Defining the Neural Substrate of the Adult Outcome of Childhood ADHD: A Multimodal Neuroimaging Study of Response Inhibition

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Abstract

Objective:
Understanding the neural processes tied to the adult outcome of childhood attention deficit hyperactivity disorder (ADHD) could guide novel interventions to improve its clinical course. It has been argued that normalization of prefrontal cortical activity drives remission from ADHD, while anomalies in subcortical processes are “fixed,” present even in remission. Using multimodal neuroimaging of inhibitory processes, the authors tested these hypotheses in adults followed since childhood, contrasting remitted against persistent ADHD.

Method:
Adult participants (persistent ADHD, N=35; remitted ADHD, N=47; never affected, N=99) were scanned with functional MRI (fMRI) (N=85), magnetoencephalography (N=33), or both (N=63) during a response inhibition task.

Results:
In fMRI analyses, during inhibition, right caudate anomalies reflected a childhood ADHD history and were present even among those who remitted. By contrast, differences related to adult outcome emerged in cortical (right inferior frontal and inferior parietal/precuneus) and cerebellar regions. The persistent ADHD group showed under-activation, whereas the remitted ADHD group did not differ significantly from the never-affected group. Magnetoencephalography showed that the association between adult symptom severity and prefrontal neuronal activity was confined to the time window covering the act of inhibition (300 ms–350 ms). Group differences in cerebellar and parietal neuronal activity occurred during the time window of performance monitoring processes (500 ms–600 ms).

Conclusions:
By combining fMRI and magnetoencephalography, the location and time window of neuronal activity that underpins the adult outcome of ADHD was pinpointed. Thus, the cortico-cerebellar processes tied to the clinical course of ADHD are separated from the subcortical processes that are not.