Neural circuitry underlying sustained attention in healthy adolescents and in ADHD symptomatology.


Abstract

Moment-to-moment reaction time variability on tasks of attention, often quantified by intra-individual response variability (IRV), provides a good indication of the degree to which an individual is vulnerable to lapses in sustained attention. Increased IRV is a hallmark of several disorders of attention, including Attention-Deficit/Hyperactivity Disorder (ADHD). Here, task-based fMRI was used to provide the first examination of how average brain activation and functional connectivity patterns in adolescents are related to individual differences in sustained attention as measured by IRV. We computed IRV in a large sample of adolescents (n = 758) across 'Go' trials of a Stop Signal Task (SST). A data-driven, multi-step analysis approach was used to identify networks associated with low IRV (i.e., good sustained attention) and high IRV (i.e., poorer sustained attention). Low IRV was associated with greater functional segregation (i.e., stronger negative connectivity) amongst an array of brain networks, particularly between cerebellum and motor, cerebellum and prefrontal, and occipital and motor networks. In contrast, high IRV was associated with stronger positive connectivity within the motor network bilaterally and between motor and parietal, prefrontal, and limbic networks. Consistent with these observations, a separate sample of adolescents exhibiting elevated ADHD symptoms had increased fMRI activation and stronger positive connectivity within the same motor network denoting poorer sustained attention, compared to a matched asymptomatic control sample. With respect to the functional connectivity signature of low IRV, there were no statistically significant differences in networks denoting good sustained attention between the ADHD symptom group and asymptomatic control group. We propose that sustained attentional processes are facilitated by an array of neural networks working together, and provide an empirical account of how the functional role of the cerebellum extends to cognition in adolescents. This work highlights the involvement of motor cortex in the integrity of sustained attention, and suggests that atypically strong connectivity within motor networks characterizes poor attentional capacity in both typically developing and ADHD symptomatic adolescents.