Abstract

Current work in establishing brain-behavior linkages in higher-cognition has been stymied by the difficulty of performing robust causal tests between theories of computation. These limitations are exacerbated when studying the interactions of large, distributed circuits (e.g., between brain networks) which result in many indirect paths of influence. Noninvasive transcranial electrical stimulation (tES) provides a new opportunity to test causal mechanisms of human cognitive brain functions and to translate systems neuroscience theory into therapy. The proposed research addresses key limitations of previous tES cognitive-enhancement, including uncertain mechanisms and efficacy. A key strength of our project is the use of individualized dynamic brain models to identify optimal tES protocols for each subject. By linking neural circuitry and optimal control of tES we build a clear pathway from systems neuroscience to precision medicine.

A second focal point of our project is validating a new, control-theoretic framework for understanding how the dynamics of salience and frontoparietal networks enable cognitive flexibility and adaptive behavior. We will demonstrate the usefulness of this theory in augmenting cognitive control (via tES), which lays the foundation for a new research program exploring how the control-theoretic properties of neural systems engender function.