



# Beyond spatial and feature-based selection: Surface-based attention enhances fMRI responses in early visual cortical areas

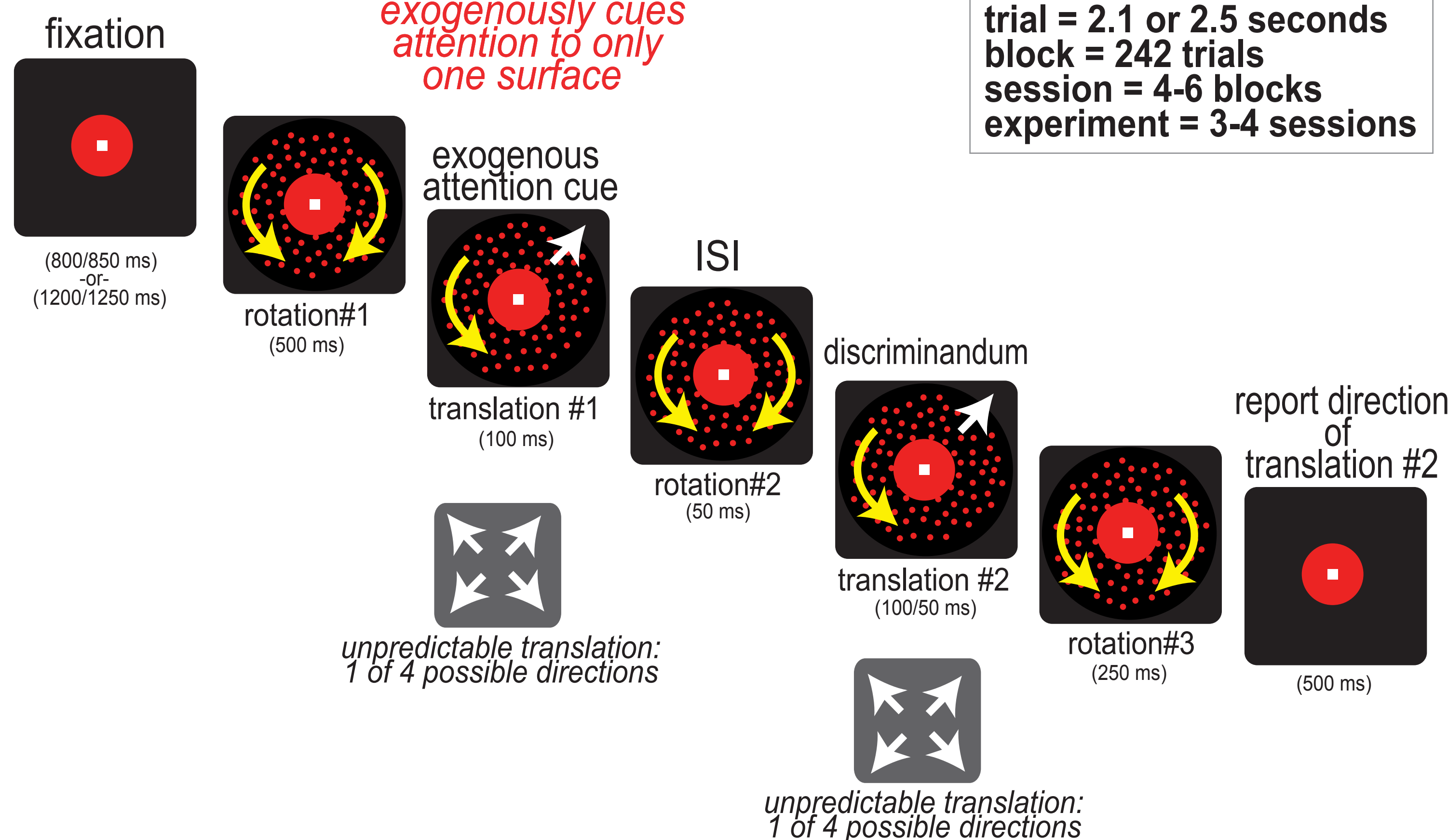
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## BACKGROUND

Many studies have examined the neuronal correlates of spatial and feature-based attention. Less is known about the neuronal correlates of object-based selection. In object-based selection if one feature of an object is selected, other features associated with the same object are also selected, and this selection persists even if the object's features change over time.

To investigate the role of early visual areas in surface-based attentional selection, we adapted a behavioral paradigm originally developed by Valdes-Sosa and colleagues and Reynolds and colleagues. In this paradigm, two superimposed transparent surfaces compete for perceptual selection. Critically, this paradigm rules out space-based selection as well as feature-based selection.

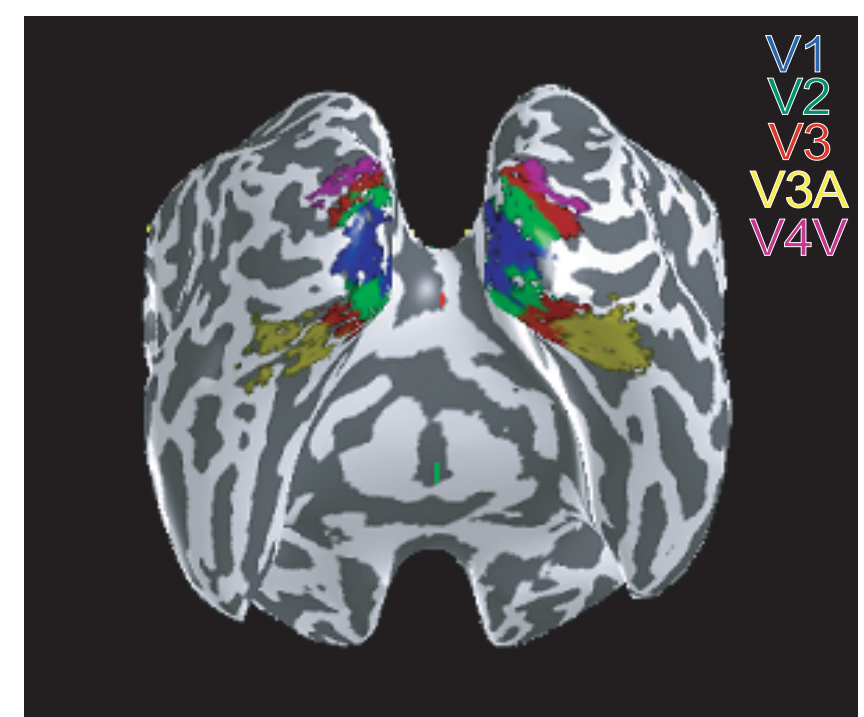
## TASK



- > Subjects were instructed to respond as quickly as possible and had a limited time to make their decision.
- > Translation #2 was a fixed duration & a post-stimulus mask (rotation #3) limited visual processing after translation offset.
- > This task precludes space-based selection; the two virtual surfaces are spatially superimposed and any change is distributed over the entire surface and occurs unpredictably.
- > This task precludes feature-based selection; both surfaces are the same color and the feature to be detected is unpredictable.

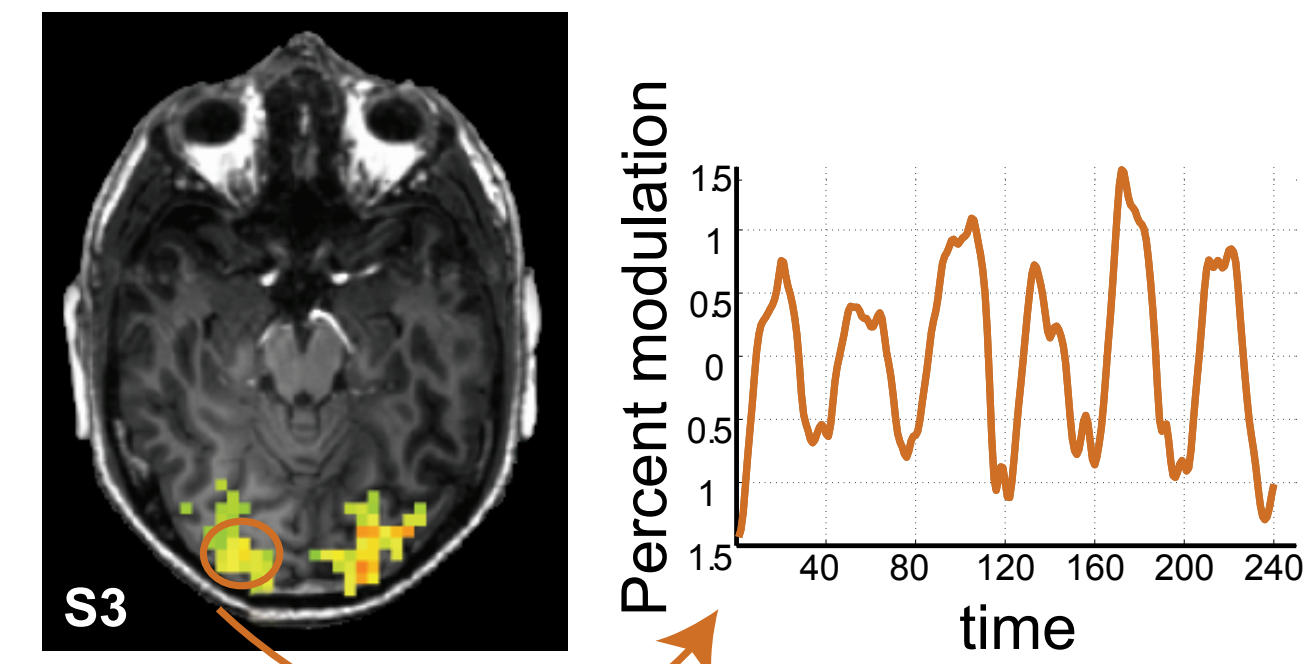
## fMRI METHODS

### retinotopic mapping



3 Tesla GE Signa EXCITE short bore  
GE 8 channel head coil  
T2\* weighted EPI pulse imaging  
TR 1050 or 1250; flip angle 90  
4x4x4 mm voxel

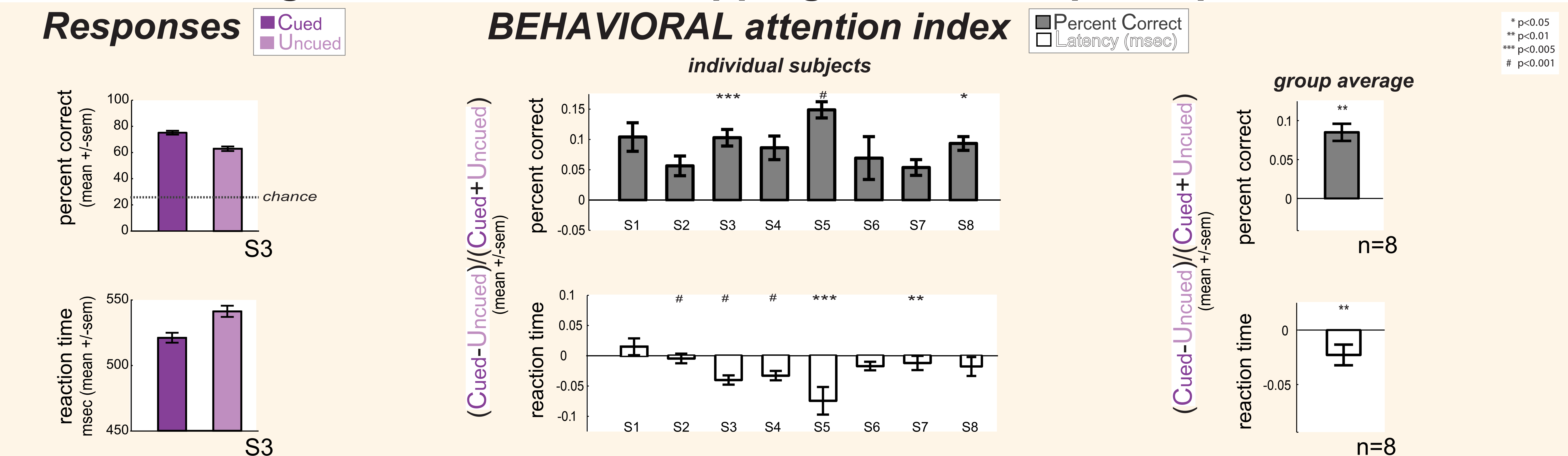
### functional localizer



rapid event-related design  
m-sequence: 3 trial types  
(cued/uncued/blank)

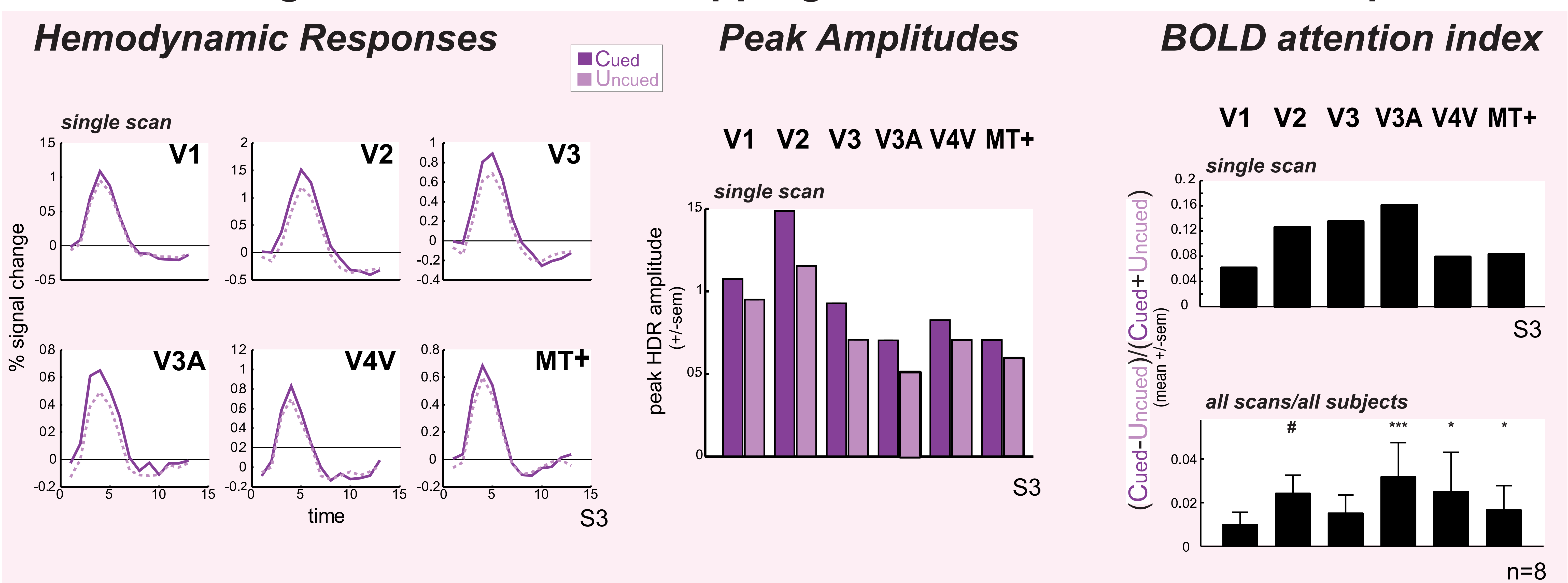
## RESULTS

### Does attending to one of two overlapping surfaces improve performance?



- > The direction of a brief translation is more accurately & more quickly discriminated for a cued vs uncued surface.
- > Our paradigm yields results consistent with earlier studies using similar paradigms and showing improved accuracy. In addition, we find improvements in measures of reaction time or time on task.

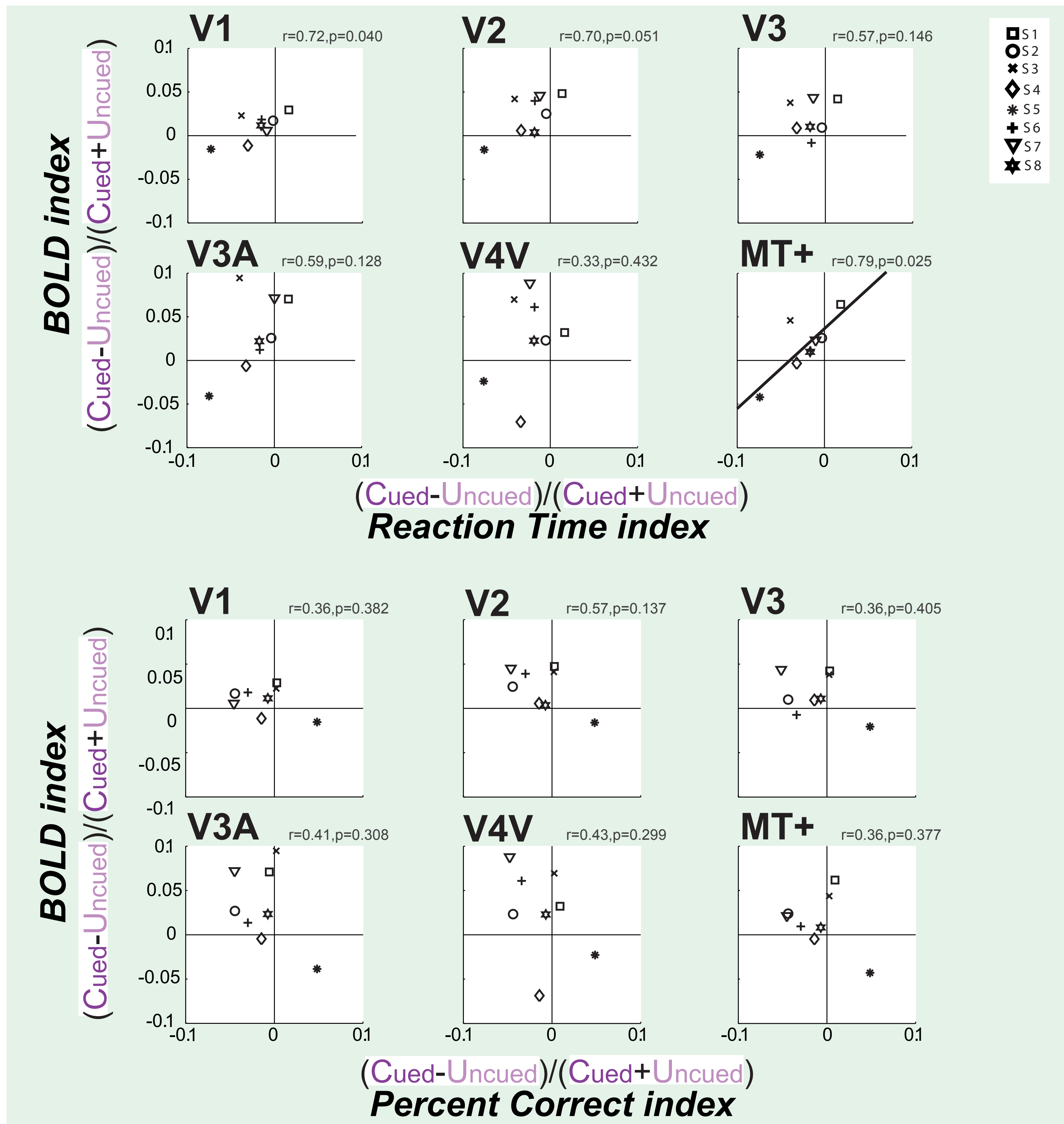
### Does attending to one of two overlapping surfaces enhance fMRI responses?



- > fMRI responses to two overlapping surfaces are enhanced for a brief translation of the cued vs uncued surface.
- > This surface-based attention effect, a positive BOLD attention index, was significantly greater than zero in several early visual areas, as early as area V2.

- > If subjects stopped attending once they had decided on their response, reaction time might be correlated with the time spent attending to stimuli. If so, elevated BOLD responses should reflect the longer duration of attention.

### Where are BOLD and behavior correlated?



- > BOLD and reaction time indices tend to be positively correlated; MT+ shows the strongest correlation.
- > BOLD and percent correct indices are weakly and negatively correlated.

## CONCLUSIONS

- > Surface-based attention effects are weakest in V1 and stronger in later visual areas, with significant effects in V2, V3A, V4V and MT+.

- > Surface-based attention effects are seen as early as V2.

- > Attention effects are not due to differences in overall arousal, task difficulty or time on task.

- > MT+ may be selectively engaged when attention is actively sustained until a decision is made regarding the direction of translational motion.

### REFERENCES

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