IGERT Integrative Graduate Education and Research Traineeship

Neuroengineering: From Cells to Systems

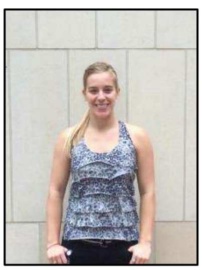
PI: Robert M. Raphael, PhD, Bioengineering, Rice University

neuroigert.rice.edu

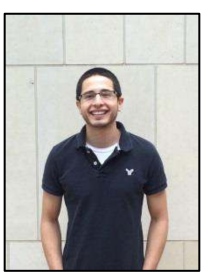
The goal of this program, led by Dr. Raphael, is to provide students with the educational and research training needed to develop new tools to understand, interface with, model, and manipulate the nervous system. Students in our program will obtain an interdisciplinary understanding of the nervous system from the level of molecular and cellular processes to the level of information processing within neural circuits composed of millions of cells. The long term goal of this research is to develop innovative approaches to the complex challenges of restoring function to individuals suffering from disorders of the nervous system.

Meet the Trainees

Cohort 1, Appointed August 1, 2014 through July 31, 2016

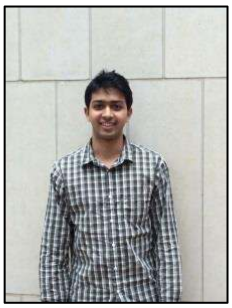


Lexi Crommett
Dept/Institution: Neuroscience, BCM
Mentor: Jeff Yau
Audiotactile Frequency Integration
Research Project: The goal of my research is to investigate how tactile and auditory frequency information is encoded and combined in the human brain. We hypothesize that shared neural mechanisms support auditory and tactile frequency processing, and a single neuronal population receives inputs from both modalities. Using behavioral and functional neuroimaging experiments, I will investigate crossmodal frequency adaptation by exploiting the fact that neurons change their responsiveness based on stimulus history. After defining how audiotactile input is combined perceptually, I plan to manipulate neural activity in the brain regions involved using transcranial magnetic stimulation to demonstrate causal involvement.

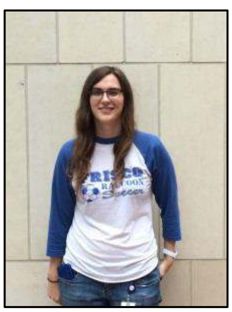


Daniel Gonzales
Dept/Institution: Electrical & Computer Engineering, Rice University
Mentor: Jacob Robinson
Small Organism Electrophysiology on a Chip
Research Project: Small organisms such as Drosophila Melanogaster and Caenorhabditis elegans are powerful model systems for the study of neurodegenerative diseases, development, and the relationship between neural activity and behavior. Although high-throughput methods are available for genetic and behavioral assays, contemporary electrophysiology is slow, laborious and highly invasive, ultimately limiting our ability to link genetic and behavioral characteristics to the activity of the nervous system. In this project, we use suspended, platinum nano-electrodes in a variety of configurations to create easy-to-use, versatile chips for high-throughput electrophysiology in small organisms.

Craig McDonald
Dept/Institution: Mechancial Engineering, Rice University
Design and Control of a Safe, Robust Tendon Actuation System for a New Generation of Wearable Robotic Exoskeletons for Rehabilitation
Mentor: Marcie O'Malley
Research Project: I I am proposing to design a novel robotic rehabilitation device to be worn on the upper body, also referred to in the robotics community as a powered human exoskeleton. An ideal rehabilitation device would be worn during a patient's activities of daily living without interfering, so that it could provide assistance to the patient as needed, enabling them to accomplish more tasks and receive more therapy simultaneously. However the stringency of the performance and design constraints on an upper-limb device have kept existing devices tethered to a laboratory setting. My proposed design will eliminate the two primary obstacles, which derive from the actuation system, to making an upper-limb device more effective: undesirable inertia of the device being added to the user's arm, and the need for precise control of the interaction forces between the user and the device.



Arun Mehadevan
Dept/Institution: Bioengineering, Rice University
Mentor: Amina Qutub
Computational Analysis of Multi-Cellular Environment During Neural Progenitor Cell Differentiation
Research Project: Cell fate decisions during neural progenitor cell (NPC) differentiation depend on both cellautonomous mechanisms and the influence of neighboring cells. Live-cell imaging has proved to be a powerful tool in visualizing dynamic progenitor cell behavior, but the influence of cellular neighborhood on NPC differentiation has been difficult to quantify. My research focuses on developing quantitative metrics based on image analysis to help reveal the influence of multicellular environment at different stages of NPC differentiation. In combination with biochemical and electrophysiological assays, this will lead to a deeper understanding of the interplay between multi-cellular influence and internal cell signaling, resulting in a more holistic and predictive model for stem cell differentiation. Ultimately, I hope to shed light on the developmental principles involved in the self-organization of functional neural circuits



Jaclyn Patterson
Dept/Institution: Neuroscience, BCM
Mentor: Dora Angelaki
Computational Modeling of Autism Spectrum Disorders (ASD)
Research Project: My current research project is to develop a computational model of autism spectrum disorders (ASD) based upon a computation performed by neuronal circuits throughout the brain, called divisive normalization. Autism is a complex neuro-developmental disorder that is increasing in prevalence (1 in 68 US children) and is commonly associated with atypical behavior in four domains: communication, stereotyped behavior, sensory perception, and social interaction. I hypothesize that divisive normalization provides a parsimonious account of perceptual consequences observed in ASD, and may explain the pervasive effects this disorder has on individuals. To explore this hypothesis, I will begin with modeling and performing psychophysical tests involving the primary visual cortex, then test the normalization model across other sensory modalities, and will hopefully use this new perspective on the disorder to illuminate novel behavioral and pharmacological approaches to treating autism.

Administered by:

Gulf Coast Consortia for Quantitative Biomedical Sciences

www.gulfcoastconsortia.org
Questions: Contact Vanessa Herrera
herrera@rice.edu , (713)348-4752

The GCC is a collaboration of:
Rice University
Baylor College of Medicine
University of Houston
University of Texas Health Science Center at Houston
University of Texas Medical Branch at Galveston
University of Texas MD Anderson Cancer Center
Institute of Biosciences & Technology at Texas A&M Health Science Center