Redefining the Neurological Basis of Fluid Intelligence: Investigating Connection Strength and Network Strength of Resting State Functional Connectivity

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Fluid intelligence (gF) is the basis of innovation, problem solving, and leadership; yet, a consistent theory of the neurological basis of gF is elusive. This study posited a new hypothesis for the basis of gF that considers three complementary graph theoretic network properties: connection strength (CS), networks strength (NS), and normalized degree (ND). From the Human Connectome Project database, Raven's Progressive Matrices (RPM) scores of de-identified healthy subjects (n=126) were used to measure gF level. BioImage Suite and MATLAB were used to 1. parcellate resting-state fMRI scans into 268 regions and 2. quantify graph theoretic properties of neural networks (in accordance with proposed and existing hypotheses for the neural basis of gF). The proposed CS-NS-ND hypothesis achieved significantly higher predictive accuracy of RPM scores than existing CS-NS, CS-ND, and CS hypotheses (accuracy_CS-ND-NS = 0.80; accuracy_CS-NS = 0.66; accuracy_CS-ND = 0.64; accuracy_CS = 0.51; $p<0.01$), signaling the greater validity of the proposed hypothesis of gF over existing hypotheses. Future studies should seek to explore networks that were 1. proposed to underpin gF in existing hypotheses (CS-NS; CS-ND; CS) but were otherwise 2. excluded from the proposed, more valid CS-NS-ND hypothesis; namely. global, subcortical, and prefrontal cortex networks should be re-evaluated for relevance to gF. This study begins to clarify the basis of gF and may have eventual clinical application towards cognitive rehabilitation and gF level evaluation with fMRI modeling (as a supplement for people who have difficulty taking written examinations, such as sufferers of stroke, ADHD, and autism).