Predicting Fluid Intelligence from Resting-State Neural Connectivity

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Fluid intelligence (gF) is the basis of innovation, problem solving, and leadership and evaluating gF is critical to the investigation, diagnosis, and treatment of cognitive and mental disorders. Written gF tests, as the foundation of gF investigations, are skewed by behavioral confounds (stress, anxiety, physical impairment, and practice effects). This study proposes to predict gF scores based on resting-state brain activity, independent of the behavioral confounds in written tests, using an optimized whole-brain modeling approach to account for the shortcomings of current seed-region models. Healthy Human Connectome Project database subjects and Raven's Progressive Matrices (RPM) scores were used to measure gF and construct a model in MATLAB that predicted RPM scores from resting state fMRI scans. Correlation analysis across all subjects (n=116) and temporal fMRI connections (35,778) yielded a RPM Network composed of connections correlated to RPM scores. A regression model was established between RPM scores and the degree of neural connectivity in the RPM network (whole-brain network value).The whole-brain network value was significantly more correlated to RPM score than previous models which used seed region network values (whole-brain: r=0.85; seed region: rmax=0.49; Fisher r-to-z transformation z-test, z-score=5.43, p=5.64e-8). Predictive power after cross validation was achieved, based on a significant correlation between observed and predicted RPM scores (r=0.51, p=7.1e-9). Thus, this study's model will minimize behavioral confounds in gF testing and provide a new clinical tool to estimate cognitive decline and empower more comprehensive diagnoses in subjects incapable of written examinations, such as suffers of stroke, ADHD, and autism.

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