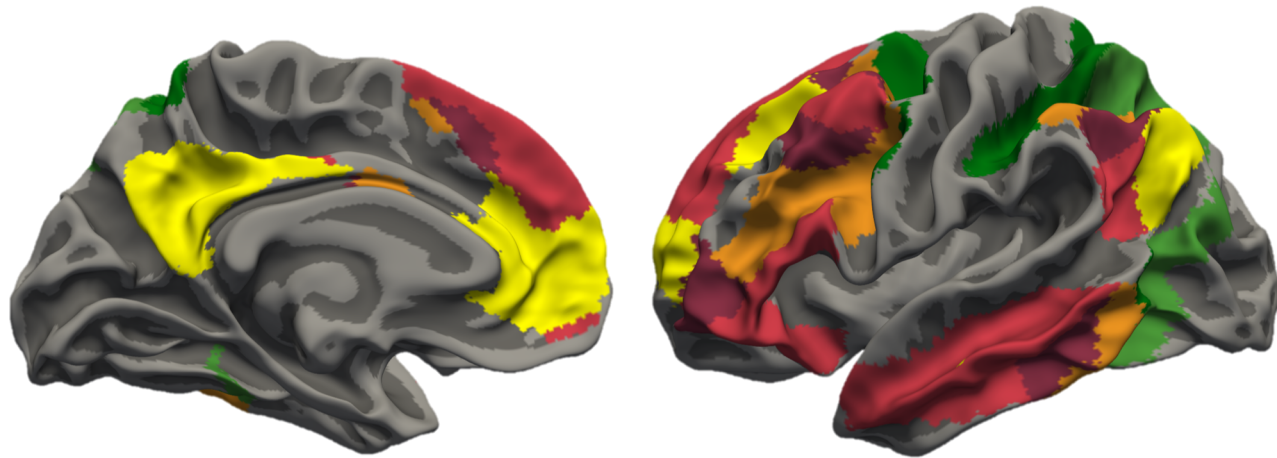
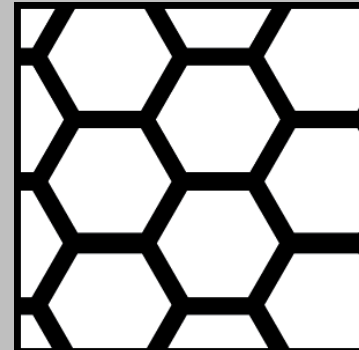
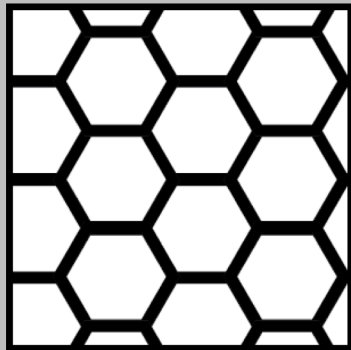
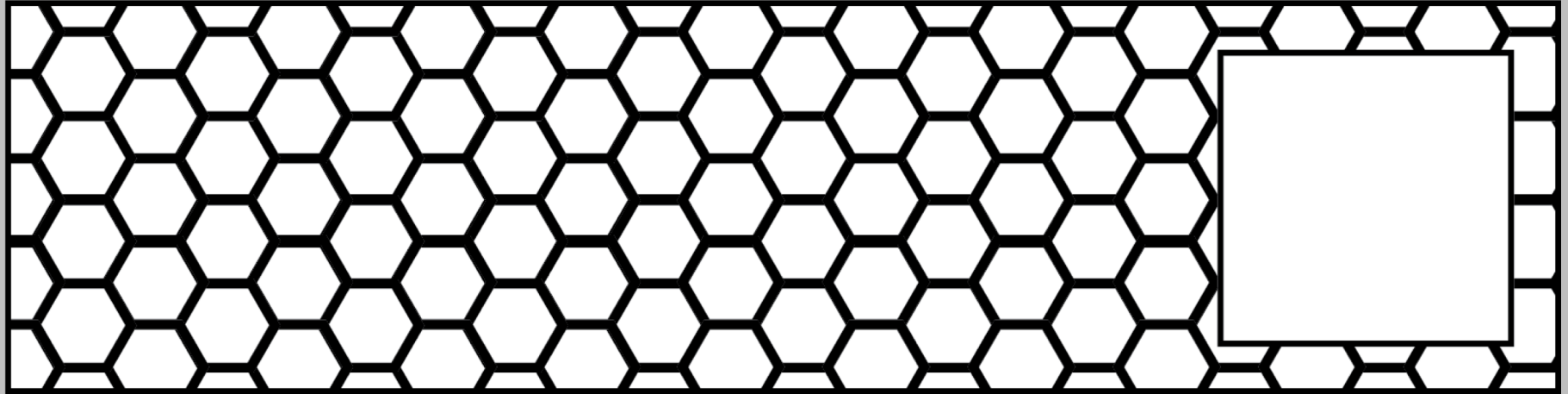


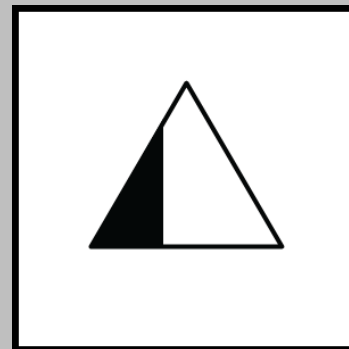
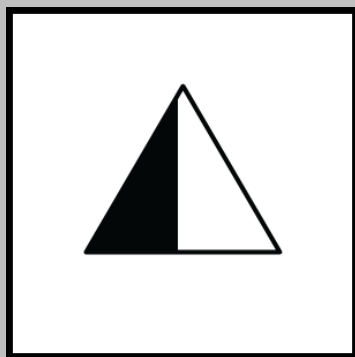
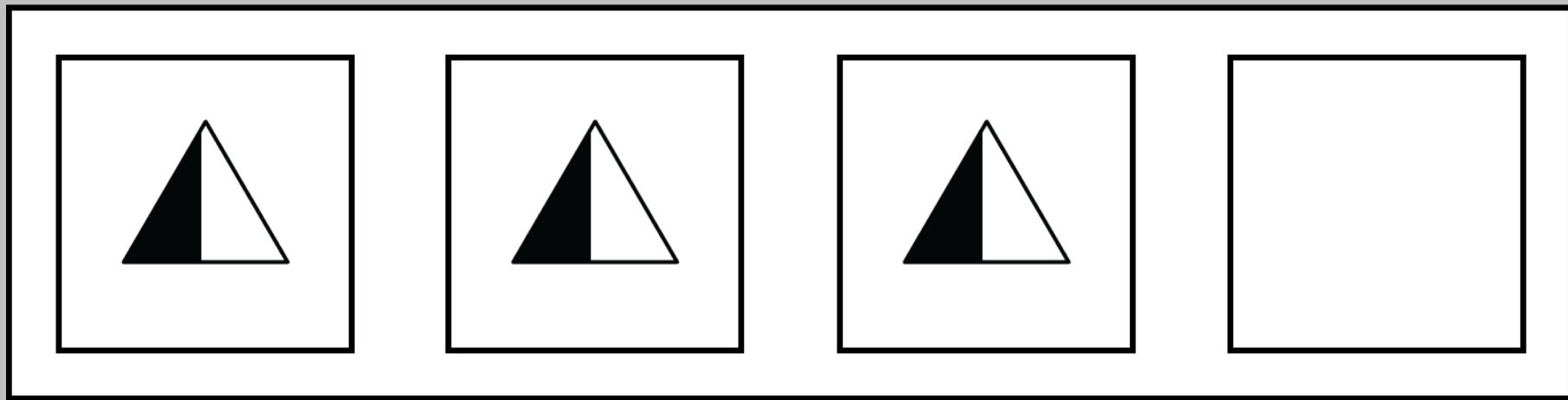
Contributions of Frontoparietal Control Network to Abstract Reasoning

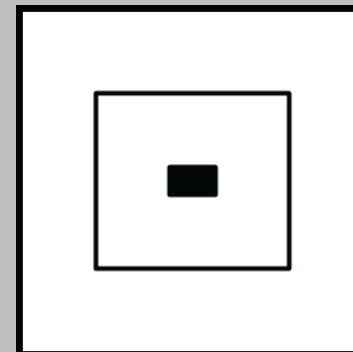
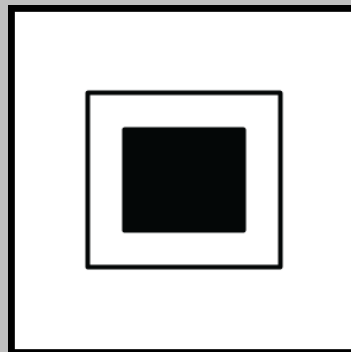
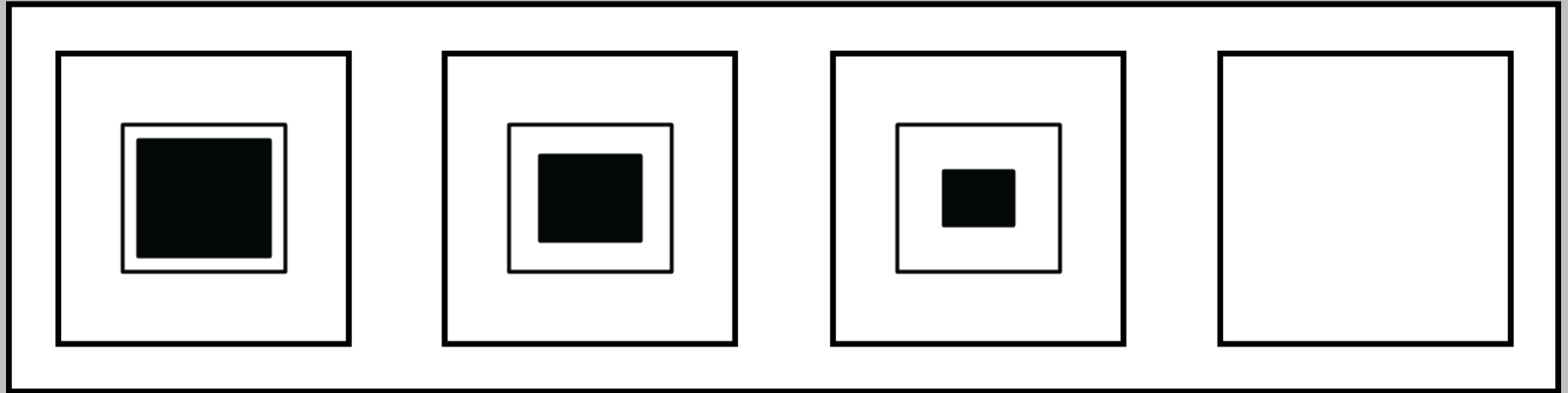


Tom Morin
GPN Retreat 2019





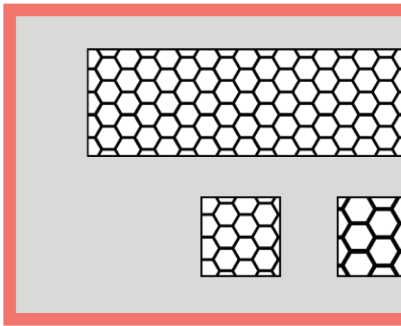




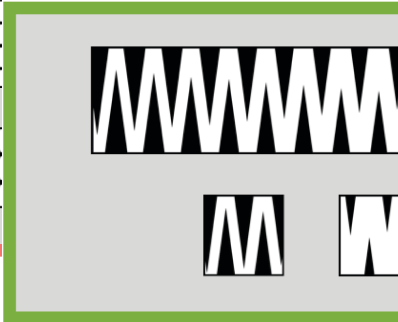
Raven's Progressive Matrices Task

- Neuropsychological test of:
 - Fluid Intelligence
 - Relational Reasoning
 - Symbolic Processing
- Several Problem Types:

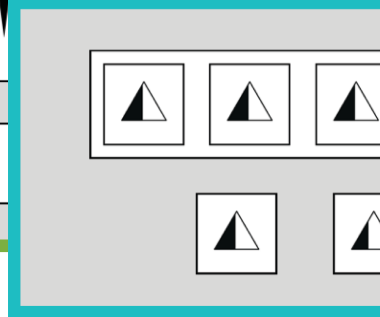
Texture Uniform



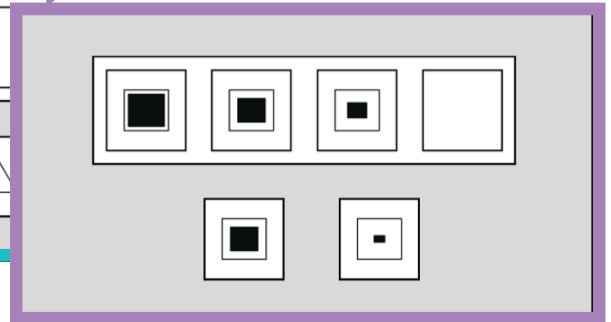
Texture Rule



Symbol Uniform



Symbol Rule



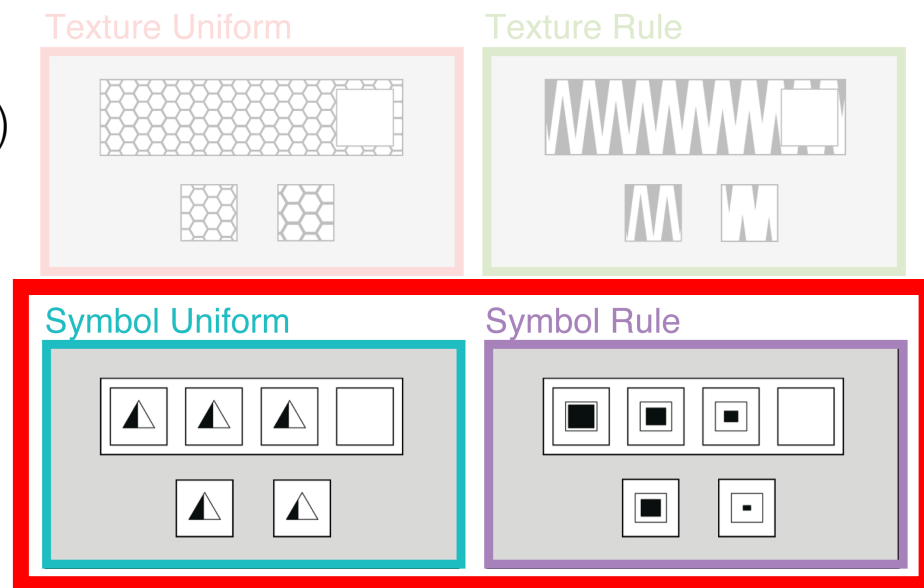
Previous Work on the Raven's Progressive Matrices Task

Computational Models

- Carpenter, Just, & Shell (1990)
- Kunda, McGreggor, & Goel (2013)
- Rasmussen & Eliasmith (2011, 2014)
- Lovett & Forbus (2017)
- Raudies & Hasselmo (2017)
- Hasselmo (*Preprint*, 2018)

fMRI Studies

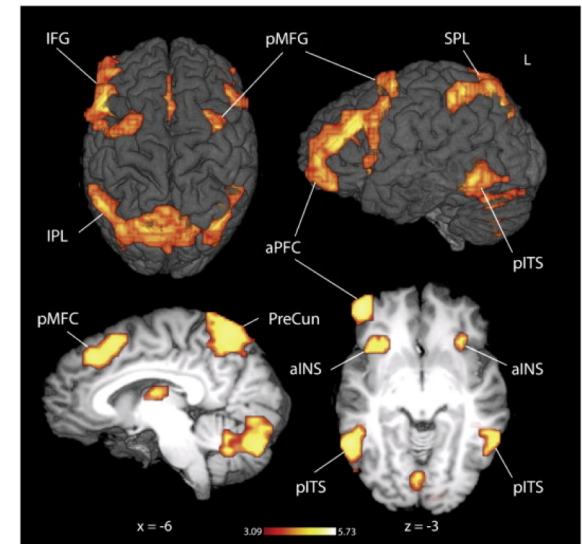
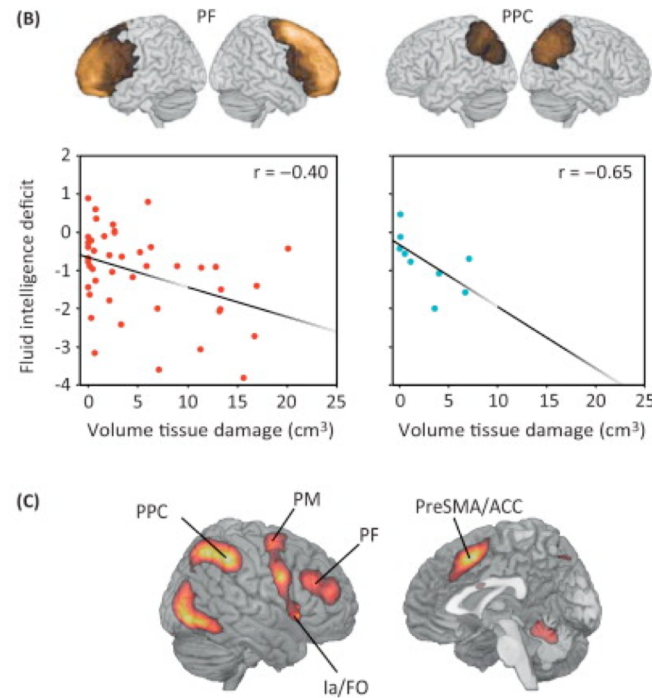
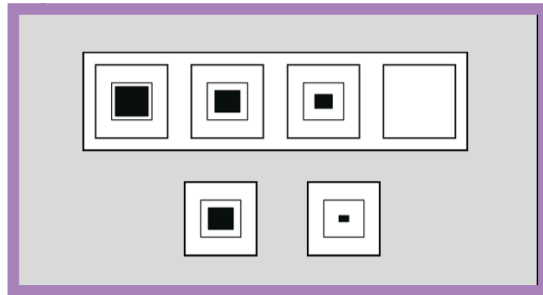
- Prabhakaran et al (1997)
- Christoff et al. (2001)
- Melrose, Poulin, & Stern (2007)
- Golde, Cramon, & Schubotz (2010)



Frontoparietal Activity Contributes to Relational Reasoning

Common Modelling Approach:

1. Deduce the visuospatial relationship between stimuli (*Parietal*)
2. Apply that rule to simulate what comes next (*Prefrontal*)



Golde et al. 2010

Genovesio, Wise, & Passingham; 2014

Motivation

Question:

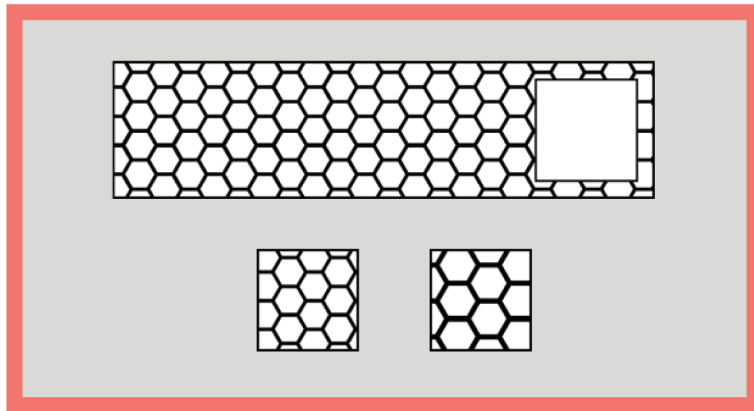
How does perceptual reasoning (texture stimuli) differ from symbolic reasoning (symbol stimuli)?

Hypothesis:

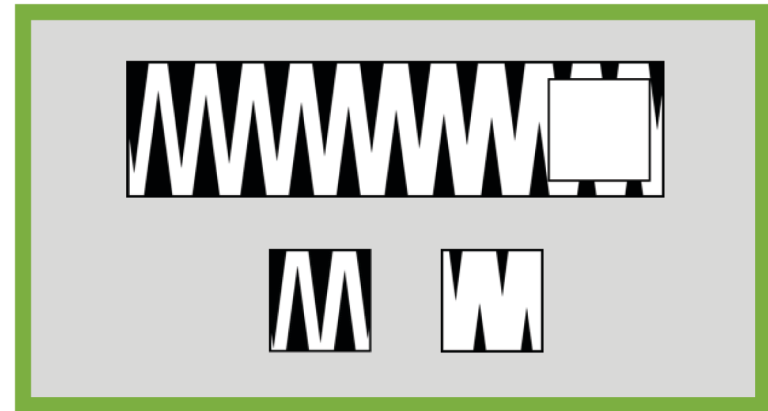
- Both types of reasoning recruit frontoparietal regions.
- Perceptual reasoning may also bring in ventral visual regions.

Task Conditions

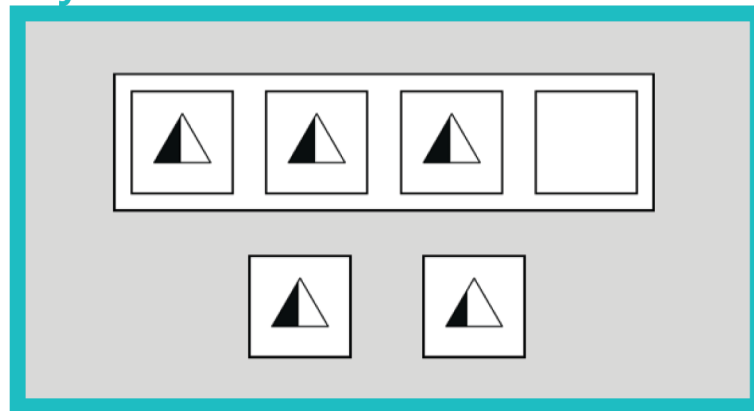
Texture Uniform



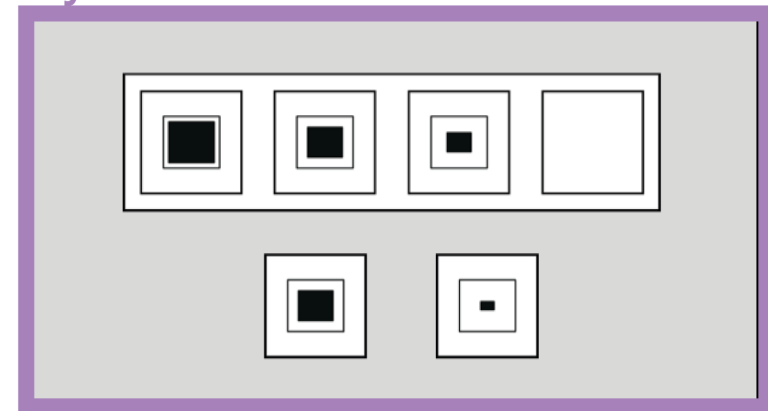
Texture Rule



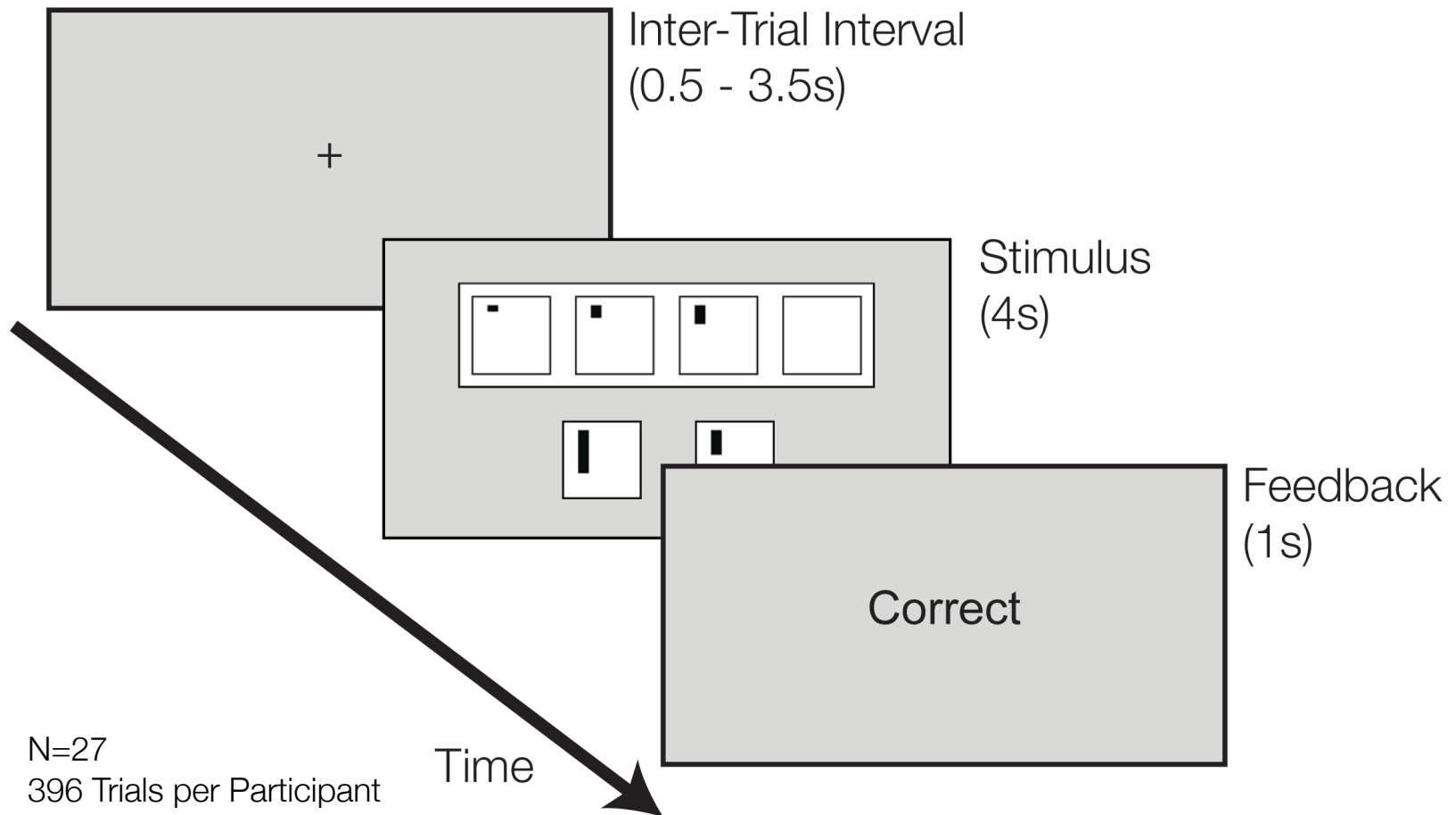
Symbol Uniform



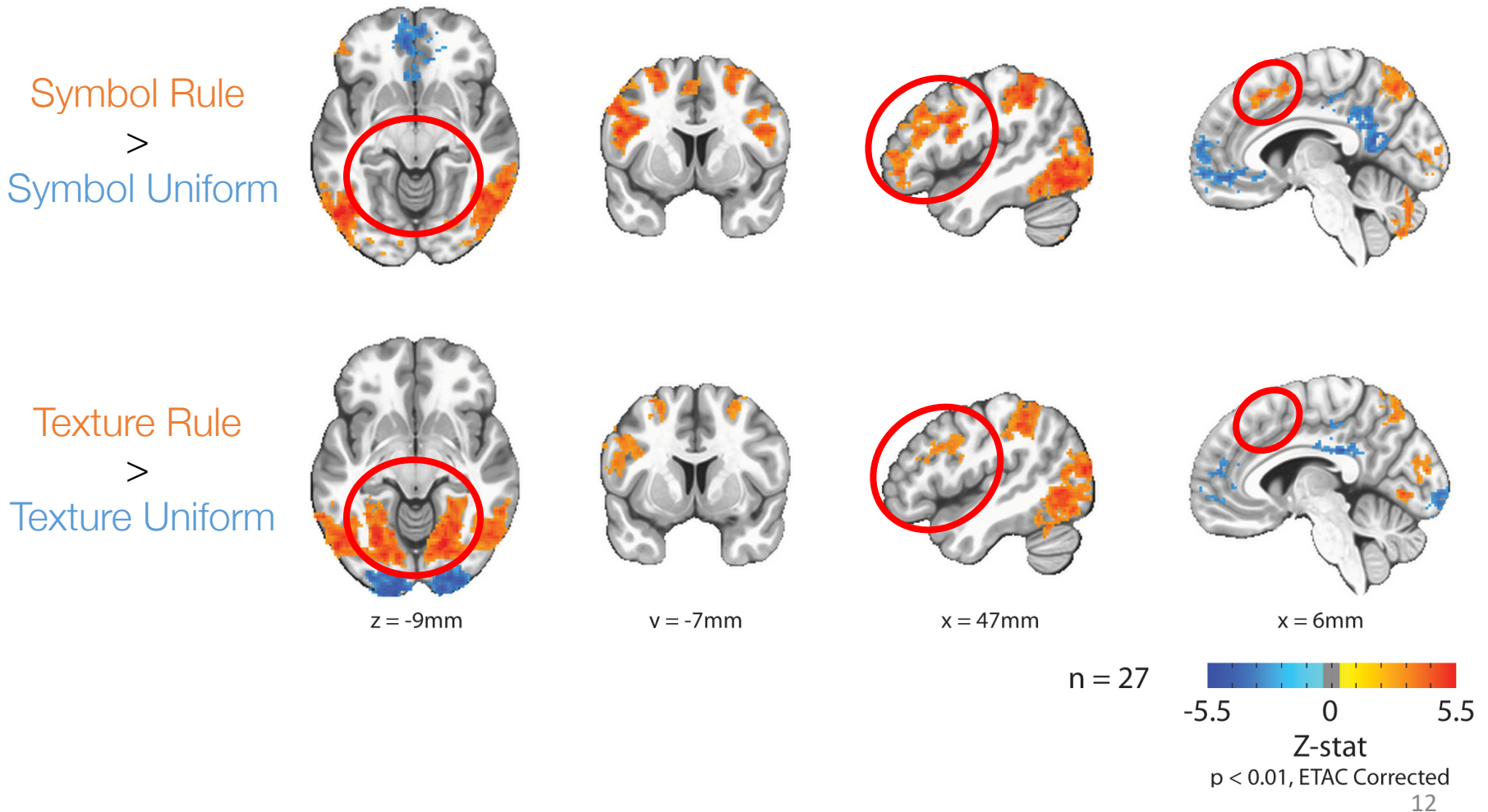
Symbol Rule



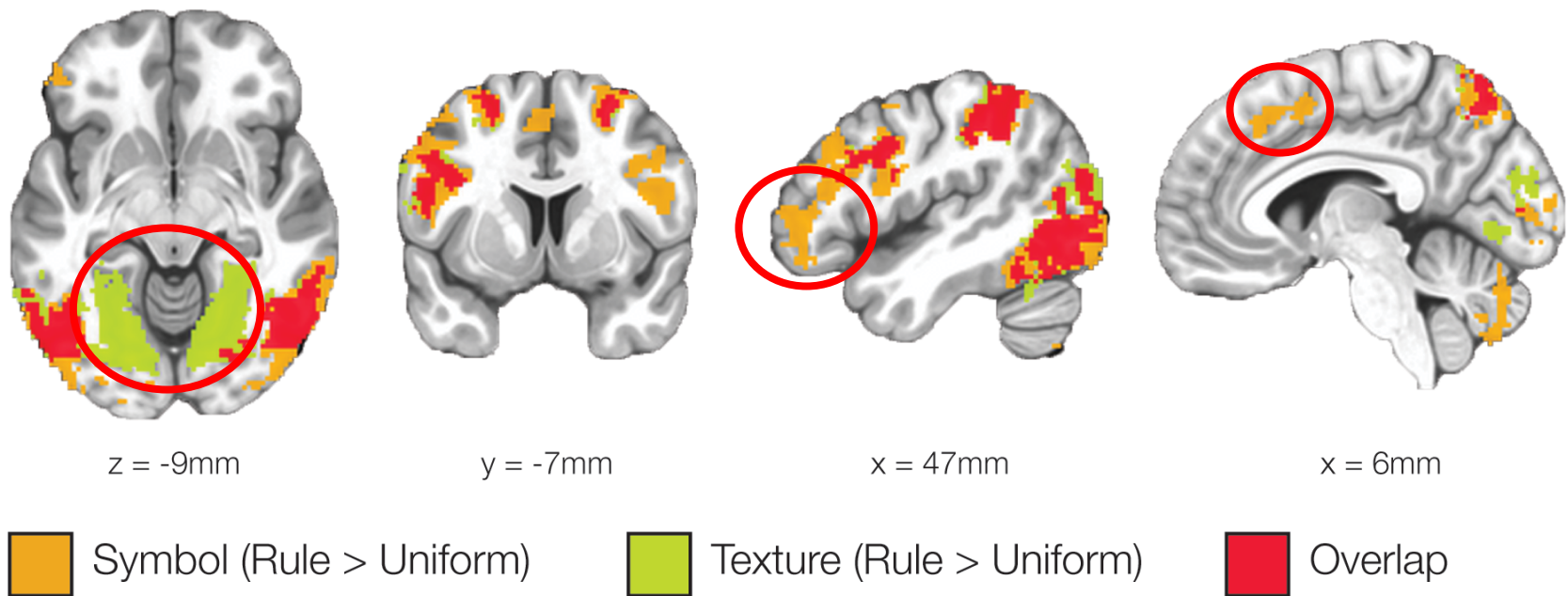
Sample Trial



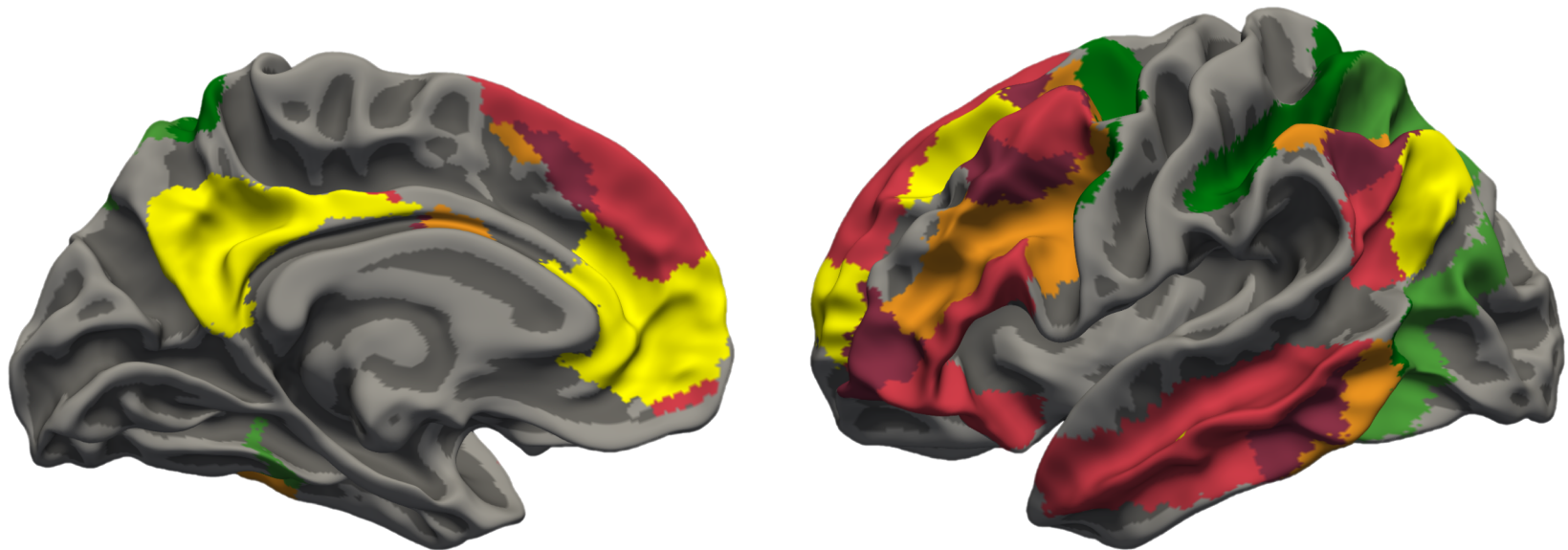
Activity During Symbolic and Perceptual Reasoning



Key Differences Between Symbolic and Perceptual Reasoning Activity



Examining Network Activity Across Symbolic and Perceptual Reasoning



17 Network Parcellation
Yeo et al. 2011



Dorsal Attention

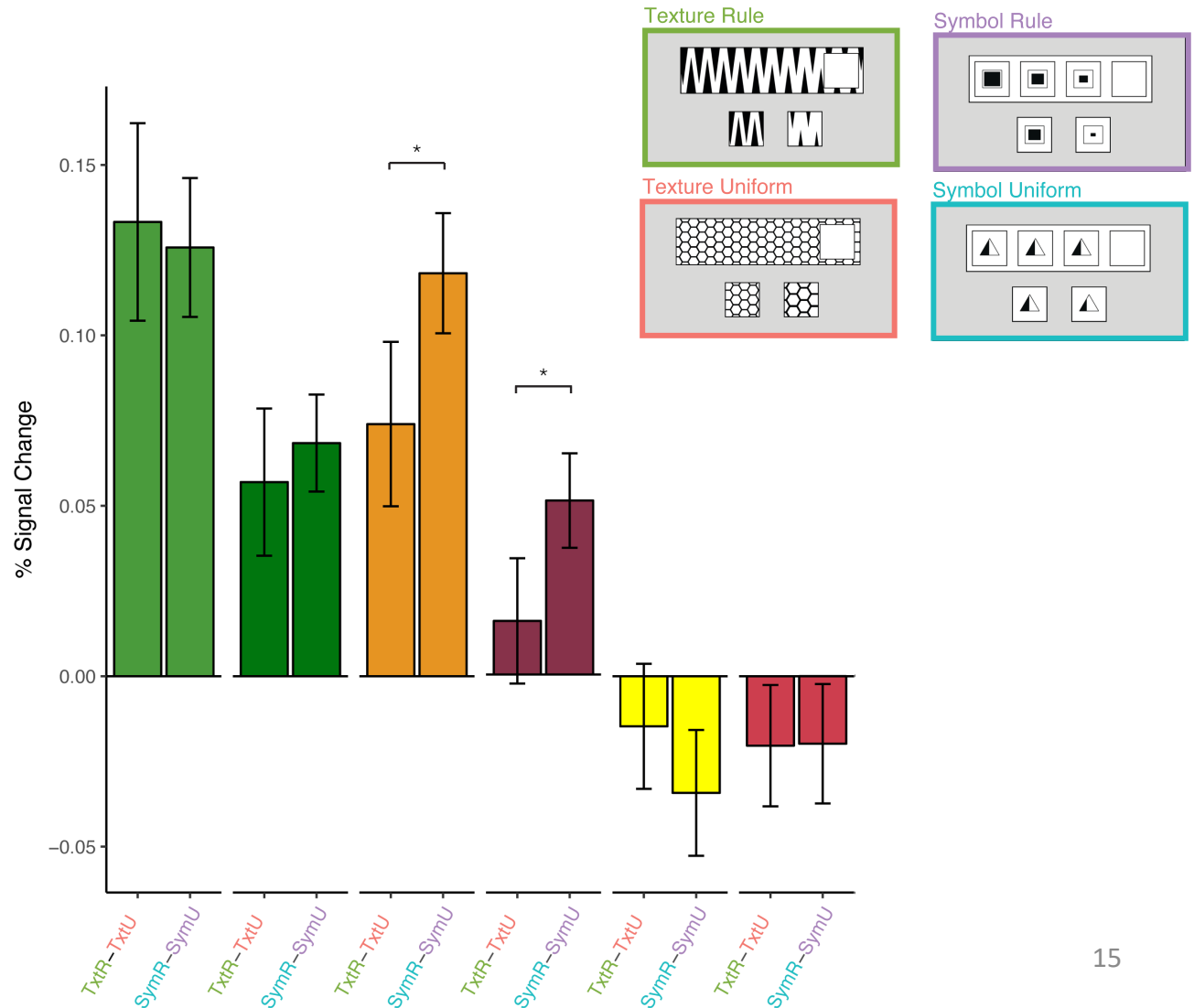
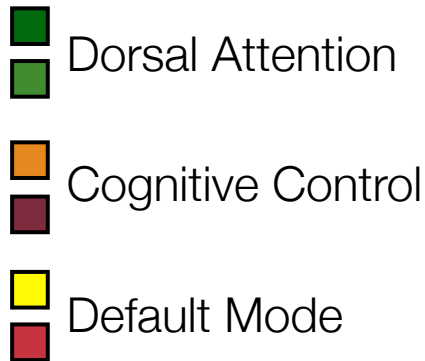
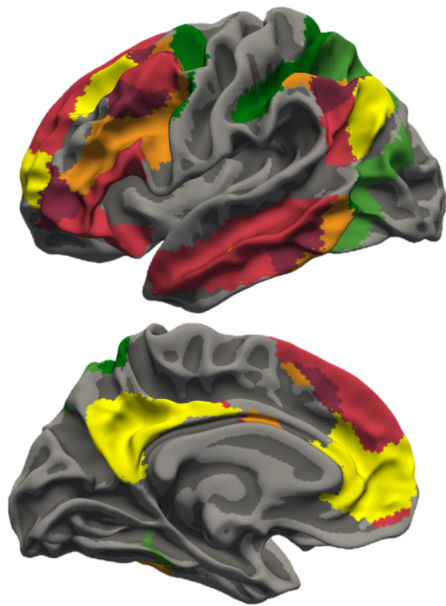


Cognitive Control



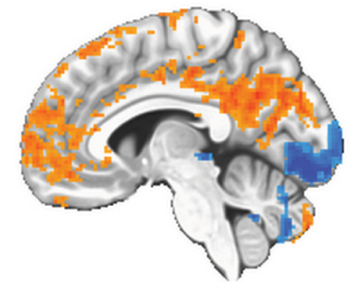
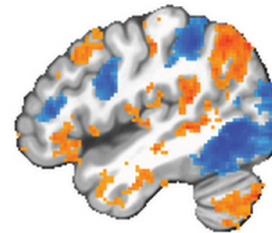
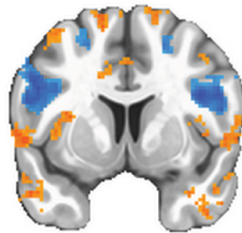
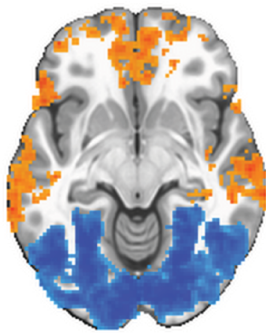
Default Mode

Differential Cognitive Control Network Activation

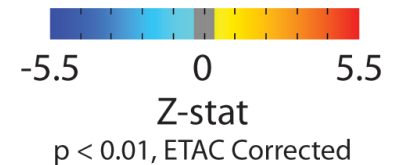


Symbolic vs. Perceptual Activity Patterns

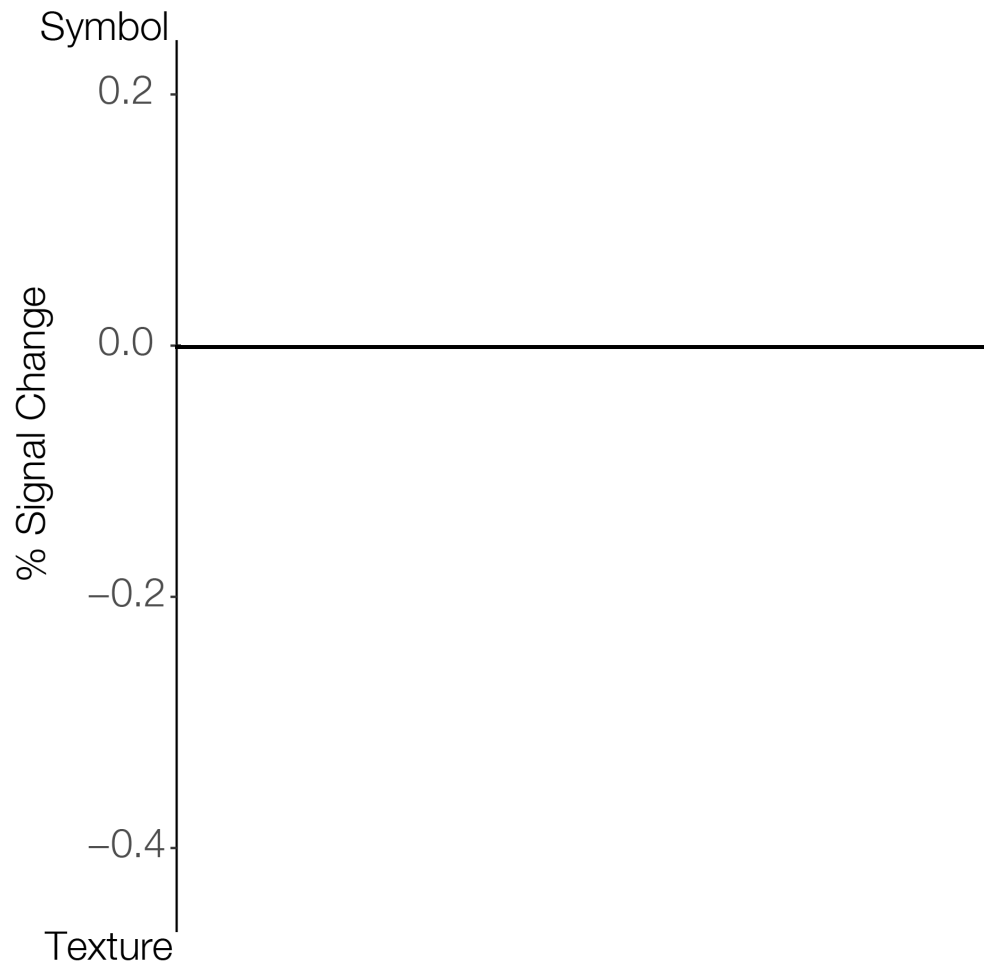
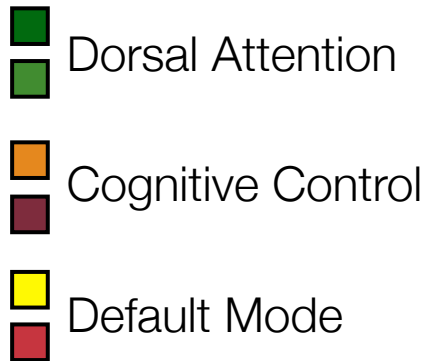
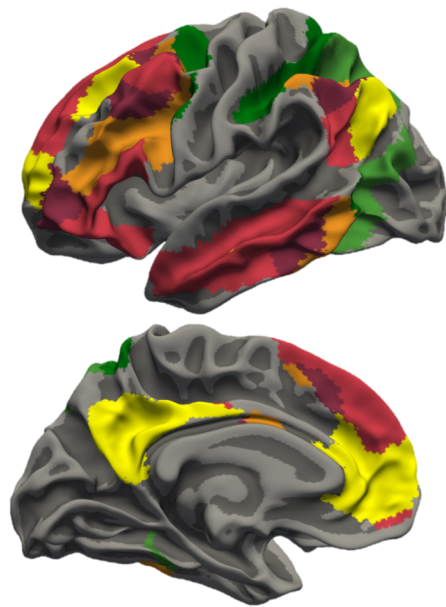
Symbol
>
Texture



n = 27



Differential Activation of CCN Subdivisions



Implications

- Future computational models might consider the additional ventral-visual processing involved in perceptual reasoning
- Processing of symbolic stimuli may draw on long-term representations (schemas)

Future Directions

- How does functional connectivity differ between conditions?
- What role do subcortical structures play in this task?
- Are there separate functions for the various nodes of the frontoparietal control network?

Thank You!



GPN

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Funding



NSF Major Research Instrumentation Award 1625552
ONR MURI Award N00014-16-1-2832
ONR DURIP Award N00014-17-1-2304

