Integration to Segregation: Analyzing Clustering Coefficients in the Brain Across Arithmetic Performance

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Arithmetic performance depends on the neural processing across distinct brain regions. This study investigates whether clustering coefficients (CCs), a graph theory metric for centrality, reflect this in the organization of a brain network. Utilizing the EEGMAT database, source reconstruction was conducted for good (Group G, n = 26) and poor (Group B, n = 10) arithmetic performances for CC analysis. Results suggested whole-brain significance when transitioning from GR (good resting) to GA (good active) and BR (bad resting) to BA (bad active), while there was no significance between GR and BR. Contextually, this implies that all parcels tend to cluster in connectivity during arithmetic tasks relative to the resting baseline, regardless of performance. However, the results also show there are statistically significant differences for select parcels between GA and BA; the left banks of the superior temporal sulcus ($p=0.017$), right caudal middle frontal gyrus ($p=0.031$), right rostral middle frontal gyrus ($p=0.018$), and right supramarginal gyrus ($p=0.047$), showed higher CCs in BA and are within lobes responsible for auditory processing, decision-making, and math computation. Past research has concluded that efficient cognition is not confined to a region but instead occurs through a distributed network throughout the brain. With higher CCs implying greater levels of segregated regions, these findings support existing research. This study sheds light on the functional structure of specific regions responsible for the variations observed in performance between groups, while highlighting the potential for optimized learning through targeted integration of select parcels.

Awards Won:
American Mathematical Society: Honorable Mention and One-Year Membership to AMS (for 5 projects with up to 3 team members per project)