UNIVERSITY of WASHINGTON

Undergraduate Research Symposium May 17, 2019 Mary Gates Hall

Online Proceedings

SESSION 1P

MCNAIR SESSION - BIOLOGICAL MANIPULATIONS TO DEVELOP MEDICAL AND ENVIRONMENTAL INTERVENTIONS

Session Moderator: Barbara Juarez, Psychiatry
MGH 295
12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Kv7.3 Potassium Channels on Midbrain Dopamine Neurons Regulate Fear Discrimination
Adriana Mendez, Senior, Biology (Molecular, Cellular & Developmental)
Louis Stokes Alliance for Minority Participation, McNair Scholar
Mentor: Larry Zweifel, Psychiatry and Pharmacology
Mentor: Barbara Juarez, Psychiatry, University of Washington school of medicine

The ability of an organism to dissociate environmental cues for either safe or threatening situations is key for survival. Generalized fear is an adaptation in which behavioral responses for threatening stimuli are produced to non-threatening cues. In mice, discriminative or generalized fear responses are modeled using a fear conditioning paradigm of two shock intensities, 0.3 mA or 0.5 mA. Mice trained at 0.3 mA intensities could discriminate between safe and threatening cues, yet mice trained at a 0.5 mA intensities displayed generalized fear behavioral responses. Previously, we had identified that dopaminergic neural activity was critical for the ability to discriminate between cues when shocked at 0.3 mA. Dopamine neurons express Kv7.3 potassium channel subunits, which modulate neural activity. I hypothesized that Kv7.3 subunits on dopamine neurons would be critical to threat discrimination and mice that had undergone mutagenesis of Kv7.3 would show generalized fear discrimination. My approach used transgenic mice expressing Cre-recombinase and viral-mediated gene delivery of cre-inducible CRISPR-Cas9 plasmids targeted for the specific mutagenesis of Kv7.3. Mice underwent a three day paradigm known as fear conditioning. Baseline freezing behavior was assessed by playing two tones, A and B. This was followed by fear conditioning trials where at the end of tone A, mice received a shock of either 0.3 mA or 0.5 mA (CS+) and at the end of tone B, mice received no shock (CS-). On the third day, mice underwent a probe trial to assess final ability to discriminate between threatening and non-threatening cues. These findings could provide insights into the mechanisms underlying neurological disorders and serve as a guide for future pharmacological interventions.

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 80

1:00 PM to 2:30 PM

Using Business Intelligence to Predict Consumer Behavior: An Executive Approach

Christine Ngoc Nguyen, Recent Graduate,
Arrido Arfiadi, Recent Graduate,
Mentor: Xiahua (Anny) Wei, School of Business, University of Washington, Bothell

Business intelligence (BI) utilizes data analytics to strategize decision-making for businesses to improve performance and sustain competitive advantage. Our goal in this research is applying machine learning and data science to predict customer purchase behaviors in order to illuminate the value of BI. We collected and compiled 3 million daily transaction-level data from a popular online grocery in 2017. The dataset details items purchased and items reordered for each transaction, as well as the time when the customer last ordered. We proposed multiple predictive models where key variables are determined through a feature selection. The estimation of our models enabled us to predict when a customer makes their next purchase, to suggest complementary products for customers, and to calculate the probability of an item being reordered. These results provide important managerial insights into improving the key performance indicators (KPI) of the online grocery business. Our BI research framework is applicable to other businesses with large volume of customer transaction data, where machine learning and data science is useful to identify growth opportunities and prescribe competitive strategies for the business.

POSTER SESSION 4

Balcony, Easel 93

4:00 PM to 6:00 PM

Heats of Adsorption of N2, CO, Ar and CH4 versus Coverage on the Zr-Based MOF NU-1000: Measurements and DFT Calculations

Graeme Oliver Vissers, Senior, Biochemistry
Mentor: Oscar Vilches, Physics
Mentor: Charles Campbell, Chemistry
Mentor: Wei Zhang, Chemistry

Metal-organic frameworks (MOFs) represent an important new class of adsorbent materials, catalysts, and catalytic supports. As such, it is important to fundamentally understand its adsorption capacity and selectivity of simple gases. NU-1000 is a prototypic zirconium-based MOF which has shown to be thermally stable up to 250 C and has a number of interesting catalytic and adsorbent properties. It is composed of zirconium oxide nodes connected by pyrene linkers with COO- end groups. We determined the isosteric heats of adsorption (Qst) versus coverage of four gases (N2, CO, Ar, and CH4) on NU-1000 by measuring volume-pressure equilibrium isotherms at very low coverages (under 0.1 monolayer) and above 90K. We then compared our experimental measurements to density functional theory (DFT) calculations of adsorption enthalpies at 77 K for the zero-coverage adsorption of the same gases at seven different types of sites of the MOF lattice. These comparisons showed remarkable agreement between the measured and theoretical isosteric heats in trend as well as reasonable agreement in magnitude, indicating that the sites predicted by DFT calculations are populated sequentially in order of decreasing absolute enthalpyt. This study further increased our understanding of adsorption on this prototype MOF at very low coverages and reaffirmed the accuracy of theoretical calculations.

POSTER SESSION 4

Commons East, Easel 82

4:00 PM to 6:00 PM

Understanding the Demand on WA I-405 HOV Lanes through Economics

Elaine Montes, Graduate, Policy Studies (Bothell Campus)
Christine Ngoc Nguyen, Recent Graduate,
Yann Ka Shaw, Recent Graduate,
Dan Ye, Fifth Year, Business Admin (Supply Chain Management)
Mentor: Xiahua (Anny) Wei, School of Business, University of Washington, Bothell

The Washington State Department of Transportation (WSDOT) implemented a fifteen-mile stretch of toll lanes between Bellevue and Lynnwood in 2015. The purpose of our research is to apply economic principles and data analysis to understand how commuters respond to toll fares and the effect of toll lanes on traffic trends on I-405. We obtained hourly individual transaction data in 2018 from WSDOT. The data

shows when and where an individual vehicle entered and exited the tolls, the toll fare, billing type, and travel time between toll plazas. We visualized the demand for toll plazas using hourly and daily transactions and captured factors driving the demand. We incorporated these factors into a regression model, which accounts for the variation in the day of the week, time of day, toll plaza and toll fare. After estimating the model, we identified variables important to the demand of toll lanes and traffic congestion. Our findings provide insights into improving traffic efficiency on the toll lanes, especially the HOV (high-occupancy vehicle) lanes. Our research is applicable to other studies related to toll lanes design and traffic optimization.