

Stimulus encoding, working memory, and action selection in dorsolateral prefrontal cortex during perceptual decision making

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Introduction

Perceptual decisions involve discriminating sensory evidence to arrive at a choice and then performing the context-appropriate motor action to report said choice. In many settings, this action selection ("where") occurs concurrently with sensory discrimination ("what") but in other settings, evidence is temporally separated from the selection of appropriate actions. When motor planning and deliberation of sensory evidence can occur in parallel, firing rates in dorsal premotor (PMd)¹ and lateral intraparietal (LIP)² areas appear to covary with sensory evidence and choice. However, this encoding of the sensory evidence is largely absent if motor planning is not possible because target identity and location is randomized and presented later in time^{3,4}. These results lead to the hypothesis that an area upstream of PMd and LIP is necessary to connect sensory evidence to motor actions in order to solve this particular decision-making task. Therefore, the locus of such perceptual decision-making is unknown but such an area should present the following:

1. Neural correlates of sensory evidence, independent of possible actions
2. Activity persists even when the stimulus is no longer available
3. Information about possible actions through target configuration encoding
4. Sensory evidence and target configuration are combined for selection of a motor action

Here, for the first time, we demonstrate that a cortical area within deep dorsolateral prefrontal cortex (DLPFC; putatively BA46) with these properties. This area integrates "what", "where", and "how" during perceptual decisions where sensory evidence and motor planning is dissociated from one another.

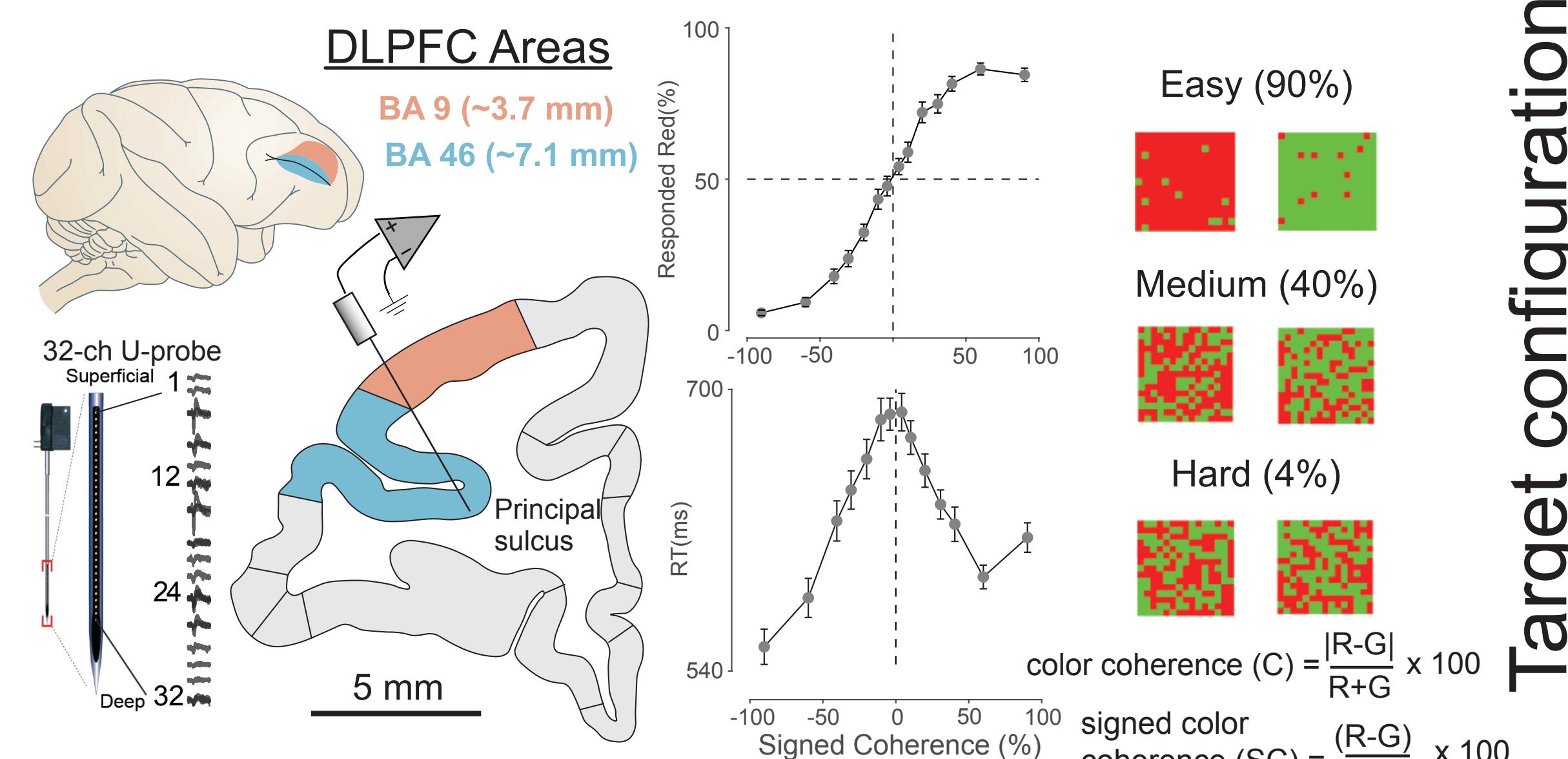
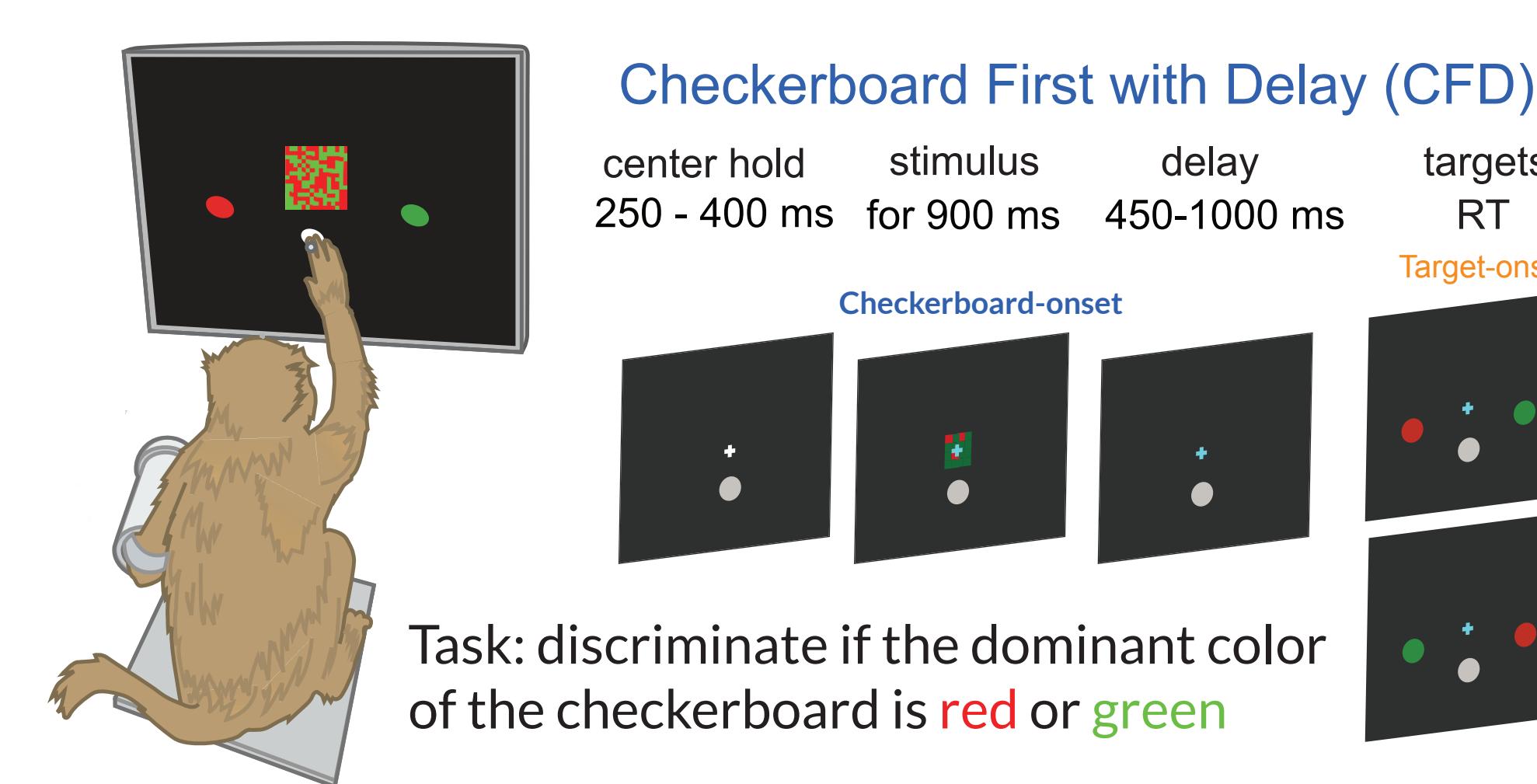
[1] Cisek, P. & Kalaska, J. F. Neural Correlates of Reaching Decisions in Dorsal Premotor Cortex: Specification of Multiple Direction Choices and Final Selection of Action. *Neuron* 45, 801–814 (2005).

[2] Shadlen, M. N. & Newsome, W. T. Neural Basis of a Perceptual Decision in the Parietal Cortex (Area LIP) of the Rhesus Monkey. *J Neurophysiol* 83, 1916–1936 (2000).

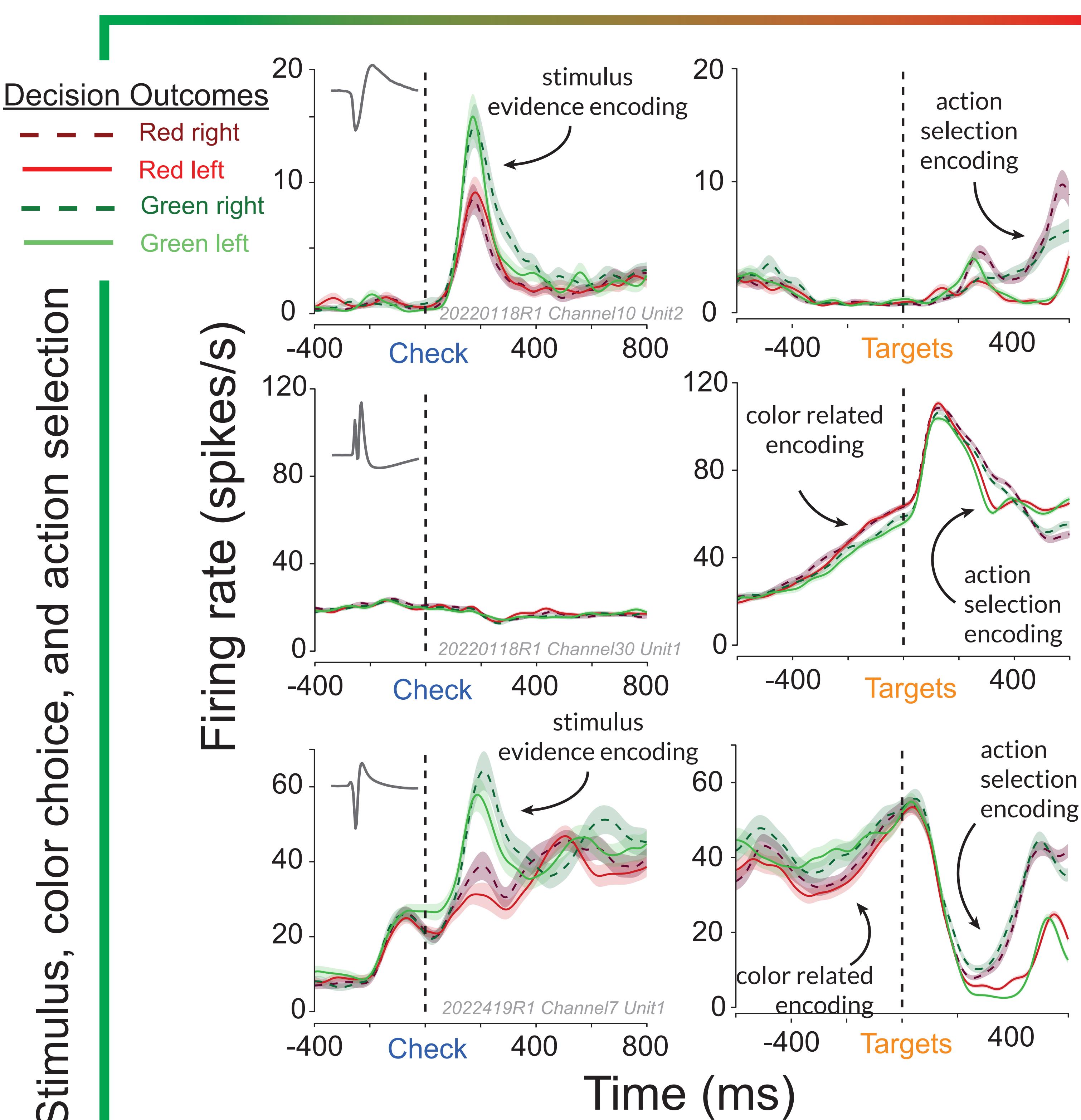
[3] Wang, M. et al. Macaque dorsolateral cortex exhibits decision-related activity only when specific stimulus-response associations are known. *Nature Communications* 10, (2019).

[4] Shushruth, S., Zylberberg, A. & Shadlen, M. N. Sequential sampling from memory underlies action selection during abstract decision-making. *Curr Biol* 32, 1949–1960.e5 (2022).

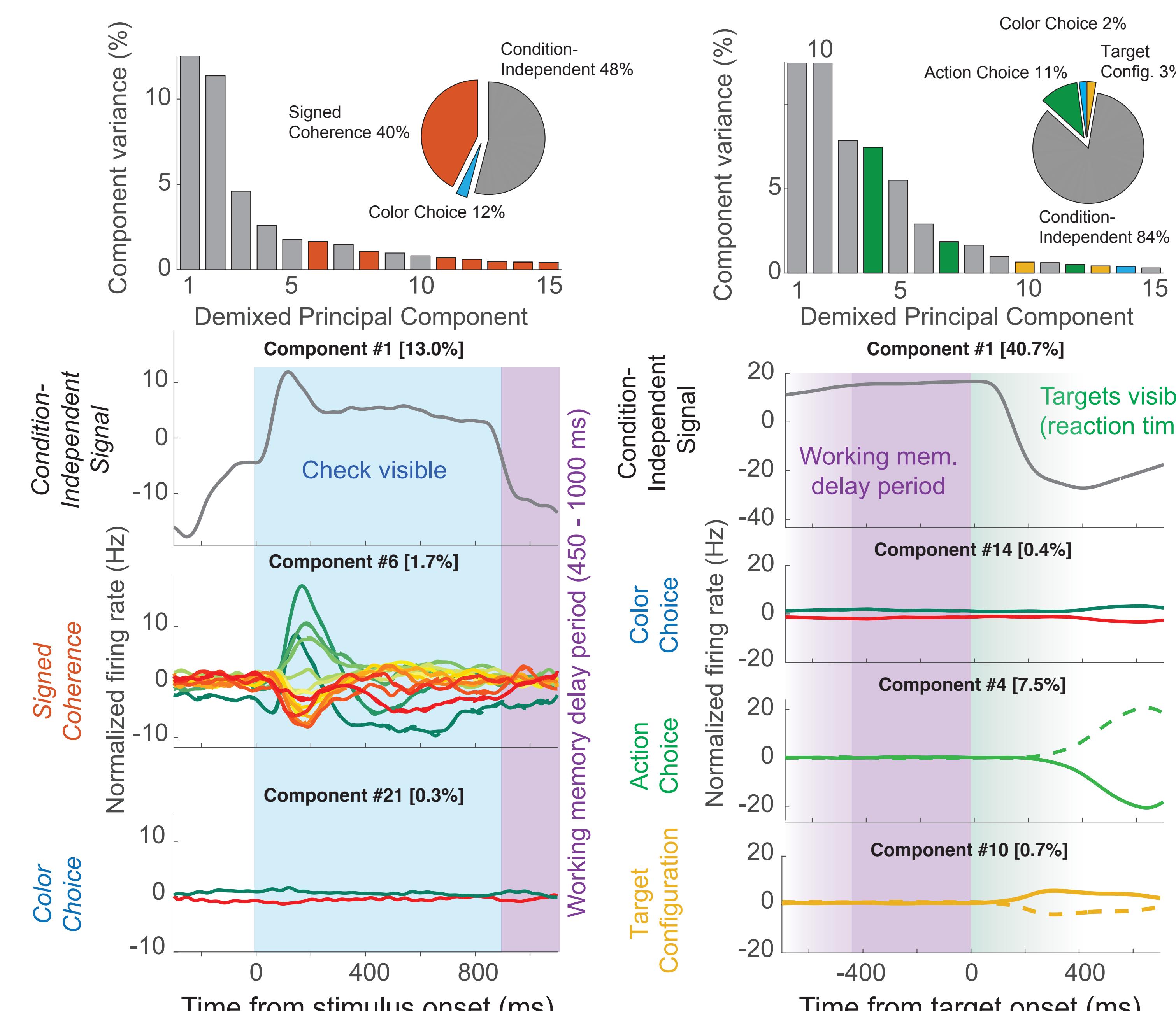
Experimental methods



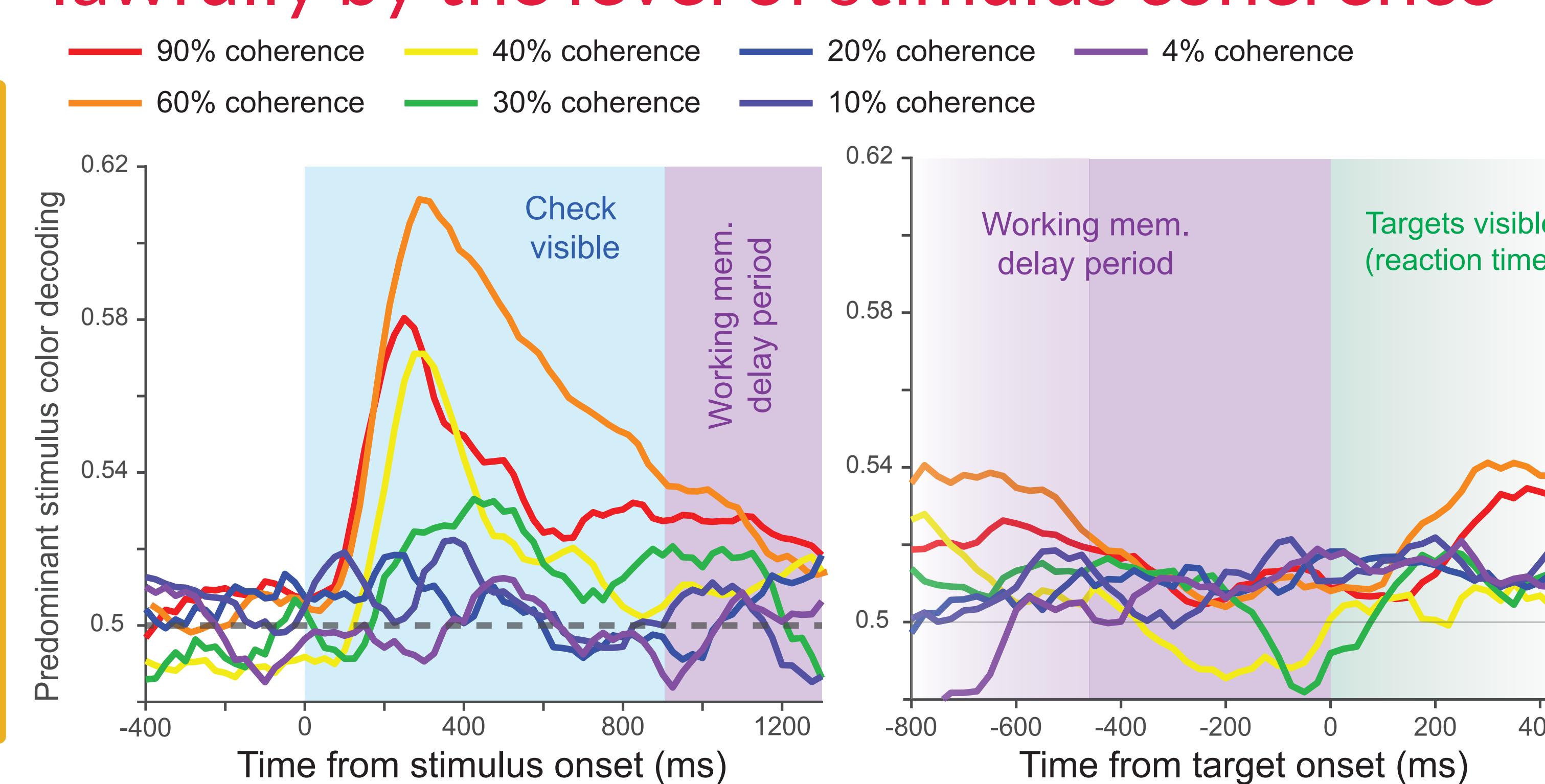
Single units encode task variables



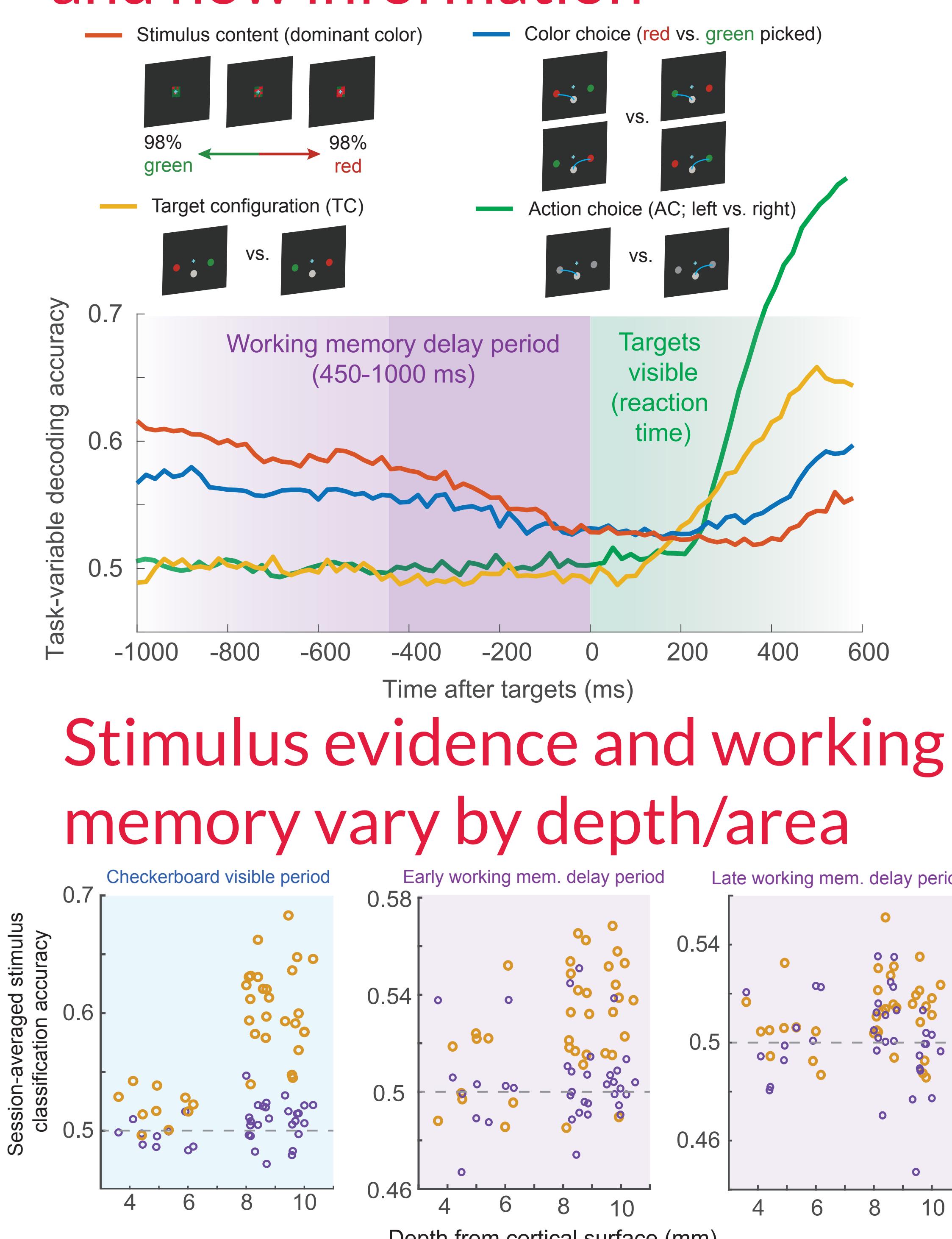
DLPFC encodes sensory evidence independent of action selection



Predominant stimulus color encoding varies lawfully by the level of stimulus coherence



DLPFC integrates what, where, and how information



Conclusions

We show, for the first time, that neurons in a cortical region in the deeper aspect of DLPFC represents sensory evidence independently of actions, encodes target configuration, and also modulates its activity related to the selection of the motor actions. The presence of sensory, context, and motor signals in the same cortical area suggests that it is 1) likely upstream of dorsal premotor/posterior parietal cortices and 2) one of the first areas involved in perceptual decisions.

Our decoding results show that this brain region encodes a graded sensory evidence signal during the working memory period, and combines it with target configuration information to compute color and action choice.

Acknowledgements

