UNIVERSITY of WASHINGTON

Undergraduate Research Symposium May 17, 2019 Mary Gates Hall

Online Proceedings

SESSION 1G

PSYCHOSOCIAL AND PHYSIOLOGICAL DYNAMICS OF RESILIENCE AND WELL-BEING

Session Moderator: Judith A Howard, Sociology
MGH 238
12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

An Investigation of Gender Effects on the Relationship between Adult Attachment Style and Coping Strategies
Savannah Marie Miller, Senior, Anthropology, Psychology
Lena Lucia Snyder, Senior, Psychology, Sociology
Mentor: Katherine Manbeck, psychology
Mentor: Jonathan Kanter, Psychology

Individuals with ambivalent and avoidant adult attachment styles are more likely to use negative coping strategies such as denial and disengagement, while individuals with a secure adult attachment style are more likely to use positive coping strategies such as reappraisal and support seeking. Certain negative coping strategies are linked with mental health problems such as depression and anxiety. Most research regarding the relationship between coping strategies and adult attachment style has been done on undergraduates and veterans. No research to date has examined gender as a moderator of the relationship between adult attachment style and coping strategies. However, research suggests that both coping strategies and adult attachment styles vary by gender. In the present study, a series of multivariate regression analyses were conducted to determine whether gender moderated the relationship between close, and anxious adult attachment styles and emotional support seeking, and substance abuse coping mechanisms. Participants (N=385) completed self-report measures of coping strategies and adult attachment styles online. This project may reveal that gender changes the relationship between adult attachment style and coping strategies. This information may help inform psychological interventions for individuals with maladaptive coping strategies and improve our ability to predict who might engage in maladaptive coping strategies.

SESSION 1Q

BIOLOGICAL STRUCTURE AND FUNCTION

Session Moderator: Matt Kaeberlein, Pathology
JHN 022
12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Improvement and Validation of Dotted Traction Force Microscopy Platform
Robin Zhexuan Yan, Senior, Mechanical Engineering
Mary Gates Scholar
Mentor: Nathan Sniadecki, Mechanical Engineering
Mentor: Kevin Beussman

Human induced pluripotent stem cell-derived cardiomyocytes (hiPSC-CM) have great potentials in biomedical research and can be used extensively in drug screening and heart simulations. To understand the cardiomyocytes, we need to perform functional analysis on these muscle cells. Therefore, we need a simple, controllable, yet biocompatible and high throughput tool to measure the cellular traction force. At the Sniadecki Lab, we are developing a new technique to measure the force generation of hiPSC-CM: dotted traction force microscopy platform. To create the platform, fluorescent proteins were first absorbed to a dotted polydimethylsiloxane (PDMS) negative and stamped onto a polyvinyl alcohol film. The film was then transferred to a soft PDMS substrate and subsequently dissolved using phosphate buffered saline solution while the patterned fluorescent proteins stained the substrate. Since the stiffness of the soft PDMS substrate is known, the force generation of the cardiomyocytes can be calculated in real time by optically tracking the deformation of the fluorescent dots. Currently, we are able to manufacture the platform with high fidelity and uniform alignment with a production time of less than 2 hours. Moreover, the cardiomyocytes can fully spread out to their in vivo state on the substrate which ensures the force measurement is valid and accurate. Potentially, this method is not limited to cardiomyocyte research and can be applied to study the interaction between force generation and cell performance of other cells. We are also exploring the possibility of automated manufacture and integration with 96-well to enable mass production.

SESSION 1T

BRAIN FUNCTION, DYSFUNCTION AND REPAIR

Session Moderator: Kathleen Millen, Pediatrics
JHN 175
12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Elucidating the Kinetics of STAT1 Phosphorylation in Response to TLR4 and IFNAR Agonists in Microglia
Rachel Anne Arnold, Senior, Neurobiology
UW Honors Program
Mentor: Jonathan Weinstein, Neurology

Ischemic preconditioning (IPC) is a robust, neuroprotective phenomenon in which a brief ischemic exposure confers resistance to injury from subsequent prolonged ischemia. Characterizing IPC may provide insight into better treatment options for those at high risk of ischemic stroke. Microglia, the immune cells of the brain, play an important role in the immune response to IPC. Previously, our laboratory found that the type 1 interferon signaling pathway in microglia is important in IPC-mediated neuroprotection. This signaling pathway is dependent upon activation of Toll-like receptor 4 (TLR4) and type 1 interferon receptor (IFNAR1). We hypothesize that in this pathway, damage-induced molecular patterns (DAMPs), which are released by brain tissues under ischemic conditions, activate TLR4 resulting in a signal cascade that activates IFNAR1, leading to phosphorylation of signal transducer and activator of transcription 1 (STAT1). Phosphorylated STAT1 (pSTAT1) then forms a complex with other proteins and induces transcription of multiple interferon-stimulated genes (ISGs). ISG expression alters the microglial phenotype, leading to neuronal and axonal protection against subsequent ischemia-related brain injury. The kinetics of type 1 interferon signaling in microglia are not yet fully understood. We aimed to further characterize this pathway by culturing primary microglia from wild-type mice, exposing them to TLR4 agonists or type 1 interferons directly, and quantifying pSTAT1 levels using flow cytometry at multiple time points. A time course of STAT1 phosphorylation in response to innate immune stimuli will provide a clearer picture of the kinetics of microglial type 1 interferon signaling in the setting of ischemia. These findings will enable us to optimize experimental timing for future experiments involving more complex and physiologic stimuli. Optimization of the kinetics of the pSTAT1 assay will also allow us to investigate how genetic ablation of specific innate immune signaling pathways (like TLR4 or IFNAR1) might modulate the microglial response to ischemia.

POSTER SESSION 2

Commons East, Easel 62
1:00 PM to 2:30 PM

New Evidence that Seasonal Flows on Mars are Dry, Windblown Sand Avalanches
Sarah C. King, Senior, Earth & Space Sciences (Physics)
Mentor: Jonathan Toner, Earth and Space Sciences

Recurring slope lineae (RSL) observed on Mars appear to be flows of liquid water because they seasonally propagate down sunny slopes in the spring and fade during the winter. Liquid water suggests the potential for life on Mars' surface and has implications for future exploration; however, recent hypotheses contend that RSL form via dry sand avalanches. To test wet vs. dry flow hypotheses, we analyzed images and topographic data from Garni crater taken by the High Resolution Imaging Science Experiment (HiRISE) during the Martian summer and winter. Our results show that RSL size correlates with areas where we expect high windblown sand deposition, such as on the SE lee side of the crater, or in small gullies below large headwalls. Additionally, RSL do not appear on the wind-scoured NW side of the crater. These surface relationships indicate that RSL in Garni crater form via a dry process in which windblown sand is deposited by prevailing NE winds and seasonally avalanches down steep slopes. To further test our conclusions, we are examining additional confirmed RSL sites on Mars to see if they display the same behavior.

POSTER SESSION 2

Commons West, Easel 24
1:00 PM to 2:30 PM

The Effects of Chronic L-DOPA on Operant Responding for Alcohol in Rats
Ivan Soto, Junior, Pre-Sciences
Mary Gates Scholar
Kayla Wang, Senior, Psychology
Mentor: Nathan Holtz, Psychiatry and Behavioral Sciences

Dysregulation of the dopamine system is a central mechanism driving substance use disorders. Our laboratory has shown that chronic cocaine consumption decreases dopamine release in the nucleus accumbens of the rat, which is a brain area that is important in reinforcement learning. This study also found that restoring dopamine transmission through the administration of the dopaminergic drug, L-DOPA, decreased their cocaine consumption. Recently, we have also shown that acute administration of L-DOPA decreases ethanol (EtOH) intake. Thus, the present study sought to examine the effects of chronic L-DOPA on operant responding for EtOH in adult male rats. Rats were presented with a 2-bottle choice between an EtOH (20%) solution or water,

daily for 21 days. Next, animals made nose poke responses (FR1) for 0.2 mLs of an EtOH (20%) solution over 1-h daily sessions for 35 days. On Days 26-35, rats consecutively received either vehicle or L-DOPA (30 mg/kg) for 5 days, counterbalanced across days, and L-DOPA decreased operant responding for EtOH compared to VEH. We are presently examining the effects of L-DOPA on dopamine release during operant responding for EtOH. Together, these data may suggest the efficacy of L-DOPA as a treatment for patients with alcoholism.

POSTER SESSION 2

Commons East, Easel 63

1:00 PM to 2:30 PM

Investigating Wetted Slope Streaks in the McMurdo Dry Valleys, Antarctica: Do Similar Flows Form on Mars?
Ping Chun Lin, Senior, Earth & Space Sciences (Physics)
Mentor: Jonathan Toner, Earth and Space Sciences

Seasonal dark streaks on Mars known as Recurring Slope Lineae (RSL) propagate down steep, warm slopes and appear to be liquid water flows. However, the mechanism behind RSL formation is controversial, and both dry granular flow and percolating water hypotheses have been proposed. To determine if water is responsible for RSL formation, I investigated similar dark streaks generated by percolating water in the McMurdo Dry Valleys (MDV) of Antarctica, an extremely cold and dry Mars analog site. The goal of this research is to identify the source of water to the MDV streaks, and to compare the MDV streaks to Martian RSL. I characterized the MDV streaks by (1) analyzing a ˜30-day time-lapse video of the streaks collected on site, (2) investigating the drainage hydrology, and (3) comparing hundreds of satellite images of the streaks from 2003-2017. My results show that the MDV streaks are very different from Martian RSL, which indicates that water is not involved in RSL formation. Unlike Martian RSL, I found that MDV streaks propagate downslope at much slower rates compared to Martian RSL, and do not grow and retreat seasonally. Furthermore, MDV streaks have distinctive patterns not apparent in Martian RSLs, and rapidly darken/lighten in response to relative humidity changes. Finally, MDV streaks form in response to extremely warm summer temperatures, conditions which are unlikely to prevail on Mars. These results are important for understanding how and if liquid water occurs on Mars' surface.

POSTER SESSION 2

MGH 241, Easel 137

1:00 PM to 2:30 PM

Integrated Point-of-Care Extraction and Detection of Nucleic Acids through Novel Isotachophoresis Design
David Curtis Juergens, Senior, Chemical Engr: Nanosci & Molecular Engr
Mentor: Jonathan Posner, Mechanical Engineering
Mentor: Andrew Bender, Mechanical Engineering

Nearly 22 million HIV-positive people are receiving antiretroviral therapy in order to suppress their HIV infections. They need consistent viral load monitoring to track viral suppression and detect the possibility of viral rebound. Nucleic acid amplification tests (NAATs) are used to measure the viral load in a patient's blood. Traditional, laboratory-based NAATs require complex robotic systems to automate HIV RNA purification, amplification, and detection from blood. Since the majority of those living with HIV are located in low and middle income countries, there is a need for rapid viral load monitoring at the point of care (POC). We aim to provide accessible HIV viral load testing through low-cost, integrated POC NAAT devices. These proof-of-concept devices operate as a two-step assay to extract and detect nucliec acids in blood. An electrophoretic separation technique called isotachophoresis (ITP) separates HIV RNA from other components in a blood sample. An isothermal nucleic acid amplification assay amplifies the purified, concentrated nucleic acids in order to detect and quantify their presence. We present our development of a novel ITP system to remove potent contaminants from Proteinase K (PK) digested serum and extract highly pure nucleic acids automatically. Through computational modelling, a dual trailing electrolyte (TE) buffer system was designed to exploit the isoelectric point of PK for its removal, while simultaneously concentrating nucleic acids away from serum components. We demonstrate system control through comparison of experimental observations to model predictions by performing dual-TE ITP on pH paper. We also show that the dual-TE system improves upon previous limits of detection for DNA extraction and detection from complex samples. Our system processes 40 microliters of blood in 20 minutes using only simple buffers, a paper strip and an electric field - making it an ideal tool for use in a rapid NAAT for HIV viral load testing.

POSTER SESSION 2

Commons East, Easel 73

1:00 PM to 2:30 PM

How is Germination Affected by Identity and Concentration of Leaf Extracts?
Sophia Basil, Senior, Environmental Science & Resource Management, Biology (Plant)
Mentor: Jonathan Bakker, Environmental and Forest Sciences
Mentor: Loretta Rafay, SEFS

Secondary metabolite chemicals are specialized chemicals produced by plants that serve specific roles in plant survival beyond aiding in growth or development. Sometimes, the presence of these chemicals negatively impacts surrounding species, a phenomenon known as allelopathy; an example of this is the inhibition of germination of neighboring species. One common non-native species that is known to have high concentrations of leaf secondary metabolite chemicals is *Plantago lanceolata* (ribwort plantain). Focusing specifically on prairies ecosystem implications, this experiment aims to test the allelopathic effects of *Plantago* leaf secondary chemicals on the germination of native prairie species. The predicted outcome of this experiment was that increased concentrations of *Plantago* extractwould lead to decreases in germination quantity. To accomplish this, numerous extraction concentrations (including a controlled no-extract treatment) of *Plantago* leaf chemicals was applied to several prairie species. These species were additionally tested in the presence of high concentrations of yarrow and lettuce extracts; yarrow is another species that contains high concentrations of secondary chemicals, while lettuce leaf material lacks substantial secondary metabolites. Prairie seeds germinated in the presence of secondary chemical extracts include yarrow, Oregon sunshine, Roemer's Fescue, Blue wildrye, and *Plantago.* 1,400 seeds per species were placed in petri dishes and germinated in either spring or summer growth chambers based on each species' germination requirement. Germination data were analyzed to determine the significance of germination inhibition by each leaf extract. Because *Plantago* is a non-native and potentially invasive species, it is important to understand the potential for native ecosystem disruption. Additionally, since yarrow and *Plantago* seeds were germinated in the presence of extracts from their own species, we could determine whether extracts have stronger effects on disparate species than on the species that the extract is derived from.

SESSION 2E

ANIMAL RESPONSES TO THEIR ENVIRONMENT

Session Moderator: Jay Parrish, Biology

MGH 238

3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

The Effects of Chronic L-DOPA on Operant Responding for Alcohol in Rats

Kayla Wang, Senior, Psychology
Mentor: Nathan Holtz, Psychiatry and Behavioral Sciences
Mentor: Paul Phillips, Psychiatry & Behavioral Sciences

Dysregulation of the dopamine system is a central mechanism driving substance use disorders. Our laboratory has shown that chronic cocaine consumption decreases dopamine release in the nucleus accumbens of the rat, which is a brain area that is important in reinforcement learning. This study also found that restoring dopamine transmission through the administration of the dopaminergic drug, L-DOPA, decreased their cocaine consumption. Recently, we have also shown that acute administration of L-DOPA decreases ethanol (EtOH) intake. Thus, the present study sought to examine the effects of chronic L-DOPA on operant responding for EtOH in adult male rats. Rats were presented with a 2-bottle choice between an EtOH (20%) solution or water, daily for 21 days. Next, animals made nose poke responses (FR1) for 0.2 mLs of an EtOH (20%) solution over 1-h daily sessions for 35 days. On Days 26-35, rats consecutively received either vehicle or L-DOPA (30 mg/kg) for 5 days, counterbalanced across days, and L-DOPA decreased operant responding for EtOH compared to VEH. We are presently examining the effects of L-DOPA on dopamine release during operant responding for EtOH. Together, these data may suggest the efficacy of L-DOPA as a treatment for patients with alcoholism.

POSTER SESSION 3

Commons West, Easel 14

2:30 PM to 4:00 PM

Fragile Race Avoiding and Overall Racism In White Undergraduates

Priscilla C. Nguyen, Sophomore, Biology (Molecular, Cellular & Developmental)
Grace Bahn, Junior, Psychology
Oluwapelumi E (Pelumi) Ajibade, Senior, Psychology
Undergraduate Research Conference Travel Awardee
Mentor: Jonathan Kanter, Psychology

Fragile race avoiding is defined as the tendency to refrain from talking about race or racial issues to hide one's bias due to sensitivity concerning the topic. Some even demonstrate discomfort or incoherence when directly talking about racial issues. This is common amongst whites who want to avoid conflict regarding racism. Although white people may believe that avoiding racial topics stops disagreements from arising, fragile race avoiding can promote ignorance about stereotypes and inhibit cultural awareness. We believe that this is a method in which individuals suppress their discomfort towards blacks. Therefore, we predict that a higher score on fragile race avoiding will correlate with higher levels in overall racism. We tested this prediction in a study in which UW undergraduate students talked about various scenarios with a research confederate to prompt a discussion about current day racial issues. Coders watched these taped interactions and rated various categories of microaggressions on a scale from zero to three. Scores of zero for fragile race

avoiding indicates that the research participant is comfortable talking about racial issues and brings up race without being prompted by the confederate. Meanwhile scores of three indicate that the participant actively avoids mentioning race and shows palpable discomfort throughout the interaction. For the scores on overall racism, coders considered the interaction as a whole and determined how black individuals would feel when in a room with the participant. A score of zero represents comfort and understanding of the racial implications these topics were created to induce, while a three shows that the participant's racist beliefs are explicit and clear. We hypothesize that there will be a positive correlation between the scores on fragile race avoiding and overall racism, indicating that fragile race avoiding is a modern form of racism in which individuals suppress their discomfort among blacks.

POSTER SESSION 4

MGH 241, Easel 146

4:00 PM to 6:00 PM

Causal Inference with Complex Networked Dynamical Systems

George Stepaniants, Senior, Mathematics (Comprehensive), Computer Science
Mary Gates Scholar
Mentor: J. Nathan Kutz, Applied Mathematics
Mentor: Bingni Brunton, Biology

Causal inference is a large and long-standing field that attempts to answer a very fundamental question: does X cause Y? This question arises in many fields such as healthcare, genomics, biology, and econometrics. The complex systems analyzed in these fields often have many interacting components mathematically represented as nodes and edges (connectivity) of a network. Network inference is the study of the time-dependent behavior of these nodes to reverse-engineer the network connectivity. The theory of causal inference has many contending definitions of causality such as state-of-the-art techniques Granger Causality (GC) and Convergent Cross Mapping (CCM). These algorithms are computationally tractable and easy to use but require strong mathematical assumptions. We simulate networks of harmonic and Kuramoto oscillators and attempt to reconstruct their ground-truth network structure using observations of oscillator displacements over time. Our analysis investigates the performance of inference methods on Erdos-Renyi and scale-free random graphs. We show that the GC and CCM inference methods systematically fail to determine network structure by returning overly sparse or dense connectivity results. These findings challenge the applications of such top-down inference approaches to physical and biological systems. Using a few basic assumptions, we demonstrate how networked systems of coupled oscillators can be successfully reconstructed if perturbations of the system are allowed. We propose a Perturbation Causal Inference (PCI) algorithm that uses systematic perturbations and tracks how perturbation cascades spread through the network. Using changepoint detection, correlation, and windowed variance statistics, we predict causal relationships between nodes in the graph. Our analysis shows that PCI works at scale and efficiently returns high accuracy reconstructions of large networks with varying coupling strengths and connectivity structures. We conclude by proposing future applications of perturbation inference methods into neuroscience and make a connection with Hebbian learning rules.

POSTER SESSION 4

MGH 241, Easel 132

4:00 PM to 6:00 PM

The Effects of Aspirin on Platelet Mechanics of Males and Females

Kenia Diaz, Senior, Biology (Physiology), English
Mary Gates Scholar
Mentor: Nathan Sniadecki, Mechanical Engineering
Mentor: Molly Mollica, Bioengineering
Mentor: Kevin Beussman

Platelets seal wounds in blood vessels in order to prevent blood loss. When there is an exposed vascular matrix, platelets bind at the wound site through the glycoprotein (GP) Ib-IX-V complex. Glycoprotein receptors allow platelets to initiate homeostasis by forming attachments to the damaged tissue. Platelets use their glycoprotein receptors to form bridges between other platelets and the surrounding proteins that form the clot within the blood vessel. Aspirin, a common household medication, produces its effects through inhibition of thromboxane production which prevents the formation of these blood clots by meddling with platelet aggregation. Standard doses of aspirin for an adult are 81mg, 325mg, and 500mg. However, there could be differences between male and female platelets, indicating that there may be different amounts of glycoprotein receptors between males and females. Here, we evaluated the force of single platelets without aspirin in males and females and single platelets with aspirin in males and females by using a reference-free traction force microscopy (TFM) platform. This TFM platform contained a grid of a fluorescent protein at known locations and was coated with von Willebrand Factor (VWF) to mediate platelet binding. Immunofluorescent staining and fluorescent imaging was conducted to visualize to platelet f-actin, a cytoskeletal component, and GPIb. Platelet binding, spreading, and contraction is observed on these substrates. By placing the platelets on the substrate, we are able to measure the deflection of the grid and determine the force a single platelet generates. In the future, we hope to measure the force of platelets at 0mg, 81mg, 325mg, and 500mg between men and women and hope to elucidate how GPIb expression, platelet

mechanics, and response to aspirin varies in males and females.

POSTER SESSION 4

MGH 241, Easel 147

4:00 PM to 6:00 PM

Enforcing Symmetries and Conservation Laws in Dynamical Systems Inference

Mason Daniel Kamb, Senior, Computer Science
Mary Gates Scholar
Mentor: J. Nathan Kutz, Applied Mathematics
Mentor: Steven Brunton, Mechanical Engineering
Mentor: Eurika Kaiser, Mechanical Engineering

Dynamical systems are ubiquitous in science and engineering. Inferring the mathematical laws that govern dynamical systems typically requires a 'scientist-in-the-loop' to guide the discovery process, via their expert knowledge and intuition about the system. Getting computers to perform this task automatically, without the guidance of a domain expert in the loop, is a grand challenge in the field of data science. A number of algorithms have been developed to infer such laws. One leading algorithm is Sparse Identification of Nonlinear Dynamics (SINDy), which applies simple linear regression coupled with sparsification to optimize a model over a large library of candidate functions. This algorithm is purely data-driven and makes no use of information that may be known previously about the dynamical system, such as symmetries and conservation laws. In this work, we develop a framework for incorporating and enforcing symmetries and conservation laws in SINDy so that the inferred models are consistent with prior domain knowledge. We analytically show how to propagate symmetries and conservation laws through the SINDy function library, and from this analytically derive linear constraints on the resultant linear regression. These constraints can be incorporated into the regression problem using options available in standard quadratic optimization packages. We implement this method and show that it provides improved accuracy and robustness on the task of inferring several canonical dynamical systems.