Modulating the Default Mode Network to Enhance Central Executive Network Function: A Pilot rTSM Study

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Abstract:

Introduction
Understanding the complex interactions among the three main large-scale brain networks, including the central executive network (CEN), default mode network (DMN), and salience network (SN), is imperative for understanding the regulation of human cognition. Previous studies have shown that the CEN governs goal-directed behavior, the DMN engages during internal cognition, and the SN acts as a modulator between the two systems. Dysfunction among these networks is implicated in various neurological and neuropsychiatric disorders, including but not limited to migraines, Alzheimer's disease, Parkinson's disease, major depressive disorder, and autism.

Methods
This study explores the potential of modulating the DMN to influence CEN activity to improve cognitive executive function. Using repetitive transcranial magnetic stimulation (rTMS), excitatory and inhibitory stimulations targeting the DMN were applied to healthy adults. Cortical oxygenation (measured by functional near-infrared spectroscopy) in the dorsolateral prefrontal region (associated with the CEN) and aspect of executive function (measured by the reverse digit span test) were evaluated before and after rTMS.

Results
Results in healthy adults show that an inhibitory stimulation of the DMN causes an statistically significant increase in cortical oxygenation in the CEN (from .59 to 1.57, $p=0.03$). While an excitatory stimulation causes the reverse effect, that relationship was not statistically significant (from .42 to -.13, $p=0.28$). Although not statistically significant, the reverse digit span also mirrored this anti-correlational relationship, suggesting not only a biological effect but also cognitive implications.

Conclusion
This bi-modal approach demonstrates a potential link between DMN modulation and CEN activity, suggesting that DMN is a plausible therapeutic target for CEN dysfunction. These findings offer initial insights into the inter-network dynamics at play between the three regions, paving the way for future studies exploring novel therapeutic interventions via networked-targeted rTMS.