Methylphenidate modulates attention network strength
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Background: Recent work has demonstrated that patterns of whole-brain functional connectivity contain information about an individual's cognitive abilities. To predict traits and behavior from connectivity, our group developed the connectome-based predictive modeling (CPM) approach. In previous work using CPM, we defined a high-attention network stronger in individuals who performed well on a sustained attention task and a low-attention network in individuals who performed poorly (Rosenberg, Finn, et al., 2016). Validating the networks as biomarkers of attention, the sustained attention CPM also predicted ADHD symptoms in an independent group of children and adolescents. To examine whether these attention networks play a causal role in attention, we compared network strength in healthy adults given methylphenidate (MPH; trade name, Ritalin), a common ADHD treatment, to a group of matched controls.

Methods: FMRI data were collected from 23 healthy participants given a single dose of MPH and 65 matched controls as they completed a stop-signal task and rested. For each participant, whole-brain functional connectivity networks were derived from rest and task data using a 268-node functional brain atlas (Shen et al., 2013). Strengths in the high- and low-attention networks were calculated as the sum of connections in each network. The Network Based Statistic was used to identify brain networks that differed between the MPH and control groups, and the hypergeometric cumulative density function was used to evaluate the edge overlap between the high- and low-attention and MPH networks. Behavioral predictions were generated with the Sustained Attention Network (SAN) CPM, a linear model that predicts attentional abilities from high- and low-attention network strength (Rosenberg, Finn, et al., 2016). Predictive power was assessed with Pearson correlations between predicted values and performance on the stop-signal task.

Results: Participants given MPH showed patterns of connectivity associated with better attention: They had stronger high-attention networks and weaker low-attention networks than did controls. Connections that were stronger in the MPH group were more likely to appear in the high-attention network, whereas connections that were weaker in the MPH group were more likely to appear in the low-attention network. Behavior on a stop-signal task was also related to network strength, as SAN CPM predictions were significantly correlated with the frequency of correct responses.

Conclusions: These results suggest that MPH acts by modulating strength in functional brain networks related to attention, and that changing whole-brain connectivity patterns
may help improve attention.