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1. Matthew Harrison, Ph.D., Associate Professor
2. George Karniadakie, Ph.D., Professor

Biostatistics

3. Lorin Crawford, Ph.D., *Associate Professor*
4. Ani Eloyan, Ph.D., *Assistant Professor*
5. Youjin Lee, Ph.D., *Assistant Professor*

Cognitive, Linguistic and Psychological Sciences

6. Oriel FeldmanHall, PH.D., *Associate Professor*
7. Yuka Sasaki, Ph.D., *Professor (Research)*
8. Thomas Serre, Ph.D., *Professor*
9. William Warren, Ph.D., *Professor*

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10. Michael Littman, Ph.D., *Professor*
11. Ellie Pavlick, Ph.D., *Assistant Professor*
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Applied Mathematics

Matthew Harrison, Ph.D. involves collaborative research with neuroscientists and the development of statistical methodology for brain science data. He has been especially interested in rigorous statistical techniques that allow neuroscientists to explore the structure of their data without burdensome modeling efforts and unrealistic assumptions. He has also worked on novel algorithms for neural decoding, including applications for closed-loop cursor control using brain-computer interfaces.

George Karniadakis, Ph.D.'s interests concern stochastic multiscale modeling of physical and biological systems, including blood flow dynamics in health and disease and neuro-vascular coupling. His current focus is on developing machine learning tools for biophysical systems.

Biostatistics

Lorin Crawford, Ph.D.'s scientific research interests involve the development of novel and efficient computational methodologies to address complex problems in statistical genetics, cancer pharmacology, and radiomics (e.g., cancer imaging). The central aim of Dr. Crawford's research program is to build machine learning algorithms and statistical tools that aid in the understanding of how non-additive genetic effects and gene-by-environmental interactions contribute to the architecture of complex traits and disease progression. An overarching theme of the research done in the Crawford Lab group is to take modern computational approaches and develop theories that enable their interpretations to be related back to classical genomic principles.

Ani Eloyan, Ph.D. focuses on computational analysis of neuroimaging data including functional and structural image processing and statistical analysis. She developed computational methods for dimension reduction specifically focusing on matrix decompositions for analyzing functional magnetic resonance imaging data. Dr. Eloyan worked extensively on statistical modeling approaches for brain connectivity analysis of people with Autism Spectrum Disorder. She developed and taught several courses in statistical methodology and in computational neuroimaging.

Youjin Lee, Ph.D.'s primary research interest is in the development of statistical and causal inference methods in complex observation studies,such as brain networks and multilevel data. Her research has applications to public health and social science, including instrumental variable methods, longitudinal data analysis, and network analysis.

Cognitive, Linguistic, and Psychological Sciences (CLPS)

David Badre, Ph.D. focuses on the neuroscience of cognitive control and memory and has contributed to our fundamental understanding of how these functions are supported in the brain. His lab seeks to understand this topic by deriving hypotheses from mechanistic models, including formal computational models, and testing them using multiple, convergent human cognitive neuroscience methods, including task-based functional MRI, functional connectivity MRI, structural MRI (i.e., diffusion tractography), brain stimulation (e.g., TMS), high temporal resolution recording methods (e.g., EEG, ECoG), and the testing of neurological and psychiatric patient populations.

Oriel FeldmanHall, Ph.D. studies the neural basis of human social behavior, with a focus on morality, altruism, and socio-emotional decision-making. They aim to understand how the brain detects, values and assesses these conflicting reward and punishment contingencies, and to examine the role of emotion and its operational power in shaping these social interactions. They combine behavioral economics and social psychology tools with imaging and psychophysiological techniques to investigate the brain mechanisms that support these complex processes.

Michael Frank, Ph.D.'s research combines multiple levels of computational modeling and experimental work to understand the neural mechanisms underlying reinforcement learning, decision making, and cognitive control – focusing on basal ganglia and frontal cortex. His lab has used these models to account for multiple patterns of cognitive changes as a function of disease and treatment (brain stimulation and pharmacology) in both humans and animal models.

Yuka Sasaki, Ph.D. is interested in neural mechanisms of visual perceptual learning and roles of sleep in visual perceptual learning in human adults. She uses psychophysics and non-invasive neuroimaging techniques including functional magnetic resonance imaging, diffusion tensor imaging, and magnetic resonance spectroscopy, as well as polysomnography. She is also interested in how aging affects neural mechanisms of visual perceptual learning.

Thomas Serre, Ph.D. seeks to understand the neural computations supporting visual perception. There is little doubt that even a partial solution to the question of which computations are carried out by the visual cortex would be a major breakthrough: it would begin to explain one of our most amazing abilities, vision; and it would open doors to other aspects of intelligence such as language, planning or reasoning. It would also help connect neurobiology and mathematics, making it possible to develop computer algorithms that follow the information processing principles used by biological organisms and honed by natural evolution.

William Warren, Ph.D. investigates the visual control of locomotion and spatial navigation, using human experiments in virtual reality, dynamical systems modeling, and agent-based simulation. The main project aims to build a vision-based "pedestrian model" that accounts for steering, obstacle avoidance, pedestrian interactions, and how these interactions generate the collective behavior of human crowds. A related line of research investigates longer-range navigation, including the process of path integration, the geometry of spatial knowledge, and how such knowledge is used to guide wayfinding. This research has broad applications to mobile robotics, computer simulation, evacuation planning, urban and architectural design, and assistive technology for people with visual-motor impairments.

Computer Science

Michael Littman, Ph.D. focuses on computational reinforcement learning, developing algorithms that learn from interaction with an environment or person to maximize a given reward function. They also study how people can specify tasks and how learning systems can acquire task specifications from interaction. Finally, in ongoing collaborations with cognitive scientists, they look at how norms and other forms of pro-social behavior can be learned. He also leads the Humanity-Centered Robotics Initiative at Brown.

Ellie Pavlick, Ph.D. leads the Language Understanding and Representation (LUNAR) Lab, which focuses on developing computational models of natural language semantics and pragmatics. The lab aims to build connections between machine learning studies of human language processing both by taking inspiration from studies of human language in order to inform computational models, and by using computational models in order to generate predictions about and improve understanding of human behavior.

Ritambhara Singh, Ph.D. develops machine learning methods with the goals of data integration and model interpretation for biological and biomedical applications. Her lab endeavors to answer important Interactionist questions in the basic biology underlying human disease by applying data-driven approaches to the massive amounts of data collected by biologists.

Engineering

David Borton, Ph.D. engages engineers, neuroscientists, mathematicians, and clinicians to create and apply state-of-the-art neural interfaces, kinematic sensors, and biochemical sensors to study neurological disease and injury in humans and relevant animal models. Their main research goals include (i) characterization of neural activity during unconstrained, complex, and natural behavior; (ii) realization of fully implanted neural recording and modulation technologies to aide in rehabilitation, augmentation, and replacement of lost neurological function; and (iii) leverage biophysical, computational, and behavioral models to predict the effects of neuromodulation on behavior.

Leigh Hochberg, M.D., Ph.D. leads the BrainGate pilot clinical trials and the Laboratory for Restorative Neurotechnology at Brown University. His research enables the real-time decoding of human motor cortical neuronal ensemble activity, with single-neuron resolution, toward the control of external devices by people with tetraplegia. A variety of computational neuroscience techniques are employed not only to decode most efficiently the intended movement of a participant's limb, but to better understand the information encoded in high-resolution human cortical activity and the dynamic nature of this activity.

Jonghwan Lee, Ph.D.'s research is at the intersection of medical photonics, neural engineering, and artificial intelligence. His lab develops novel technologies for label-free imaging and genetics-free modulation of biological systems, under clear targets of clinical application.

Neuroscience

Ahmed Abdelfattah, Ph.D. invents molecular tools to study how the brain works. Brain circuits process information in the form of electrical and chemical signals to form memories and shape behaviors. However there is no natural contrast mechanism associated with these signals. In the lab, we use bioengineering and chemical approaches to develop molecular tools to visualize and study the brain. Our research combines electrophysiology, fluorescence imaging, protein engineering, and advanced genetic approaches to visualize the structure and function of the nervous system.

Theresa Desrochers, Ph.D. seeks to understand how we plan, monitor, and carry out sequential tasks that unfold in time. Though these tasks are central to our everyday lives, the ability to carry out a complex sequential task effectively is disrupted in a wide range of psychiatric and neurological disorders. It is at the basis of real world executive dysfunction. However, we have very little understanding of how the brain accomplishes these sequential tasks. The Desrochers lab seeks to understand how habits, sequential motor function, and serial attention are organized by combining animal and human experimental models.

John Donoghue, Ph.D. has a strong track record of contribution in basic neuroscience in the areas of plasticity, cortical function and information processing, and in applied neuroscience in the area of neurotechnology, particularly brain-computer interfaces. His lab's fundamental research question has always been to understand how the cerebral neocortex accounts for flexible behavior, their model has always been the motor cortex, and they have always sought ways to translate their findings into useful human clinical applications.

Stephanie Jones, Ph.D. integrates human electrophysiological brain imaging (Magneto- and Electro-encephalography MEG/EEG) and biophysically principled computational neural models to study thalamocortical dynamics of healthy brain function and disease. She has used this integrated approach to study the cellular and circuit level dynamics underlying sensory evoked and spontaneous rhythmic activity in human MEG/EEG recordings and their modulation with perception, attention, practice, and healthy aging. She works closely with clinicians and animal electrophysiologists to develop data driven models that provide testable predictions on brain dynamics and their impact on function.

Karla Kaun, Ph.D. uses the powerful molecular and genetic tools available in the fruit fly *Drosophila melanogaster* to investigate the neural substrates of memory, reward, and addiction at the molecular and cellular level. The basic circuit motifs underlying reward responses are remarkably similar across phyla, from flies to primates. The lab uses the extremely well characterized mushroom body memory circuit in Drosophila, to understand the neural dynamics underlying appetitive behavioral decisions. Combined with the close inter-departmental collaborations at Brown, the Kaun lab's participation in this training grant provides an ideal interface for using computational approaches to integrate the circuit principles uncovered in behaving Drosophila into a more complex neural platform relevant to human behavior.

Christopher Moore, Ph.D. studies the mechanisms underlying brain dynamics and their meaning for behavior. His lab takes a systems-level approach, seeking to understand how multiple cell types and brain areas interact.

Matt Nassar, Ph.D. investigates how neural mechanisms of information processing impact decisions and afford complex behavior. His research relies on computational models to link behavior to their neural mechanisms, often by using indirect measures of neural activity (e.g. fMRI, MRS, EEG, and pupillometry) to distinguish between potential neural mechanisms. This integrative computational approach allows him to use experimental results from different levels of analysis (e.g. single neurons, population summaries, behavior) to inform a multi-level understanding of information processing and decision making.

David Sheinberg, Ph.D. aims to understand how the brain makes sense of the constant barrage of sensory information that is picked up by our peripheral senses. By combining behavioral and neurophysiological studies in non-human primates, they ask how the activity of single neurons working together in the brain empowers the visual system to explore complex environments and recognize objects, scenes, and actions. A central question they study is how experience affects these processes and how information from more than one source can be integrated to give rise to the impression of an object.

Wilson Truccolo, Ph.D. develops data-driven stochastic models of neuronal network dynamics with the following goals: (a) to understand how collective dynamics in neuronal ensembles distributed across different brain areas contribute to behavior and cognition; (b) to develop neural decoding and closed-loop control approaches for brain-machine interfaces designed to assist people with neurological disorders (e.g. paralysis, epilepsy), and (c) to predict, detect and control pathological events in Alzheimer’s, epilepsy, Parkinson’s, and other psychiatric and neurological diseases and disorders.

Neurosurgery

Wael Asaad, M.D. studies the neuronal basis of visual-motor learning, decision-making and motor function across the prefrontal cortex, basal ganglia and thalamus. Embracing the interactionist approach, they undertake systems neuroscience projects in humans and nonhuman primates, focusing on recording neurophysiology during the performance of psychophysical tasks to study adaptive behavior. Their ultimate goals are to understand and harness the mechanisms of learning to augment neural plasticity in the setting of obsessive compulsive disorder (OCD), brain injury, stroke and other psychiatric and neurological illnesses, and to design new methods of advanced neuromodulation.

Psychiatry and Human Behavior

Benjamin Greenberg, M.D., Ph.D. leads two related lines of research focusing on development of brain circuit based treatments in neuropsychiatry. At Butler Hospital, his group works on the neurocircuitry of noninvasive brain stimulation in OCD, using transcranial neuromodulation and neuroimaging. This occurs in the context of an NIMH-funded P50 translational Conte Center, which he co-Directs. At the Center for Neurorestoration and Neurotechnology (CfNN) at the Providence VA Medical Center, where Dr. Greenberg is Associate Director, the research team focuses on studying effectiveness and predictors and mechanisms of action of neuromodulation for depression, posttraumatic stress disorder (PTSD), and the affective dimension of chronic pain. The latter work uses computational approaches, in collaboration with Dr. Stephanie Jones.

Hwamee Oh, Ph.D. investigates cognitive and neural bases of human memory and how the memory system changes with both normal and pathological brain aging processes, with a special emphasis on preclinical older adults. Her lab uses cognitive neuroscience methods and multimodal neuroimaging techniques such as functional/structural MRI and PET detecting Alzheimer's disease pathology (e.g., amyloid plaques) *in vivo*. The overarching goal of her research is to understand neurocognitive underpinnings of Alzheimer's disease pathology and develop early behavioral and neural biomarkers that help identify individuals at a higher risk of developing Alzheimer's disease and other dementias.

Noah Philip, M.D. uses cutting edge technology to understand and treat serious psychiatric disorders, such as major depressive disorder and PTSD. They use noninvasive brain stimulation and functional neuroimaging, including transcranial magnetic stimulation, low-current stimulation, network-based resting state functional connectivity and virtual reality. Active studies in the Philip lab range from first-in-human studies of novel stimulation devices, rational development of individualized stimulation parameters, and multimodal imaging assessments of how trauma and negative effects impact brain responses to stimulation.

Steven Rasmussen, M.D. focuses on understanding the role of frontostriatal circuitry in the etiology of OCD and the use of this understanding to develop novel circuit based interventions for the illness. Current projects are focused on 1) the use of neuroimaging, cognitive tasks and clinical assessments to test a structural equation model of two core features of anxiety/OC spectrum disorders and 2) the development of invasive and noninvasive closed loop neuromodulatory circuit based treatments for OCD.