

Effects of interictal epileptiform discharges on cognitive performance and pupillometry in pediatric epilepsy: a multi-modal deep learning approach

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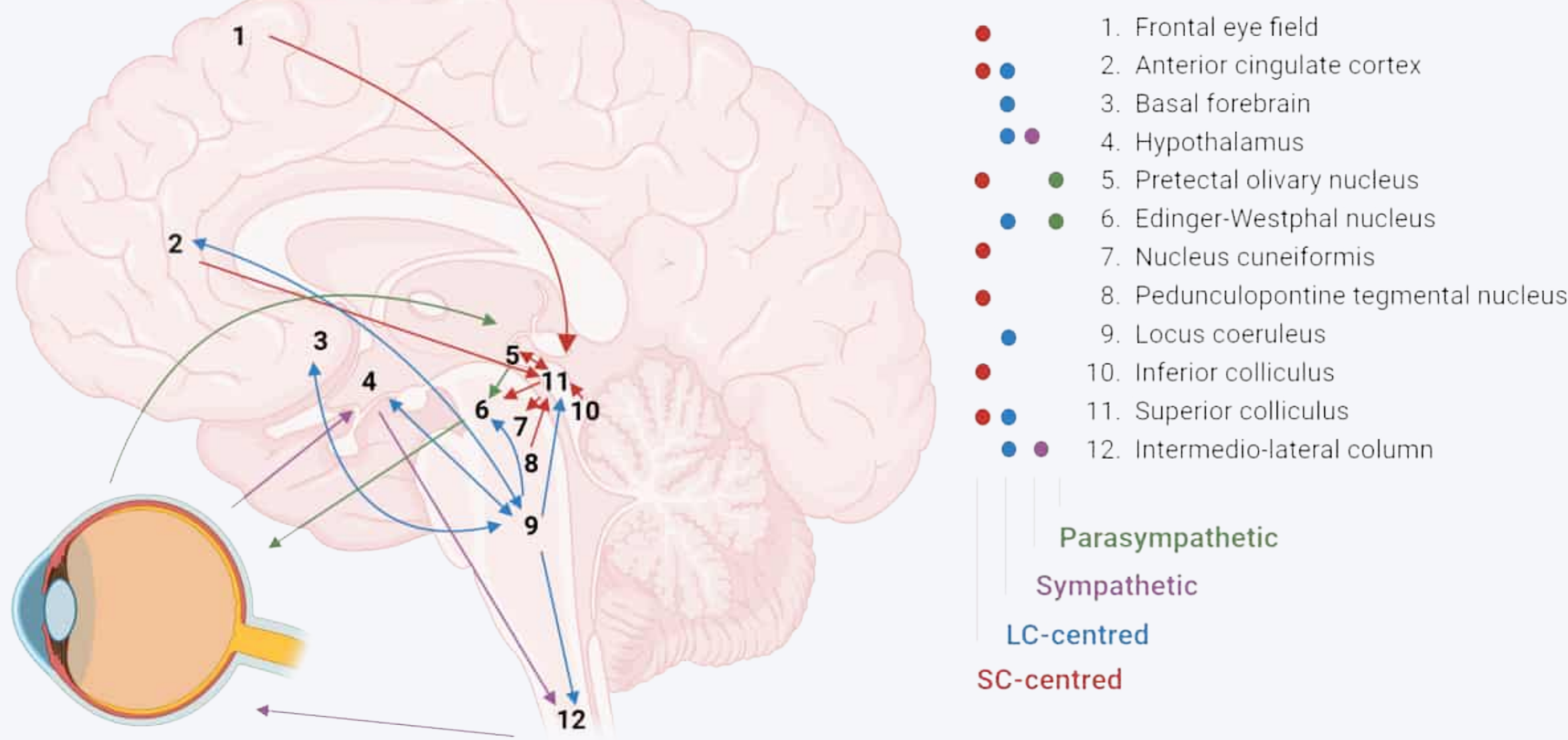
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At-a-glance

Using intracranial recordings from children with epilepsy, we leverage deep learning to model pupillary time courses and explore the relationship between neural activity, pupil dynamics, and cognitive performance. Our findings reveal that interictal epileptiform activity disrupts task performance but has a variable impact on the neural-pupil relationship across participants.

Introduction



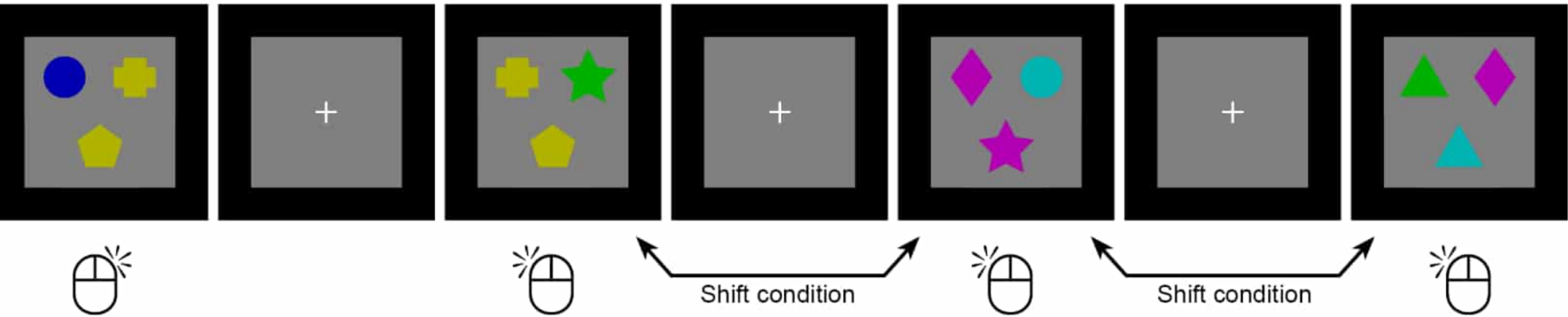
Attentional networks that affect pupil size. Adapted from Strauch et. al. (2022)¹.

- Pupillary response reflects sensory and goal-oriented cognitive processes¹, but specific contributions of cognitive processing to pupillary dynamics remains unclear.
- Impact of interictal epileptiform discharges (IEDs) on these relationships has not been thoroughly investigated.
- We leverage deep learning and statistical models to uncover relationships between between pupil size, neural activity, and behavioural outcomes in the presence and absence of IEDs.

Methods

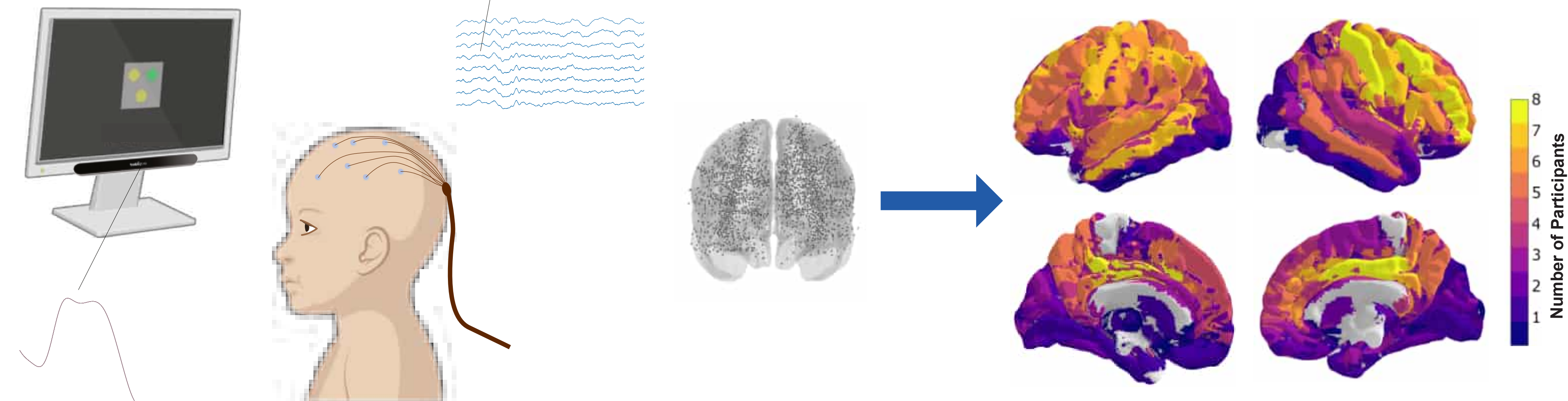
Attentional Set-Shifting Task

Up to 4000 ms 800-1200 ms



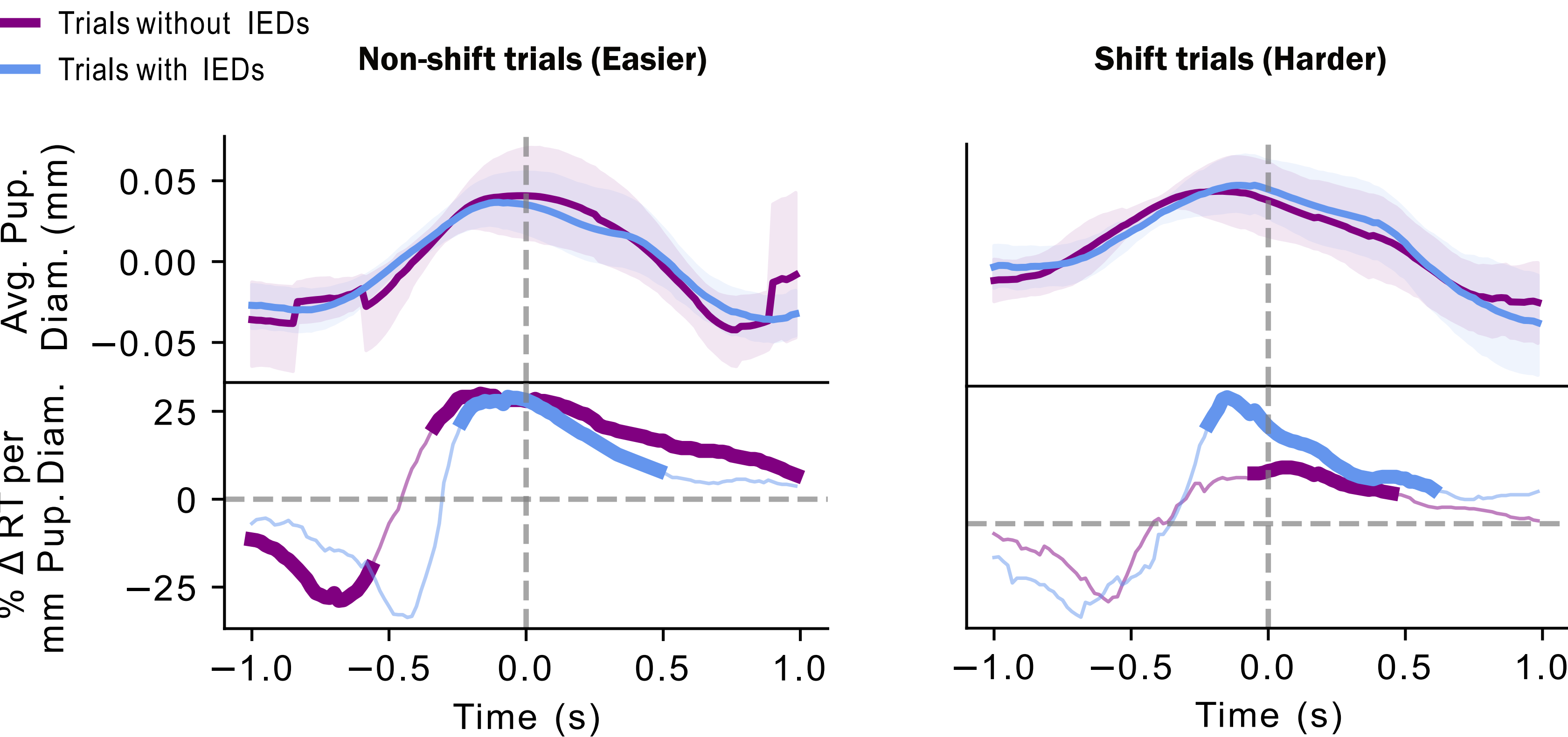
Intracranial electroencephalography and eye-tracking simultaneously recorded during cognitive task

SEEG electrode distribution across participants (N = 13)



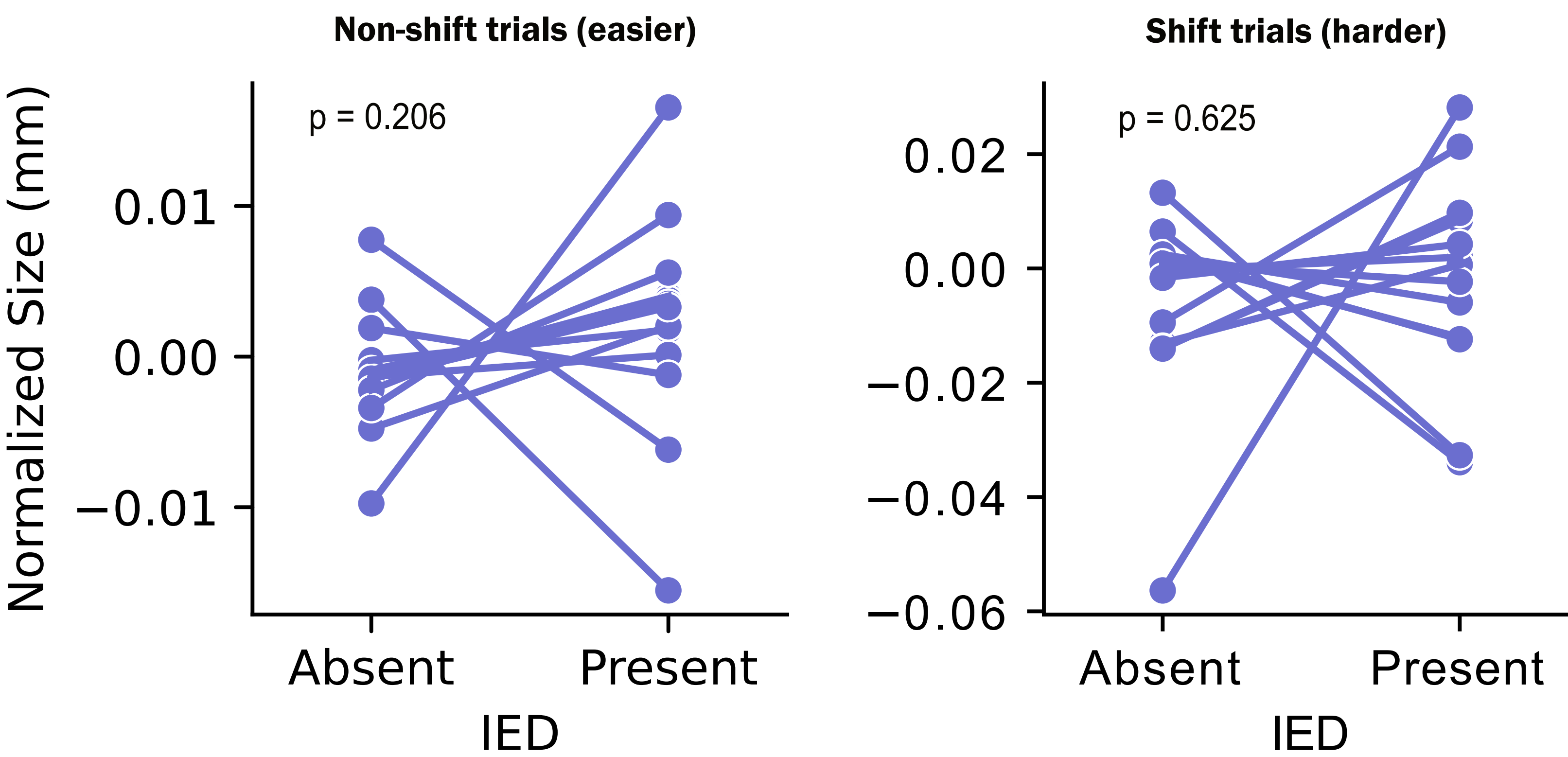
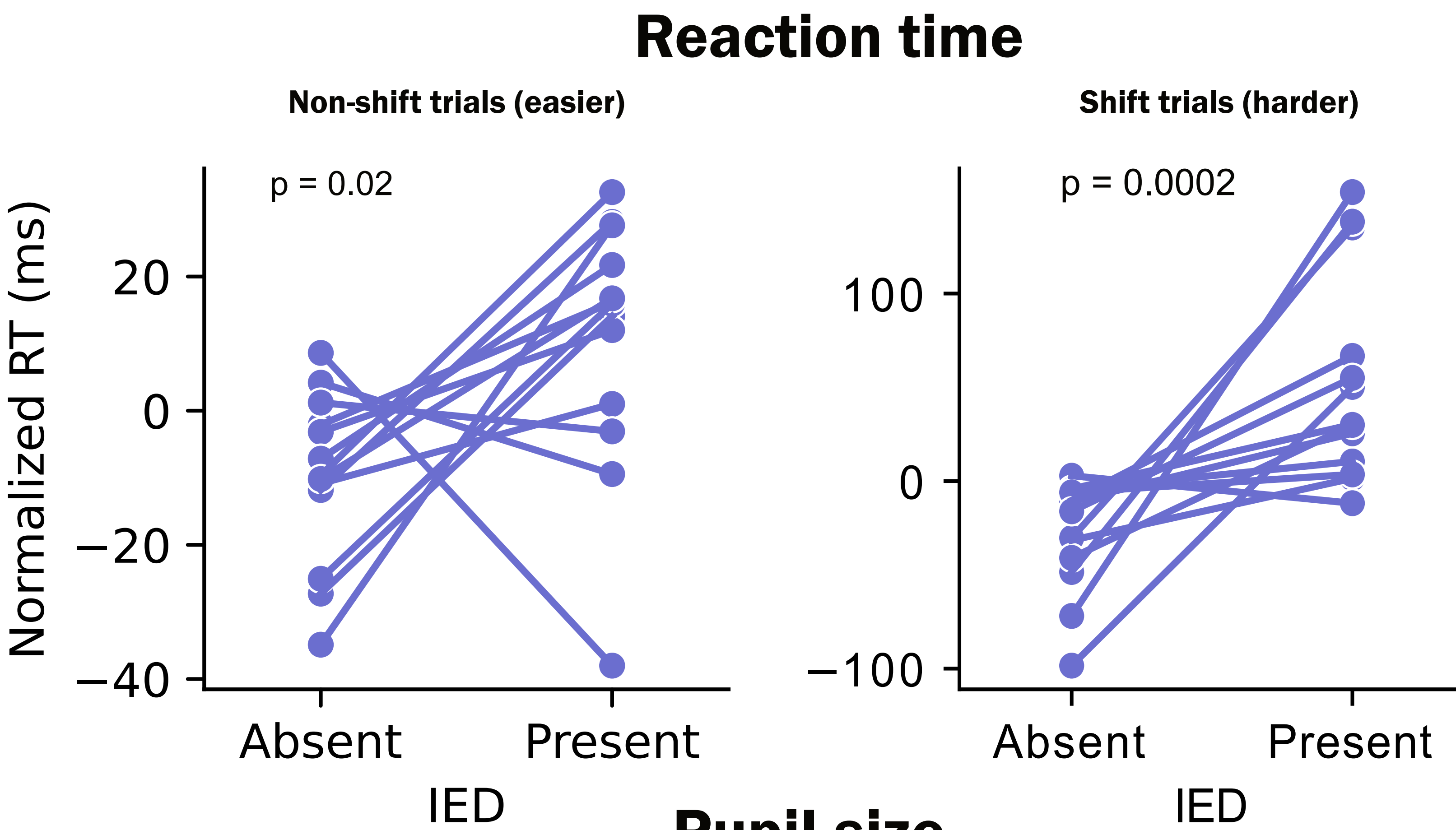
- Mixed effects models were used to identify relationships between task performance, pupil size, and neural activity.
- Using EEG-ViT^{2,3} architecture, participant-specific models were trained to predict pupil diameter time courses from SEEG signals.

1 Relationship between pupil size and reaction time is task-stage dependent



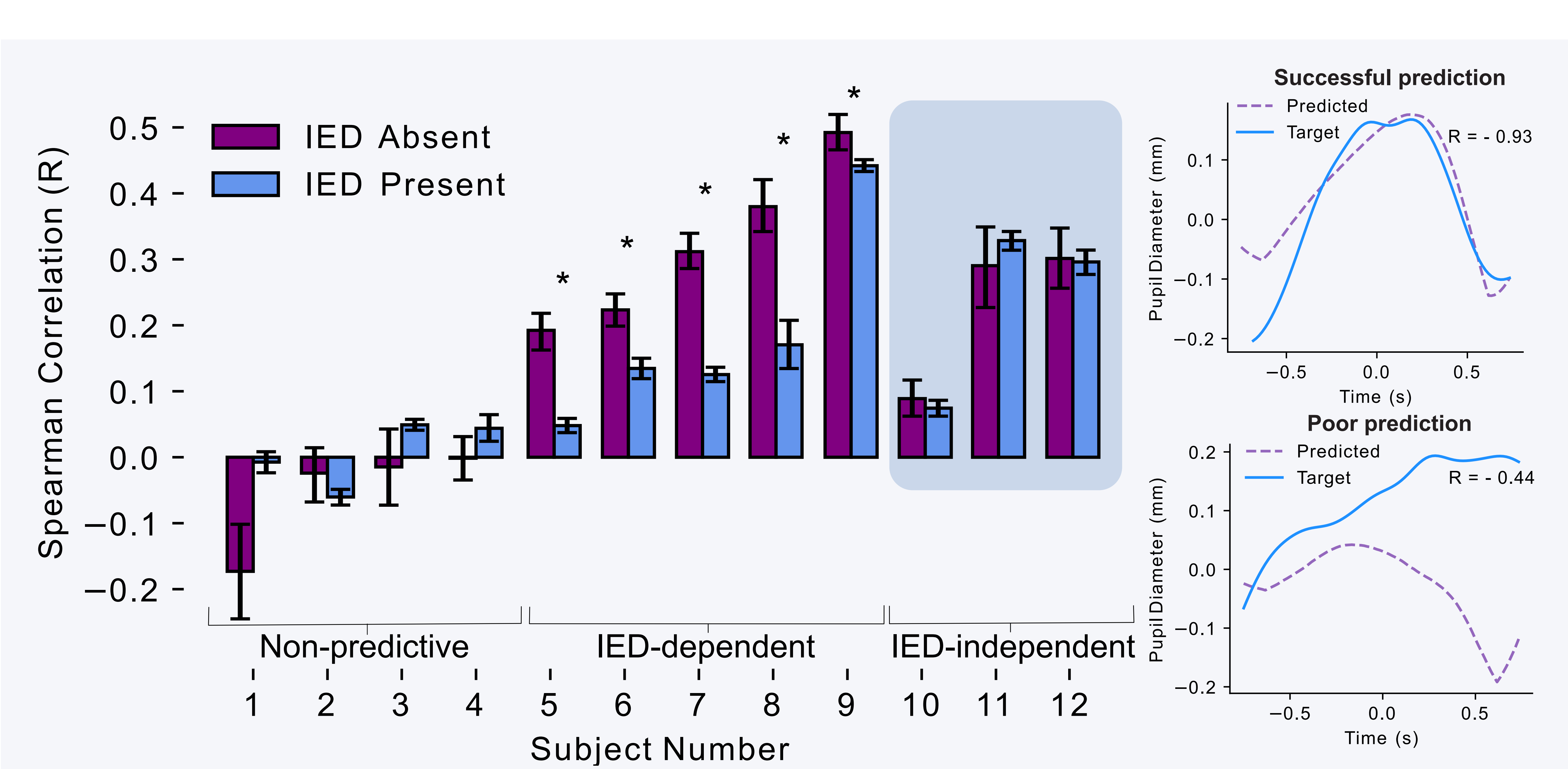
- Smaller pupils associated with faster RT during peri-stimulus period ($p < 0.05$ corrected, bold line).
- Larger pupils size associated with faster RT during interstimulus period ($p < 0.05$ corrected, bold line).
- Pupil size may reflect attention in preparation for a task, but reflect cognitive load during a task.

2 IEDs are significantly associated with increases in reaction time but not pupil size

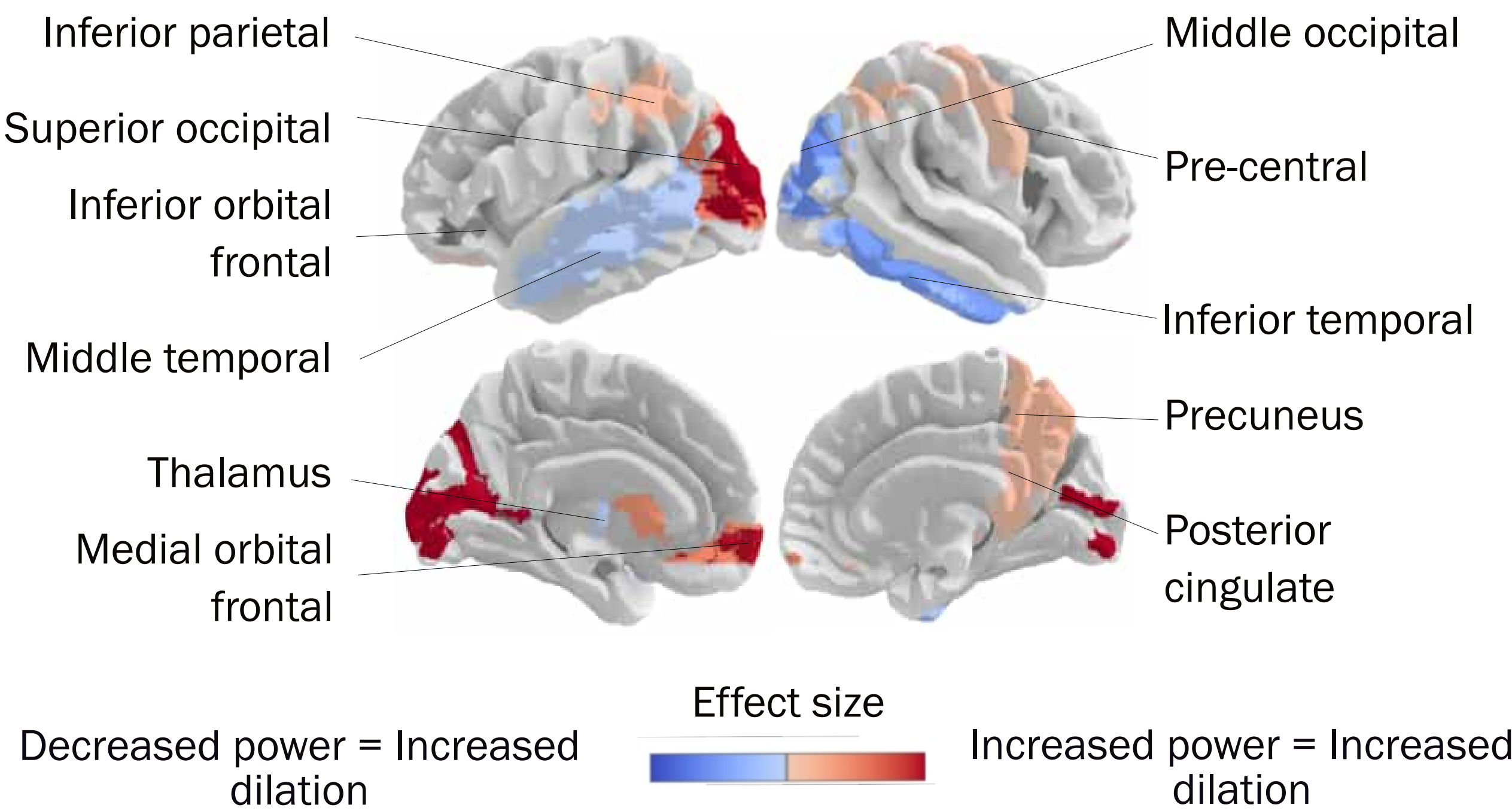


Results

3 Impact of IEDs on deep learning model performance varies across participants



4 Task relevant regions are associated with changes in pupil size



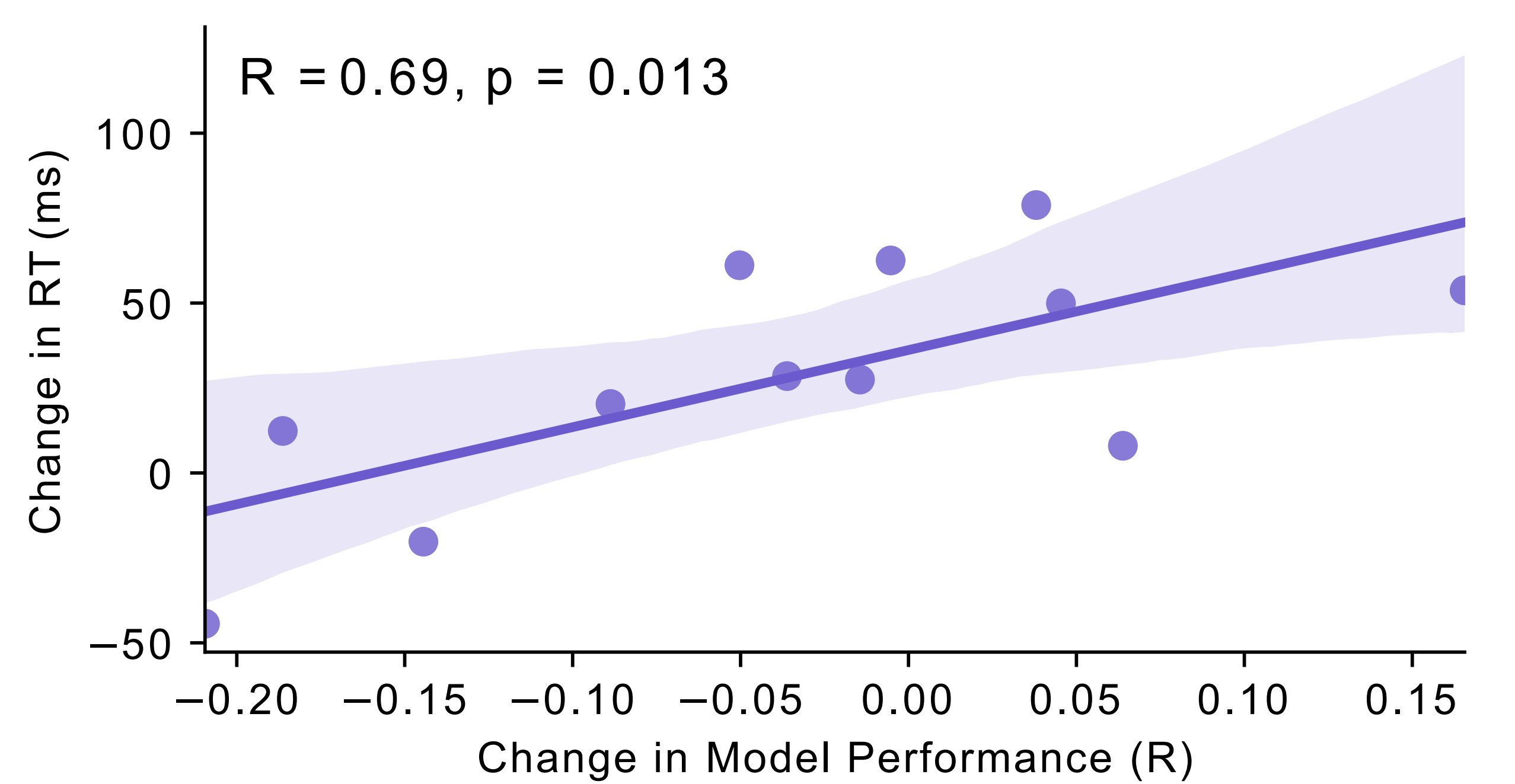
Conclusions

Complex relationship between cognitive processing, pupillary dynamics, and IEDs in children with epilepsy.

Pupillometry may serve as a measure of cognitive function in pediatric epilepsy.

Further research required to explore the observed variability in IED effects on model performance across participants.

5 IED impact on model performance is associated with change in reaction time



References

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