PROJECT SUMMARY (See instructions):

Many, if not most of our activities in daily life require complex, multi-phase tasks. For instance, grasping an object or walking is a concert of sensorimotor control and coordination performed phase-by-phase, involving an array of brain regions. Accordingly, complex tasks like these are the most affected after neurological insult such as traumatic brain injury (TBI) or stroke. They also are among those tasks most important for recovery of activities of daily living. Conventional therapy uses movement as the primary outcome, but largely ignores potential maladaptive neural compensations. Our goal is to first understand the interplay between the different stages of performing these complex tasks and the corresponding neural activity, and then to shape this activity accordingly to see whether we can improve performance of specific stages. Successful use of this innovative technological approach to changing neuromotor performance would open invaluable new approaches to rehabilitation medicine. In this project we propose to explore the relationships between neuromagnetic signals recorded from specified regions in the sensorimotor network using magnetoencephalography (MEG) and corresponding stages of a multi-phase fine motor task. MEG is the only non-invasive imaging technology that has both the temporal and spatial resolution to examine networks of regions in phasic responses. We have chosen to examine performance of an isometric pinch force visuomotor tracking task which has direct relevance to activities of daily living and has been used previously to describe specific performance decrements related to aging and to neurological disorders such as Parkinson's disease and essential tremor. We predict that specific functional networks of activity underlie performance during different phases of our task. In the second part of the proposal, we will develop and validate in a small cohort the experimental setup for real-time neurofeedback of the aforementioned circuitry and neural activation patterns, with the expectation of improving task phase performance without performing the task itself. Eventually this paradigm could be adapted to enhance learning or re-learning multi-phase complex tasks by patients with neurological disorders such as TBI and stroke, promoting positive neuroplastic changes.

RELEVANCE (See instructions):

This research represents a novel approach to examining multi-phase sensorimotor coordination and subsequent interventions. We believe our project team and idea exemplify the intent of UT BRAIN as cross-disciplinary team with untested, innovative techniques that cross boundaries. The project team is composed of the contact PI, Dr. James Sulzer, Ph.D. (UT Austin, Mechanical Engineering), who specializes in real-time fMRI-based neurofeedback, and is involved in the experimental design, setup and real-time neurofeedback development, Dr. Larry Abraham, Ed. D. (UT Austin, Kinesiology), a motor control expert who is responsible for the task design, running the experiments, and analyzing the task performance data, Dr. Paul Ferrari, Ph.D. and Dr. Mark McManis, Ph.D. (Dell Children's Hospital), who have extensive expertise in MEG and will assist with designing and conducting the experiment, and Dr. David Schnyer (UT Austin - Psychology), with expertise in human neuroimaging including EEG, MEG and fMRI methods will help with the study design and data analysis. This is the first time this team has worked together.