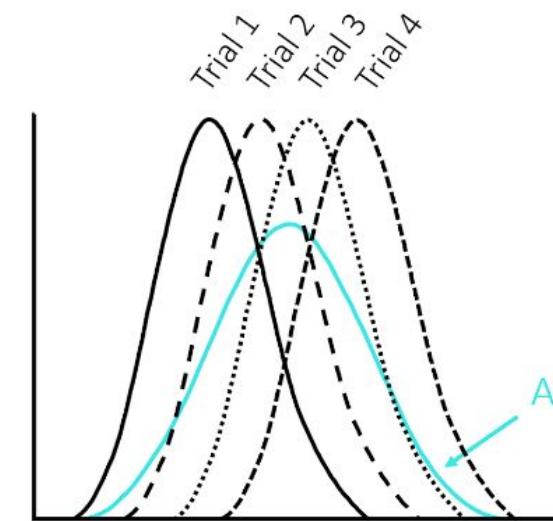
Trial type 1



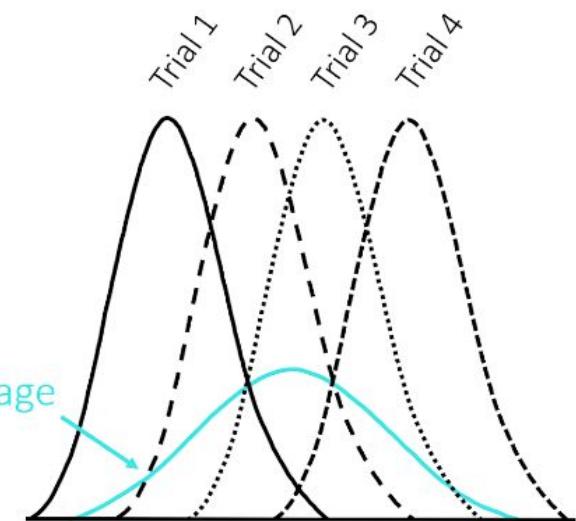
Trial type 2



Low latency variability



High latency variability



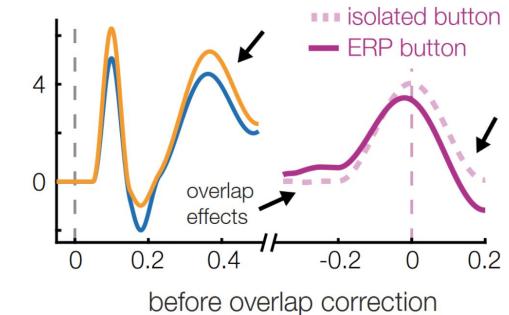
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## Regression-ERP framework

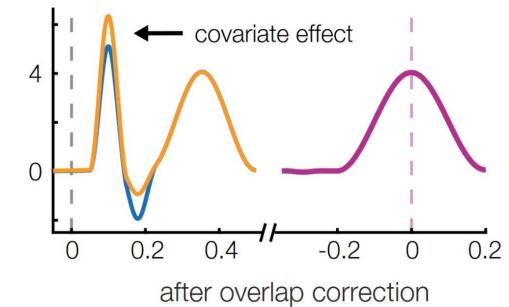
# REGRESSION-BASED MODELS

## I. Mass univariate model

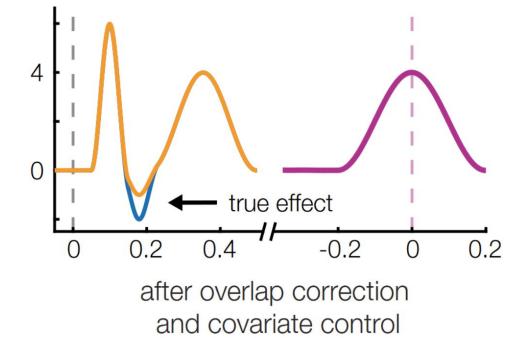
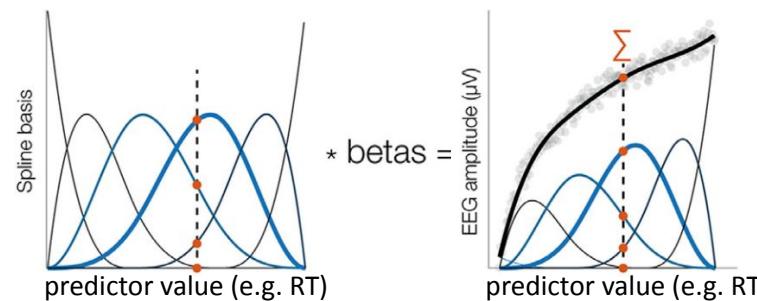
→ comparison to traditional ERP averaging



## II. Deconvolution model → overlap correction



## III. Generalised additive model → overlap correction and covariate control

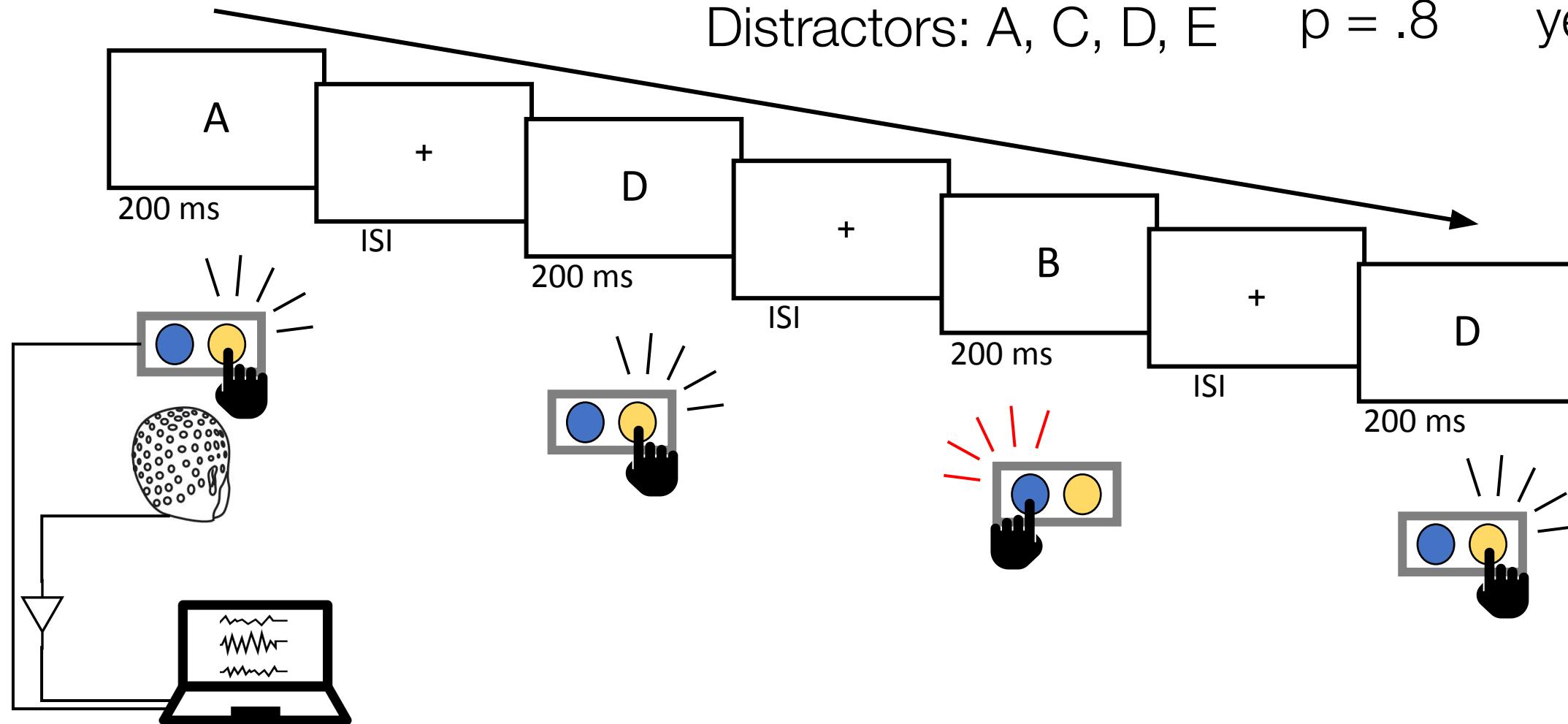


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## Visual oddball paradigm

# ODDBALL TASK

Target: B       $p = .2$       blue  
Distractors: A, C, D, E       $p = .8$       yellow

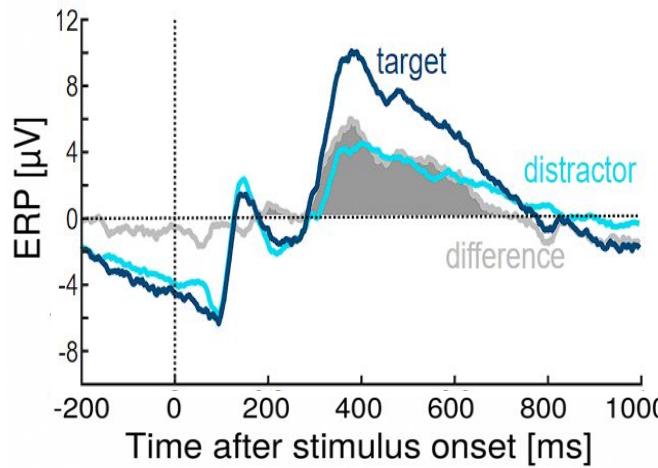


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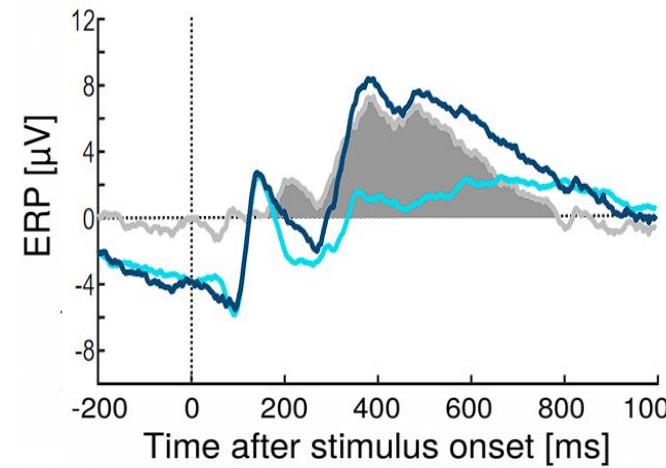
## Previous work

# PREVIOUS WORK

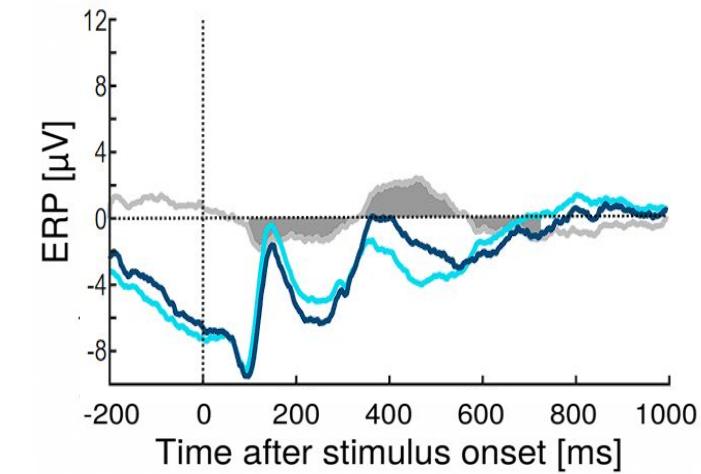
Before overlap correction



After overlap correction



After overlap correction and response time control



Problem: Not enough data!

⑥

My approach

# THIS STUDY

Experiment: Replication of ERP Core visual oddball paradigm

Analysis: 3 models

I) Mass univariate model:

→ comparison to the traditional ERP averaging approach

II) Deconvolution model:

→ overlap correction

III) Generalised additive model:

→ overlap correction and response time control

→ model RT for stimuli and responses simultaneously

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## Results

Comparison to the ERP Core  
Overlap effects  
RT effects

# COMPARISON TO ERP CORE I)

## Behavioral results

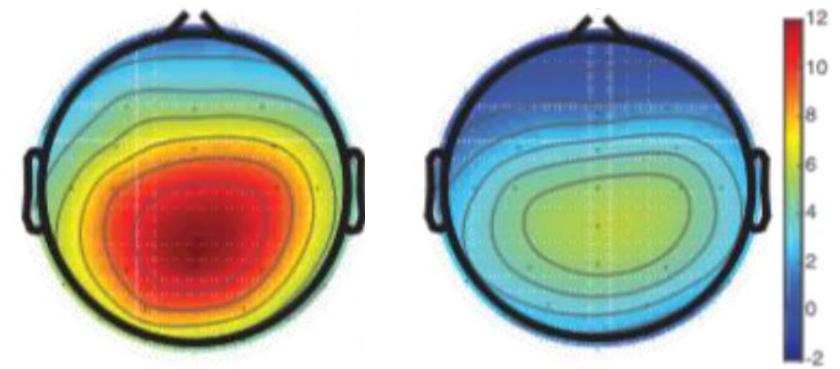
### ERP Core

Trial type	Response time [ms]	Accuracy [% correct]
Targets	$424.57 \pm 67.67$	$89.81 \pm 7.94$
Distractors	$378.08 \pm 66.03$	$98.90 \pm 1.51$

### This study

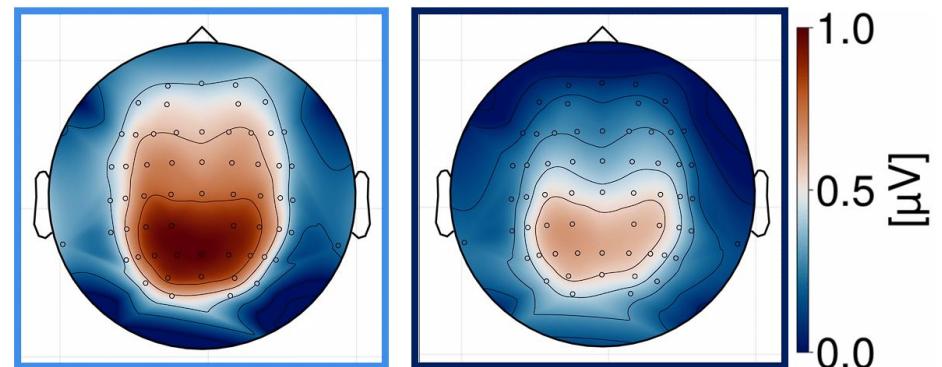
Trial type	Response time [ms]	Accuracy [% correct]
Targets	$409.71 \pm 54.31$	$83.72 \pm 12.13$
Distractors	$340.37 \pm 62.62$	$99.25 \pm 0.76$

## Scalp topographies



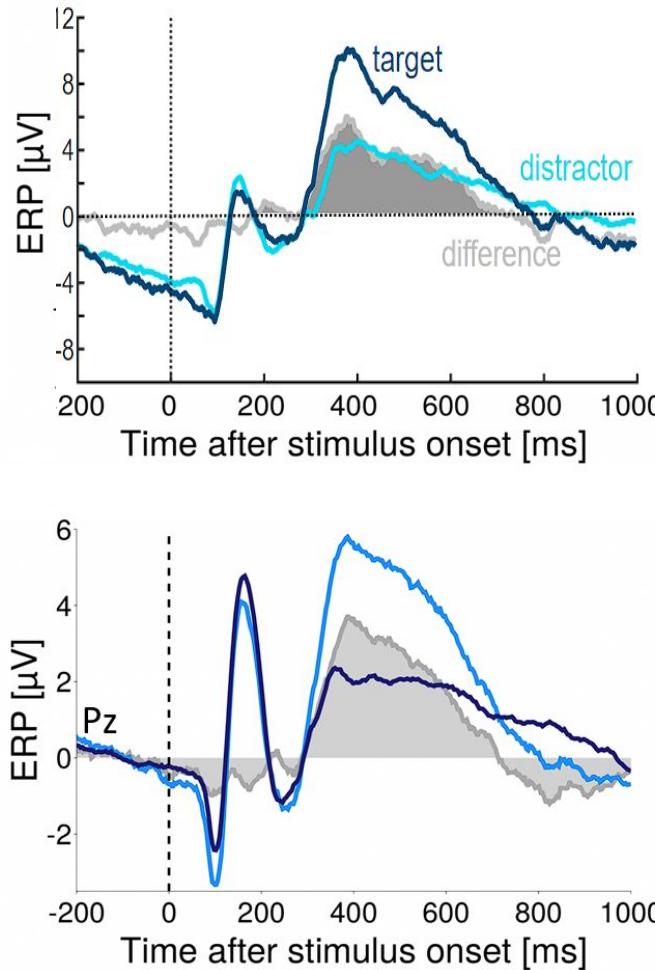
Targets

Distractors



# COMPARISON TO ERP CORE II)

Before overlap correction

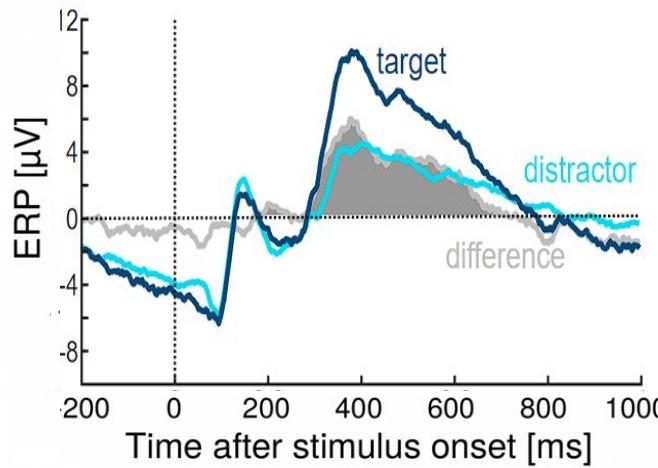


Stimulus-locked	P300 mean amplitude [µV]
ERP Core	6.29
This study	2.48

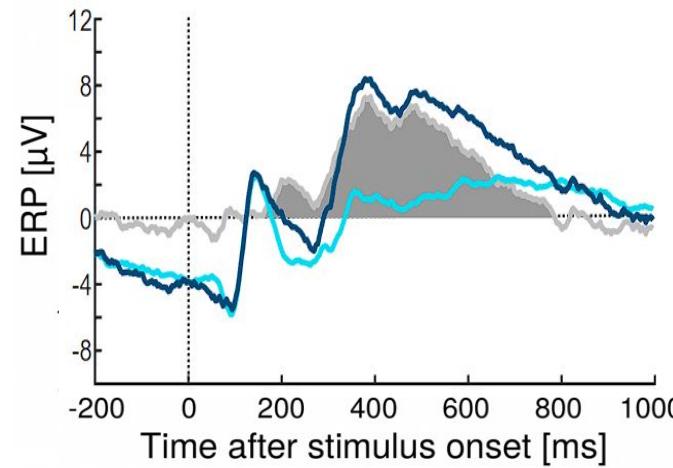
# COMPARISON TO ERP CORE III)

Before overlap correction

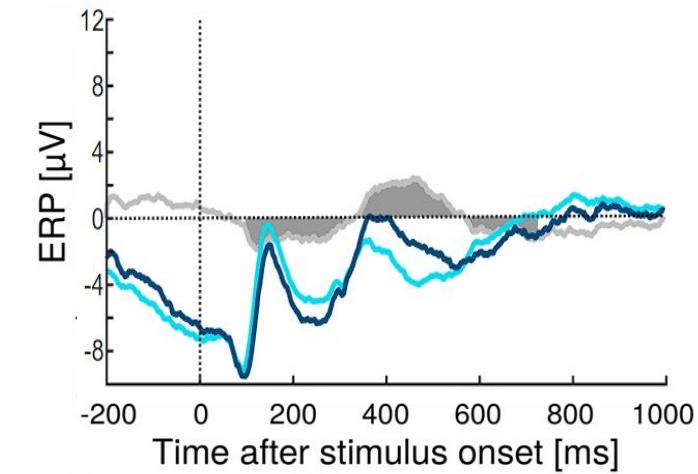
ERP Core



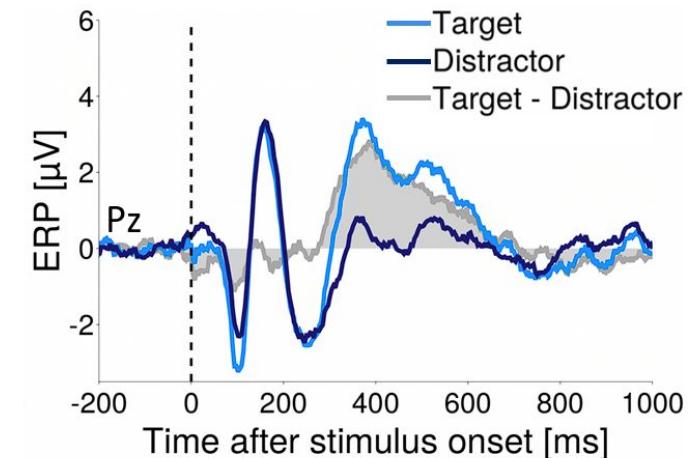
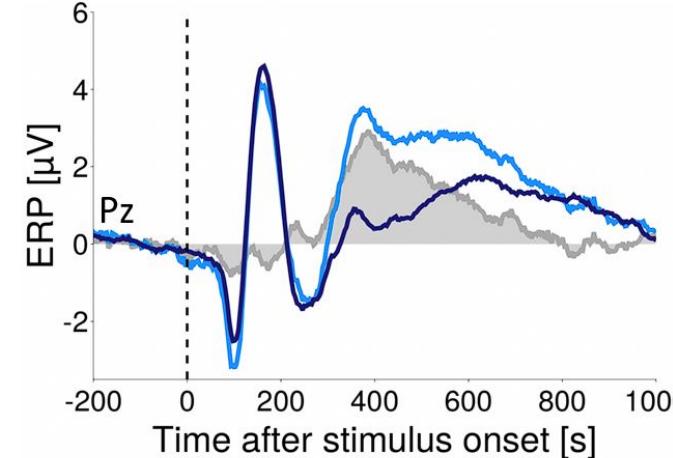
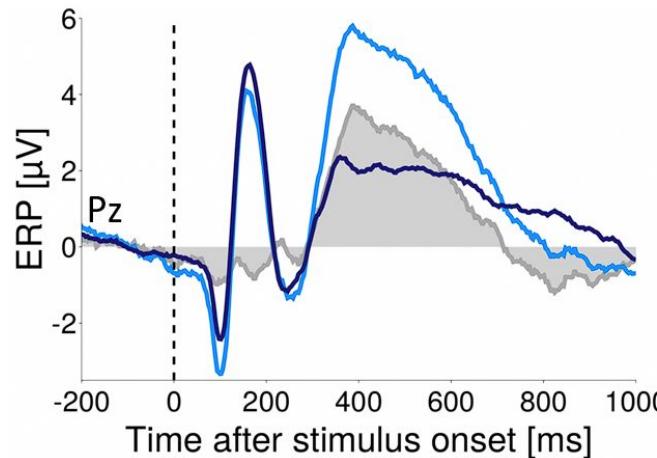
After overlap correction



After overlap correction and response time control

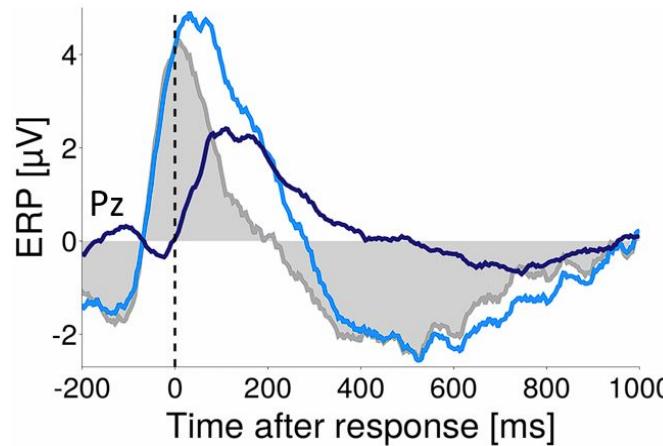


This study

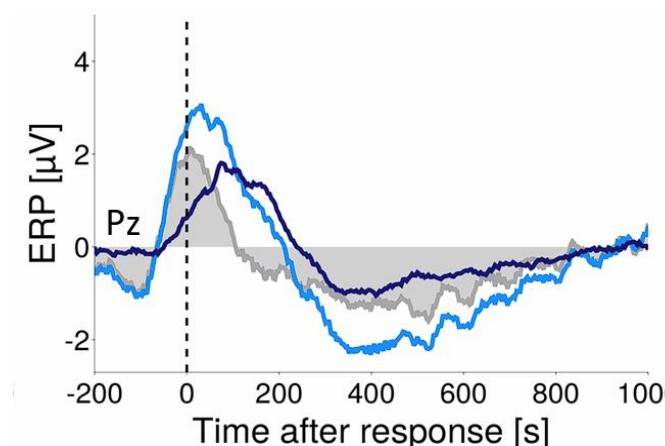


# RESPONSE-LOCKED rERPs

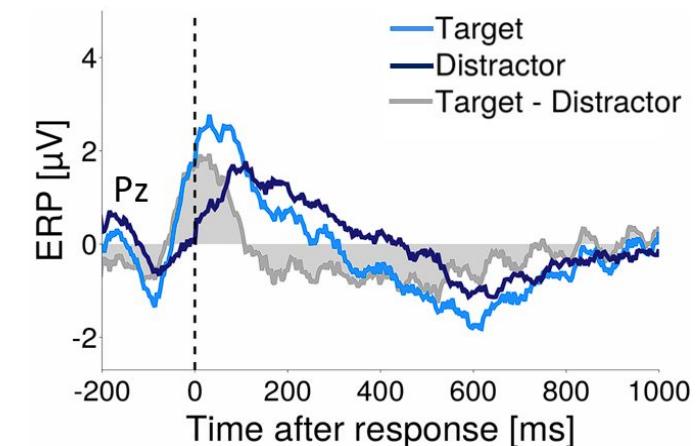
Before overlap correction



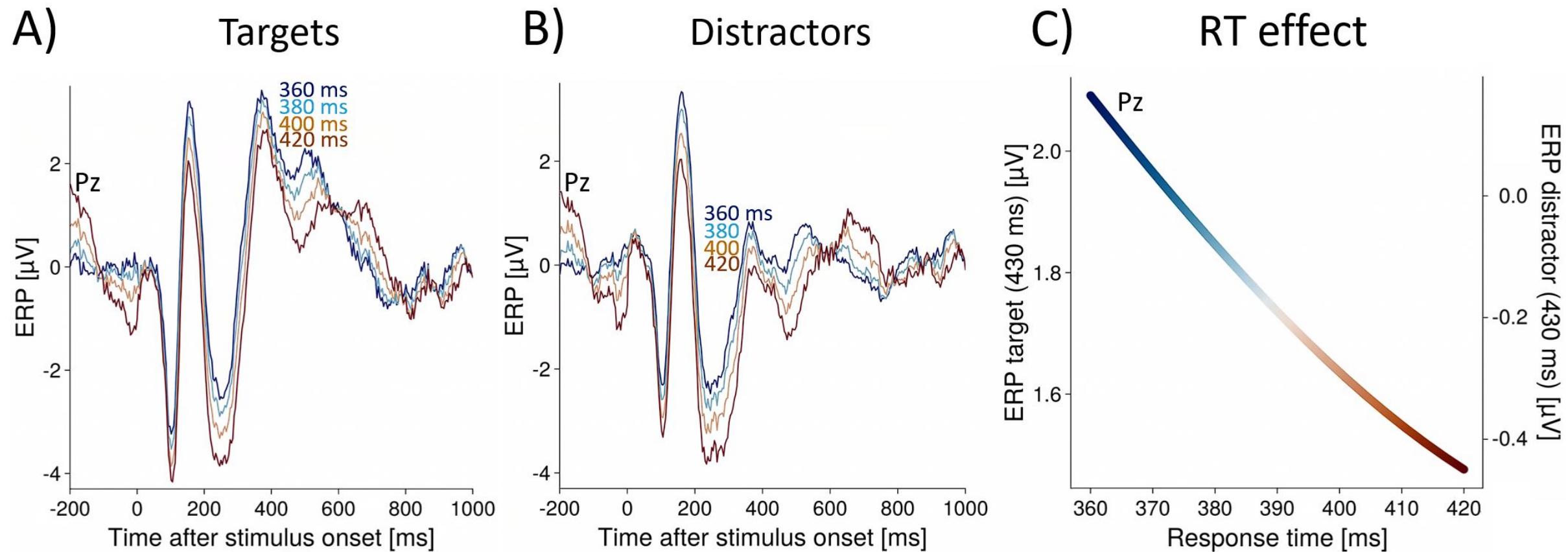
After overlap correction



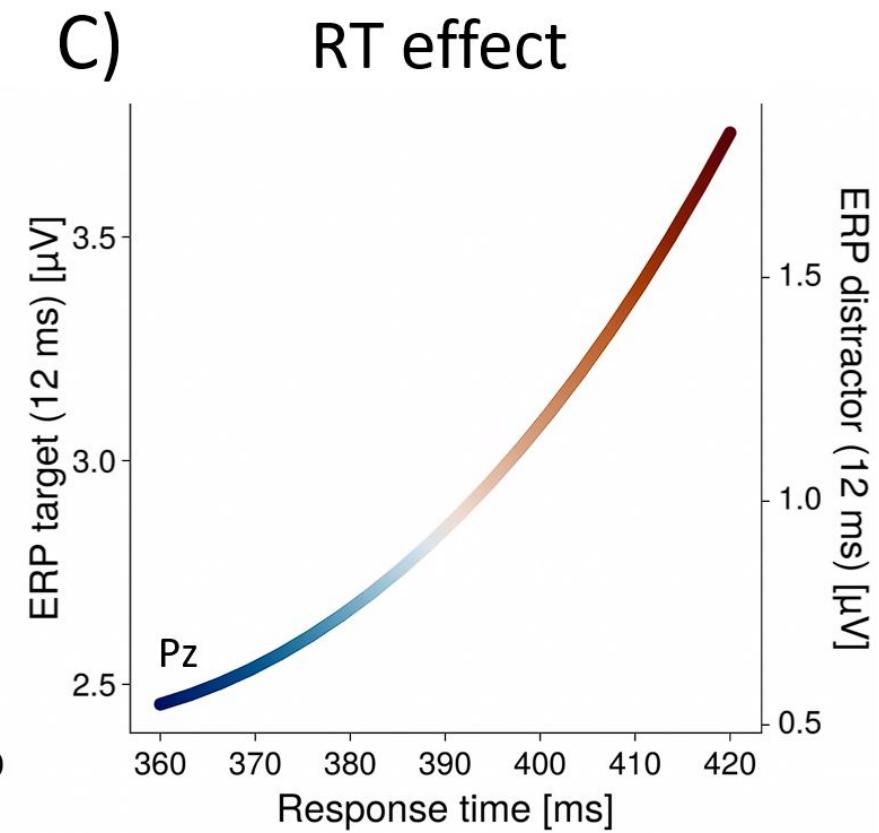
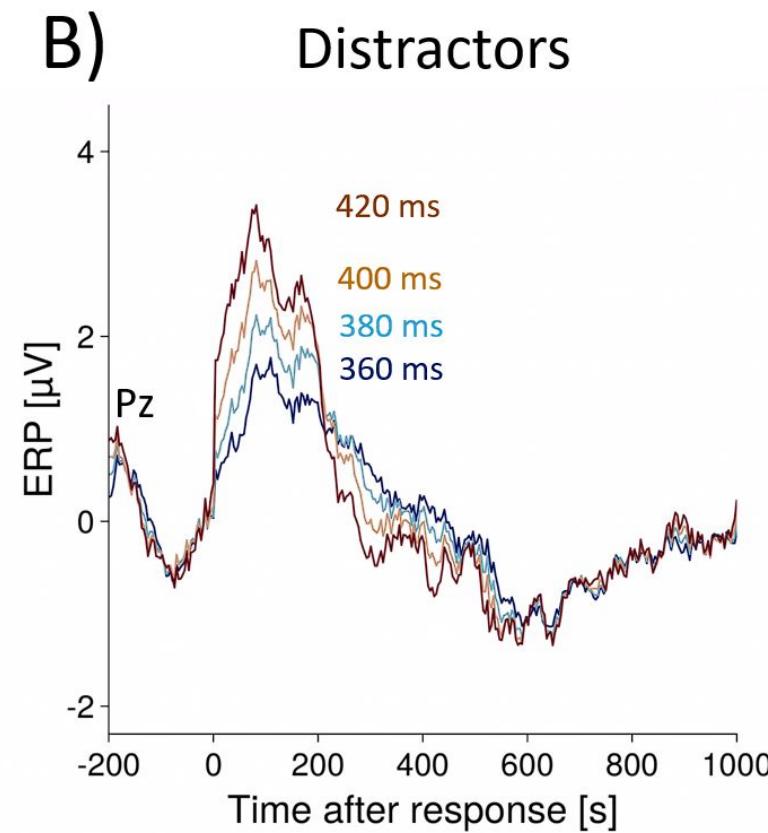
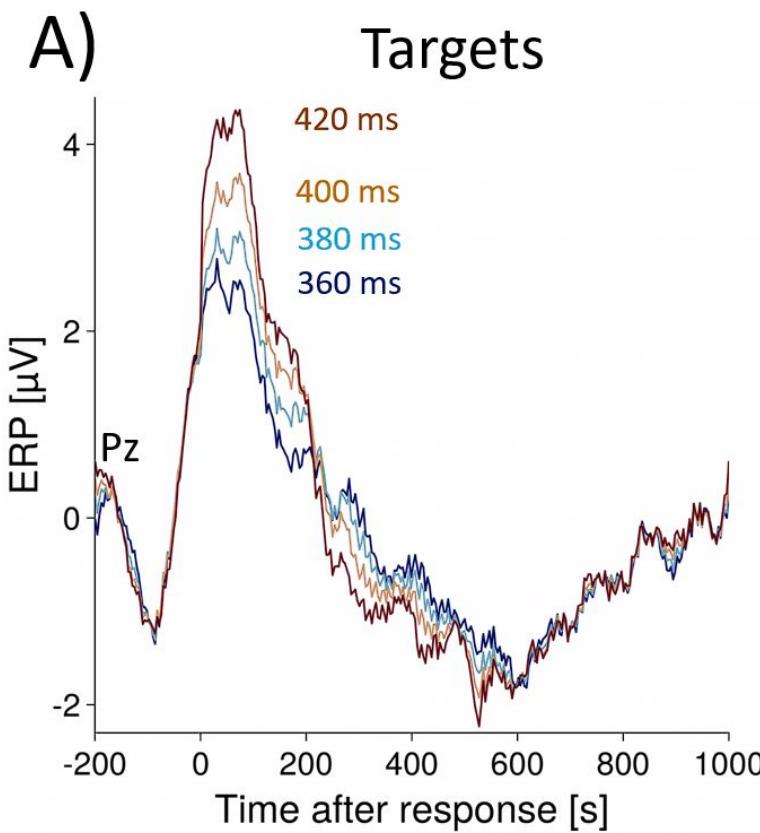
After overlap correction and response time control



# STIMULUS-LOCKED RT EFFECT



# RESPONSE-LOCKED RT EFFECT



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## Limitations

## STUDY LIMITATIONS

- I) Amplitude differences to ERP Core
- II) Signal-to-noise ratio
- III) Artefacts

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## Takeaways

# WHAT WE LEARNED FOR FUTURE STUDIES

## Overlap correction & modelling nonlinear effects

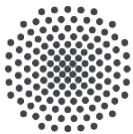
- Increase accuracy of ERP estimates
- Decrease bias for differences between conditions



# SOURCES

- [1] Luck, S. J. (2014). *An introduction to the event-related potential technique* (Second edition). The MIT Press. p.7.
- [2] Adapted from “Unfold: an integrated toolbox for overlap correction, nonlinear modelling, and regression-based EEG analysis” by B. V. Ehinger and O. Dimigen, 2019, PeerJ, 7, e7838. CC-BY 4.0.
- [3] Adapted from “Compensation of trial-to-trial latency jitter reveals the parietal retrieval success effect to be both variable and thresholded in older adults” by J.G. Murray, G. Ouyang and D.I. Donaldson, 2019, Frontiers in Aging Neuroscience, 11:179. CC-BY.
- [4] Adapted from Skukies, R., & Ehinger, B. (2021). Modelling event duration and overlap during EEG analysis. [Unpublished].
- [5] Kappenman, E. S., Farrens, J. L., Zhang, W., Stewart, A. X., & Luck, S. J. (2021b). Supplementary materials for ERP CORE: An open resource for human event-related potential research. *NeuroImage*, 225. <https://doi.org/10.1016/j.neuroimage.2020.117465>

# Thanks for your attention!



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