THE UNIVERSITY OF BRITISH COLUMBIA

School of Biomedical Engineering

Faculties of Applied Science and Medicine

SYNERGY RESEARCH DAY

Trainee Talks

10:45AM | LSC 1003

In partnership with:

GSAT

THE UNIVERSITY OF BRITISH COLUMBIA

Michael Smith Laboratories

Djavad Mowafaghian CENTRE FOR BRAIN HEALTH

Enhanced MRI Segmentation of White Matter Lesions: A Multi-Scale Approach

Tarek Alkabbani

Dr. Teresa Liu-Ambrose Lab

The accurate segmentation of White Matter Hyperintensities (WMH) in MRI scans is crucial for the diagnosis and treatment of various neurological disorders. This project presents a novel approach that leverages the strengths of multiple Convolutional Neural Networks (CNNs) to enhance WMH segmentation. Specifically, we designed three distinct CNN models, each finely tuned to be sensitive to lesions of different sizes. The final segmentation result is derived from a weighted combination of the predictions from each model, optimizing the accuracy for lesions of varying dimensions.

This multi-model approach addresses the limitations of single-model methods, which often struggle with accurately segmenting smaller lesions, particularly those adjacent to paraventricular regions. By assigning appropriate weights to each model's output based on its performance in identifying lesions of its target size, our method aims for more reliable detection across all lesion categories. The models were trained and validated using a dataset of MRI scans annotated with WMHs. We anticipate that this approach will improve the robustness of the model for deployment in a variety of clinical settings, leading to enhanced diagnostic capabilities and better patient outcomes.

Psilocybin Macrodoses Improve Decision-Making and Impulsivity in Gambling Rats

Elena Greenall

Dr. Catharine Winstanley Lab

Animal models of gambling-like behaviour such as the cued rat Gambling Task (crGT) can be used to elucidate the underlying neural mechanisms of pathological gambling. As such, neuropharmacological agents that improve decision-making or impulsivity on the crGT may serve as potential treatments for gambling disorders. Our pilot data suggests that psilocybin macrodoses are one such compound that may attenuate risky or impulsive decisions. Thus, this experiment aimed to extend the pilot study to determine the sex-specific and dose-specific effects of psilocybin macrodoses, the length of time these effects last, and to characterise psilocybin's effect on the 2A serotonin receptor. Male and female Long-Evans rats (n = 30) were trained to stability on the crGT. Rats were given intraperitoneal injections of psilocybin macrodoses (0.3 or 1.0 mg/kg) 30 minutes prior to behavioural testing. Following a washout period, rats were given intraperitoneal injections of saline or the 2A antagonist M100,907 (0.03 mg/kg) 60 minutes prior to behavioural testing followed by psilocybin (1.0 mg/kg) 30 minutes prior to behavioural testing. At the 1.0 mg/kg but not the 0.3 mg/kg dose, both sexes showed a decrease in impulsivity for 3-4 days, while only males showed an improvement in choice score on the day of dosing. At the second administration of the 1.0 mg/kg dose, neither sex showed an improvement in choice score, but did show a shift in preference to more optimal choices in the crGT on day of dosing. This choice preference shift was not observed when administering M100,907, indicating the observed behavioural changes from psilocybin are dependent on the serotonin 2A receptor. These findings suggest there are dose and sex-dependent effects of psilocybin on decision-making and impulsivity in the crGT and validate its mechanism of action. Therefore, there is potential for therapeutic uses of psilocybin in humans with gambling disorders.

How AI Uses Tissue Images to Diagnose Rare Metastatic Cancers

Björn Holst

Dr. Ali Bashashati Lab

For most cancer subtypes, targeted therapies exist. When a cancer metastasizes, treatment becomes increasingly complex. The 5 year survival rate for metastatic cancer is 17% (stage IV) compared to 56% for pre-metastatic stage III cancer. Metastatic cancer is responsible for over 90% of all cancer deaths. Effective treatments require knowledge of the site of origin. Nonetheless, in 1-2% of all cancer cases, a tissue of origin (TOO) remains unknown. When extensive pathology, radiology, endoscopy, and laboratory evaluations fail, patients receive nonspecific combination chemotherapy with disheartening outcomes. Fewer than 25% of people diagnosed with Cancer of Unknown Primary (CUP) live past 1 year. For patients with CUP, finding a TOO is imperative. As digital pathology gains popularity, an increasing amount of hospital imaging and omics data is digitized and stored. Foundation models trained on cancer histology data are continually improving as data availability rapidly increases. These models are powerful encoders of histology data into relevant, tissue related features. We hypothesize that these large models, despite never having seen rare cancers, contain important features and biomarkers necessary for rare metastatic cancer discovery. Our project aims to leverage the representations of these foundation models to perform TOO discovery inexpensively and explainably for in-hospital contexts. We use whole slide image (WSI) encodings from these models to perform downstream TOO classification using lightweight multi task networks and data-driven unsupervised learning. The results are explainable organ predictions that support pathologists rather than replace them.

Investigating Silicon Photonic Biosensors For Hormone Measurement During Perimenopause

Myra Wei

UBC Biosensors Team

Menopause is clinically confirmed following twelve months without menstruation – after an average of seven years during which symptoms of the menopausal transition significantly impact quality of life. Surveys have shown that participants feel their symptoms have affected their work performance, with loss of productivity or loss of income from needing to reduce working hours. As these symptoms are linked with fluctuating hormone levels, frequent quantification of multiple hormones can give insight into forming a prospective diagnosis and allow for personalized treatment plans. However, existing quantitative methods for hormone measurement are practically infeasible for the required frequent monitoring as they are costly, time consuming, require trained professionals, and/or are unable to monitor enough hormone targets for this application. Silicon photonics (SiP) combined with microfluidics is a promising solution to achieve these quantification goals in a low-cost, point of care “biosensor” system. SiP biosensors can detect hormones in fluids by measuring changes in refractive index at the surface of the sensor when hormones are captured onto it. A microfluidic chip enables precise control and delivery of fluid to the sensor surface. This poster details the preliminary research towards simultaneous detection of multiple hormones on a SiP platform. It includes contributions to characterizing the sensor performance, risk mitigation of the microfluidic setup, and a plan to demonstrate hormone detection that is relevant to the menopausal transition. These experiments aim to deepen our knowledge of the biosensors, enabling informed research decisions and encouraging project success.

IBD Microbiota Modulates Mucus & Butyric Acid Production in Human Microbiota-Associated Mouse Model

Brian Deng

Dr. Carolina Tropini Lab

Inflammatory bowel disease (IBD) affects millions of people worldwide and is characterized by chronic and relapsing inflammation of the gastrointestinal (GI) tract. Trillions of microorganisms such as bacteria reside within the GI tract, collectively termed the microbiota, and play a crucial role in human health, producing anti-inflammatory compounds such as short-chain fatty-acids (SCFAs). Patients with IBD have an altered and less diverse microbiota, which is associated with worse health outcomes, and are known to have lower levels of SCFAs, specifically butyric acid. In this study, we aimed to explore how an IBD microbiota can modulate gut physiology and SCFA levels in the absence of inflammation. We therefore transplanted fecal samples of patients with IBD (IBD-microbiota) or healthy controls (HC-microbiota) into mice lacking a microbiota. After four weeks of microbiota stabilization, we characterized the bacterial community and SCFA concentrations in cecal contents and intestinal health via microscopy. IBD-microbiota mice displayed reduced bacterial diversity, lower butyric acid concentrations, and altered intestinal mucus, an essential layer protecting the host from microbial invasion. As the microbiota is known to degrade the mucus layer, we investigated the gene functions present in both microbiotas. We found that predicted mucus degradation pathways were enriched in IBD-microbiota mice, while butyric acid production pathways were depleted, consistent with our experimental findings. Overall, our data suggest that loss of specific members of the microbiota leads to profound changes in mucus, SCFA levels, and predicted microbiota function. Further research is required to elucidate mechanisms by which specific bacteria influence gut physiology, potentially paving the way for targeted microbiota-based therapies.

ABOUT SBME SYNERGY

The SBME Synergy Undergraduate Summer Research Program is a fantastic opportunity for students to gain paid hands-on research experience in one of UBC's world-class biomedical engineering labs; partners include researchers from the Djavad Mowafaghian Centre for Brain Health (DMCBH), the Genome Science and Technology Graduate Program (GSAT), the Michael Smith Laboratories, and of course, SBME.

During the program, students work on a defined research project with a UBC supervisor, participate in professional development programming, network at student socials, and present their research at our Synergy Research Day.

SBME Synergy awards are open to all undergraduate and medical students.

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