Individual Neural Network Activity Patterns Underlie Complex Cognitive Task Performance: An fMRI Study with Clinical Implications

Fendrich, Sarah

Understanding the neural mechanisms that underlie the ability to flexibly switch between brain states and adapt to fluctuating environments is imperative in addressing cognitive flexibility deficits in autism, an extremely heterogeneous disorder. In an ongoing study in a research laboratory, fMRI scans were obtained from eleven neurotypical individuals during the completion of a cognitive flexibility task. The present image-analysis study examined neural activity patterns from these scans in correspondence with two sources of conflict present in the task: the switch between cognitive states, and the management of incongruent stimuli. Large variability was revealed between, and even within single participant's neural reconfiguration processes; however, task-switch specific neural activity ($Z > 2.3$; $P < 0.05$) was observed consistently in parietal and frontal regions. Despite localized activation in the parietal lobe, subsequent Psycho-Physiological Interaction analyses revealed a general lack of connectivity with this region, supporting the variability of involved neural circuitry. During the management of incongruent stimuli, accuracy costs were reduced by increases in the strength of region activations ($r = -0.53$; $p = 0.03$), and increased by the involvement of a larger number of regions (switch: $r = 0.30$; $p = 0.06$; incongruent: $r = 0.27$; $p = 0.08$) at a trend level. This study is the first to identify that neural reconfiguration processes vary on a day-to-day basis within single individuals, and to delineate the behavioral implications of brain activity during task completion. These findings provide a crucial step forward in understanding cognitive deficits, thus in development of therapeutic interventions for individuals with autism.