A Real-Time, Objective Measure of Consciousness

Abstract

At present, it is challenging to measure the level of consciousness and functional state of the brain after brain injury. The state of the science is to use rating scales, such as the Glasgow Coma Scale, to measure consciousness. To date, there is no objective measure to assess the level of consciousness. In this proposal, we will use cutting-edge tools from machine learning and signal processing to build a real-time measure of consciousness. This tool, which we call "SeeMe," uses detailed facial analyses to examine command following in TBI patients. We will time-lock the SeeMe behavioral measure with depth cortical recordings to extract the electrophysiological biomarkers of goal-directed behavior from direct cortical recordings. Thus, we will have a tool to synchronize and quantify brain and behavior and shed light on the underlying mechanism of recovery of consciousness. Subsequent to the funded period, we will be well-positioned to test specific mechanistic hypotheses about the emergence of consciousness.

The NIH is very interested in this tool. We have met with them several times, and they have encouraged us to apply to the BRAIN Initiative: Brain Behavior Quantification and Synchronization (R61/R33 Clinical Trial Optional). This seed grant will help us to collect the necessary preliminary data for this proposal. We are planning to apply to this FOA in February 2024. The first half of this grant is for tool development, but in the second half, we will test a mechanistic hypothesis which we term the *autocatalytic* hypothesis, in which neuronal ensembles (groups of neurons encoding thoughts and percepts) catalyze the development of additional ensembles. With our tool in hand, we will be well-positioned to test this hypothesis.

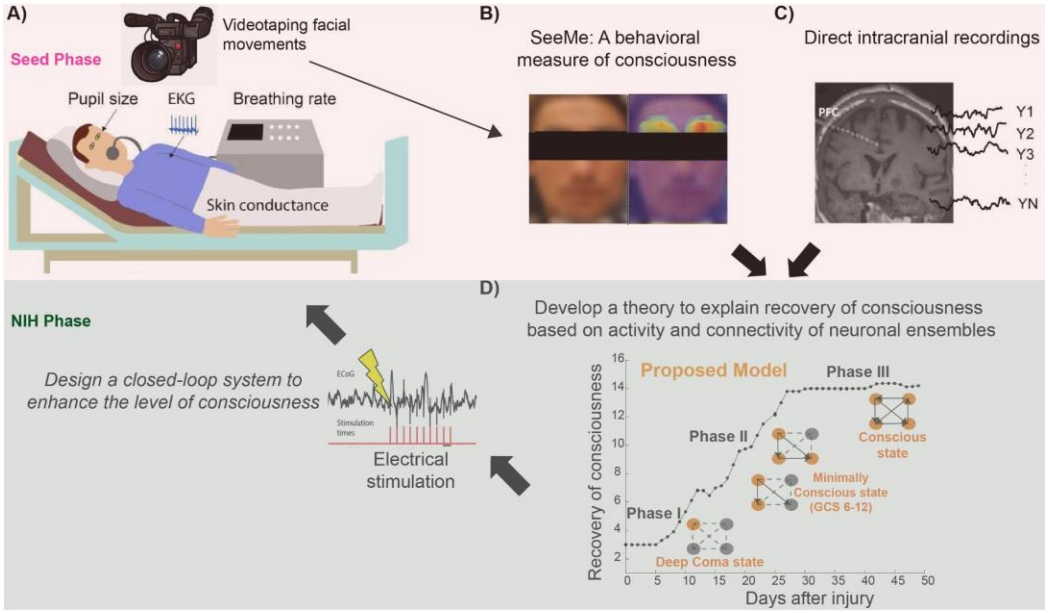

Figure 1. Research plan for the Seed grant (top box in pink) and longer term for brain initiative NIH proposal (bottom box in gray). During the Seed grant, we will perform A) data collection B) developing SeeMe, and C) connecting return of consciousness to electrophysiological biomarkers using direct brain recordings. In NIH proposal, with these tools, D) we will develop a theory explaining the return of consciousness and examine possible effects of electrical stimulation in facilitating the return of consciousness.