Altered Dorsal Attention and Default Network Connectivity Associated with Dimensional Measures of Attention-Deficit/Hyperactivity Disorder

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· **Audience:** This work is of relevance to attention-deficit/hyperactivity disorder (ADHD) researchers and those interested in the cognitive neuroscience of attention and impulsivity. More generally, researchers interested in the application of resting state fMRI technique in different brain disorders may also find this research pertinent.

· **Purpose:** Attention-deficit/hyperactivity disorder (ADHD) is associated with symptoms of inattention, hyperactivity and impulsivity[1], but the neural network disruptions believed to underlie this disorder are not well defined. A dominant theory posits that ADHD is a disorder of dysfunctional activity of the default network (DN) [2], a neural network implicated in introspective processes. The dorsal attention network (DAN), which typically displays anti-correlation with the DN[3], has likewise been implicated in the etiology of ADHD [4]. Inappropriate levels of DN activity relative to the DAN are hypothesized to interfere with the functional domains of each network[3], and could thus manifest as behavioral symptoms of ADHD. Therefore, we sought to test the hypothesis that ADHD is associated with altered functional synchronization within the DAN and DN, as well as compromised between-network anti-correlation.

· **Methods:** Seed-based functional connectivity analyses defined the DAN and DN from resting-state fMRI scans of 195 children with ADHD and 241 typically-developing children (from the ADHD-200 Sample). We combined categorical diagnoses with dimensional measures of ADHD symptoms in linear regression analyses to investigate the association of ADHD symptoms to network-level and voxel-level functional connectivity both within and between the DAN and DN.

· **Results:** Within the DAN, greater inattention ($t=4.27$, $p<0.001$) and impulsive ($t=3.64$, $p<0.001$) symptoms were associated with increased connectivity. Symptoms of inattention were also associated with diminished functional competition between the DAN and DN ($t=4.27$, $p<0.001$). This deficit was driven by integration of superior parietal regions of the DAN into the DN and integration of retrosplenial cortex, parahippocampal gyrus, and middle temporal gyrus regions of the DN into the DAN (Figure 1A). Symptoms of impulsivity were associated with diminished functional competition between DAN and DN regions in typically-developing children (Figure 1B), but this brain-behavior relationship was disrupted in ADHD ($t=-2.43$, $p=0.015$).

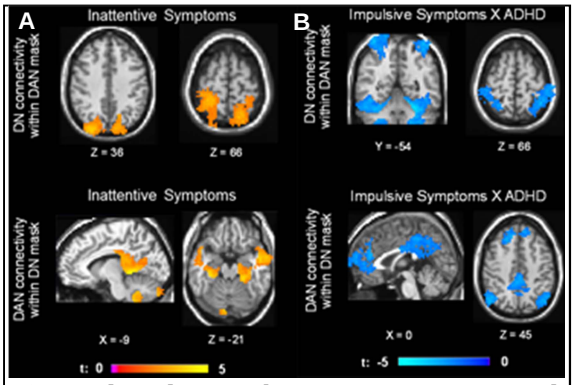

Fig. 1 Altered network connectivity associated with **A**) inattention and **B)** impulsivity.

· **Discussion:** Altered functional connectivity within and between the DAN and DN associated with symptoms of ADHD supports hypotheses that neural network-level abnormalities contribute to ADHD-related behavioral impairments. Compromised anti-correlation between the DAN and DN provides a mechanism by which internal, self-referential processes may be prone to interfere during externally-directed attention demanding tasks in children with ADHD.

· **Conclusion:** The network-level disruptions revealed by this study provide plausible neuronal mechanism for ADHD and potential target for clinical investigations (e.g., evaluating treatment effects). Furthermore, these brain-behavior relationships support the utility of characterizing ADHD using dimensional scales, which provide increased sensitivity to detect individual differences in behaviors that exist across both healthy and patient populations. However, the differential associations between typically-developing and ADHD children in the relationship between inter-network connectivity and impulsivity measures suggest that a combination of both categorical and dimensional measures of ADHD may best characterize this disorder.

· **References:**

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