BBI

Brain and Behavior Initiative

4th Annual BBI Seed Grant Symposium

NOVEMBER 17, 2020 | 3 PM | ZOOM WEBINAR

Agenda

3:00 Welcome – Dr. Reza Ghodssi

3:05 Remarks – Dr. Laurie Locascio, Vice President for Research

3:10 Presentations from 2019 Awardees

- *Moving beyond the "Yuck Factor": measuring brain responses to water reuse terms and determining if natural environmental images change responses*
  Edward Bernat and Rachel E. Rosenberg Goldstein*****
- *Nexus between sustainable buildings and human health: a neuroscience approach*
  Edward Bernat and Ming Hu*****
- *Molecular connectomics of activity-dependent circadian circuit development*
  Najib El-Sayed, Peter Nemes, and Colenso Speer*****
- *Neural representations of continuous speech and linguistic context in native and non-native listeners*
  Ellen Lau***** and Jonathan Simon
- *The impact of transcutaneous vagus nerve stimulation on therapy outcomes in aphasia*
  Rochelle Newman, Polly O'Rourke, and Kristin Slawson*****
- *The Impact of Race and Gender on Cyberbullying and Interventions among Middle School and High School Students*
  Rashawn Ray***** and Cixin Wang

3:45 Q&A

4:00 Remarks – Dr. Elizabeth Quinlan

4:05 Remarks – Dr. Mary Ann Rankin, Provost

4:10 Presentations from 2020 Awardees

- *Time-Release Capsules for Neurotransmitter Delivery to the Brain of Behaving Birds*
  Gregory Ball*****, Robert Dooling, and Srinivasa Raghavan
- *Learning Age and Gender Adaptive Gait Motor Control-based Emotion Using Deep Neural Networks and Affective Modeling*
  Aniket Bera*****, Dinesh Manocha, and Jae Kun Shim
- *Sex differences in exercise effects on brain microvascular endothelial glucose metabolism*
  Alisa Clyne*****, J. Carson Smith, Ganesh Sriram
- *Black men's mental health: Healing from complex trauma and toxic environments*
  Craig Fryer, Joseph Richardson, and Kevin Roy
- *Engineering behavior to have transgenerational consequences*
  Quentin Gaudry and Antony Jose*****
- *Competing Values in Hearing Healthcare Service Delivery*
  Eric Hoover***** and Katie Shilton

4:45 Q&A

5:00 Closing – Dr. Jens Herberholz

* denotes presenter

FY19 Awardees

Moving beyond the "Yuck Factor": measuring brain responses to water reuse terms and determining if natural environmental images change responses

Edward Bernat and Rachel E. Rosenberg Goldstein

As climate change and population growth increasingly stress the nation's freshwater resources, there is a critical need to expand the use of alternative water sources including recycled water. Although water experts understand the importance of water reuse (the beneficial use of recycled water), a documented challenge is consumers' negative perceptions, or the "yuck factor." Exposure to the environment, or images and videos of the natural environment, reduce anxiety and increase feelings of relaxation and happiness, and attention restoration. We hypothesize that natural environmental beauty images and videos could decrease negative perceptions of water reuse and other pressing environmental issues, including climate change. Our project is operating in two phases: in phase 1 we 1) examined neural responses to a variety of water reuse terminology and 2) evaluated the effects of water reuse promotional videos on individuals' responses to water reuse terms; in phase 2 we will 1) examine neural responses to terms related to climate change, water challenges, sustainable food, and mental health and 2) evaluate the effects of natural environmental beauty still images and videos on individuals' responses to environmental terms. Our preliminary findings show that water reuse promotional videos were associated with EEG changes from pre- to post-video exposure for all water reuse word types, suggesting enhanced attention, engagement, and information processing. Additionally, water reuse promotional video exposure differentially impacted EEG changes for terms related to the specific reuse applications highlighted in the videos. These results suggest that promotional videos targeting specific aspects of water reuse can influence individuals' attention to, and engagement with, this important water conservation technique. Educational and stress-reducing images and videos could change the public's perceptions of critical environmental issues, paving the way for promoting behavioral and regulatory changes that could ameliorate these issues' impacts.

Nexus between sustainable buildings and human health: a neuroscience approach

Edward Bernat and Ming Hu

The building science community, particularly environmental scientists, have rightfully focused their efforts on reducing or eliminating exposures to indoor air contaminants. However, other more subtle but equally deleterious psychological or mental health effect—characterized by mood changes, increased stress, and decreased productivity—have been more difficult to measure consistently and are currently assessed post-occupancy, making remediation highly unlikely. The goal of this research project is to develop, test, and validate a data-driven approach using virtual reality (VR) and electroencephalogram (EEG) technology for assessing the effect of architectural building design features on occupants' emotional and cognitive functions—proxies for mental health and wellbeing. The project will provide technology-enabled, repeatable measures for quantifying the "soft" benefits of building design features thus providing an economically viable and repeatable assessment model, pre-build.

Molecular connectomics of activity-dependent circadian circuit development

Najib El-Sayed, Peter Nemes, and Colenso Speer

A key challenge in neurobiology is understanding how synaptic organization establishes circuit function underlying cognition and behavior. Reconstructing brain circuits with synaptic resolution ("connectomics") provides structural blueprints that help focus hypotheses about neuronal physiology and computation. Importantly, connectomes are not fixed, but instead undergo significant plasticity guided by molecular/genetic programs and sensory/environmental experience. To address a gap in our current understanding of mechanisms regulating connectome dynamics, we propose a new approach—molecular connectomics—combining the strengths of advanced transcriptomic, proteomic, and high-resolution imaging methodologies to investigate circuit plasticity across multiple biological scales (RNAs --> proteins --> subcellular compartments --> individual neurons --> multi-neuronal microcircuit ensembles). Using our platform, we will map molecular and structural plasticity within visual connectomes essential for circadian physiology/behavior, learning, and mood in the mammalian brain.

Neural representations of continuous speech and linguistic context in native and non-native listeners

Ellen Lau and Jonathan Simon

Much previous research has established that listeners and readers routinely generate context-based predictions that constrain perception and interpretation of language, but the form of this top-down/bottom-up interaction is still hotly debated. One critical question is how far down the processing hierarchy predictions are propagated—e.g. if 'I heard a dog…' predicts the word 'bark', does this modulate neural responses in units that represent lower-level speech sounds and acoustic features, as well as higher-level semantic units? This project aims to study this question for non-native speakers with difficulties in language comprehension. The method proposed here is poised to provide more accurate estimates of top-down influences on neural responses because it tackles longstanding limitations of standard approaches with respect to the format of the input (controlled vs. naturalistic) and the ability to estimate spatiotemporal response functions for multiple stages of processing simultaneously.

The impact of transcutaneous vagus nerve stimulation on therapy outcomes in aphasia

Rochelle Newman, Polly O'Rourke, and Kristin Slawson

Following a stroke, many individuals experience an extreme increase in their difficulties accessing the names for common objects—part of a general language difficulty known as aphasia. People with aphasia experience a loss of language and the hallmark feature of most aphasia syndromes is difficulty with word finding. Therapeutic treatment involves extensive re-training of difficult-to-access words. This project examines whether transcutaneous vagus nerve stimulation (tVNS) can improve the efficacy of clinical therapy. tVNS is a user-friendly, noninvasive method of stimulating the peripheral branches of the vagus nerve through an earbud worn by the user, and the ultimate goal of this treatment study is to determine if enhancements from tVNS would lead to faster rates of improvement in naming performance in individuals with aphasia.

The Impact of Race and Gender on Cyberbullying and Interventions among Middle School and High School Students

Rashawn Ray and Cixin Wang

Over half of adolescents have been the victims of repeated online harassment by peers in the past year, more commonly known as cyberbullying. Victims suffer mental health consequences from this harassment, including depression, anxiety, lower self-esteem, and suicidal thoughts. Relative to traditional bullying, victims of cyberbullying are much more likely to commit suicide. In recent years, suicide rates have increased most significantly among Black boys. Despite the detriment of online aggression there is little research that addresses how the race and gender of victims impact the likelihood of bystanders to intervene. Our research aims to identify how reactions to cyberbullying and subsequent intervention strategies depend on who is being bullied. We test how the race and gender of victims impact 1) whether peers see behaviors as cyberbullying, 2) the likelihood of peer intervention, and 3) what strategies peers use to intervene. In addition to developing an educational plan that will be implemented by Prince George's County Public Schools, the knowledge gained from this research will be used to develop a virtual reality bystander intervention program to improve mental health outcomes among youth, better understand how the physiology (as measured by heart rate, stress, and reaction time) of bystanders shape intervening, and reduce cyberbullying by understanding how the race and gender of victims dictate cyberbullying.

FY20 Awardees

Time-Release Capsules for Neurotransmitter Delivery to the Brain of Behaving Birds

Gregory Ball, Robert Dooling, and Srinivasa Raghavan

Vocal communication is essential to the success of many social species, and over the past several decades, songbird vocal behavior has emerged as one of the most productive models for understanding the neurobiology of vertebrate learning. Much is known about how various hormones and

neurotransmitters act within the brain to regulate the learned social behavior of birdsong, including the fact that, in canaries (*Serinus canaria*), the motivation to communicate by song depends on the action of steroid hormones like testosterone in the brain. However, the specific mechanisms of this effect are not yet understood. Traditionally, researchers have studied how testosterone motivates singing by delivering the hormone via injection. But administering these injections has required handling or temporarily restraining the canaries and thus complicated researchers' ability to measure their natural behavior. Dooling, Ball, and Raghavan along with their graduate students, Chelsea Haakenson (NACS) and Leah Borden (ChBE) posit a new approach to drug delivery: time-release capsules. These capsules allow for a drug to be released in the brain while the bird is behaving normally. Behavioral measurements at the time of testosterone release from the capsules in a normal bird will allow researchers to examine the still unclear non-genomic, rapid effects of steroid hormones. If this approach works, it will open up a whole new level of temporal and spatial precision in understanding the neuroendocrine effect on brain function in a complex vertebrate brain.

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Learning Age and Gender Adaptive Gait Motor Control-based Emotion Using Deep Neural Networks and Affective Modeling

Aniket Bera, Dinesh Manocha, and Jae Kin Shim

Detecting and classifying human emotion is one of the most challenging problems at the confluence of psychology, affective computing, kinesiology, and data science. While previous studies have shown that human observers are able to perceive another's emotions by simply observing physical cues (like facial expressions, prosody, body gestures, and walking styles), this project aims to develop an automated artificial intelligence based technique for perceiving human emotions based on kinematic and kinetic variables—that is, based on both the contextual and intrinsic qualities of human motion. The proposed research will examine the role of age and gender on gait-based emotion recognition using deep learning. After collecting full-body gaits across age and gender in a motion-capture lab, Bera, Shim, and Manocha will employ an autoencoder-based semi-supervised deep learning algorithm to learn perceived human emotions from walking style. They will then hierarchically pool these joint motions in a bottom-up manner, following kinematic chains in the human body, and coupling this data with both perceived emotion (by an external observer) and self-reported emotion.

Sex differences in exercise effects on brain microvascular endothelial glucose metabolism

Alisa Clyne, J. Carson Smith, and Ganesh Sriram

This project looks to design more effective exercise training for those at risk of Alzheimer's disease (AD) by identifying and studying a biomarker for earlier detection of AD: brain glucose uptake. Brain glucose uptake is ripe for research not only because reduced glucose uptake generates cognitive decline but also because, as a measure of cognitive decline, brain glucose uptake registers changes based on multiple known risk factors for AD: age, sex, and the presence of a protein known as *APOE4*. Although researchers currently know the major risk factors for developing AD—the elderly are more at risk than the young; women are more at risk than men (over 60% of patients with AD are female); and those with one or more copies of the *APOE4* allele are at increased risk for developing AD at a younger age—this project aims to address multiple axes of this matrix simultaneously. We hypothesize that brain glucose uptake from female subjects with *APOE4* alleles will be the lowest, and we posit that exercise will begin to reverse this effect, increasing brain glucose uptake and delaying cognitive decline. As far as we know, this research is the first to study how exercise impacts glucose metabolism with sex and *APOE4*.

Black men's mental health: Healing from complex trauma and toxic environments

Craig Fryer, Joseph Richardson, and Kevin Roy

For black men, experiences of trauma begin early in life, are prolonged, and remain unresolved. These experiences also underlie the vast majority of mental health disparities, particularly higher levels of depression linked to psychosocial stressors and a lack of access to quality mental health services. This project explores the biological, psychological, and sociological factors associated with black men's experiences of trauma by drawing on complementary quantitative and qualitative methods for both basic and applied research. In order to explore trauma past, present, and future, the study will: 1) gather a more complete understanding of how black men give meaning to prior trauma and violence, particularly childhood experiences; 2) assess the ongoing stress and risk in toxic environments, including stressors like incarceration, family conflict, racialized violence of police and gang activity,

and limited employment and educational opportunities; and 3) catalog the creation of strategies for healthy resilience to toxic environments. Research suggests not only that resilience is a distinct path of recovery from trauma but also that there are more paths to resilience than are commonly acknowledged. Accordingly, this study is attuned to black men's own strengths and adaptations—such as the utilization of close intimate and family relationships—to remain resilient in the face of extensive trauma.

Engineering behavior to have transgenerational consequences

Quentin Gaudry and Antony Jose

The origins and boundaries of innate behavior have been debated for centuries: where does nature end and nurture begin? This project proposes to engineer a synthetic behavior to understand plausible solutions to this ancient conundrum and develop a paradigm for rigorous experimental analysis—that is, essentially to use nurture to change nature. Such synthetic biology approaches are already being used to build new regulatory circuits within cells and to rewire nervous systems. Therefore, the goal of this proposal is to engineer the organismal regulatory circuits such that the adaptation to an odor is lost for many generations in the roundworm (*nematode C. elegans*). This ambitious goal can be attempted only in well-characterized systems, but it will be transformative by connecting behavior to transgenerational epigenetics using synthetic biology, providing a mechanistic explanation of a new behavior from molecular to population scales. Progress in this research direction will inform current explorations of the inheritance of behavior through epigenetic changes in mammals and has the potential to launch the field of synthetic behaviors that complements our current capabilities of modifying behaviors through the rewiring of neuronal circuits.

Competing Values in Hearing Healthcare Service Delivery

Eric Hoover and Katie Shilton

Hearing loss is both widespread and impactful: it affects one in three American adults aged 65-74, and it has been correlated with many mental health difficulties, including depression, anxiety, loneliness, and cognitive decline. Moreover, these negative outcomes redound disproportionately to marginalized groups, who face socioeconomic, racial, cultural, and geographical barriers to hearing healthcare access. In order to reduce these health disparities by promoting access and affordability, the FDA will be introducing in August 2020 an over-the-counter (OTC) service delivery model that can supplement the traditional, clinical delivery model. However, the inherent values embedded in each delivery model have yet to be taken into account. For example, to what extent does a focus on cost-reduction sacrifice the traditional model's core values of health, safety, education, and counseling? This project will use a value-sensitive design framework to disclose the values enacted in both OTC and traditional service models with an eye toward improving the development, administration, and use of hearing technologies.

Who we are

The mission of the Brain and Behavior Initiative (BBI) at the University of Maryland is to revolutionize the interface between engineers and neuroscientists by generating novel tools and innovative approaches to understanding complex behaviors produced by the human brain.

We focus on the development of novel approaches to image neuronal function, the development of micro/nano system diagnostics and drug delivery technologies, and the development of big data methods in order to push the frontiers of our initial research themes, ranging from single neurons to mental health.

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