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PROCEEDINGS OF THE 6TH ANNUAL MCGILL UNDERGRADUATE SCIENCE SHOWCASE

Celebrating Undergraduate Research with
McGill's Office of Science Education (OSE)

McGill Science Undergraduate Research Journal (MSURJ)

About the Undergraduate Science Showcase

Offered by the Office of Science Education, the Undergraduate Science Showcase is a student learning initiative that supports students in developing academic skills and culminates in a celebration of their work. At this annual, community-wide event, undergraduates share their scientific research, field work, in-class assignments, and passion projects in the form of scientific posters and creative presentations. The Office of Science Education has had the privilege of gathering the McGill community at the Undergraduate Science Showcase since 2020.

About MSURJ

The *McGill Science Undergraduate Research Journal (MSURJ)* is a student-run, peer-reviewed academic journal that publishes undergraduate science research. Established in 2005 to promote undergraduate research and provide students with publishing and peer-review experience, MSURJ serves as a platform for students to share their innovative work with the broader scientific community.

A Note from the Editors

We are delighted to present this collection of abstracts from the 2025 Undergraduate Science Showcase. The diverse range of topics demonstrates the curiosity, dedication, and scientific rigor of our undergraduate researchers. We extend our gratitude to the Office of Science Education (OSE) who makes this event possible. Each abstract represents countless hours of inquiry, experimentation, and analysis, and we invite you to explore this impressive collection of undergraduate scholarship.

The abstracts in this volume reflect the cutting-edge research being conducted across various departments at McGill University. From innovative approaches in physics and biology to groundbreaking studies in psychology and environmental science, this collection showcases the exceptional talent and dedication of our undergraduate researchers.

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Analyzing Acoustic Damping Effects in Bubble Oscillations Across Various Liquids

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The study of acoustic interactions between sound fields and bubbles has diverse applications in medicine, engineering, and biology, including optimizing ultrasound imaging, reducing watercraft damage, and advancing our understanding of aquatic animal biology. The study of sound-bubble interactions also provides a flexible tool since bubbles can be modeled using various theoretical frameworks, such as a simple harmonic oscillator. Our investigation focuses on modeling vibrating bubbles in various liquids as harmonic oscillators. Our research is motivated by a common Brazilian practice used to assess alcohol content, where the sound of a partially filled bottle being struck changes if the bottle is quickly inverted beforehand. This distinct sound results from the liquid's state, particularly the bubbles formed within it. Specifically, this sound difference can be attributed to the damped oscillations of the induced bubbles in the viscous liquid. We recorded the sound spectrum before and after the rotation to compare peak frequencies. Liquids were categorized based on how long they maintained the sound difference, quantifying the damping phenomenon using quality factors from a Lorentzian fit of the sound spectrum. This established a direct relationship between the oscillation's period and amplitude and the liquid's properties. Results indicated that as viscosity increases, the quality factor decreases, reducing bubble vibrations and causing the sound difference to fade more quickly. This study highlighted the role of viscous damping as a sound attenuator and successfully demonstrated the relationship between emitted frequencies in different beverages, enhancing our understanding of bubble dynamics.

Optimizing Candle Shapes for Maximum Flame Luminosity and Minimal Wax Residue

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Keywords: Burning rate, Candle shape, Flame luminosity, Fluid dynamics, Thermal convection, Wax efficiency

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Combustions are among the most widely used energy conversion methods, with candles as a small-scale example. As with similar processes, energy efficiency in candles is often sought. While previous studies have investigated independently the behavior of candle flames, burning wax, and air flows, an optimized relationship between all three remains underexplored. This study aims to investigate candle shapes that maximize flame luminosity, and to explore the shapes resulting in minimal wax residue. To investigate the former, the relationship between luminosity and wax pool radius will be explored through both theory and experimentation. Then, for the latter, the growth rate of the wax pool as a function of time will be theoretically and experimentally studied. Candle shapes will be predicted based on the previous results and fluid dynamics theory. They will then be tested and compared. Preliminary results show that an inverted paraboloid-shaped candle produces the most luminous flame, and thin cylindrical candles (radius ~ 1cm and less) limit wax residue the most, but more trials will be recorded as to ensure accuracy of these results, and explore more shapes. This study's limitations include measurement precision affected by environmental factors like natural air currents, even in a controlled setting, and the limited number of candle shapes that can be tested, which might not fully capture the most optimal geometries. Regardless of the specific findings, this study will contribute to a better understanding of small-scale combustion processes, with potential applications in energy efficiency, more sustainable candle designs, and fluid dynamics research.

Comparing Clinical Efficacy of C5, C3 and Factor B Inhibition in Paroxysmal Nocturnal Hemoglobinuria

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Keywords: Paroxysmal nocturnal hemoglobinuria, Complement, Ravulizumab, Pegcetacoplan, Iptacopan

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Paroxysmal nocturnal hemoglobinuria (PNH) is a rare, life-threatening hematologic disorder that is caused by unregulated complement activation, leading to chronic red blood cell (RBC) hemolysis, anemia, fatigue, and an increased risk of thrombosis. The therapeutic landscape for PNH includes three key complement-targeting agents: ravulizumab (C5 inhibitor), pegcetacoplan (C3 inhibitor), and iptacopan (factor B inhibitor), each acting at different points in the complement cascade and demonstrating variable clinical efficacy. This study evaluates each treatments' clinical effectiveness through a comparative analysis of six pivotal phase 3 trials, integrating primary and key secondary endpoints as well as commonly reported PNH biomarkers. The analysis encompasses both treatment-naïve patients and those transitioning between complement inhibitors. Findings suggest that factor B inhibition provides the most robust overall clinical efficacy, while C3 inhibition offers superior protection against hemolysis by blocking complement activation at an earlier stage. Although C5 inhibition remains a viable treatment option, it is associated with a higher likelihood of breakthrough hemolysis. However, limitations of this comparison of pivotal phase 3 trials include: heterogeneity in patient baseline characteristics, differences in trial design, variability in endpoint selection, and discrepancies in biomarker reporting. Ultimately, this work demonstrates the need for a greater understanding of the complement cascade and the effects of its inhibition at different points of activation in relation diseases, such as PNH, that arise from its dysregulation.

Optimization of Viral DNA Extraction from Vaginal Swabs

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The vaginal virome remains uncharacterized in healthy individuals and even more so in people with gynecologic conditions, despite its role in the maintenance of microbial homeostasis and potential for clinical application. In conditions such as vulvovaginal candidiasis (VVC), the bacterial composition of the vagina is altered in an attempt to provide defense; however, the bacterial viruses, or bacteriophages (phages), present in this environment have yet to be identified. Thus, this project aimed to establish a protocol for the extraction of viral DNA from vaginal swabs to allow for the further characterization of the vaginal virome. Initially, we applied the established virome extraction protocol using the QIAGEN QIAamp MinElute Virus Spin Kit, optimized for fecal samples. This approach had limited success due to the low biomass swabs used as input. A modified TRIzol protocol with post-purification human DNA depletion using the NEBNext Microbiome DNA Enrichment Kit yielded sequenceable DNA libraries, although with significant human DNA contamination. Our final optimized protocol begins with lysis of host cells prior to virion DNA extraction with the Cytiva Virus Pathogen kit. Our optimized protocol proved to be successful in the extraction of DNA from vaginal swabs, with minimal human DNA contamination and successful enrichment of viral reads in the final dataset. Future work using this protocol will focus on the characterization of bacteriophages present in the vaginal environment, and determine how they differ in health and disease, such as in the context of VVC.

Characterizing signals associated with the pre-TCR during T cell development

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Developing T cells are subjected to a gauntlet of tests in the thymus to ensure a safe and effective T cell receptor (TCR) repertoire. β-selection, a checkpoint early in T cell development, tests the functionality of rearranged TCRβ chains. Cells with functional TCRβ chains receive pre-TCR signals which promote survival, proliferation, differentiation, and maturation of the TCR. While the signals associated with the mature TCR have been carefully studied, those associated with the pre-TCR have not been well described. Thus, we sought to characterize the pre-TCR signals which occur during early T cell development. We first evaluated the role of pre-TCR signaling across early developmental stages. Sorted T cell progenitor populations were co-cultured with OP9-DL4 cells in the presence or absence of BAY61-3606, an inhibitor of the pre-TCR signaling-mediator, Syk; the effect on survival and developmental progression was tracked by flow cytometry over several days. Our data indicate that Syk-dependent pre-TCR signaling is important for cell survival and differentiation beyond the β-selection checkpoint. However, the dependence on Syk-mediated pre-TCR signals decreases with development and is not necessary by the immature single-positive stage. We subsequently characterized the duration and magnitude of pre-TCR signals. Fetal pre-β-selection thymocytes were loaded with a calcium-indicator dye and subjected to time-lapse imaging; calcium flux was analyzed over time in individual cells. Preliminary data indicate that pre-TCR signaling events in a polyclonal population are infrequent and characterized by low, sustained levels of intracellular calcium. Together, our findings describe the pre-TCR signals associated with early T cell development.

Type 2 immunity at the interface between helminth infection and stunting

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Keywords: Growth stunting, Helminth infection, Mouse models, Type 2 immunity, Undernutrition

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Early life, defined as before the age of two, represents a critical development window. Many development-associated issues, like stunting, arise from suboptimal conditions during this period. Stunting, defined as two standard deviations below the height-for-age median, affects almost 30% of children under five. While many factors contribute to stunting, epidemiological evidence emphasizes that early life helminth infections, combined with undernutrition, may be major drivers. Helminths induce a potent type 2 immune response, which, potentially favoured in undernourished conditions, can modify systemic metabolism linked to development. Despite the prominence in developing countries, no publications have reported the early life interactions between helminths, undernutrition, and stunting. Thus, we seek to elucidate a potential relationship between these variables. We hypothesize that undernutrition increases the anti-helminth type 2 immune response, exacerbating early life stunting. Mouse pups are weaned onto an undernourished or control diet and are subsequently infected with a well-characterized helminth. Two- or four-weeks post-infection, immune cells and antibodies are quantified using various imaging and quantitative methods. Our lab has established a murine stunting phenotype reliant on both helminth infection and undernutrition, and our data suggest that a type 2 immune response may drive stunting. While mice are valuable models for studying this interaction, they possess temporal developmental differences from humans. While preliminary, our data suggest that our stunting model depends on a type 2 immune response. This is the first study examining this response in an interplay between undernutrition, helminth infection, and stunting – an initial step towards addressing determinants of childhood stunting.

Increasing Oocyte Yield Through the Modification of Hormone Delivery

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The McGill Integrated Core for Animal Modeling (MICAM) creates mouse disease models using CRISPR-Cas9 technology. A key step to generating genetically modified animal models is to produce fertilized oocytes. To obtain large numbers of oocytes, female mice must be superovulated by hormone injections. Typically, superovulation is induced by the administration of five international units (IU) of pregnant mare serum gonadotropin (PMSG) and five IU of human chorionic gonadotropin (hCG) by intraperitoneal (IP) injection 48 hours apart. However, a recent report has shown the administration of PMSG by subcutaneous (SC) injection results in a higher average yield of oocytes per mouse. This would allow the superovulation of fewer mice to generate the same number of oocytes, a key refinement to the process. This study split cohorts of female mice into two groups per injection session. Half of a cohort was given hormones using the standard superovulation regime, and half were given PMSG SC. Both cohorts were given hCG IP. On average, 23.58 oocytes were collected per female mouse given PMSG SC while 16.43 oocytes were collected per female mouse given PMSG IP. This resulted in 7.15 more oocytes collected per female mouse administered PMSG SC rather than IP. For every three mice injected with PMSG IP, two females need to be injected with PMSG SC to collect the same number of oocytes. This study demonstrates that the administration of PMSG SC does result in the collection of more oocytes per mouse, reducing the number of female mice needed to be housed and superovulated.

Assessment of the Role of Connection Length on Methodological Variance in Dynamic Functional Connections

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Dynamic functional connectivity (dFC) is the study of changes in brain functional organization over time. dFC has been a growing field of research due to its importance in understanding cognitive processes and its potential applications as a biomarker for neurodegenerative diseases. However, the choice of dFC assessment methodology has been found to significantly impact dFC results, putting into question the reliability of the findings using these methods. Considering recent studies revealing the impact of structural connectivity on functional connectivity, we speculated that connection length as a structural aspect may indirectly influence dFC magnitudes and variability. In this study, we examined the impact that connection length had on dFC variability across methods. Furthermore, these connections were inspected according to whether they are intra- or inter- brain networks (i.e., the connection is between two regions that belong to the same or different brain network). We conducted our analysis in Python using resting-state functional MRI data of 395 subjects taken from the Human Connectome Project and evaluated them using seven well-known dFC assessment methodologies. The study revealed that longer connections lead to greater variation in dFC over methods for both intra- and inter-network connections. Interestingly, in short connections, being inter-network increases dFC variance over methods. Some current limitations of this study include using Euclidean distance as a measure of connection length and assuming functional connections are independent in parametric statistical analyses. Our investigation is a step forward understanding the factors influencing the observed inconsistency in dFC patterns estimation obtained from different methodologies.

Conservative versus Surgical Treatment of Pediatric Both-Bone Forearm Fractures: A Systematic Review and Meta-Analysis

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Keywords: Bone both forearm fracture, Pediatrics, Conservative treatment, Surgical treatment, Skeletally immature

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Treatment of both-bone forearm fractures (BBFF) in skeletally immature patients includes surgical and conservative strategies, however, there is no literature-supported consensus on which provides optimal patient outcomes. This systematic review and meta-analysis compare the outcomes of surgical versus conservative treatment in the management of BBFF in skeletally immature patients. A search of Medline, Scopus, PubMed, and CENTRAL databases was performed from inception to August 2024. Studies included reported outcomes for BBFF treated surgically (intramedullary nailing, plating) or conservatively (casting) and were selected per PRISMA guidelines. Statistical analyses were conducted using DataParty, which utilizes Python 3.8.10. A total of 25 studies with 1187 patients (surgical: 837; conservative: 350) were included. Patients in the surgical group had a mean age of 8.59 years, while those treated conservatively averaged 10.92 years. The complication rate was higher in the conservative group (43%, 95% CI [0.33, 0.52]) compared to the surgical group (16%, 95% CI [0.07, 0.27]), with high heterogeneity observed in the surgical group ($I^2 = 93\%$). The union rate was 100% in the conservative group and 99% in the surgical group, with minimal heterogeneity ($I^2 = 0\%$ and 13%, respectively). Excellent price grading was reported in 83% (95% CI [0.73, 0.91]) of cases managed conservatively and 77% (95% CI [0.59, 0.91]) of surgically treated cases, with high heterogeneity ($I^2 = 77\%$ and 91%, respectively). In conclusion, surgical treatment of BBFF may reduce complication rates compared to conservative management. Future high-quality trials are warranted to further clarify management guidelines for pediatric BBFF.

Optimising Zeolite Synthesis for Efficient Carbon Capture and Conversion to Renewable Natural Gas

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The growing need for cleaner energy production has spurred the development of advanced materials capable of addressing environmental challenges. This has driven research into materials that can capture carbon dioxide while maintaining sustainability and cost-effectiveness. Zeolites, aluminosilicate materials synthesised from abundant elements, present a promising solution as dual-function materials (DFMs) for both CO2 capture and conversion to renewable natural gas (RNG) via methanation. To understand how structural differences can affect CO_2 adsorption, this study investigates the synthesis and performance of three zeolite types – small (Chabazite, CHA), medium (MFI, ZSM-5), and large (Faujasite, FAU, Y-zeolite). Each was synthesised from scratch using silica and aluminium precursors, with fluoride and alkali promoters to facilitate framework formation. This encompassed a sequence of material addition, gel aging, crystallisation, and drying to produce the powder. Among these materials, the Y-zeolite was hypothesised as the optimal candidate due to its large pore structure providing the most abundant number of sites for CO_2 adsorption, assessed by exposing the materials to simulated air streams (400 ppm CO_2). Confirmed through X-ray Diffraction (XRD) and CO_2 Temperature-Programmed Desorption (TPD), Y-zeolite demonstrated high CO_2 adsorption capacity and structural stability across repeated cycles. However, CHA exhibited sensitivity to water, whereas ZSM-5 synthesis trials remained inconsistent, requiring further optimisation to be achievable in the laboratory. Future work will focus on refining synthesis procedures for repeatability, evaluating long-term performance under realistic conditions, and assessing candidature for industrial scale-up. These findings propel zeolites as viable materials for power-to-gas (P2G) applications, contributing to carbon emissions reduction measures.

Trauma, Dreams and Psychological Boundaries: A Perspective on Emotional Resilience and Psychopathology

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A traumatic event can profoundly affect individuals emotionally and physically, with trauma referring to the psychological response to such events. While most people recover over time, some struggle to process their experiences, leading to conditions such as anxiety, mood, or personality disorders. Ernest Hartmann's concept of boundaries – developed in the context of personality differences in dream content – offers insight into why certain individuals may be more vulnerable. Hartmann describes boundaries as sensitivity and fluidity across domains, which this paper argues can be linked to unique psychopathological vulnerabilities. Dream content, influenced by one's boundary profile, provides insights into associated emotional tendencies. By processing emotional memories and reflecting current preoccupations, as well as associative unconscious processes of memory consolidation, dreams form a tangible therapeutic avenue within the broader context of trauma, boundary profiles, and psychopathology. This review paper has two objectives: first, to investigate how boundary profiles influence psychopathological responses to trauma, and second, to explore how dreams reflect and address these same processes, highlighting dream-based interventions as a promising method for reducing specific psychopathological vulnerabilities. To do so, I propose a framework, conceptualized as two "loops," that illuminates the intricate interplay between trauma, boundaries, and dreams, offering a novel perspective on individual resilience, vulnerability, and unique pathways to recovery. In doing so, I hope to expand on traditional diagnostic and treatment models and contribute to the growing movement towards a dimensional understanding of mental health.

Sexual and Gender Minority Youth in ACCESS Open Minds: Severity at Presentation to Diverse Youth Mental Health Services

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Childhood and adolescence are crucial periods in the development of healthy individuals. However, they are also times of increased risk of mental illnesses. Among youth, sexual and gender minorities face greater adversity and higher mental health risks than their cisgender and heterosexual peers, with gender minorities experiencing worse outcomes than sexual minorities. While substantial research has examined adversities and mental health disparities for sexual and gender minority youth relative to the general population, no study has yet investigated how severity at presentation to healthcare services differs between sexual and gender minorities. Since gender minorities face more adversity, it was hypothesized that their severity at the initial assessment would be higher. Using the ACCESS Open Minds database, which includes data from 5,232 youth aged 11 to 25 who were referred for or sought mental health help at 12 diverse sites across Canada, the severity of mental health presentations of 722 sexual minority youth and 258 gender minority youth was analyzed. Severity was determined by scores on the Kessler Psychological Distress Scale (K10), Clinical Global Impression (CGI) scale, and the Social and Occupational Functioning Assessment Scale (SOFAS). No significant differences were found for K10 and CGI, but gender minority youth had significantly lower SOFAS scores than sexual minority youth. Differences in social and occupational functioning without differences in severity of mental distress may reflect an important role for social discrimination against gender minorities, and its consequent impacts on the social and vocational possibilities for these youth.

Generating and Testing a Many-qubit Entangled State for Controlled Quantum Teleportation

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Keywords: Controlled quantum teleportation, Multi-qubit entanglement, Quantum simulation, Qiskit

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Multipartite entangled states are essential for controlled quantum teleportation (CQT). CQT enables secure and conditional quantum information transfer among multiple parties. Recently, the six-qubit "tetrahedron" state was identified as a novel candidate for enabling CQT of a two-qubit state by Z. M. McIntyre and W. A. Coish. Despite its theoretical promise, this state has yet to be experimentally realized. In this project, we will employ IBM Qiskit, a quantum computing software package, to perform a classical simulation of the tetrahedron state, modeling realistic conditions that include decoherence, state preparation errors, and measurement imperfections. By examining the influence of noise on entanglement and teleportation fidelity, we aim to gain insights into the state's feasibility for near-term quantum hardware. This approach involves constructing the quantum circuit for the tetrahedron state, incorporating realistic noise models, and analyzing the cumulative effect of errors at each gate operation. Our ultimate goal is to identify critical noise thresholds that limit the state's performance and inform future hardware implementations. The insights from these simulations will guide experimental efforts to realize the six-qubit tetrahedron state and advance controlled quantum teleportation protocols for multi-qubit systems.

Characterization of Mitochondrial Morphology in a Neuropathic Pain Rat Model Using Transmission Electron Microscopy

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Keywords: Chronic pain, Mitochondrial morphology, Neuropathic pain, Spinal cord, Transmission electron microscopy

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Chronic pain affects millions of individuals worldwide, yet remains poorly managed due to limited therapeutic options and the adverse effects of current treatments. As mitochondrial health in the central nervous system plays an important role in neuronal function and signaling, elucidating changes to organellar health during chronic pain may provide novel therapeutic insights. This study aims to investigate the morphological changes in spinal cord mitochondria in a chronic constriction injury (CCI) rat model of neuropathic pain using transmission electron microscopy (TEM). The primary objective is to compare the mitochondrial morphology in synaptic terminal and dendritic regions of spinal cord sections from naive and CCI rats at different time points in pain progression. Mitochondrial size, shape, and cristae area, as well as synaptic terminal area and synapse length will be quantified using ImageJ (FIJI). We hypothesize that chronic pain will induce distinct alterations in mitochondrial morphology that may reflect or cause changes in cellular function and contribute to modulation in nociceptive signaling. By identifying specific mitochondrial changes associated with neuropathic pain, this study seeks to deepen our understanding of nociceptive neuronal signaling and contribute to the development of targeted therapies for chronic pain management.

Exploring the Link between Impulsivity, using the UPPS-P Impulsive Behavior Scale, and Decision-making Regarding Risky Choice

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Keywords: Decision-making, Impulsivity, UPPS-P Impulsive Behavior Scale, Reaction time, Personality, Risky decision-making

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Acting without forethought is a characteristic some individuals exhibit in their everyday lives, particularly those prone to impulsive behaviour. Many personality models incorporate impulsivity as a fundamental psychological construct (Whiteside & Lynam, 2001). Consequently, understanding how impulsivity influences decision-making, especially in risky contexts, is essential for understanding the behavioural manifestation of personality traits. In this study, we aimed to determine the association between impulsivity, measured by the UPPS-P Impulsive Behavior Scale (Lynam, Smith, Whiteside, & Cyders, 2006), and risky choice decision-making measured by a risky choice paradigm (da Silva Castanheira, Fleming, & Otto, 2021; Rutledge, Skandali, Dayan, & Dolan, 2014). A total of one hundred and forty-two participants took part in the online study, where they completed the paradigm, as well as the UPPS-P questionnaire. The task involved presenting participants with a choice between risky and certain options. A regression analysis was conducted to examine the relationship between their probability of selecting the risky option, their reaction time when making that choice, and their UPPS-P Impulsive Behavior Scale scores. The results revealed that higher scores on the UPPS-P predicted a higher probability of picking the risky option. Moreover, higher scores on this scale predicted faster reaction times in the task, especially when participants rated high on both (Positive and Negative) Urgency subscales of the UPPS-P. Overall, this study provides a deeper understanding of how distinct facets of impulsivity contribute to risky decision-making behaviours, particularly by influencing both the likelihood and speed of risky choices.

Genetic Analysis of a Spontaneous Mutation Disrupting Midline Localization in Drosophila Follicular Epithelium Cells

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Keywords: Drosophila egg chamber, Midline, Mutation identification, Nuclear localization, Oogenesis

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In the Drosophila ovary, the developing germline is surrounded by an epithelium of somatic follicle cells. This epithelium displays dynamic patterning by transcription factors throughout oogenesis, and these transcription factors play a crucial role in specifying cell fates within the developing egg. Previous studies have identified midline (mid), a T-box transcription factor, as one such regulator. mid is expressed in the posterior region of the follicular epithelium cells in response to epidermal growth factor receptor (EGFR) signaling early in oogenesis, and its expression remains restricted to these cells during later stages.

Mid is detected in the nuclei of the cells, as predicted for a transcription factor, but it is first translated in the cytoplasm of the cell before localizing to the nucleus. Mid immunofluorescent staining in wildtype follicular epithelia has also been observed to be occasionally cytoplasmic. Together this suggests potential dynamic regulation of Mid subcellular distribution, however the underlying mechanisms remain unclear. We have identified a recessive mutation, referred to as r12m, that is associated with defective nuclear localization of Mid. In clones of follicle cells that are homozygous for r12m, Mid levels are reduced and Mid appears mislocalized from the nucleus, presenting as a hazy cytoplasmic smear rather than being clearly located within nuclei. We are conducting exploratory genetic analysis using techniques such as complementation tests, genetic mapping, and candidate gene testing to map the r12m mutation and identify the affected gene, with the goal of advancing our understanding of mid regulation and subcellular localization.

Childhood trauma exposure does not moderate resting respiratory sinus arrhythmia during a prenatal yoga intervention

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Pregnancy may induce a period of wide-ranging physiological changes and stress, including lowered resting respiratory sinus arrhythmia (RSA). Low resting RSA has been associated with various mental health symptoms such as depression, anxiety, and externalizing behaviors. Research suggests that women with a history of childhood trauma may experience lifelong dysregulation of their stress response systems, and therefore may be particularly vulnerable to such health effects. While a broader body of literature suggests mind-body interventions may serve as a meaningful buffer, research addressing such interventions in this population is limited. Therefore, this study examined the potential moderating effects of childhood trauma exposure on changes in resting RSA, following a short virtual yoga intervention. RSA was collected through an application on participants' cellphones, which uses non-invasive photoplethysmography to collect heart rate. Data collection is ongoing, however preliminary results with 32 pregnant women do not show a significant moderating effect of childhood trauma exposure on changes in resting RSA ($F = 1.764$, p-value $= 0.181$). Initial findings suggest that childhood trauma exposure does not impact the efficacy of yoga interventions on RSA during pregnancy. Limitations of this study include a small, highly educated and majority White sample. Given the implications for developing interventions that are effective in pregnant women regardless of their background, future research that expands upon these findings could improve women's health and offspring development.

Structural Covariance-Based Morphometric Connectivity in Psychosis: Investigating Dysconnectivity and Cognition Across Disease Stages with Ultra-High Field MRI

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Psychosis is among the most disabling disorders worldwide due to its broad spectrum of symptoms. Research has recognized brain dysconnectivity as a key feature of psychosis and is closely linked to cognitive impairments. Conventionally, brain connectivity is defined as structural and functional connectivity. This study employs a novel approach by using structural covariance, the correlation between morphometric changes across individuals, to define morphometric connectivity (MC). Although previous research has linked MC to developmental and cognitive processes, its role in psychosis and its relationship to cognition remain understudied, partly due to limitations associated with low-field magnetic resonance imaging (MRI) studies. This study investigates how MC and its correlation with cognitive functions is impacted by disease progression in psychosis. Data were collected using 7-Tesla MRI from 112 participants (HC = 31, FEP = 62, CHR = 10, MEP = 9). MC was computed using Graph Theory (strength and efficiency) from cortical thickness (62 regions) and hippocampal volume (18 subfields). Across disease stages, changes in MC were evaluated using a General Linear Model, while partial correlation matrices (correcting for age, gender and total brain volume) compared shifts in the relationship between MC and cognitive performance. Preliminary analysis shows that, as disease progresses, MC is significantly impaired in certain regions (10/80 regions), and the correlation between MC and cognitive functions is weakened in specific regions (13/80 regions). The result deepens our understanding of structural covariance-based MC as a hallmark of psychosis and its progression, offering insights into the cognitive decline in psychotic patients.

Understanding Cognitive Impairment in Early Psychosis through Functional Brain Dysconnectivity: A Whole-Brain Voxel-wise Analysis Approach

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Early psychosis (EP) is the early stage of onset of psychosis symptoms, characterized by a loss of touch with reality. Cognitive impairment is prominent and even precedes symptom onset in individuals with psychosis, which is commonly driven by alterations in functional brain connectivity. Previous work has focused on brain regions defined a priori and relied on the assumption of normal distributions, which can hinder result generalizability. This project aims to build upon previous findings in a data-driven way and share code following open science principles. We utilize the Human Connectome Project-Early Psychosis dataset of 183 participants consisting of resting-state functional magnetic resonance imaging (rs-fMRI) scans and phenotypic data of a variety of cognitive domains, such as attention, memory and processing speed. Functional connectivity is calculated in a voxel-wise manner to derive voxel-whole brain connectivity patterns. Multivariate Distance Matrix Regression (MDMR), a non-parametric technique, is then applied to assess relationships between functional connectivity differences and cognitive scores. Statistics for hypothesis testing follow an asymptotic null distribution, and theoretical p-values can be calculated such that the results are more robust. Further, scripts detailing the data analysis will be shared on GitHub, linked to an Open Science Framework project to aid replicability. We expect to identify some well-known brain areas implicating specific impairments, which will be externally validated in a follow-up study. This may provide a wholistic view on brain-cognition relationships for early psychosis and guide for future applications in other fields of research.

A Stitch in Time Saves Nine: Early Trajectories of Psychotic-Like Experiences (PLEs) and Cognitive Bias in Children from the Adolescent Brain Cognitive Development (ABCD) Study.

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Psychiatric disorders often emerge in late adolescence, but identifying childhood risk factors can promote earlier detection and prevent severe mental illness. Psychotic-like experiences (PLEs), a mild form of subclinical psychotic symptoms, are more common in childhood than adulthood. Their persistence may be crucial to understanding their clinical significance. Few studies have explored the link between persistent PLEs and later mental health outcomes in adolescence. Additionally, cognitive biases, including attentional biases toward emotional stimuli, are linked to various mental health symptoms, including psychosis. This study investigates whether persistent, distressing PLEs co-occur with attentional bias and predict later psychopathology. We hypothesize that distressing PLEs at two or more timepoints correlate with attentional bias (measured at year 1 and year 3 follow-ups) and predict higher symptoms of emotional dysfunction, psychosis, and externalizing psychopathology. Our sample, from the Adolescent Brain Cognitive Development study (Data Release 5.0), included 5740 participants (mean age = 9.5, SD = 0.5). Preliminary results showed no significant relationship between Emotional Word Emotional Stroop performance and distressing PLEs at year one and year three, as indicated by mean endorsed distress scores. Correlations did not differ for participants with a mean distress score above zero across at least two assessments. These findings could suggest that persistent-distressing PLEs in childhood may predict a different domain of future symptoms than attentional biases toward emotional stimuli. Ongoing analyses will help determine the relevance of attentional biases and persistent distressing PLEs in predicting future symptoms of emotional dysfunction, externalizing, and psychosis.

Development of a Ligand Trap to Inhibit Follicle-Stimulating Hormone

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Follicle-stimulating hormone (FSH) is essential for ovarian folliculogenesis and female fertility. After menopause, pituitary-derived FSH rises and stays elevated, while estrogen levels decline. Although controversial, some studies claim that chronically elevated FSH drives menopausal co-morbidities, including increased adiposity and decreased bone mass. To investigate whether FSH acts in extragonadal tissues, this study aimed to develop a soluble receptor-based trap to bioneutralize FSH in circulation. The ligand trap is a homodimeric Fc-fusion construct containing two copies of the hormone-binding domain of the human FSH receptor (hFSHR-HBD) fused to the IgG Fc domain. The Fc domain confers solubility to the ligand trap in serum and dimerization, whereas the hormone-binding domain is designed to sequester FSH, thereby blocking or attenuating its actions. To generate an expression construct for recombinant protein production, the hFSHR-HBD was PCR amplified and ligated into an Fc expression vector. The recombinant hFSHR-HBD-Fc construct was transformed into bacteria for plasmid amplification and purified before transfection into mammalian cells. Protein expression in cells was confirmed by western blot. However, the protein was not secreted into the cell culture media for reasons we have not yet determined. Future efforts will focus on optimizing protein expression and secretion by modifying different elements of the vector. If successful, this ligand trap could effectively neutralize FSH, serving as a powerful tool to investigate the hormone's systemic effects.

Assessment Experience and Study Strategies: Impacts on Evaluation Anxiety and Academic Self-Efficacy in a First-Year Science Course

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While the transition towards university is exciting for many first-year students, it can also result in tremendous stress from the level of rigour needed in lab reports, midterms, oral presentations, etc., leading to evaluation anxiety. This can result in discrepancies between perceived and actual academic performance and thus negatively contribute to mental health. Science education research aims to formulate potential teaching methods to foster a better learning environment in undergraduate courses. This study looked into the effects of students' assessment experiences on evaluation anxiety, consisting of state (SEA) and trait evaluation anxiety (TEA), as well as the relationship between study strategies and academic self-efficacy in a large undergraduate science course at a Canadian university. A survey using a reversed seven-point Likert scale was distributed to students (n = 591), yielding a 7.1% response rate. The results indicated that elaboration strategies were favoured, based on the average values for rehearsal and elaboration study methods obtained using descriptive statistics in SPSS. According to bivariate correlation analysis, both learning methods were positively associated with SEA with a slightly higher correlation for elaboration. SEA and self-efficacy varied inversely; therefore, higher anxiety may be associated with less accurate self-predictions for academic success. It was noted that test/exam anxiety may diminish as the student feels more confident, however it can also boost academic motivation. These findings could inform future research on evaluation anxiety with a larger sample size, and less bias from self-reporting and time constraints, implementing pedagogical approaches to minimize anxiety in science education.

Analysis of the Regulatory Pathway Between DNA Replication and Cell Division

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Cell division and chromosome replication are tightly coordinated in bacteria. The dipM gene in *Caulobacter crescentus* is known to be involved in cell division, but its role in chromosome replication remains unclear; previously, a dipM mutant was found to be capable of replication but not of maintaining a plasmid. This study investigates dipM's function in both processes and aims to identify interacting genes. We hypothesize that dipM regulates chromosome replication through interactions with cell cycle proteins. To test this, a mutagenesis was conducted to screen to isolate *Caulobacter* mutants with replication defects, expecting to identify mutations that disrupt chromosome replication. Fluorescence-labeled replication reporters will be used to detect cell cycle abnormalities, likely revealing mislocalized replication proteins in dipM mutants. Genetic complementation was used to determine whether introducing wild-type dipM can restore normal replication and division. A whole-genome library and DNA sequencing will be used to identify affected genes, predicting new regulatory components within this pathway. Finally, bioinformatics tools such as BLAST will analyze these genes, potentially uncovering conserved mechanisms of bacterial cell cycle regulation. This study is expected to provide insight into bacterial cell cycle regulation. However, potential genetic redundancy and the need for further validation may pose challenges. Ultimately, this research could inform microbial genetics and antimicrobial development.

The Effect of Gullies on Barbadian Urban Geomorphology

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Gullies are gorge-like structures, which are largely understudied geomorphological aspects of the Barbadian landscape. There is a concern for the stability of settlements situated on gully cliffs and the relationship that anthropogenic development has with the gullies themselves. A set of exploratory measurements were taken on three different study sites. The gullies were selected for measurements based on the presence of urban development and ease of accessibility for field measurements. Variables such as undercutting, slope angle, and anthropogenic activity were taken on-site or through remote sensing. Statistical and descriptive analyses were then done to compare the gullies' relationship between terrace, stability, and anthropogenic activity. A factor analysis of mixed-data and ANOVA analysis found that WHG was particularly distinct from the other two, with a maximum captured variance of 26.2%. Age was seen to be related to higher and sheerer cliffs that included more instances of undercutting. The two gullies on the younger terrace were seen to have an exceptional shape with each side being morphologically distinct. The side that had a gentler slope and lower cliff was positively correlated with anthropogenic activity.Limitations include lack of accessibility, and difficulty finding proper weighting of stability variables. The large dataset created could be used as a starting point for longitudinal studies and analysis to better find stability, shape, and anthropogenic development change over time. The measurements taken have proven to find notable patterns and correlations and could be the foundation for future rapid risk assessment tools.

Biomineralization and Shell Morphology in Response to Abiotic Calcium Sources in Cepaea Nemoralis

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Abiotic sources of minerals are critical for the growth and morphology of various organisms, specifically *Cepaea Nemoralis*, which integrates environmental calcium into its outer shell. Understanding how environmental sources of minerals influence the development of this animal can help deepen our understanding of the interactions between the environment and the organisms that populate it. Traditional studies of mollusk shell morphology often involve desiccation and separation of the animal from the shell. However, this study improves animal welfare while maintaining accurate determination of growth. In vitro conditions such as humidity, temperature, and light cycles were analogous to natural environments, and a control meal of organic lettuce was provided to each test group. The treatment applied between groups were varying levels of solidified calcium carbonate, which is absorbed in its mineral form by *C. Nemoralis*. A sample size of 45 snails was used, with all snails randomly divided into five separate treatment groups (nine per group). Over a period of 14 days, each snail's mass was recorded, which was representative of shell mass. Significant differences were found between the control group and the treatment group of two grams of CaCO3. The control group expressed a mean growth rate of 0.10 grams over 14 days in comparison to the treatment group, which had a mean growth rate of 0.26 grams, an 160% increase in growth rate. However, the difference in growth rates between treatment groups of increasing levels of substrate was minimal, suggesting that shell growth plateaus at a specific level of calcium consumed.

It's Not Always Black and White: How Color Enhances L1 and L2 Idiom Processing

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Idioms are non-compositional expressions whose meanings transcend the literal interpretation of their components (e.g., "break the ice"). They highlight the psycholinguistic tension between direct retrieval and compositional semantic analysis. Past research suggests L1 readers rely more on direct retrieval and idiom familiarity, while L2 readers depend more on word-by-word compositional processing. Supporting this, studies show that disrupting an idiom's canonical form impacts L1 readers more than L2 readers. This study explored the reverse effect by strengthening an idiom's canonical form through font color. L1 and L2 readers read English sentences containing idiomatic/literal phrases, presented in colored/standard font, and judged whether the phrases made sense. Accuracy and reaction times were recorded. In L1 readers, idiom superiority (i.e., better performance for idioms than literal phrases) was driven by familiarity, with color coding enhancing this effect for more familiar idioms. In L2 readers, idiom superiority was influenced by both familiarity and decomposability, with color coding amplifying both effects. These findings suggest that L1 readers primarily rely on direct retrieval, whereas L2 readers utilize both direct retrieval and compositional processing, with color coding aiding idiomatic processing for both groups.

Impact of Phosphate Supplementation and PPi Reduction on Osteocyte Lacunar-Canalicular Network in XLH

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Proper phosphate homeostasis is critical for bone mineralization, with disruptions leading to skeletal abnormalities affecting growth and load-bearing capacities. X-linked hypophosphatemia (XLH), caused by mutations in *PHEX* gene, results in elevated fibroblast growth factor 23 (FGF23), a phosphaturic hormone that can cause impaired renal phosphate reabsorption and osteomalacia. High-phosphate diets improve mineralization in *Hyp* mice carrying inactivating *Phex* mutation but fail to restore osteocyte connectivity, possibly due to persistent mineralization defects around osteocyte lacunae. Excess inorganic pyrophosphate (PPi), a mineralization inhibitor, may contribute to these defects. This study investigates whether reducing PPi via the *Enpp1asj/asj* mutation, which impairs ENPP1-mediated PPi production, while supplementing phosphate in *Hyp;Enpp1asj/asj* mice, enhances osteocyte numbers and restores lacunar-canalicular connectivity. *Hyp, Enpp1asj/asj*, *Hyp;Enpp1asj/asj*, and wild-type (WT) mice (n=16, two per group) were assigned to either a standard chow or high-phosphate diet (2%P) for two weeks starting at six weeks of age. Dissected humeri were stained with rhodamine and embedded in epoxy for confocal microscopy to examine lacunar-canalicular connectivity, with 3D reconstruction performed using Dragonfly software. Osteocyte networks were severely disrupted in *Hyp* mice, with larger lacunae and reduced connectivity, showing minimal improvement with phosphate supplementation. *Enpp1asj/asj* mice had fewer osteocytes and reduced connectivity regardless of diet. *Hyp;Enpp1asj/asj* mice exhibited increased osteocyte numbers on a high-phosphate diet but retained irregular lacunae and disrupted connectivity, suggesting PPi reduction increases cell number but not full network restoration. Small sample sizes limit statistical significance; future work will expand sample sizes (e.g., n=80 mice, ten per group) and refine imaging analysis to quantify osteocyte morphology and connectivity.