Perception With and Without Attention: Neural Correlates of Grouping by Similarity in Preattention and Divided-Attention Conditions

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neuropsychology of vision
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Introduction

Previous behavioral research has shown that individuals are susceptible to illusions that require grouping local elements, even when they are unaware of them[1,2].

To determine whether the neural correlates recruited for perceptual grouping are modulated by attentional allocation, an fMRI investigation was conducted using a visual illusion task.

Methods

Participants
- 15 right-handed healthy adults (8 F; M_{age} = 31 ± 5.9 years)

Acquisition Parameters
- 3T Philips Achieva, 8 channel head coil
- Gradient-echo EPI (TR/TE = 2000/30ms, 179 volumes, voxel size = 3.75 x 3.75 x 4 mm, slices = 30, α = 90)
- 4 scans (2 preattentive, 2 divided-attention) acquired during the Line discrimination task[1]

Preprocessing & Analysis
- Motion/slice scan time correction, spatial smoothing (FWHM = 6 mm), temporal high-pass filtering
- Multi-subject RFX GLM, Deconvolution, and Region of Interest analyses
- Multiple comparisons corrected using cluster threshold estimation

## Line Discrimination Task
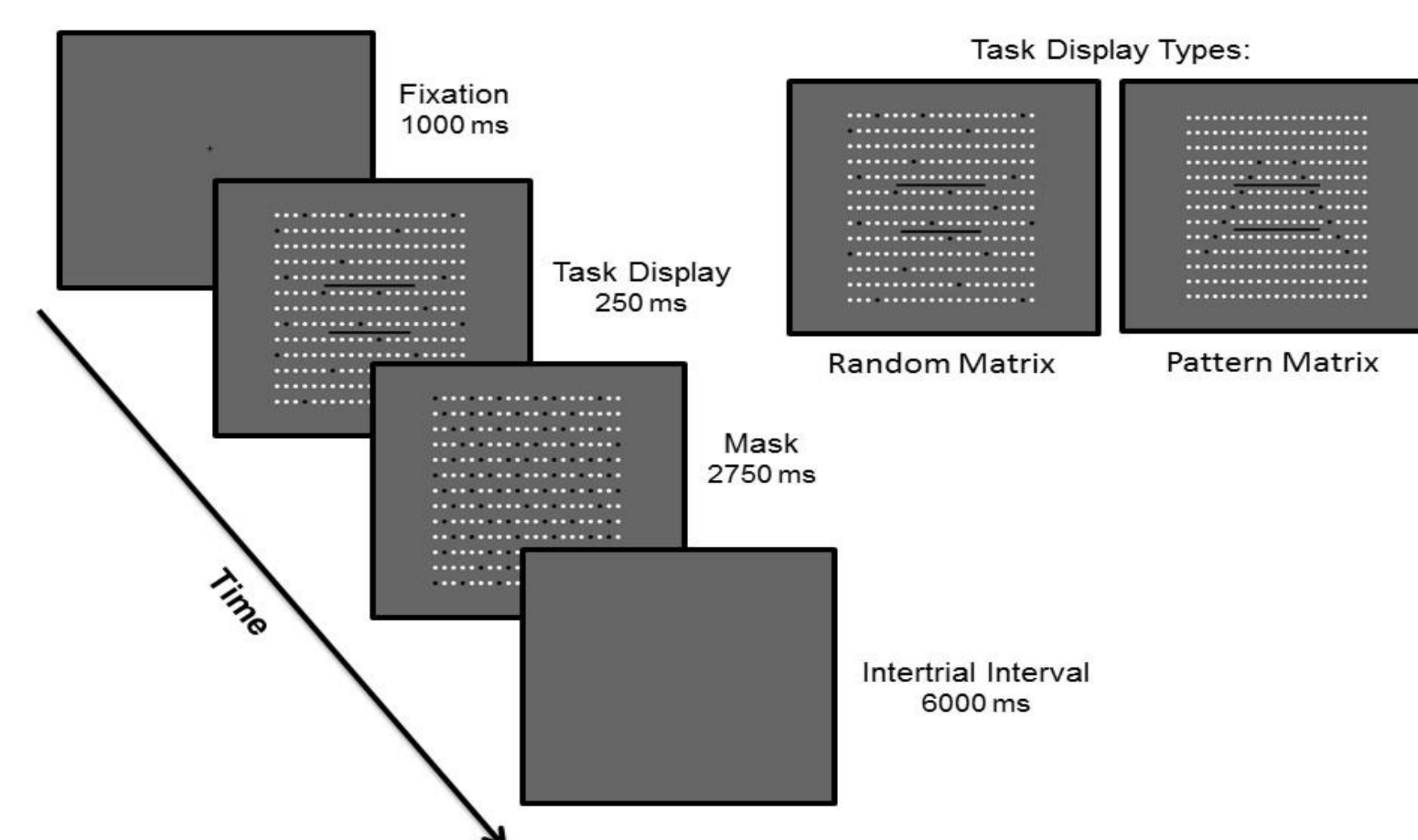
Preattention vs Divided-Attention Trial Events. A line discrimination task was performed where background black and white dots could be organized to induce the Ponzo illusion. Questions following two blocks of preattentive trials probed whether participants could see and identify the background pattern – thereby creating a divided-attention condition for the remaining blocks.

## Perceptual Grouping Occurs Prior to Attention
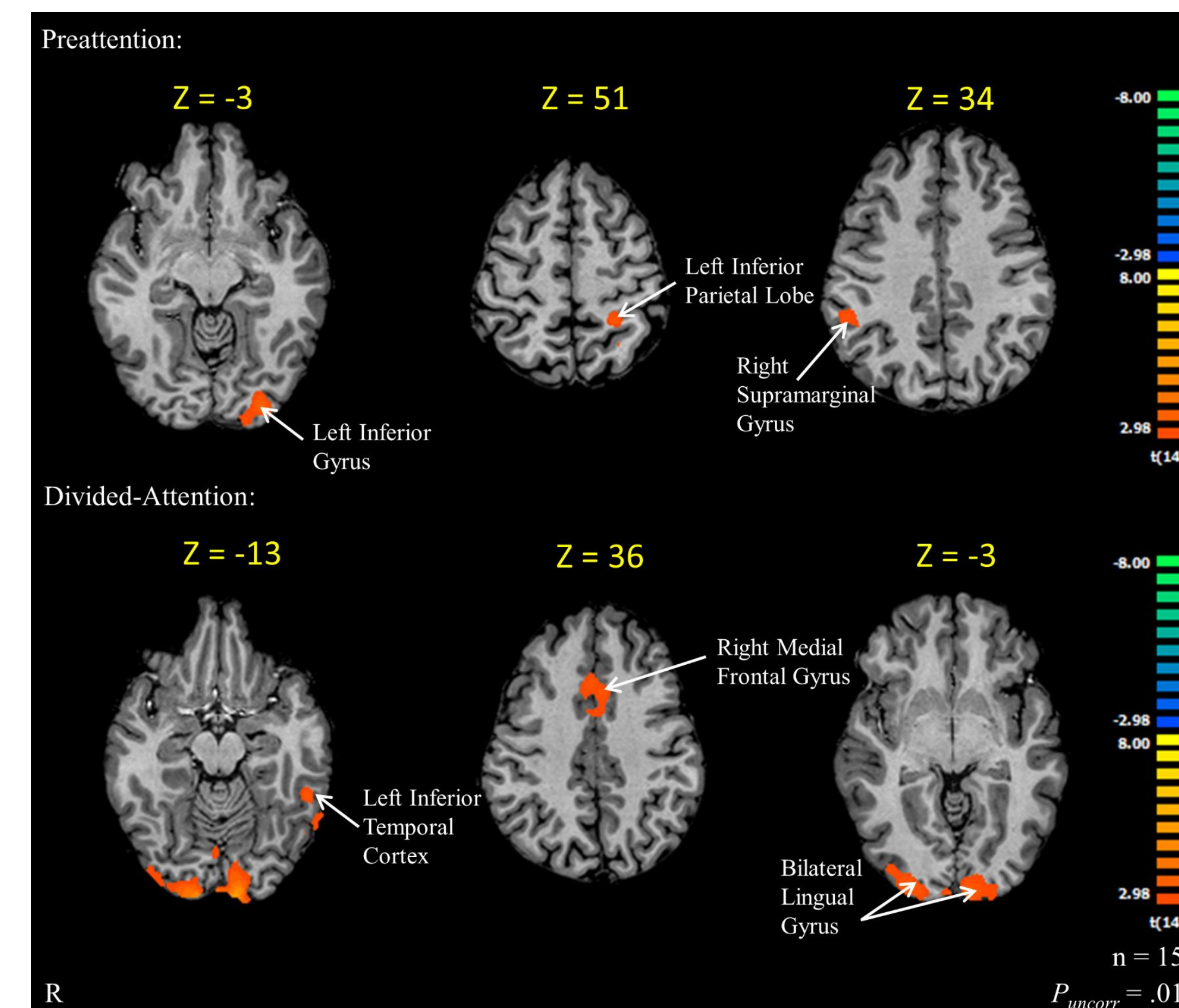
Activations resulting from GLM Analysis contrasting pattern (+) and random (-) conditions. Greater activation in divided-attention condition suggests attention is a modulating factor in perceptual grouping.
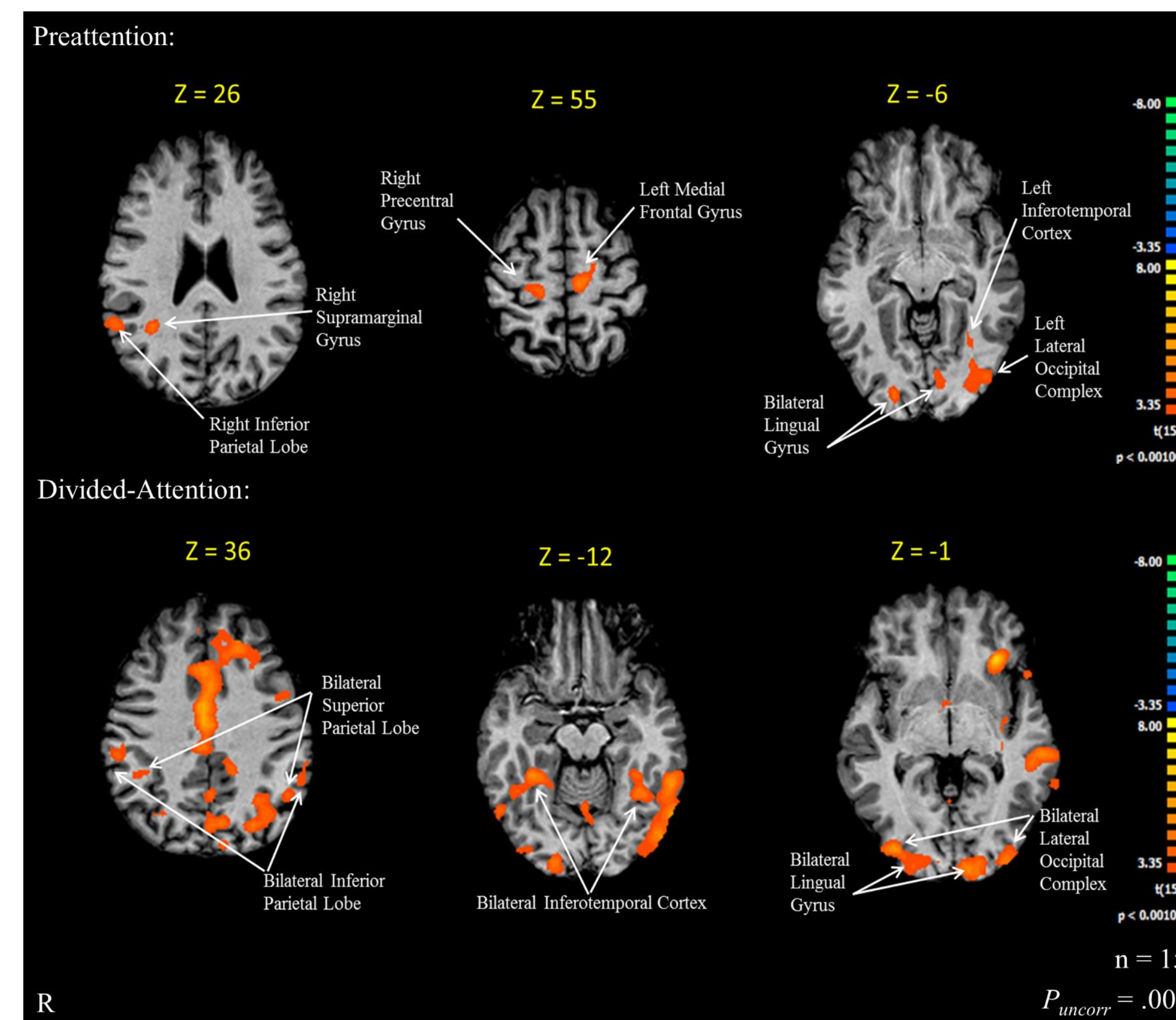

Activations resulting from Deconvolution Analysis contrasting pattern (+) and random (-) conditions. Inferotemporal cortex activation, associated with object recognition, for both attentional conditions suggests perceptual grouping occurs prior to attention.

Neural Correlations with Behaviour
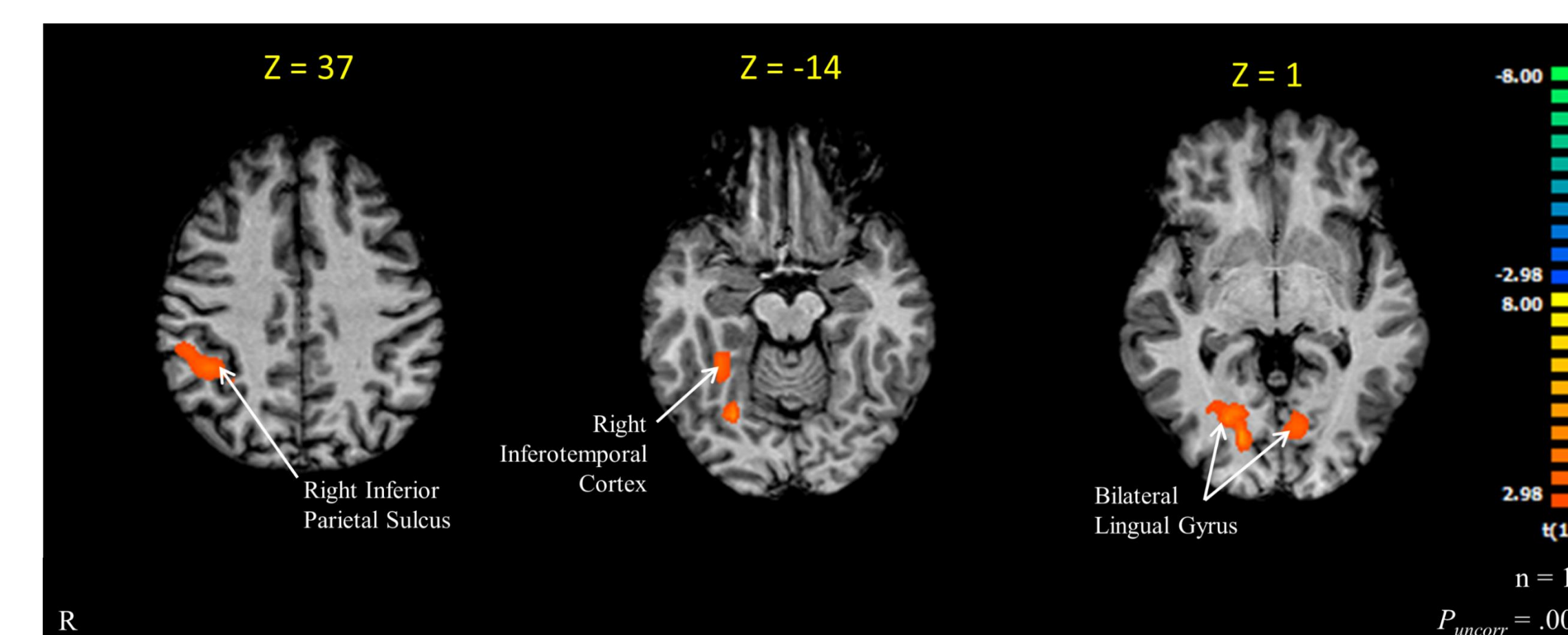
Regions of interest (ROIs) defined by collapsing across attentional conditions (preattention and divided-attention) and applying a contrast of the random (-) and pattern (+) conditions.
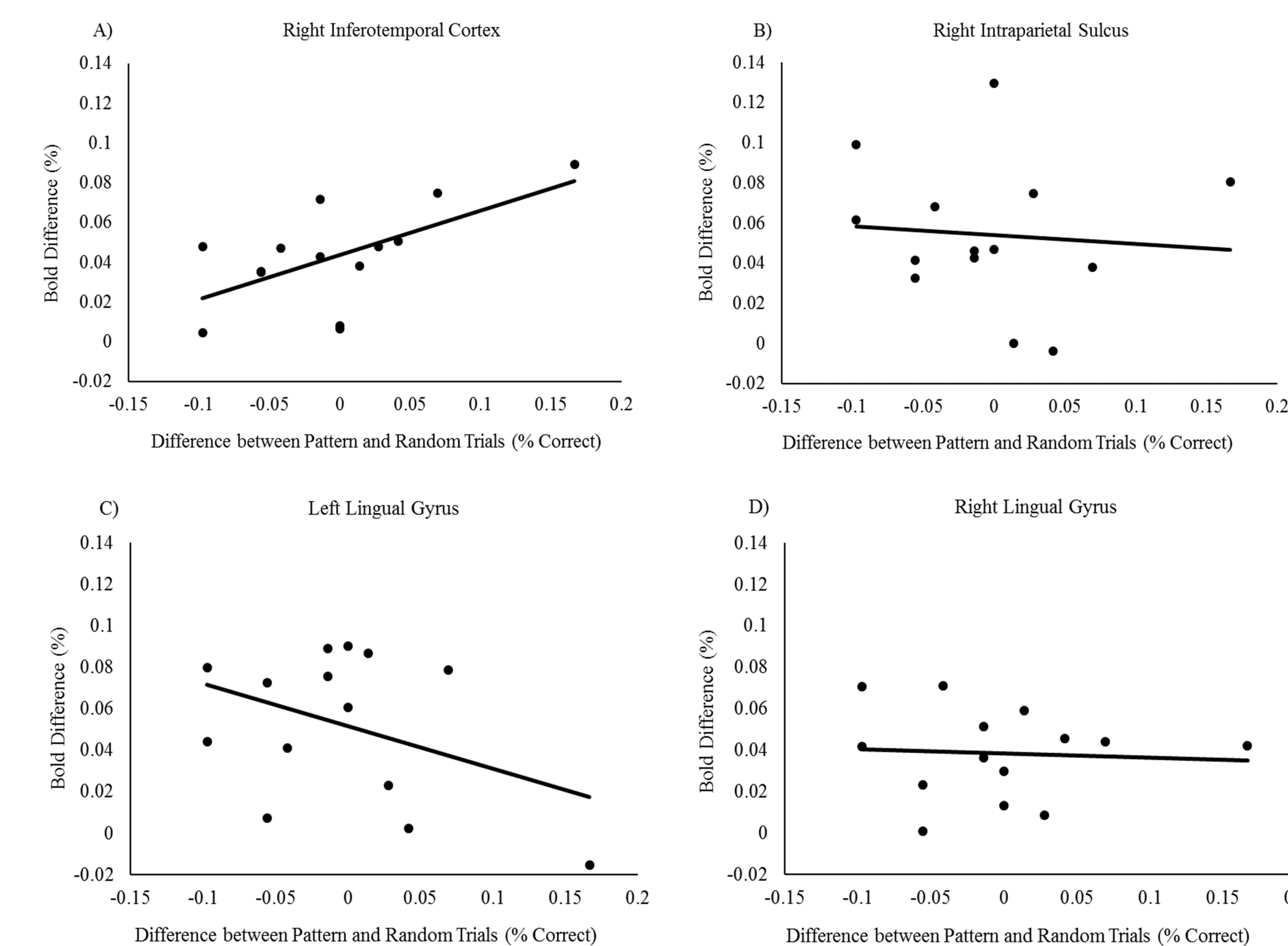
A significant positive correlation of the right inferotemporal region with illusory susceptibility (A) supports previous research that neural activity in this region encodes the details of an object representation, to allow the brain to distinguish between different percepts.

No other significant correlations were found between the behavioral data and ROIs (B-D), highlighting the importance of inferotemporal cortex in perceptual grouping.

Random vs Pattern Performance
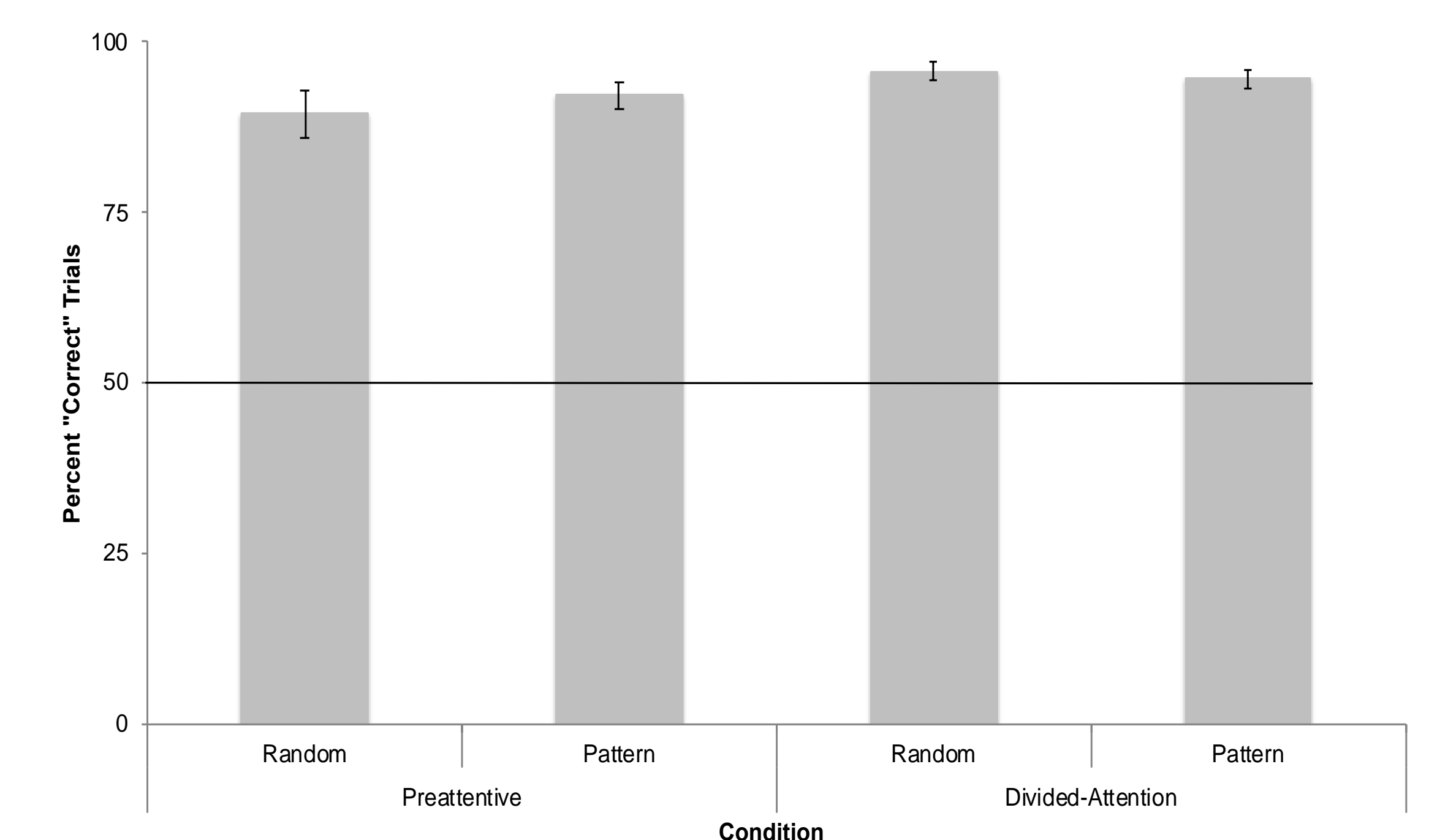
Participants were able to successfully identify the longer of the two lines in random trials and "correctly" made illusion-based responses in pattern trials.

Conclusion

- **Visual information we are not aware of can influence our perception of the visual world.**

- **Neural mechanisms driving perception are modulated by attentional allocation.**

References

1. Moore, C. M. & Egeth, H. (1997). Perception without attention: Evidence of grouping under conditions of inattention. *Journal of Experimental Psychology: Human Perception and Performance, 23*(2), 339-352.
2. Carther-Krone, T.A., Shomstein, S., & Marotta, J.J. (2016). Looking without perceiving: Impaired preattentive perceptual grouping in Autism Spectrum Disorder. *PloS ONE, 11*(6), e0158566

Acknowledgements

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