

Insights into multimodal imaging classification of ADHD.

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Attention deficit hyperactivity disorder (ADHD) currently is diagnosed in children by clinicians via subjective ADHD-specific behavioral instruments and by reports from the parents and teachers. Considering its high prevalence and large economic and societal costs, a quantitative tool that aids in diagnosis by characterizing underlying neurobiology would be extremely valuable. This provided motivation for the ADHD-200 machine learning (ML) competition, a multisite collaborative effort to investigate imaging classifiers for ADHD. Here we present our ML approach, which used structural and functional magnetic resonance imaging data, combined with demographic information, to predict diagnostic status of individuals with ADHD from typically developing (TD) children across eight different research sites. Structural features included quantitative metrics from 113 cortical and non-cortical regions. Functional features included Pearson correlation functional connectivity matrices, nodal and global graph theoretical measures, nodal power spectra, voxelwise global connectivity, and voxelwise regional homogeneity. We performed feature ranking for each site and modality using the multiple support vector machine recursive feature elimination (SVM-RFE) algorithm, and feature subset selection by optimizing the expected generalization performance of a radial basis function kernel SVM (RBF-SVM) trained across a range of the top features. Site-specific RBF-SVMs using these optimal feature sets from each imaging modality were used to predict the class labels of an independent hold-out test set. A voting approach was used to combine these multiple predictions and assign final class labels. With this methodology we were able to predict diagnosis of ADHD with 55% accuracy (versus a 39% chance level in this sample), 33% sensitivity, and 80% specificity. This approach also allowed us to evaluate predictive structural and functional features giving insight into abnormal brain circuitry in ADHD.