Proposed research theme: Neuroplasticity

A deeper understanding of neuroplasticity – or the brain's ability to reorganize itself after traumatic injury or neurological disorders– has the potential to transform our understanding of how the brain works, and to unlock new treatments for brain disorders. Research under this theme includes neuroengineering research focused on enhancing neuroplasticity through brain-computer interfaces, cellular and molecular neuroscience research focused on understanding the synaptic and non-synaptic causes of neuroplasticity at a cellular level, and cognitive neuroscience research focused on the remapping of cognitive functions at a systems level.

Existing strengths

Center for Neuroengineering: Rice is currently home to a multi-disciplinary, interinstitutional Center for Neuroengineering which recently received an NSF IGERT Training Grant. Research in the center includes *translational neuroengineering* approaches for enhancing neuroplasticity, including Rob Raphael's (BioE) research on recovery of hearing function, Caleb Kemere's (BioE) research on deep brain stimulation and manipulation of the hippocampal memory circuit and Marcia O'Malley's (MechE) research on using neurally controlled robotics to enhance motor rehabilitation.

T.L.L. Temple Foundation Neuroplasticity Laboratory: This is one of only a few laboratories in the country examining the behavioral consequences of stroke and traumatic injury and how changes in the brain underlie the behavioral changes. Randi Martin, Tatiana Schnur and Simon Fischer-Baum (Psychology) are developing novel methods for measuring the cortical reorganization of cognitive functions during the first year post stroke and using non-invasive neuromodulation techniques (transcranial direct current stimulation, transcranial magnetic stimulation) to enhance recovery.

Connections with TMC: There are potential connections with many academic departments at both BCM and UT-HSC. TIRR Memorial Hermann has been ranked as the nation's third best rehabilitation hospital, and its focus on stroke and brain injury creates a natural connection for translating the research of Rice scientists.

Targeted investments

Targeted hires should be made to increase communication among different disciplines at Rice in order to facilitate interdisciplinary research on neuroplasticity.

1. Cognitive neuroscientist with imaging methods emphasis. The methods might include real-time fMRI or brain-computer interfaces that use or ERP or mind-reading via multivariate pattern analysis or response similarity analyses. Such a hire could interact with those in the neuroengineering field, for instance, in the development of prostheses.
2. Neuroengineering or psychology hires with research on animal models of brain damage and recovery.
3. Biology hire with research on neuroplasticity at the cellular level.

Outcome of targeted investments

The outcome of the targeted investments would be to create a unique center for neuroplasticity with research spanning cellular to systems levels, and moreover, including a focus on translating theoretical work into applications enhancing recovery from brain damage. This area has high funding priority at a federal level, taking a central role in President Obama's BRAIN Initiative. It cuts across disciplines, pulling researchers from the Schools of Engineering, Natural Science and Social Science, achieving the cross-disciplinary goals of the IBB. Educationally, it aligns with the development of the Neuroscience undergraduate major. Finally, with many existing pieces currently in place, Rice is in a position to achieve pre-eminence with some additional investment.