# IGRAD

3rd Annual Interdisciplinary Graduate Research & Discovery Conference 2021

# Abstract Book

University of Toronto, Scarborough Campus

May 14-15, 2021

## Session 1 | May 14 1:30 – 2:30

**Measuring and predicting the intention-behavior gap**
Wilson, Daniel and Hutcherson, Cendri (short talk)

The intention-behavior gap, that vexing estrangement between what we intend to do and our actions, is a topic that has been considered across a variety of contexts. From economists distinguishing between stated and revealed preference, to the concept of "involuntary manslaughter" in the law, we are often forced to grapple with this idea of misalignment between our rational intentions and the boots on the ground reality of our actions. As Whitman pointed out, we contain multitudes, and within those multitudes is both the person who decided, in the morning, to go to bed at 10pm, and the one who is up past midnight watching one "last" episode on Netflix. While there has been a great deal of interest in distinct manifestations of this intention-behavior gap, and specifically whether we can reduce the gap in certain contexts to practical effect (e.g. growing voter turnout, increasing gym visits), it has received surprisingly little consideration as a cohesive higher level construct. Gaining understanding of an individual's trait and state intention-behavior gap levels would be key in terms of designing critical individually targeted interventions that could help minimize this gap. As a first step toward this end I am developing a program of research that looks to use our modern tools and affordances (specifically recurrent neural networks and passive data collection via smartphones) to create a predictive model of an individual's intention-behavior gap, which would seek to identify points in time when an individual was about to fall into a high gap state.

**The impact of ammonia emissions on air quality in urban and remote regions**
Herrera, Beatriz and Strong, Kimberly (short talk)

Worldwide, the air quality pollutant of greatest concern is particulate matter, due to its association with premature human mortality. Recent studies suggest 10.2 million premature deaths every year due to only the fossil fuel component of fine airborne particulate matter (PM2.5). Some precursors of PM2.5 are ammonium salts that can account for up to 50% of particulate matter mass. The source of ammonium salts is atmospheric ammonia ($NH_3$), the most abundant alkaline compound in the atmosphere involved in atmospheric reactions with potential consequences to the environment, human health, and radiative forcing. $NH_3$ is primarily emitted by agricultural activities, livestock, natural sources, fertilizers, and biomass burning, and it is present in urban and remote environments. $NH_3$ emissions and depositions strongly depend on environmental conditions such as temperature and moisture. $NH_3$ has a short lifetime on the order of hours to a few days and exhibits a strong temporal and spatial variability. This research investigates atmospheric $NH_3$ in urban and remote environments, including the Arctic, using a combination of ground-based FTIR (Fourier Transform InfraRed) measurements, satellite data, and atmospheric models. This research will examine $NH_3$ variability and trends at various Network for Detection of Atmospheric Composition Change (NDACC) urban and remote sites distributed worldwide. It will also evaluate the role of atmospheric NH3 in PM2.5 formation in Mexico City's megacity and improve the understanding of the long-term impacts of boreal wildfire NH3 on the Arctic.

**Potential obesogenic effect of a complex contaminant mixture on Cree First Nations adults of Northern Québec, Canada**
Akbar, Lamia; Zuk, Aleksandra M; Martin, Ian D; Liberda, Eric; and Tsuji, Leonard JS

Obesity incidence and prevalence is of increasing concern in First Nations communities around Canada. In addition to diet and physical activity, environmental pollutants have been suggested as a potential contributory factor to obesity associated morbidity. Owing to the exposure of Cree First Nations people to various persistent organic pollutants (POPs) and toxic metals, it is important to examine the association between obesity in these communities, and contaminant body burdens. To determine whether selected morphometry measures (body mass index [BMI], waist circumference [WC] and body fat percentage) are associated with body burdens of 10 POPs and toxic metals. Using data from the Nituuchischaayihtitaau Aschii Multi-community Environment-and-Health study in the eastern James Bay (Eeyou Istchee) Cree communities, this cross-sectional study examined morphometric and contaminant measures of 695 eligible participants. Sex stratified principal component analysis was conducted on blood plasma concentrations of 10 POPs and toxic metals. BMI, WC, body fat percent, and resultant contaminant components were used to create generalized linear models, and adjusted for covariates (age, total lipids, smoking, and n-3 fatty acids). Two principal components (PCs; PC-1 and PC-2) were extracted for both males and females. For females, PC-1 explained 73.3% and

PC-2 explained 10.5%, and for males, PC-1 explained 71.6% and PC-2 explained 11.2% of the variance in contaminant burden. For both sexes, PC-1 loaded highly for polychlorinated biphenyl (PCB) congeners, organochlorine pesticides and, to a lesser extent, mercury and lead. PC-2 loaded highly for cadmium for females, and cadmium and lead for males. After adjusting for covariates, the generalized linear model showed that PC-2 was significantly and negatively associated with BMI, body fat percent, and WC in males and females. Our cross-sectional analysis indicates a negative association between cadmium with various obesity measures in both males and females. Null associations were found between PCBs and organochlorine pesticides and morphometry.

**Characterizing the Onset of the Fear Extinction Switch in Mice**
Premachandran, Hanista and Arruda-Carvalho, Maithe (short talk)

The ability to acquire fear memories is an adaptive behaviour that can enhance survival. However, heightened or dysregulated fear can promote anxiety and fear disorders, which often have their onset in early development. Despite evidence of the early incidence of mood disorders, not much is known about the maturation of neural mechanisms underlying fear regulation. Two brain regions of interest, the prefrontal cortex (PFC) and amygdala, are implicated in mental illness symptomatology and are required for fear inhibition or extinction. Importantly, PFC-amygdala circuit strengthening stabilizes at around adolescence in mice, coinciding with a remarkable switch in the way rodents extinguish fear memories. Specifically, there is a switch between an immature, permanent type of extinction that does not require the PFC, towards an adult, ineffective type of extinction that requires the PFC. However, no study to date has causally implicated the PFC-amygdala circuit in the onset of the adult-type extinction system. Our preliminary data suggests novel and exciting sex differences in the onset of the extinction switch, with females demonstrating an earlier switch. Our next step is to investigate synaptic strengthening and see whether this corresponds to the timing of the behavioural switch. We expect that age- and/or sex-specific differences in the timing of this behavioural extinction switch will correlate with the timing of PFC-amygdala synaptic strengthening.

**Interactions between respiration and photosynthesis during growth at elevated CO2**
Chadee, Avesh and Vanlerberghe, Greg C (short talk)

Plants will experience an elevated atmospheric concentration of CO2 (ECO2) in the future. Since CO2 is a rate-limiting substrate for photosynthesis, ECO2 will likely have profound and pervasive effects on carbon and energy metabolism. I am examining how ECO2 influences the metabolic interactions that occur between photosynthesis and respiration. To do so, I analyze metabolic components of chloroplasts and mitochondria that are hypothesized to maintain carbon and/or energy balance in response to environmental change. These include a chloroplast glucose 6-phosphate (G6P)/phosphate translocator called GPT3, a chloroplast G6P shunt associated with the Calvin cycle, chloroplast cyclic electron transport pathways, and a mitochondrial non-energy conserving terminal oxidase called alternative oxidase (AOX). Experiments indicate that AOX protein amount in leaves increases over time at ECO2 but not at ambient CO2. Additional experiments indicate that, along with AOX, GPT3 also responds dynamically to both short-term and long-term changes in growth CO2 concentration. Subsequent experiments aimed at manipulating the sugar and/or phosphate status of excised leaves indicate that both AOX and GPT3 gene expression are highly responsive to carbohydrate and phosphate levels, however more investigation is required to determine the functional significance of these responses. Further research will use AOX knockdown and overexpression plants to investigate the potentially complementary roles of mitochondrial respiration and chloroplast G6P transport in maintaining carbon and energy balance during growth at ECO2.

## Session 2 | May 14 3:30 – 4

**Reliable Prediction of the Octanol-Air Partition Coefficient**
Baskaran, Sivani; Duan Lei, Ying; and Wania, Frank

The octanol-air equilibrium partition coefficient, KOA, is frequently used to describe the volatility of organic chemicals, whereby the solvent n-octanol serves as a substitute for a variety of organic phases ranging from organic matter in atmospheric particles and soils, to biological tissues such as plant foliage, fat, blood and milk, and to polymeric sorbents. Because measured KOA values exist for just over 500 compounds, most of which are non-polar halogenated

aromatics, there is a need for tools that can reliably predict this parameter for a wide range of organic molecules, ideally at different temperatures. The ability of five techniques, specifically poly-parameter linear free energy relationships (ppLFERs) with either experimental or predicted solute descriptors, EPISuite's KOAWIN, COSMOtherm, and OPERA, to predict the KOA of organic substances, either at 25 °C or at any temperature, was assessed by comparison with all KOA values measured to date. A technique's performance was quantified with the mean absolute error (MAE), the root mean square error (RMSE), and the estimated uncertainty of future predicted values, i.e., the prediction interval. We also considered each model's applicability domain and accessibility. The ppLFER equation using experimental solute descriptors was best able to predict the log KOA at 25 °C and at any temperature. Even if solute descriptors have to be predicted in the absence of experimental values, ppLFERs are the preferred prediction method, also because they are easy to use and freely available.

**HIV-2, integration sites and pathology**
Kabi, Manisha and Filion, Guillaume (short talk)

Four decades ago, the HIV/AIDS pandemic started to spread through the world, becoming the most deadly spillover of our time — AIDS killed ten times more people than COVID-19. AIDS emerged from two spillovers from monkeys: one from chimpanzees that became HIV-1, and one from sooty mangabeys that became HIV-2. Patients with HIV-2 have milder AIDS symptoms than patients with HIV-1. For this reason, HIV-2 has attracted less attention from researchers, but the key mechanisms that make HIV-2 less harmful than HIV-1 are not well understood. Both viruses need to integrate their DNA into the host genome. Previous studies in HIV-1 have shown that the genomic sites of proviral integration affect the persistence of infection but almost nothing is known about HIV-2. A cohort study suggests that HIV-2 integreates more often than HIV-1 in heterochromatin where it is silenced. This could be one of the key features explaining the differences between the pathologies. Our research is focused on mapping the integration sites of HIV-2 in cell models and comparing them with available maps of HIV-1 insertion sites. In the long term, this work will help us understand the mechanisms of pathology in the HIV family of viruses.

**Coping with health threats: The costs and benefits of managing emotions**
Smith, Angela M; Willroth, Emily; Gatchpazian, Arasteh; Shallcross, Amanda; Feinberg, Matthew; and Ford, Brett Q

How people respond to health threats can influence their own health and, when facing communal risks, even their community's health. We propose that people commonly respond to health threats by managing their emotions with cognitive strategies like reappraisal, which can reduce fear and protect mental health. However, because fear can also motivate health behaviors, reducing fear may also jeopardize health behaviors. In two diverse U.S. samples (N=1,241) tracked across three months, sequential and cross-lag panel mediation models indicated that reappraisal predicted lower fear about an ongoing health threat (COVID-19), and in turn, better mental health, but fewer recommended physical health behaviors. This trade-off was not inevitable, however: using reappraisal to increase socially-oriented positive emotions predicted better mental health without jeopardizing physical health behaviors. Examining the costs and benefits of how people cope with health threats is essential for promoting better health outcomes for individuals and communities.

## Session 3 | May 15 11 – 12

**Is spatial navigation in echolocating bats affected by pesticides?**
Sandoval-Herrera, Natalia; Faure, Paul A; and Welch, Kenneth Jr

Bats are potentially exposed to pesticides by eating contaminated insects in croplands. Commonly used pesticides such as organophosphates (OPs) are neurotoxic for non-target vertebrate species and even low doses can impair essential processes such as locomotion and cognition. These neurotoxic effects are usually sublethal and can therefore be difficult to study using traditional toxicological assessments. Behavioral studies are a promising alternative to evaluate sublethal effects of pesticides on bats. Echolocating bats often develop individual stereotyped flight patterns as they become familiar with a novel space. We evaluated bats' ability to memorize and navigate a new space by comparing the consistency of flight in bats exposed and unexposed to pesticide. We orally dosed captive big brown bats (Eptesicus fuscus) with an environmentally relevant concentration of Chlorpyrifos, a common insecticide, and tracked their flight

behavior while exploring a tent. We evaluated similarity of flight trajectories within and between trials, time spent in flight, and landing frequency. We also quantified cholinesterase (ChE) activity in brain and plasma as biomarkers of potential neurotoxicity. Preliminary results suggest there is increased variability of flight trajectories in bats exposed to Chlorpyrifos within trials, and an increase in landing frequency compared to unexposed bats. Exposed bats presented a 30% reduction of ChE activity in the brain. These results support the sensitivity of behavior as a biomarker of toxicity and as a tool to elucidate potential ecological implications of anthropogenic stressors on wildlife.

**The Effects of N-Acetylglucosamine Supplementation on Galectin-Glycan Interactions in B Cells**
Yoganathan, Myuran and Treanor, Bebhinn (short talk)

B cells play a critical role in adaptive immunity by detecting and producing antibodies against invading pathogens. To initiate an immune response, B cells must bind antigens through their B cell receptors (BCRs), triggering a signaling cascade necessary for differentiation into effector cells. An important factor mediating B cell signaling is the interaction between BCRs and co-receptors. These interactions are often facilitated by galectins, a family of soluble proteins that bind and crosslink glycoproteins. For example, studies have shown that galectin-9 (Gal9) brings together IgM-BCRs and the inhibitory co-receptor CD22, thus suppressing B cell signaling. During N-glycosylation, glycosyltransferases sequentially modify and increase the branching of N-glycans, thereby increasing the avidity of galectin binding. Interestingly, these glycosyltransferases have sequentially decreasing affinities for their shared metabolite, uridine diphosphate N-acetylglucosamine (UDP-GlcNAc), suggesting that UDP-GlcNAc may be a rate limiting metabolite in N-glycan processing. Although UDP-GlcNAc is formed through the hexosamine pathway, B cells can also uptake GlcNAc directly to fuel UDP-GlcNAc synthesis. Therefore, we hypothesize that GlcNAc supplementation will increase Gal9 mediated interactions between BCRs and CD22, resulting in inhibition of B cell signaling and suppression of autoimmune disease. Through flow cytometry, we show that GlcNAc supplemented B cells have greater N-glycan branching and Gal9 binding. We also show that GlcNAc supplementation alters the spatial organization of IgM-BCR and CD22 nanoclusters on the surface of B cells. Lastly, we hope to examine whether GlcNAc supplementation is able to suppress B cell activation and autoimmune disease in a mouse model of autoimmune arthritis.

**Ventral hippocampal projections to the prefrontal cortex are necessary for approach-avoidance conflict decision-making**
Kates, Jeffrey; Cavdaroglu, Bilgehan; and Ito, Rutsuko

Aberrant 'approach-avoidance conflict' decision-making is a defining feature of various neuropsychiatric illnesses afflicting Canadians. Approach-avoidance conflicts occur when organisms encounter stimuli that signal both rewarding and aversive outcomes simultaneously. Recent evidence has demonstrated that the ventral hippocampus (VH) is critical in regulating decision-making under approach-avoidance conflict. Moreover, the infralimbic cortex (ILC) and medial orbitofrontal cortex (mOFC) – both of which display functional connectivity with the VH – are involved in outcome representation as well as determining preference for 'risky' or uncertain outcomes. However, it remains unclear how these regions interact to moderate behaviour under approach-avoidance conflict. In this study, we used a novel, operant, conflict decision-making task that required rats to choose between a low reward option or a high reward option that was paired with varying shock intensities. Post-training, projections from the VH-ILC or VH-mOFC were chemogenetically inhibited in the animals while performing the task, allowing for quantification of choice preference. We found that inhibition of VH-ILC, but not VH-mOFC, projections significantly shifted choice preference towards the conflict (high reward) option. Computational modelling of reaction-time data suggests that inhibition of VH-mOFC projections alters the accumulation of evidence necessary to make decisions at higher shock intensities. Taken together, these findings indicate that VH projections to the prefrontal cortex differentially regulate approach-avoidance conflict behaviour.

**The plastic cycle – an unknown branch of the carbon cycle**
Xia Zhu (short talk)

As a result of increased production and use of plastic in our everyday lives, large amounts of plastic pollution are ending up in the environment. Plastic may take hundreds to thousands of years to decompose, and break up into smaller and smaller pieces in the environment. Currently, the fate of plastic is poorly understood both locally and globally. How might we begin to fill this immense gap in knowledge? I argue that by using a biogeochemical cycling

framework, we can better describe the transport of plastic pollution in the environment. This framework will also help us to fill in the gaps in our knowledge of plastic cycling. For instance, places of accumulation of plastic can be referred to as “reservoirs”. The movement of plastic particles from one location to another per unit time and area can be referred to as “fluxes”. I also argue that all plastic ever produced are part of the carbon cycle, and that we need to better understand how plastic pollution influences carbon transport. To this date, over seven billion tonnes of plastic pollution have been produced from chemicals extracted from the fossil carbon reservoir. The magnitude of this pool of carbon is similar in magnitude to global carbon fluxes, and thus it is not negligible and plastics should be treated as a branch of the carbon cycle. The next step is to better understand how plastic moves carbon, and to fill in the blanks in the global plastic cycle.

## Session 4 | May 15 1:30 – 2

**Addressing the relevance of climate adaptation in Nova Scotian lobster industries – contributions to a comprehensive fact base**
Poon, Lachtin (short talk)

Two years ago, Halifax Regional Municipality declared a climate emergency, followed by the development and finally adoption of a climate adaptation plan under the name “HalifACT 2050”. The plan outlines the goals as well as actions in progress to help Halifax Regional Municipality get back on track in terms of reaching its carbon emission targets by 2050. However, one aspect that is very much lacking from this plan is a comprehensive fact base – climate change impacts, inadequately addressed secondary impacts, and adaptation options that are available to the community to tackle them. In 2012, an ocean heatwave struck the Northwest Atlantic Ocean which largely impacted the fisheries of the Province of Nova Scotia; most notably its lobster industry, where Nova Scotia contributes more than 50% of the commercial value generated by all lobster landings in Atlantic Canada combined. The phenomenon exposed and underlined the lack of preparedness of fishing industry management, their climate resilience and adaptation. In accordance with the research “milestone” outlined in the municipal adaptation framework developed by the International Council for Local Environmental Initiatives (ICLEI), large contributions are suggested to the development of adaptation options for Nova Scotia’s lobster industry under climate change in future local climate adaptation plans. Halifax and other municipalities in Nova Scotia must prepare to have alternative solutions and emergency response options should the lobster industry, an industry that many Nova Scotian communities rely on, be compromised under current drastically changing climate conditions.

**Characterizing the antiviral activity of PSGL-1 in HIV infection**
Burnie, Jonathan; Persaud, Tejnarine; Thaya, Laxshaginee; Liu, Qingbo; Miao, Huiyi; Grabinsky, Stephen; Norouzi, Vanessa; Lusso, Paolo; Tang, Vera; and Guzzo, Christina

Human immunodeficiency virus (HIV) has had a tremendous global impact with over 35 million deaths and estimates of 37 million people worldwide currently living with HIV. Although remarkable advancements in HIV treatment and prevention have been developed since the virus was first discovered, much work remains to eradicate infection on a global scale. One natural defence that the human immune system has developed to combat infection are cellular restriction factors which can perform antiviral roles against a range of different viruses. Recently, the cellular protein P-selectin glycoprotein ligand-1 (PSGL-1), a protein well characterized for its role in cellular adhesion and the trafficking of white blood cells throughout the body, was identified as a novel HIV restriction factor. Since then, several antiviral functions of the protein have been characterized. One well described antiviral function of PSGL-1 is its ability to physically incorporate into the external envelope of virus particles, which effectively reduces particle infectivity. We have performed a series of experiments to characterize the antiviral activity of PSGL-1 in the most physiological relevant samples to date, using primary cells for infection and plasma samples from HIV-infected individuals. This work provides novel evidence that HIV viruses with PSGL-1 on their surface may in fact facilitate infection rather than inhibit it.

**Nuclear magnetic resonance of living organisms – metabolite identification and monitoring in-vivo**
Lysak, Daniel H; Kock, Flavio VC; Soong, Ronald; and Simpson, Andre J

Nuclear Magnetic Resonance (NMR) is a technique that allows the non-destructive chemical analysis of samples. Similar to magnetic resonance imaging (MRI), NMR has become increasingly applied to elucidate the biochemical processes occurring in living. This study of the biomolecular "fingerprint" of an organism – metabolomics, focuses on the fluxes of important small compounds such as carbohydrates and amino acids. The organism itself is used as a "biosensor" to probe the effects of exposure to stressors such as environmental pollutants or anoxic stress. NMR has a number of advantages compared to other commonly used metabolomics techniques (namely mass spectrometry) including: non-selective detection of compounds, excellent reproducibility and facile sample preparation. NMR is the only modern analytical tool that is able to study organisms in-vivo, allowing real-time examination of permanent and temporary changes, as well as gauging recovery. However, despite these advantages, due to the complexity of living organisms, whose metabolic processes involve hundreds or thousands of compounds, NMR peak overlap and line shape is still a challenge. To address these issues, we report the use of a singlet state filter for selective identification of metabolites in in-vivo and ex-vivo Daphnia magna (water fleas). This technique allows identification and monitoring of individual metabolites (or small groups of metabolites), in complex mixtures such as living organisms. The concentrations of glucose, serine and phenylalanine were monitored and found to increase during the process of anoxic stress, and the singlet filtered helped improve line shape and greatly reduced overlap, demonstrating its potential for in-vivo metabolomics.

**Uptake of Ozone by Pollen**
Simon, Sarah and Murphy, Jennifer

Ground-level ozone is a highly reactive air pollutant, known to cause significant damage to agricultural, horticultural and wild vegetation. The main pathway of ozone damage to the plant is through its interactions with the leaves, but the effect to the reproductive organs like pollen is often ignored. The reaction of ozone with pollen is important to investigate to determine the impact on ozone concentrations, allergenicity of the pollen, and the viability of the pollen for reproduction. By exposing pollen to high levels of ozone in small air chambers we can measure the reaction of ozone to the pollen surface and determine the viability of exposed pollen grains.