Random matrix theory for analyzing the brain functional network in attention deficit hyperactivity disorder.


Abstract

Attention deficit hyperactivity disorder (ADHD) is the most common childhood neuropsychiatric disorder and affects approximately 6-7% of children worldwide. Here, we investigate the statistical properties of undirected and directed brain functional networks in ADHD patients based on random matrix theory (RMT), in which the undirected functional connectivity is constructed based on correlation coefficient and the directed functional connectivity is measured based on cross-correlation coefficient and mutual information. We first analyze the functional connectivity and the eigenvalues of the brain functional network. We find that ADHD patients have increased undirected functional connectivity, reflecting a higher degree of linear dependence between regions, and increased directed functional connectivity, indicating stronger causality and more transmission of information among brain regions. More importantly, we explore the randomness of the undirected and directed functional networks using RMT. We find that for ADHD patients, the undirected functional network is more orderly than that for normal subjects, which indicates an abnormal increase in undirected functional connectivity. In addition, we find that the directed functional networks are more random, which reveals greater disorder in causality and more chaotic information flow among brain regions in ADHD patients. Our results not only further confirm the efficacy of RMT in characterizing the intrinsic properties of brain functional networks but also provide insights into the possibilities RMT offers for improving clinical diagnoses and treatment evaluations for ADHD patients.