

Dynamic task representations induced by evolving task uncertainty: an fMRI study

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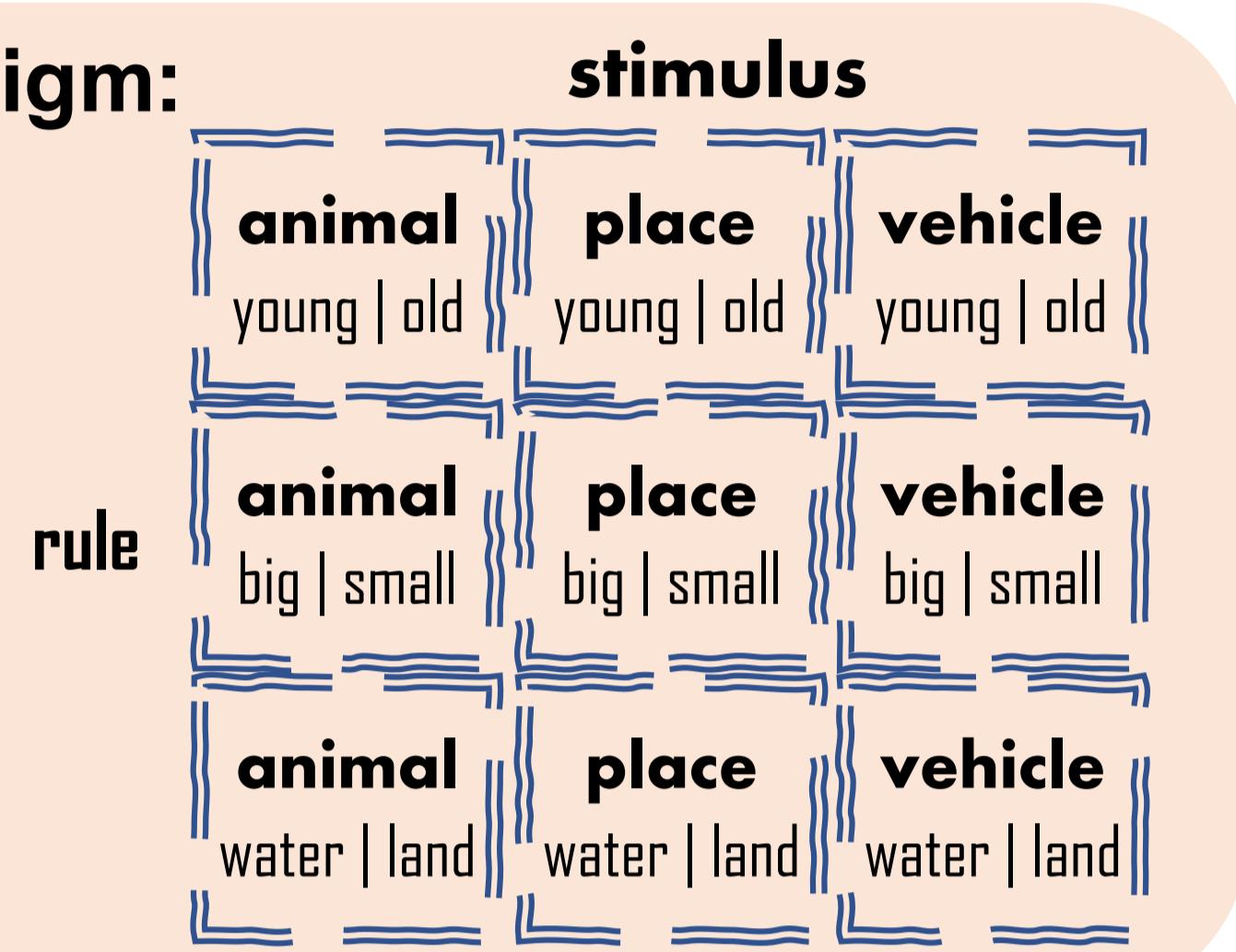
Background:

- One of the hallmarks of humans' cognitive flexibility regards the ability to dynamically adjust and control our intentions and actions.
- We previously demonstrated that people can dynamically adjust their task preparation when the to-be-performed task varied in uncertainty (Chai et al., 2024, *Cognition*).
- The neural mechanisms underlying this dynamic cognitive control is unclear.

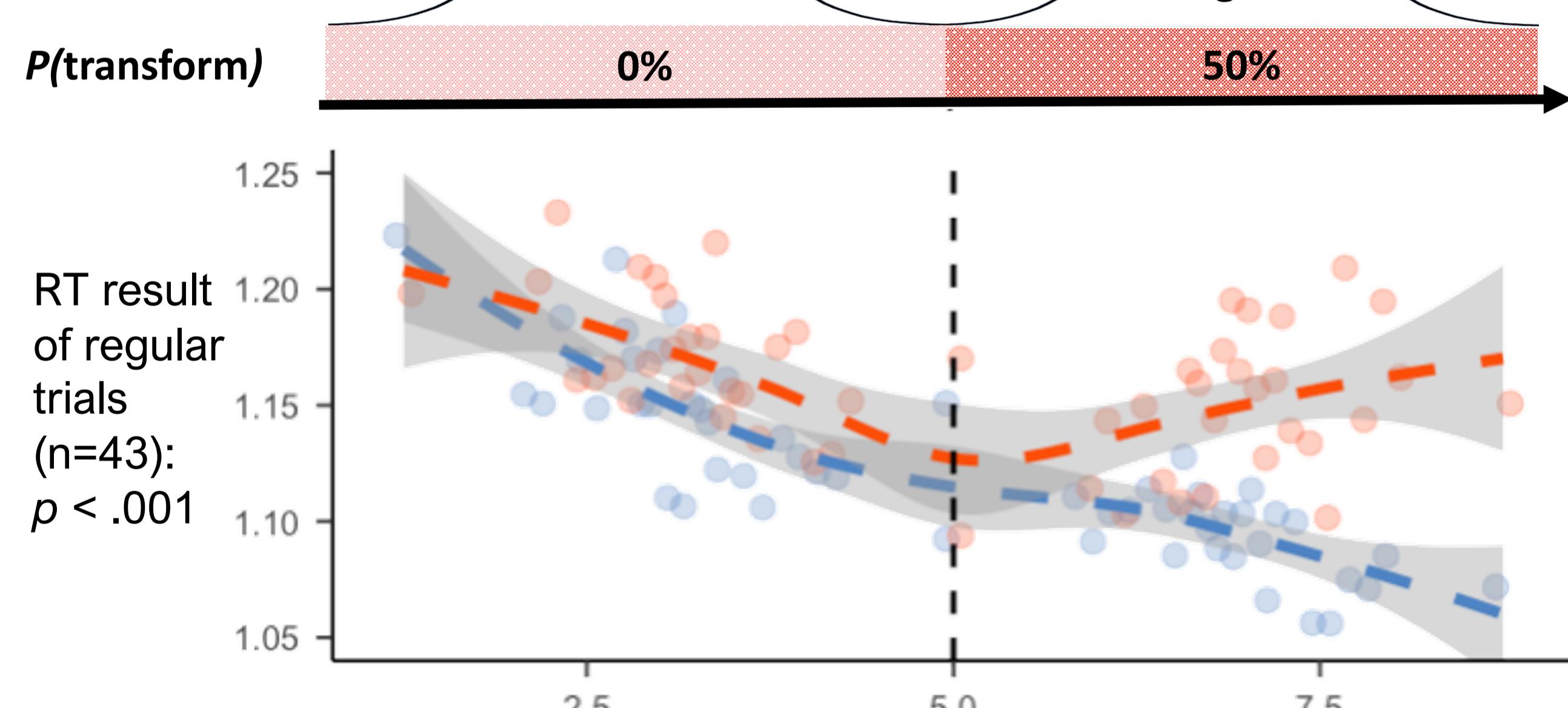
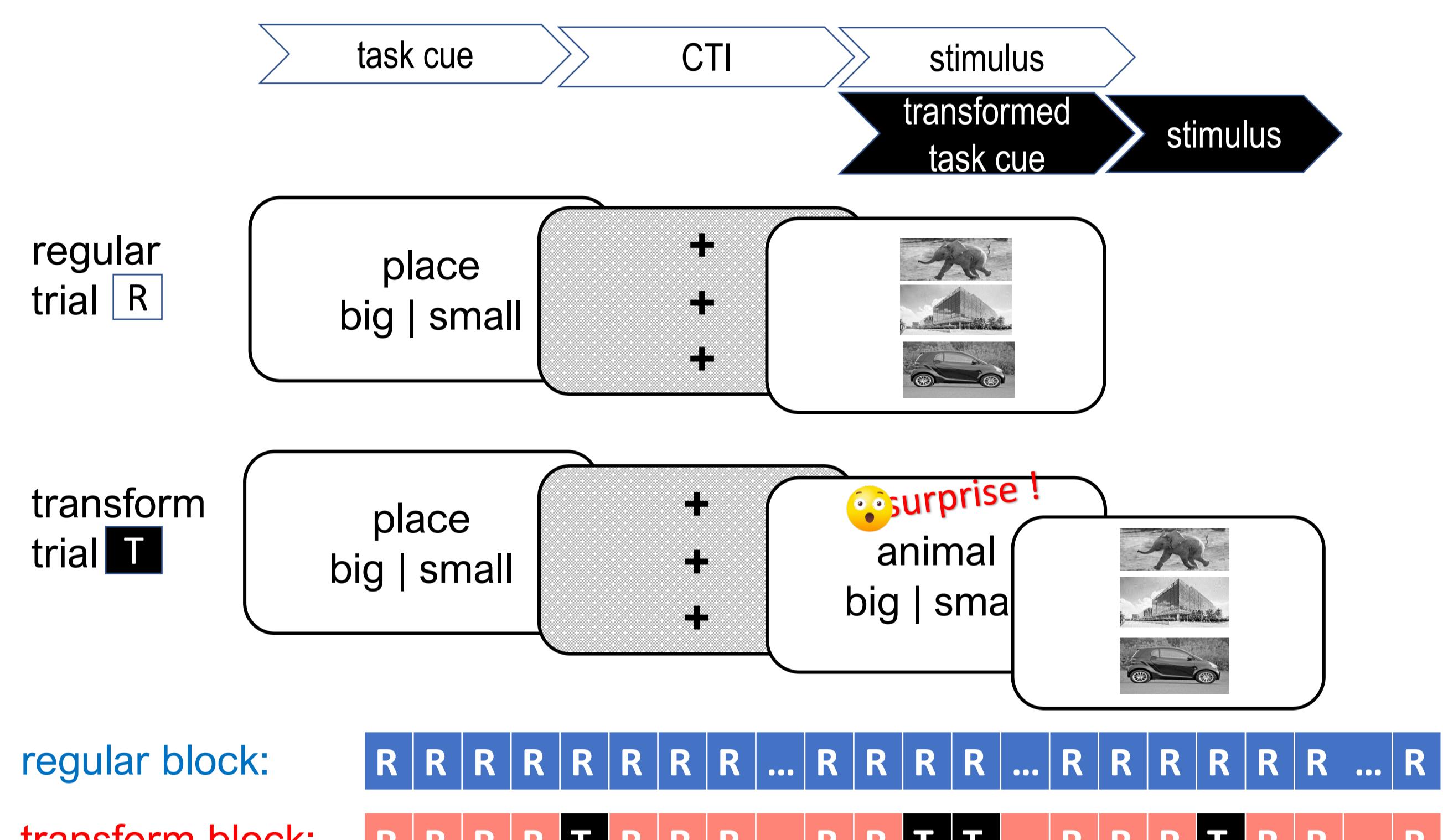


Task transformation paradigm: image categorization

- 9 different tasks were created by factorially combining 2 task dimensions: **stimulus** and **rule**.

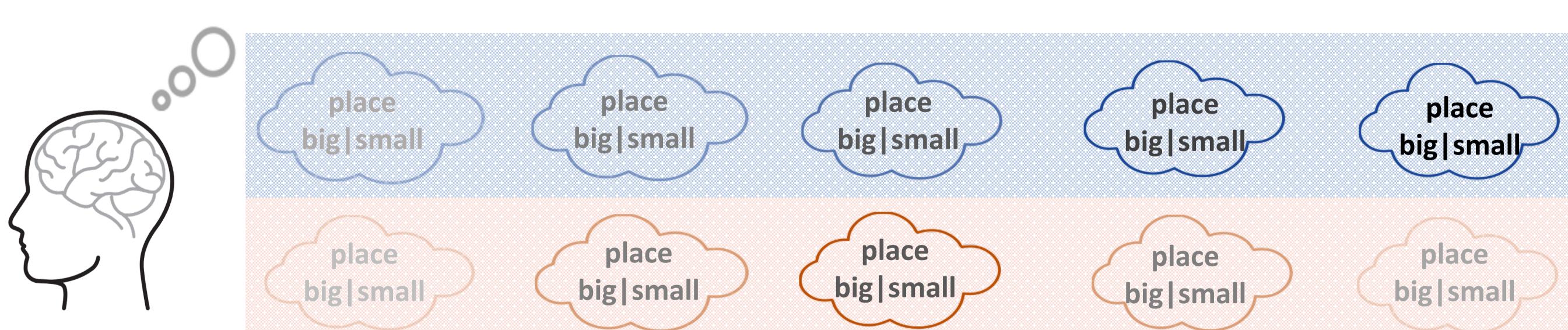


Task transformation paradigm: main manipulations

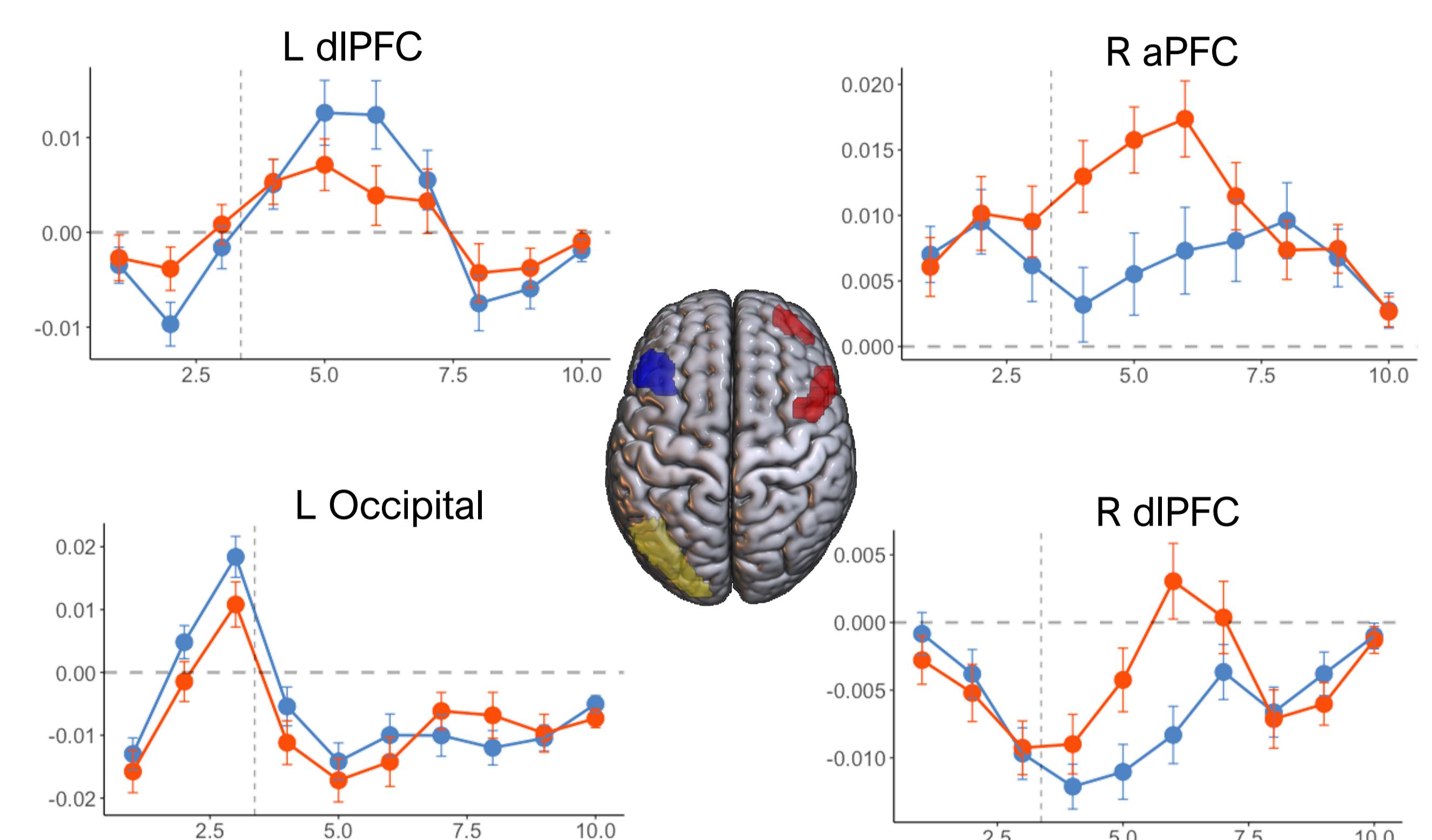
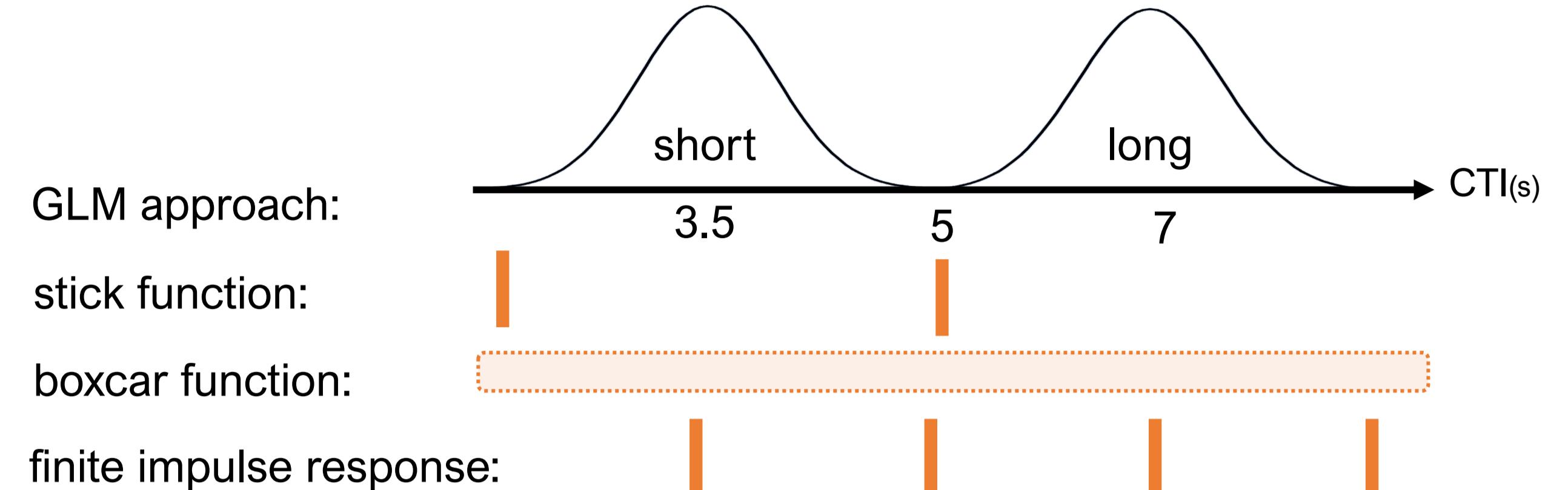


Neural hypothesis:

The evolving task uncertainty would require dynamic regulation regarding the strength of task representations in order to facilitate flexible goal setting in the transform blocks.

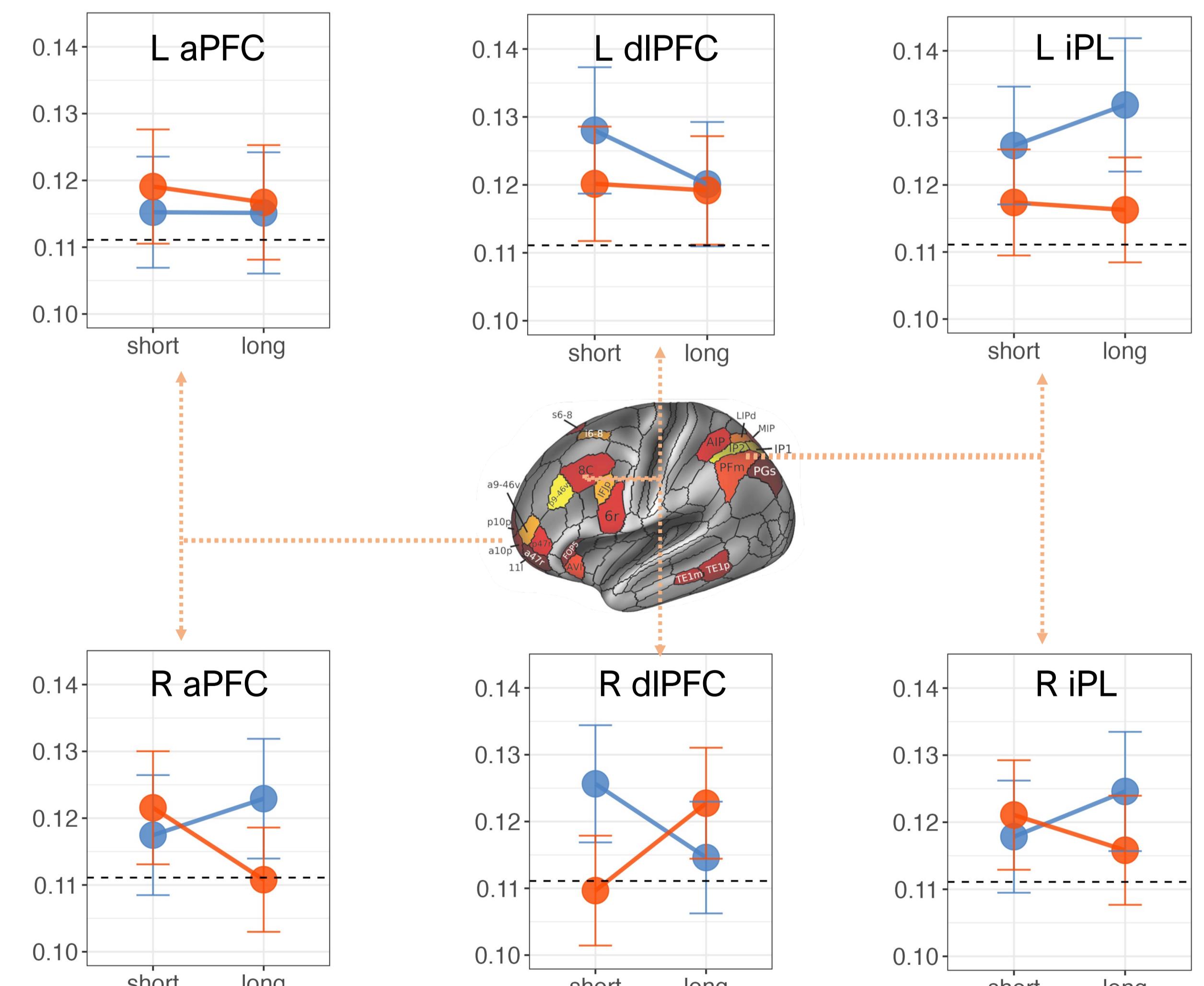


fMRI results : Univariate analysis



- Univariate contrasts revealed condition-dependent activation in several sub-regions within PFC:
 - Transform:** right lateral PFC, anterior PFC
 - Regular:** left lateral PFC, left premotor
- BOLD dynamics further unveiled the potentially diverging roles these sub-regions play in supporting flexible cognitive control.

Multivariate task decoding



- 9-way task decoding using SVM, separately for each CTI length (short and long) and block type (regular and transform);
- ROIs were selected from multiple demand (MD) network independently identified based on HCP-MMP1 atlas (Assem et al., 2020), including aPFC, dIPFC, and iPL;
- We found above chance decoding across ROIs ($p < .001$), higher decoding accuracy in regular than in transform blocks ($p = .006$), and distinct interaction (CTI : block type) between ROIs ($p = .001$).
- Our results indicate that task uncertainty modulates the strength of task representation overall, and regions within MD network exhibited distinct uncertainty-driven representational dynamics.

References:

Chai, M., Holroyd, C., Brass, M., & Braem, S. (2024). Dynamic changes in task preparation in a multi-task environment: The task transformation paradigm. *Cognition*, 247, 105784.

Assem, M., Glasser, M. F., Van Essen, D. C., & Duncan, J. (2020). A domain-general cognitive core defined in multimodally parcellated human cortex. *Cerebral Cortex*, 30(8), 4361-4380.

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