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Connecting Young Minds (CYM) 2023 Undergraduate Research Conference: 5-Minute Scientific Research Presentations

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Abstract
Connecting Young Minds (CYM) is a bilingual research conference created and run by students at the University of Ottawa. Our mission is to enrich the undergraduate experiences of STEM students by providing a vessel to inspire interest in research, paving the way for brighter futures and innovative minds. The conference allows students to present or propose their research to an audience and a panel of judges, gain experience drafting scientific literature, and the chance to network with industry professionals and past valedictorians from the University of Ottawa. Each year, CYM hosts an undergraduate-level research competition in which participants submit an abstract or a proposal on their research. Top candidates are selected by a panel of professional scientists to further compete at the conference, where they are given five minutes to present their research followed by a Question & Answer period. Oral presentations are also judged by professional scientists and three grand winners are selected on the conference day. Additionally, the CYM Conference engages the interests of students in STEM programs through presentations and networking sessions held by keynote speakers. Abstracts in this booklet were submitted by participants on a volunteer basis.

Keywords: Connecting Young Minds; undergraduate research conference; bilingual conference; scientific research; abstract competition; research presentations; science; technology; engineering; math

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Conference Abstracts

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Connecting Young Minds 5-Minute Scientific Research Presentation Abstracts

A single-cell molecular atlas of murine ventricular septation

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Ventricular septal defects, the most common form of congenital heart disease, result from incomplete closure between the left and right ventricles. This septation process is known to be governed by an intricate genetic network, yet the cellular origin of the ventricular septum and its regulatory mechanisms remain to be further elucidated. Utilizing single-cell RNA sequencing (scRNA-seq) datasets of developing murine hearts (GSE193346), my preliminary analysis revealed that *LysM*, conventionally recognized as a macrophage marker gene, is specifically but transiently expressed in developing ventricular septal cardiomyocytes from embryonic day 9.5 (E9.5) to E14.5. Additionally, lineage tracing using postnatal *LysM-Cre;Rosa26*^{TdTomato} reporter mice showed the exclusive red fluorescence of TdTomato protein in the interventricular septum. Collectively, these findings prompted us to postulate that the mature ventricular septal cells are developmentally originated from LysM-expressing cells in early embryonic hearts. However, the cellular and molecular mechanisms of this developmental process have not been explored. In this proposed study, I aim to build a molecular map of ventricular septal development at single-cell resolution. To achieve this, I will isolate LysM-lineage cells at three developmental stages of *LysM-Cre;Rosa26*^{TdTomato} mice (E10.5, E16.5 and P7) by flow sorting and subject them for multiomic profiling of the transcriptome and epigenome at single cell resolution (scRNA-seq and scATAC-seq). The resulting dataset will be bioinformatically analyzed with three overarching objectives. Firstly, this data will unveil distinct cell populations and gene expression patterns that may have been overlooked in traditional bulk analyses. I will next conduct a trajectory analysis to reconstruct the developmental trajectory of ventricular septation, identifying critical transition points and potential molecular regulators. Additionally, I will construct potential gene regulatory networks guiding ventricular septation using the SCENIC+ package. By unveiling these intricacies, this study holds potential for identifying novel therapeutic targets relevant to congenital heart anomalies and cardiac tissue regeneration.

Leveraging functional genomics to explore the vulnerabilities in the human fungal pathogen *Candida albicans*

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Fungal diseases lead to 1.6 million deaths annually across the world. *Candida albicans*, a human commensal fungus classified by the WHO in the "critical priority group" of fungal pathogens, causes invasive fungal infections mainly in immunocompromised patients with a mortality rate up to 40%. These infections are very difficult to treat, as treatment options are limited to only 3 major classes of antifungals, and rampant resistance development against each of these drugs is exacerbating their lethality. To combat this crisis, we sought to discover novel antifungal targets that function in the calcineurin pathway that governs key virulence phenotypes in *C. albicans*, by leveraging a functional genomics approach using the Gene Replacement and Conditional Expression (GRACE) mutant library. Each mutant strain has one allele of a specific gene replaced with a *HIS3* marker and the remaining allele under the control of a tetracycline repressible promoter. During the summer, we constructed 273 new GRACE mutants and improved the library coverage of the *C. albicans* genome from 67% to 71%. The entire library was then screened in the presence of FK506, an inhibitor of the calcineurin pathway. Growth of each strain in rich media supplemented with doxycycline (DOX, a tetracycline analogue) and DOX with FK506 were assessed by measuring OD600 at 48 hours. Median absolute deviation (MAD) cutoffs were used to identify strains growing well in DOX but showed little-to-no growth in DOX with FK506. A total of 69 hits were identified as important for *C. albicans* tolerance to FK506, including genes involved in cytoskeleton organization and glycosylation, many of which were previously unknown in the calcineurin pathway. Current steps involve validating these hits according to a multiplicative model and exploring their role in the calcineurin pathway.

Virtual reality companion for dementia patients in long-term care: A feasibility study

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This project focuses on addressing the issue of social isolation among persons with dementia (PWDs) in long-term care (LTC) through the development of an innovative immersive virtual reality (VR) application. The application features an autonomous artificial companion in the form of an avatar, capable of engaging in verbal conversations with PWDs using embedded microphones and speakers in VR goggles. The trial involving 10 PWDs revealed that the virtual companion sparked engagement and positive memories, though challenges like speech recognition software difficulties and varying dementia severity were observed. The study underscores the potential of VR to enhance PWDs' quality of life by mitigating social isolation, emphasizing the need for refining conversation dynamics and accommodating different levels of dementia. This work holds significance in the healthcare realm by showcasing the promise of immersive VR to alleviate social isolation among PWDs, with future iterations potentially incorporating advanced AI-driven conversation capabilities.

Concurrent administration of amiloride and pioglitazone: A novel approach to type-2 diabetes management

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Patients with diabetes are statistically four times more likely to die of heart disease complications. Pioglitazone is an FDA-approved drug known for increasing cardiorespiratory fitness (CRF) in patients with type 2 diabetes (T2D), a common risk factor in T2D medications. However, this drug has been found to cause renal water retention, and the mechanism underlying this side effect is not clearly understood. Therefore, it is crucial to develop an alternative low risk medication for insulin-resistant patients at risk of cardiovascular diseases. On the other hand, Amiloride is a drug known to decrease renal water retention without altering the glucose lowering mechanisms of T2D drugs. Therefore, we hypothesize that Amiloride will reduce renal water retention caused by Pioglitazone and increase CRF. Based on previous studies, we will conduct our research on T2D db/db mouse model. The negative control group will consist of mice group injected with saline, the controlled group with Pioglitazone, and the experimental group with Pioglitazone and Amiloride. We will monitor blood glucose levels, hematocrit concentrations, and CRF markers like heart rate, lactate levels, and VO2 peaks. Our predicted results will show that the combined drug therapy preserves Pioglitazone's glucose-lowering and CRF-enhancing roles while reducing renal water retention. Our overall aim is to develop a combined drug therapy that lowers blood glucose levels, enhances CRF, and minimizes renal water retention. Our study will promote advancing the combination to clinical trials and noticeably improve T2D treatment via furthering investigations on the efficacy of combined drug therapy in patients.

Investigating spring migration timing and activity patterns of silver-haired bats (*Lasionycteris noctivagans*) in Waterloo, Ontario

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Silver-haired bats (*Lasionycteris noctivagans*) undertake extensive spring migrations covering hundreds or even thousands of kilometers. A timely migration is crucial for successfully raising pups. However, research on bat activity during these migrations is limited. Addressing this gap can help mitigate human infrastructure conflicts during migrations and enhance conservation efforts. Our focus is on determining migration timing and activity patterns of *L. noctivagans* in Waterloo, Ontario. My hypothesis suggests *L. noctivagans* will pass in two waves, the first attributed to females with the incentive to raise pups. We compared activity with non-migrating Big Brown bats (*Eptesicus fuscus*) to identify migration-associated variations. Four acoustic monitors were placed near forest edges or calm water to record echolocation calls. From April 9 to June 18 2023, 9712 echolocation calls were identified from both focal species. Recordings were sorted and given a species identification using the SONObat software. *Lasionycteris noctivagans* were coming through in a single wave and activity persisted through the last days the monitors were up. This indicates the migration likely extended beyond the study period, significantly longer than previously identified. Both species peak in activity during dusk, differing from activity patterns observed during fall migrations. *Eptesicus fuscus* activity varied with temperature, while *L. noctivagans* activity remained

consistent, suggesting a weaker temperature effect. The nightly activity pattern and extended migration period highlight critical times that require protection for *L. noctivagans* from human conflicts. Our results emphasize the necessity for further research into migration endpoints and their influential factors.

Pilot test: Declarative memories in women with breast cancer following chemotherapy treatment

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Breast cancer is the most prevalent cancer diagnosis worldwide. Chemotherapy has pervasive effects on attention, processing speed, and memory. The hippocampus, a critical structure in memory processing, is highly sensitive to the neurotoxic effect of chemotherapy and is a potential mechanism mediating chemotherapy-related memory impairments. This preliminary study aims to better understand how chemotherapy impacts various cognitive domains, particularly memory. Women aged 30 to 65 with breast cancer who are >6 months post-chemotherapy (n=17) and healthy controls (n=14) participated in this virtual pilot study via Gorilla. A neurocognitive battery assessed attention (Digit span forward, DSF), working memory (Digit Span Backward, DSB), language (Verbal Fluency Test, VFT), cognitive workload (Task Load Index, NASA-TLX), episodic memory (Immediate and Delayed Recall of Taler Stories; Verbal Paired Associates, VPA), and subjective perception of autobiographical memory (Survey of Autobiographical Memory, SAM). Preliminary findings suggest the ability to recall episodic details did not differ between breast cancer survivors and the control group (VPA, p = .333) after immediate assessment of episodic memory (Taler immediate, p = .236). However, breast cancer survivors recalled fewer episodic details after a short delay in comparison to controls (Taler Delayed, p = .017). Both groups reported similar levels of subjective difficulties in episodic memory (SAM, p = .862), and performed similarly on the language task (VFT, p = .934). Although both groups had more difficulty on the working memory task (DSB, p = .731) than the attention task (DSF, p = .105), there was no significant difference between the groups. Overall, breast cancer survivors subjectively reported requiring more cognitive effort (NASA-TLX, p = .003) when completing the VFT compared to other tasks. Characterizing specific types of cognitive processes, specifically memory, impacted by chemotherapy is critical in guiding targeted treatment planning aimed at improving breast cancer survivors' quality of life.

Assessment of gait parameters during dual task timed up and go tests using a portable gait analysis system: A comparison based on age and presence of stroke

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Dual tasking is a fundamental component of most daily activities, requiring coordination, cognitive function, and attentional divide. These skills often deteriorate with age and after having a stroke leading to compromised dual-task performance. A major factor of independence after stroke includes being able to perform daily activities with minimal assistance, which often involves carrying out two tasks at once, specifically while walking. Gait analysis holds significant promise as a fall risk assessment tool in physical rehabilitation practices. This cross-sectional study aims to examine how cognitive and manual dual tasks impact gait parameters in young adults, older adults, and people living with stroke using the Timed Up and Go test (TUG) and by calculating dual-task cost when adding an additional task to the TUG. The TUG is a quick and reliable test which involves standing up, walking three meters and back, and sitting down. We hypothesize that performing cognitive and manual tasks during the TUG will differently affect spatiotemporal gait parameters in the three participant groups, indicating if the cost associated with attentional divide constitutes a marker for risk for falls. The TUG will be performed on the Strideway® portable pressure-sensing walkway for gait analysis which provides immediate insights into kinetic and spatiotemporal gait parameters. This has not been previously done under dual task conditions and in stroke patients. Understanding dual-task effects on gait has the potential to recommend rehabilitation interventions for stroke survivors and older adults, ensuring independence in daily activities and minimizing fall risks, ultimately improving their quality of life.

Exploring psychedelic-assisted neuroplasticity for the potential treatment of ADHD: A research proposal

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This research proposal aims to explore potential psychedelic-assisted therapies to induce neuroplastic changes for the treatment of Attention Deficit Hyperactivity Disorder (ADHD). ADHD is a prevalent neurodevelopmental disorder that expresses symptoms of attention dysfunction, impulsivity, excessive motor activity and hyperactivity, often leading to impaired cognitive functioning and decreased quality of life. While behavioural therapies and stimulant drugs can be beneficial for some patients, they may not provide long-term relief for all patients and can be associated with adverse effects. The prospect of using psychedelics, such as Psilocybin and LSD, in clinical therapy to treat mental disorders such as Post-Traumatic Disorder (PTSD), chronic anxiety, treatment-resistant depression and other neuropsychiatric diseases has sparked renewed interest in the field of psychedelic research. By altering synapses and neural pathways through microdosing, these drugs have demonstrated the capacity to cause neuroplastic alterations in the brain. Microdosing involves low, repeated doses to potentially achieve therapeutic effects. By examining whether psychedelic-assisted therapies can encourage neuroplasticity in people with ADHD, this proposal aims to further this line of inquiry with a view to potentially reducing core symptoms. In the proposed study involving a randomized controlled trial, a carefully chosen group of adults with ADHD will participate in a structured program that includes sessions of psychedelic-assisted therapy. To measure changes in neural connections, brain anatomy, and functional networks of the frontal cortex and basal ganglia before and after the intervention, neuroimaging methods like functional MRI and diffusion tensor imaging will be used. Behavioural evaluations and self-report tools will also be used to assess changes in ADHD symptoms, cognitive function, and quality of life. The research could have wide-ranging effects on the fields of psychiatry and neurology, providing a novel way to meet the demands of ADHD patients who do not respond well to conventional therapies.

Anacardic acid inhibition of reactive oxygen species production in non-alcoholic fatty liver disease

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Affecting 20% of the population, non-alcoholic fatty liver disease (NAFLD) is the most common liver disease in Canada. Characterized by an excess build-up of adipose tissue, the pressing issue is that NAFLD may lead to more severe illnesses. In particular, the excess visceral adipose tissue and oxidative stress associated with NAFLD are sources of increased reactive oxygen species (ROS) production. The corresponding ROS have been shown to impact insulin-signaling pathways and cause oxidative DNA damage leading to diabetes and liver cancer, respectively. The first line of treatment currently involves lifestyle changes, with liver surgery or transplantation required in cases of cirrhosis. However, no preventative drug therapies are currently in use. In NAFLD, oxidative stress and the resulting calcium ion influx have been speculated to increase ROS, specifically superoxide, production by increasing lipoxygenase and prostaglandin-endoperoxide synthase activity to catalyze the conversion of xanthine dehydrogenase to xanthine oxidase. Therefore, this research proposal aims to inhibit lipoxygenase and prostaglandin-endoperoxide synthase activity to reduce ROS production and prevent further consequences of NAFLD. For this, anacardic acids (AnAs) will be used in an *in vivo* mouse model as AnAs have been proven to inhibit potato lipoxygenase and ovine prostaglandin-endoperoxide synthase activity. AnAs will be produced from an inbred line of *Pelargonium xhortorum* and isolated and purified as performed by Grazzini et al. Groups of vitamin E-deficient mice mimicking oxidative stress and wild-type mice will be given daily doses of AnA injections at varying concentrations for a month alongside control groups receiving saline injections. Initial and final superoxide levels will be measured and compared using fluorescence and electron paramagnetic resonance. If a mean percent decrease in superoxide levels is observed, this proposal will help confirm the role of lipoxygenase and prostaglandin-endoperoxide synthase in NAFLD and support the testing of this ROS-inhibiting technique in larger animal models.

Defining safe initial stay times for adults during uncompensable heat stress

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Ontario workplaces rely on upper heat stress limits recommended by occupational safety agencies to manage worker health and safety in hot environments. However, no guidance is provided on safe initial stay times before heat-mitigation controls should be employed (rest, cooling). Further, the guidelines assume a one size fits all, failing to consider age-related differences in physiological strain and fatigue that can affect heat tolerance. This project will contribute to a larger WSIB-

funded project directed at defining safe initial stay times for prolonged work in hot environments. Physiological responses of study participants such as thermal, cardiovascular, hydration, inflammation, and others will be assessed over a prolonged workday and the next workday in young and older adults. The data collection and data analysis for this part of the project will be directed at assessing age-related differences in work time for the initial morning work. Conclusions made from this study will help determine safe initial stay times for adults during prolonged work in hot environments and contribute to understanding age related differences in physiological strain in heat.

Investigating the impact of chemotherapy on salience network connectivity in breast cancer patients

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Chemotherapy is a common form of treatment for breast cancer patients (BCP), yet its side-effects are associated with long-lasting structural and functional changes to the brain. Chemotherapy impacts structures involved in the salience network and the recollection network, including the anterior insula, the dorsal anterior cingulate (dACC) and the hippocampus. The recollection of personal memories in BCP has yet to be studied but remains fundamental as salient memories aid in emotional regulation. This study aims to investigate the alterations in the recollection network and the salience network using functional magnetic resonance imaging (fMRI) and the Autobiographical Memory Task (AMT) in BCP who have received chemotherapy. Participants in this study will be asked to come up with 40 personal memories before fMRI scanning. They will be asked to recall, mentally replay, and rate them on vividness (i.e., sensory details) while in the fMRI scanner. The ratings will be on a scale of 4, with a rating of 4 representing highly vivid memories, and a rating of 1 representing low vividness of the memory. Through the AMT, we anticipate that BCP will have an impoverished recollection of memories during the fMRI session compared to healthy controls (HC). Through neuroimaging, we anticipate lower connectivity between the anterior insula and dACC as well as hypoactivation in the hippocampi of BCP compared to HC. These alterations are likely to contribute to the memory deficits experienced by BCP undergoing chemotherapy treatment. By utilizing fMRI and the AMT, this study will provide valuable insights into the brain regions and function impacted by chemotherapy in memory recollection. Understanding these possible dysfunctions can contribute to the development of interventions to mitigate the cognitive effects of chemotherapy and improve the quality of life for BCP post treatment.

Conflicts of Interest

The authors have no conflicts of interest to declare.

Authors' Contributions

GT: President of the Connecting Young Minds (CYM) Undergraduate Research Conference reviewed abstract submissions to ensure proper formatting standards, assisted undergraduate authors with their submissions, drafted the CYM abstract, drafted and formatted the abstract booklet, and gave final approval of the abstract booklet to be published.
LT: Secretary of the Connecting Young Minds (CYM) Undergraduate Research Conference reviewed abstract submissions to ensure proper formatting standards, contributed to the drafting of the CYM abstract, and gave final approval of the abstract booklet to be published.

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