

SPECIFIC AIMS

Cognitive control deficits are a core feature of many neurodevelopmental disorders, yet the underlying neural mechanisms remain poorly understood. This knowledge gap hampers the development of targeted interventions and biomarkers for early diagnosis. The goal of this research is to characterize the neural mechanisms of cognitive control across typical development and in neurodevelopmental disorders, specifically attention deficit hyperactivity disorder (ADHD) and autism spectrum disorder (ASD).

We will pursue the following specific aims:

Aim 1: Characterize developmental trajectories of neural circuits supporting cognitive control

Hypothesis: Cognitive control networks show protracted developmental trajectories that differ between typically developing children and those with ADHD or ASD.

We will use multimodal neuroimaging (fMRI-EEG) to map developmental changes in neural activation and connectivity during cognitive control tasks across ages 7-18 years in all three groups.

Aim 2: Identify disorder-specific neural signatures of cognitive control deficits

Hypothesis: ADHD and ASD are associated with distinct patterns of neural dysfunction during cognitive control tasks, despite behavioral similarities.

We will apply machine learning techniques to identify disorder-specific neural signatures that differentiate ADHD and ASD from typical development and from each other.

Aim 3: Determine the relationship between neural network dynamics and individual differences in cognitive control abilities

Hypothesis: Individual differences in cognitive control abilities are better predicted by neural network dynamics than by diagnostic category.

We will use computational modeling to characterize the relationship between neural network dynamics and performance on cognitive control tasks, accounting for both within- and between-group variability.

This research will significantly advance our understanding of the neural basis of cognitive control in typical and atypical development, with implications for the development of personalized interventions and objective biomarkers for neurodevelopmental disorders.