Brain Network Topology and Dynamics in ADHD Individuals During Video Game Play

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Perceptual load erases performance differences between ADHD and non-ADHD subjects in a naturalistic task. In an in-progress fMRI study, we investigate the brain network topology that may underlie this effect. Initial results suggest that those with ADHD exhibit reduced activation in default mode regions during low cognitive and perceptual load.

Introduction:

Individuals with ADHD exhibit **abnormal network topology** in several large-scale brain networks (executive network, salience network, default mode network).[1,2]

Recenty, we showed that connectivity within the executive network **degrades non-linearly** in response to increasing attentional load.[3]

In behavioral work (See *Study 1*) we found that ADHD individuals exhibit increased susceptibility to distraction in a naturalistic task, and that perceptual load **mitigated these effects**.[4]

In this study, we investigate network connectivity differences between ADHD and non-ADHD individuals during naturalistic task performance and how these differences interact with cognitive and perceptual load.

Study 1

PROCEDURES

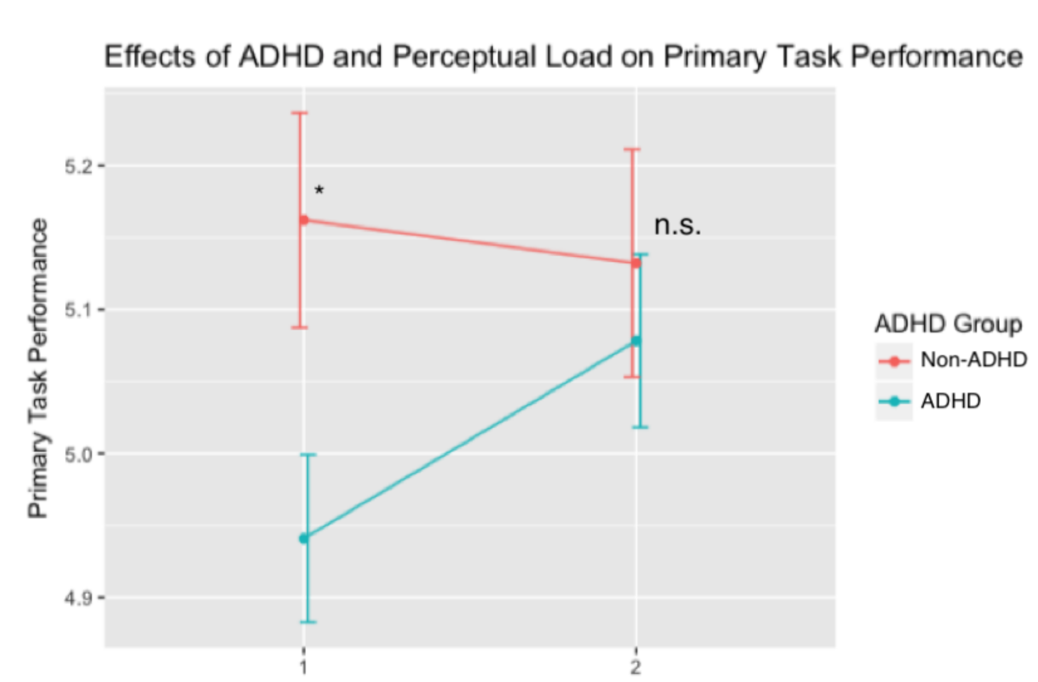
Subjects (n = 158) played 30 minutes of *Asteroid Impact*,[5] a video game stimulus developed in Python.

In a cognitive load condition, subjects completed a n-back rule maintenance task during game play.

In a perceptual load condition, opacity of in-game objects was reduced, increasing the difficulty of object identification.

RESULTS

Subjects with ADHD underperformed non- ADHD at low perceptual load, but showed no differences in performance under high perceptual load. $F(1, 157) = 7.59$, $p = .005$



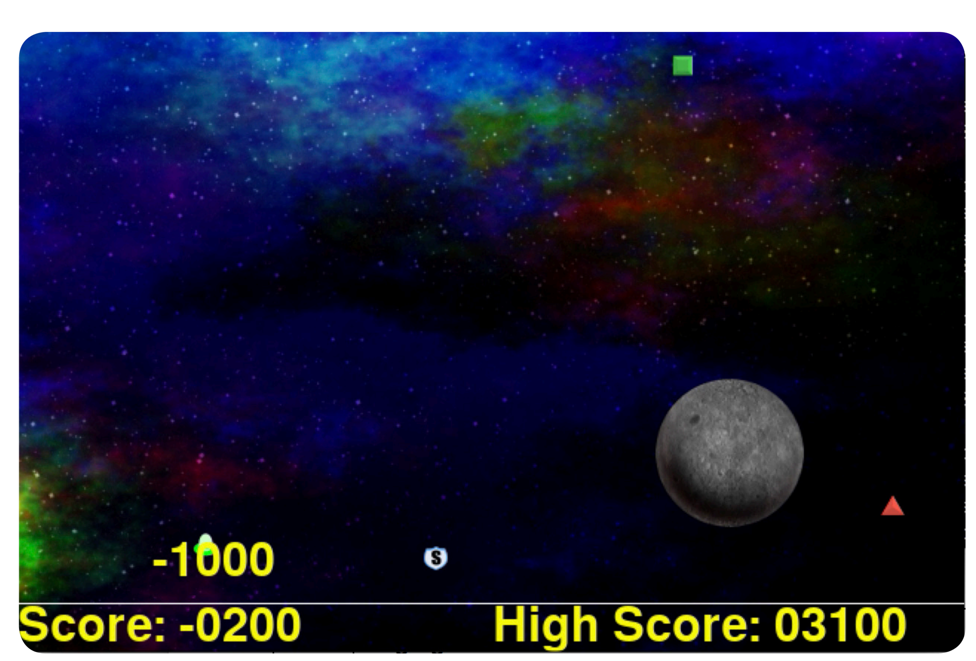
Study 2 (In Progress)

Subjects (n = 26, n_{ADHD} = 13, $n_{non\text{-}ADHD}$ = 13) played three versions of *Asteroid Impact* (cognitive load, perceptual load, and control) while undergoing brain scanning (final n ~ 40).

36 minutes of gameplay (12 control, 12 cognitive load, 12 perceptual load). 10 second breaks between each round.

ADHD was assessed in a prescreener using the ADHD self-report scale (ASRS). Participants were asked to refrain from taking medication on the day of their scan.

Preprocesssing performed in `fmriprep` and data analysis conducted in SPM using `Nipype`.



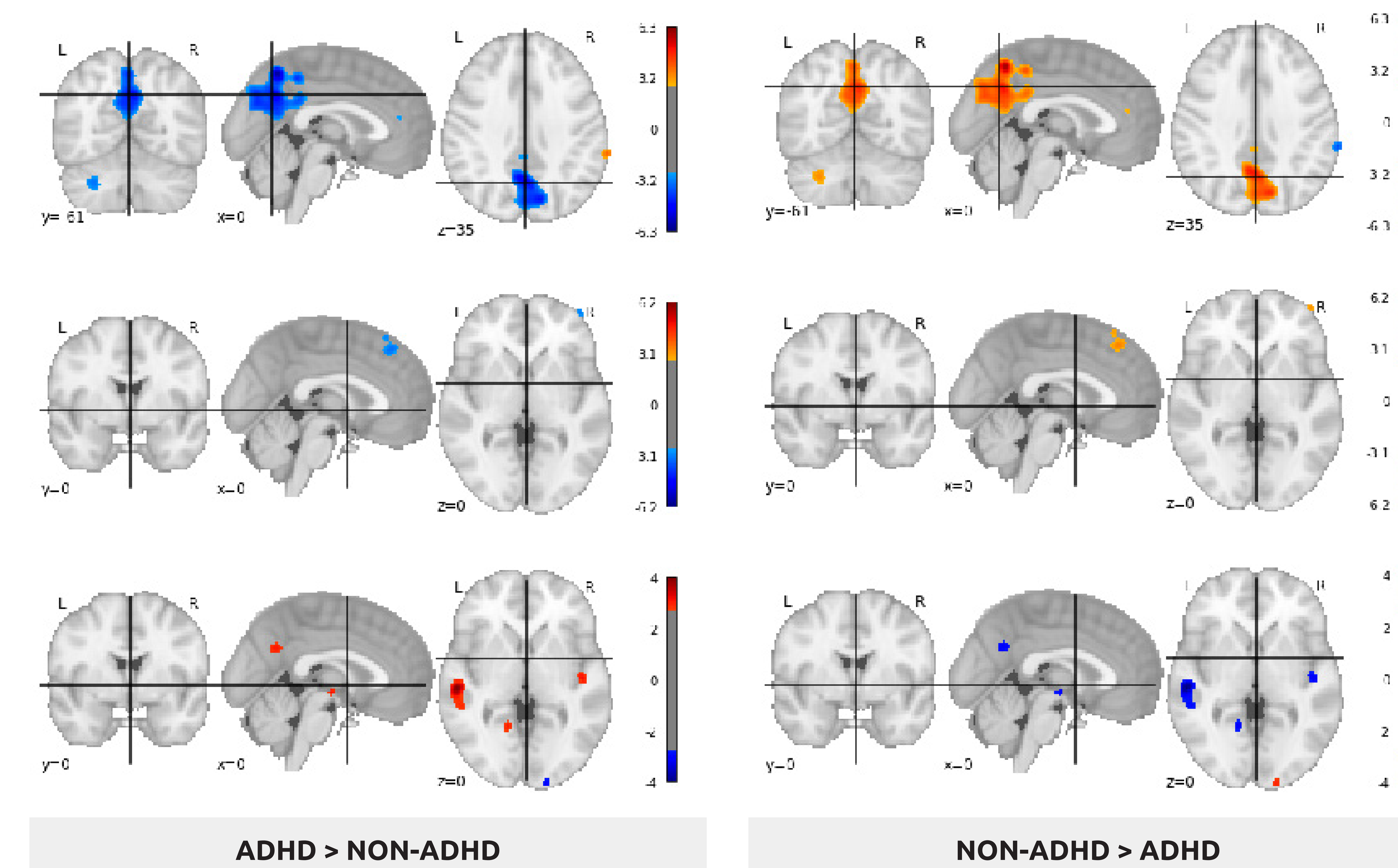


Figure 1: Sample contrast (n=6) between ADHD and non-ADHD brains during control (top), cognitive load (middle), and perceptual load (bottom) conditions. Cluster FDR corrected to p < .05. Individuals without ADHD exhibit increased activation in the precuneus during the control condition, and in medial prefrontal regions during cognitive load. ADHD indivduals exhbit increased activation in intraparietal and posterior cingulate regions during perceptual load.

Discussion:

- Activation differences observed between ADHD and non-ADHD subjects during *Asteroid Impact* gameplay point to promising future directions, but further work is needed.
- Future network-based analyses will aim to test the hypothesis that those with ADHD exhibit less robustness in excutive networks, and that perceptu-al load may mitigate this deficit.

REFERENCES
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