science, mathematics & computing division

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senior project poster session

Data-Driven Insights:
Analyzing Rural Internet Access and Its Impact on Education and Employment through Computational Methods

Maha Abdul Wahab

Advisor: Kerri-Ann Norton

This study examines the relationship between internet access and educational and employment outcomes in rural areas, with a focus on underrepresented communities in New York State. It analyzes how disparities in broadband availability, affordability, and digital literacy contribute to unequal access to academic and professional opportunities. Using a mixed-methods approach grounded in quantitative analysis, the study employs descriptive statistics, independent t-tests, and point-biserial correlation to evaluate how internet connectivity influences outcomes such as high school graduation, college enrollment, and job access. Various visualization techniques in the R programming language are also used to help interpret and communicate the data. Data is drawn from government reports, peer-reviewed studies, and regional datasets on digital infrastructure and socioeconomic indicators. The analysis highlights clear associations between limited internet access and diminished outcomes in both education and employment. The study further evaluates the role of policy efforts, such as the Affordable Broadband Act and federal investment programs, in mitigating the digital divide. The findings emphasize the urgency of targeted infrastructure improvements to ensure equitable development across rural communities.

Seeds: A Memory and Map for the Future

Shanique Alladen

Advisor: Cathy Collins

Soil seed banks function as reservoirs of propagules, maintaining the potential for plant regeneration across time. The persistence of seeds in the soil provides a mechanism for ecosystem stability, contributing to vegetation dynamics and community resilience. While the role of seed banks in buffering plant communities against disturbance is well established, there is still room for exploration in understanding how below-ground seed bank richness reflects above-ground plant compositions. This study investigates the relationship between soil seed bank richness and the structure of the existing vegetation in an old-field ecosystem. The study approach to understanding this function involves collecting soil from 28 plots at Montgomery Place on the Bard College campus, where above-ground plant composition has been previously documented. Germination trials conducted in a controlled growth chamber facilitate species identification, allowing for direct comparisons between seed bank richness and historical (2022) and contemporary (2024) above-ground plant community composition. By assessing the degree of congruence between below and above-ground richness, this study aims to refine our understanding of the role of soil seed banks in plant community dynamics and their implications for conservation and ecological restoration. Findings can inform conservation strategies by clarifying the role of seed banks in environmental restoration and long-term community resilience.

Investigating Microbial Contributions to Baseball Aerodynamics: Lena Blackburne Mud RPM Effects

Spencer Azzara

Advisor: Brooke Jude

Each Major League Baseball (MLB) season over 900,000 baseballs are used, every single one is rubbed with a mysterious "magic mud." Originating from the banks of the Delaware River, Lena Blackburne mud has been used for over 85 years to improve grip and reduce the glossy finish on factory-made baseballs. Rule 4.01(c) of the MLB Rulebook mandates that baseballs be "properly rubbed with mud so that the gloss is removed." Before regulation, players used inconsistent substances, like spit, tobacco, or regular dirt that lead to unfair advantages. This prompted the MLB to adopt Lena Blackburne mud to standardize the playing field. Prior analysis shows that it contains about 90% quartz and clay, and includes Pleistocene taxa, but its microbial composition remains largely unexplored (Knebel et al. 1988).

This study investigates whether microbes within the mud have an affect on baseball revolutions per minute (RPM) when pitched. Baseballs were divided into three groups: LB mud, autoclaved LB mud, and no mud. Each was pitched under identical conditions, using a Rapsodo machine, RPM data was collected and analyzed for statistical significance. If significant differences are observed, microbial identification will follow. This research aims to determine whether the "magic" of Lena Blackburne mud stems from its microbial life or its geological composition.

Stress and Trauma Symptoms and Their Possible Effects on Students' Academic Performance

Evelina Benderska

Advisor: Sarah Dunphy-Lelii

The ongoing full-scale invasion of Ukraine has profoundly impacted the lives of students, disrupting their education and contributing to psychological distress. This study investigates the effect of war-related stress on the academic performance of Ukrainian college students currently studying abroad.

Through an online survey administered to 16 participants, I explored self-reported changes in cognitive functioning, including concentration, memory, motivation, and overall academic performance, before and after the onset of the war in February 2022. Results indicate significant declines in key academic indicators, such as the ability to meet deadlines, complete assignments without stress, and sleep quality.

Additionally, stress-related factors, including the impact of trauma on grades and concentration, showed a marked increase. While this study does not establish a causal relationship, it highlights the urgency of providing psychological support for students affected by conflict.

Given the emotional and academic toll of war, the findings emphasize the need for further research with larger, more diverse samples to develop targeted interventions and better support the mental health and academic success of Ukrainian students during these challenging times.

Plant-Based Diets and Consequent Reforestation: A Coupled Strategy for Climate Change Mitigation

Andrés Block Martínez

Advisors: Beate Liepert & Gidon Eshel

Extensive evidence suggests that meat consumption and animal agriculture have significant negative effects on the climate and the environment, while plant-based items are considerably less harmful and resource-intensive. Eshel et al. have proposed that by completely replacing meat with plant-based alternatives, 35 to 50% of agricultural land use and agricultural GHG emissions in the United States could be effectively eliminated. While these results are already significant, they only consider avoided operational emissions from the forgone meat industry, and they do not address the potential additive effects of subsequent policies such as the reforestation of freed cropland. Throughout this project, it is shown that the mitigation potential of plant-based diets (measured in $tCO_{2eq}\ y^{-1}$) could be potentially optimized by the reforestation of retired cropland. In the first part of this project, I quantify the additional carbon mitigation potential (in $tCO_{2eq}\ y^{-1}$) that would be obtained from the reforestation of retired cropland, considering two different scenarios: one where it is assumed that all meat is completely replaced across the conterminous US, and one where only beef is assumed to be replaced. To do this, I use the FAO's EX-ACT tool to simulate the proposed reforestation scenarios at each plot of relevant cropland across the conterminous US. Additionally, I perform a geospatial analysis using ArcGISPro to evaluate the different input parameters of EX-ACT at each plot of relevant cropland across the conterminous US. The average mitigation potential from sequestration due to the reforestation of retired cropland across the entire area of study was found to be 8.4 $tCO_{2eq}\ y^{-1}\ ha^{-1}\ y^{-1}$ for the replacement of all meat and 7.9 $tCO_{2eq}\ y^{-1}\ ha^{-1}\ y^{-1}$ for the replacement of only beef. Additionally, the net mitigation potential of plant-based diets (considering both avoided emissions and carbon sequestration from reforestation) was found to be 582 $MtCO_{2eq}\ y^{-1}$ for the replacement of all meat and 420 $MtCO_{2eq}\ y^{-1}$ for the replacement of only beef. Overall, it was found that the combination of plant-based diets and reforestation could mitigate up to 98% of current annual emissions from the

Agriculture sector of the US with the replacement of all meat, and up to 71% with the replacement of only beef. In the second and third parts of this project, I use satellite-retrieved data and perform more geospatial analyses with ArcGISPro to estimate the changes in monthly albedo, absorbed downward shortwave radiation (DSR), and the latent heat flux (ET), which are dominant components of the Earth's surface energy budget equation in the context of reforestation. This is particularly useful for understanding how reforestation affects the local climate. The results indicate an increase in the net amount of absorbed energy at the surface (considering both changes in absorbed DSR and in ET) for all 12 months resulting from the proposed reforestation scenarios. The maximum monthly increase in absorbed energy at the surface was found to be 13 W/m^2 for the replacement of all meat and 11 W/m^2 for the replacement of only beef, both in the month of July. The minimum monthly increase was found to be -0.02 W/m^2 for the replacement of all meat, and 0.1 W/m^2 for the replacement of only beef, both for the month of December. These results ignore the complex coupling between albedo and ET. An interesting consequence of the proposed reforestation scenarios is a general reduction in the amount of monthly evaporated water, leading to potential benefits in drought management and mitigation. The net effect of the proposed reforestation scenarios on the surface energy fluxes and on surface temperatures remains uncertain.

From Damsels to Directors: Does Identification with Disney Princesses Predict Agency and Self-Esteem?

Adelaide Braunhill
Advisor: Natalie Wittlin

Identification with Disney Princesses, who are both influential and ubiquitous, may shape young girls' perception and development of agency, which is linked to high self-esteem. The first goal of the current study was to determine if identification with agentic Disney Princesses during childhood was correlated with higher levels of agency displayed by participants. The second goal was to determine if participants would feel more identification with high agency Disney Princesses than low agency Disney Princesses. Young women were asked to respond to a survey containing measures on identification levels with Disney Princesses during childhood, agency, and self-esteem. The results did not show a correlation between identification with agentic Disney Princesses and higher levels of agency displayed by participants. The results also did not show higher levels of identification with high agency Disney Princesses than low agency Disney Princesses. Results did, however, find a moderate to strong correlation between participants' agency and participants' self-esteem. My findings do not support existing theories that engagement with Disney Princesses can either positively or negatively affect young women's gendered attributes or self-esteem but do support theories that it is important for women to display agentic traits as they are closely linked to high self-esteem.

Optimization of Olefin Aziridination via Visible Light Photocatalysis: Nitrogen Source and Reaction Efficiency

Zachary P. Burmeister
Advisor: Emily McLaughin

Carbon-nitrogen (C-N) bonds are ever-present in both natural and unnatural small molecules. This work addresses the optimization of a relatively new methodology used to create two C-N bonds simultaneously using visible-light photocatalysis for the purpose of producing substituted aziridine products. Recently, visible-light photocatalysis has been shown to be an effective tool for small scale production of aziridines. Our research aims to improve the scalability of these reactions, the purification process, and examine electrophilic nitrogen sources such as bench-stable N-aminopyridinium ylides and related salts. In this presentation we report recent findings on the scope of the reagents and the effects of scale in our aziridination methodology, including under flow conditions.

Arc Length of Generalized Residue Designs

Ezra Calderon

Advisor: John Cullinan

This project explores the mathematical and geometric properties of *residue designs*, a class of modular constructions formed by connecting points on a circle using the rule $k \mapsto ak \pmod{n}$. These visual patterns reveal connections to group theory, number theory, and trigonometric identities. We present two main results: a closed-form formula for the total length of string required to construct a residue design, and an analysis of the number of distinct strings necessary for various values of a and n. The length result generalizes prior work by Dr. David Richeson and is extended to cases where $\gcd(a - 1, n) \neq 1$, introducing scaled symmetry in the designs. We also employ group theory: we examine the action of the multiplicative group $U(n)$ on $\mathbb{Z}/n\mathbb{Z}$ and connect the number of strings to the number of group orbits under this mapping. While our initial conjecture proposed a ratio of the group order to the order of a, a detailed counterexample in $U(243)$ reveals this to be incomplete. This leads to a more nuanced understanding involving non-unit elements and singleton orbits. The paper also considers residue designs on ellipses, where the presence of elliptic integrals complicates closed-form analysis. We conclude with proposed directions for refining the string-count conjecture and suggest computational strategies to explore further generalizations.

Milkweeds, Monarchs, and Soil Microorganisms: The Net Effects of Climate Warming, Herbivory, and Soil Biota on Common Milkweed (*Asclepias syriaca*)

Reed Campbell
Advisor: Cathy Collins

Anthropogenic disturbances have accelerated climate change and have widespread implications on the natural world. Climate warming is expected to affect plants and animals individually, however, less is known about how it will affect their interactions. One iconic plant-animal interaction is between common milkweed (*Asclepias syriaca*) and the monarch caterpillar (*Danaus plexippus*). Monarch caterpillars are host-specialists and have an obligate mutualistic relationship with milkweed. Simultaneously, milkweed interacts with below-ground microorganisms that can be either mutualistic or pathogenic. In my study, I conducted a fully-factorial, 85-day laboratory experiment assessing the net effects of sustained late-spring temperatures (current, 68°F or future, 80°F), soil conditions (live or sterilized), and herbivory (monarch caterpillar or artificially-induced) on milkweed growth and defense. Ultimately, I found that there are complex, interactive net effects of temperature, soil biota, and herbivory on milkweed growth and defensive mechanisms. There were early, but ephemeral effects of temperature and soil biota on milkweed height and root-shoot ratio. By the conclusion of the study, there were significant, interactive effects of temperature, soil biota, and herbivory on plant biomass and latex. While climate warming in the near future is unlikely to drastically affect milkweed, projected future warming may suppress its above-ground growth and reduce its ability to defend against insect herbivores.

Tverberg Type Problems in Four Dimensions and Above

Gabo Cassell-Ramirez

Advisor: Steven Simon

Tverberg's theorem states that every set of $(d + 1)(r - 1) + 1$ points in $\mathbb{R}^d$ can be partitioned into r subsets whose convex hulls contain a common point. Subsequent theorems have shown that by applying finite Fourier analysis, given a large enough set of points, with fewer points than required for a full Tverberg partition, one may still ensure that the set of points may be partitioned into subsets which each contain one of the vertices of certain polytopes (such as a regular polygon, a prism, an antiprism). For my senior project, I have proposed a generalization of an antiprism in even dimensions higher than two which I call a cascading antiprism and prove a Tverberg type theorem showing that given a set with enough points in some even dimension higher than two one can partition these points into subsets whose convex hulls contain the vertices of a cascading-antiprism. I also propose a related polytope, which I call a divisor polytope that can be projected onto all the regular polygons whose number of sides is a divisor of the total number of vertices of the polytope, and prove a Tverberg-type theorem for this polytope. Finally, I prove that one of the types of facets of a four-dimensional cascading antiprism is an antiprism.

Mediating Role Reversals:
Child Language Brokering in the Healthcare Field

Isabel Chin Garita

Advisor: Justin Dainer-Best

This study explored the influence of child language brokering and acculturation on healthcare experiences. Child language brokering occurs when a child mediates interactions between two groups with linguistic and cultural differences (McQuillan & Tse, 1995). The healthcare field grapples with challenges in communication between patients and healthcare providers (Dal mas et al., 2020), so this study aimed to understand how the cultural and linguistic differences involved in child language brokering might impact healthcare experiences. Due to time constraints, recruited participants were adults, some of whom had child language brokered and some of whom had not. This study also examined how intercultural contact, known as acculturation, relates to healthcare experiences. Questions from the Language Broker Survey (McQuillan & Tse, 1995) and newly formulated questions were used to inquire about language brokering experiences. There was a statistically significant positive correlation between difficulty of language brokering and pressure to language broker ($r = 0.513$, $p < 0.001$). Independent t-tests comparing the healthcare experiences of those who did child language broker and those who did not showed no statistically significant difference in experiences between the two groups. There were also no statistically significant correlations between healthcare experiences and acculturation levels. On open responses, participants noted that language brokering impacted their developmental trajectory and maturity. They also reported particular difficulty with translation of medical terms. Future research should involve mixed methods with a larger sample and more targeted questions on child language brokers' experiences.

The Smells of Fear:
Exploring the Effects of Predatory Olfactory Cues Upon the Foraging Behavior of the Eastern Grey Squirrel

Marianne Chipman
Advisor: Bruce Robertson

Predators leave behind olfactory cues in the form of fur, urine, feces, etc, which are utilized by prey species to judge risk of predation and alter their movements. Research has also shown that certain species have interest in the olfactory cues of competing species, investigating areas they have urinated in. Despite our knowledge of how prey species react to and avoid predatory olfactory cues, our exact knowledge of how this influences specifics of prey behavior is unknown. We also have a limited understanding of how competitor olfactory cues influence behaviors in prey species. This research seeks to better understand how olfactory cues of predator and competitor species influence the foraging behavior and avoid behaviors of the Eastern grey squirrel. This research was conducted through the usage of giving-up-density feeding trays treated with the urines of the Red Fox and Raccoon on squirrel populations at 6 local sites with 30 total data points. This study design seeked to further understand the effect of olfactory cues on the amount of food eaten out of giving-up-density trays, reflecting squirrel's assessment of risk in relation to the olfactory cue. This research found that the olfactory cue treatments applied did not have a significant effect on the number of peanuts eaten per tray.

Canine Connection:
Exploring the Role Dogs Have in Shaping Parent-Child Relationships

Mayerli Collantes Cook
Advisor: Frank Scalzo

Dogs have been beneficial animals to humans by serving as therapy animals, animal assistants, and companions. Dog ownership has been associated with various mental health improvements across all age groups. The present proposed study recruited families with children aged 8-12, both with and without a family dog, to examine how the presence of a dog influences children's relationship and attachment patterns within the family. Participating children completed three standardized questionnaires: the Lexington Attachment to Pets Scale (LAPS), Parent-Child Communication Scale (PCCS), and Security Scale (SS). In addition, the Child Attachment Interview (CAI) was conducted to further assess attachment to parents. Families without pet dogs or any pets served as a comparison group and did all the questionnaires except for the Lexington Attachment to Pets Scale (LAPS). The results are discussed in terms of how child-dog attachment may contribute to children's social and emotional development, family functioning and support.

Understanding the Binding Potential of Ru80 to Dihydrofolate Reductase Enzyme

Luke Collins
Advisor: Swapan Jain

The folate pathway has long been studied as a target for anti-cancer research. This is due to the role of dihydrofolate reductase (DHFR) enzyme as an essential catalyst for the biosynthesis of purines, which is crucial for DNA production. Transition metal complexes may have the potential to inhibit the activity of DHFR, thereby slowing tumor growth. My research focuses on the anticancer potential of novel ruthenium compounds. The unique chemical properties of ruthenium compounds provide promising alternatives to traditional platinum-based drugs because of their potential for selectivity and reduced side effects. The ruthenium complex under study is Ru80 which consists of two ruthenium centers coordinated to phenformin, a known antidiabetic drug. In this project, I examine the efficacy of this compound through UV absorption assays, enzymatic activity assays, and ITC. These methods offer insights into how varying the drug's incubation time affects DHFR activity as well as the thermodynamic parameters of the Ru80 binding mechanism.

Regulator Period Values at Maximal Conifold Points on Degenerate Quantum Curves

Anna Elizabeth Allen Connelly

Advisor: Charles Doran

This thesis investigates a family of identities connecting regulator periods on mirror curves to special values of the Bloch–Wigner dilogarithm, established by Doran, Kerr, and Sinha-Babu as a consequence of the Codesido–Grassi–Mariño conjecture relating quantum curves and spectral determinants. These identities arise at the maximal conifold point, where the degeneration of the mirror curve reveals arithmetic structure related to algebraic K-theory, which is beyond the scope of this thesis. We develop a computer algebra algorithm that automates the extraction of constant terms from multinomial expansions of Laurent polynomials under balancing constraints to study new examples of this identity. The results provide numerical evidence across lattice polygons, including cases not yet proven analytically. The algorithm streamlines the computation of dilogarithmic asymptotics, enabling broader investigation of mirror curve families. Ongoing collaboration with S. Sinha Babu and C. Doran will extend this work to more generalized polygons, as part of a larger effort to clarify how arithmetic and geometric structures interact across algebraic and differential geometry in mathematical physics.

Quantum Modeling of Ru80

Freddy Coronel

Advisors: Swapan Jain, Matthew Greenberg & Stefan Mendez-Diez

This project investigates the molecule Ru80, a ruthenium-based compound, through a combination of quantum modeling and experimental binding studies. Using Density Functional Theory (DFT) calculations in ORCA, the study evaluated the geometry, electronic structure, and thermodynamic properties of Ru80 during ligand substitution reactions with imidazole, guanine, adenine and water. These reactions are designed to mimic enzyme-Ru coordination interactions, where a chloride ligand is displaced by a neutral donor. Complementary wet lab experiments were performed using isothermal titration calorimetry (ITC) to quantify the binding affinity and thermodynamic parameters (Δ G, Δ H, Δ S$) associated with Ru80's ligand exchange behavior. By integrating computational and experimental data, this study provides a molecular-level understanding of how Ru80 interacts with potential enzymatic targets. The correlation between DFT-predicted data and ITC binding parameters offers insight into Ru80's mechanism and highlights its potential inhibitory agent.

From Theory to Computation: Numerical Modeling of Light Diffraction

Emma Derrick
Advisors: Ethan Bloch & Harold Haggard

Ray optics tells us that light passing through an aperture would cause a perfect shadow, but we see experimentally that this is not true because of diffraction, which is the bending of light around obstacles. Christiaan Huygens created a model called the Huygens Principle to visualize the propagation of light as a series of secondary wavelets on the primary wavefront that add up at a later point to give the propagated wave. Two hundred years later, Gustav Kirchhoff derived an integral from Maxwell's equations that shows that the Huygens Principle is an accurate representation of the diffraction of light. Although this integral is a very powerful tool for calculating the propagated field, it has to be solved numerically in all cases, except the most simple. This project looked at various numerical methods of integration as a tool for visualizing the diffraction of light. These methods include Riemann sums, the trapezoid rule, Simpson's rule, Monte Carlo integration, and Discrete Fourier Transform (DFT).

Stackjack:
Evaluating the Efficacy of Game Based Learning for Data Structures and Computer Science Education at Large

Christopher Dominguez
Advisor: Robert McGrail

This study evaluates the efficacy of Stackjack, a game-based learning (GBL) adaptation of the card game Blackjack designed to teach stacks and queues as they relate to computer science education. With rising concerns over student disengagement and AI-driven shortcuts, examining more effective methods of connecting with students and communicating material is a worthwhile endeavor. In this experiment traditional lecture-based instruction was compared with an interactive gameplay approach. Eighteen undergraduate students were divided into control (lecture only) and experimental (lecture and Stackjack) groups before completing an exam that assessed both conceptual understanding and practical applications of stacks and queues as data structures. Results showed no statistically significant difference in exam performance between groups, though observed preliminary data and qualitative feedback suggested participants perceived Stackjack as beneficial. This study highlights the challenges in measuring engagement and knowledge retention while suggesting refinements for future implementations of game based learning in computer science curriculums and the education sector at large.

Refinement of the Theoretical Spectrum of PH3 Using MARVEL Analysis of the Measured Rovibrational Spectra of PH3

Chloe Dufeu

Advisors: Clara Sousa-Silva & John Cullinan

A preliminary refinement of the phosphine molecule spectrum found in Sousa-Silva et al. is presented in this thesis. The refinement process is done by swapping experimentally found rotational-vibrational energy levels into the theoretical data set of energy levels. A total of 8,808 experimental transitions were considered from 13 different publications. The Measured Active Rotational-Vibrational Energy Levels (MARVEL) technique was used to extract the energy levels from these transitions. Once the experimental energy levels were matched to their corresponding theoretical energy level and swapped into the data, the refined hot line list and spectrum was computed using a program called ExoCross. It was computed for a temperature of 2,000K with pressure of 0.01 bar. The line list contains a total of 1,727,113 transitions. The original and updated spectrum is compared to the latest HITRAN database of phosphine transitions. In order to adequately compare these data sets, transitions from the HITRAN data were matched to the original and updated list of transitions. For the original and updated transitions that correctly match the HITRAN transitions, we see an improvement in the line positions of the updated transitions.

Experimental Evolution of Cross-Resistance between Agricultural and Clinical Azoles in Opportunistic and Environmental Yeasts

Sarah Enam

Advisor: Robert Todd

The widespread use of azole antifungals in both clinical medicine and agriculture has contributed to a global rise in antifungal resistance, raising concerns about cross-resistance to antifungal drugs following environmental fungicide exposure. This study investigated the development of resistance and cross-resistance in *Candida albicans* and *Lachancea fermentati* strains following in vitro exposure to clinical (fluconazole) and agricultural (tebuconazole, imazalil) azoles. Changes in antifungal susceptibility were assessed using Kirby-Bauer disk diffusion assays after an in vitro evolution experiment.

Results indicated that exposure to any single azole frequently induced broad cross-resistance to other azoles, with conditioning by triazoles (fluconazole and tebuconazole) producing more pronounced reductions in susceptibility than conditioning by the imidazole (imazalil). While imazalil conditioning generally resulted in lower levels of resistance, it still conferred partial cross-resistance. Several colonies exhibited morphological adaptations, including biofilm formation and filamentous growth, traits associated with phenotypic tolerance; others developed diverse resistance profiles, suggesting multiple mechanistic pathways to resistance. These findings demonstrate the capacity of yeasts to rapidly evolve multi-azole resistance following single-azole exposure and highlight the interconnected risks that agricultural fungicide use poses to clinical antifungal efficacy. This highlights an urgent need for cohesive policy regulating antifungal use across both agricultural and clinical domains. Understanding how environmental exposures drive antifungal resistance is critical to preserving the effectiveness of current antimycotic therapies and mitigating the spread of multidrug-resistant fungal pathogens.

An Assessment of the Environmental Impacts of Artificial Turf Fields: Recommendations for the Installation, Management, and Sustainable Use of Artificial Turf

Cole Ewalt

Advisor: Beate Liepert

This research investigates the release and environmental movement of microplastic pollution from artificial turf, using Ferrari Field at Bard College as a case study. Synthetic turf systems, composed of polyethylene fibers, crumb rubber infill, and layered backing materials, are increasingly used in recreational spaces, yet their contribution to microplastic contamination remains under-addressed. Through a combination of field sampling, laboratory analysis, geospatial mapping, and thermal imaging, this study documents how microplastic particles are dispersed by player activity, maintenance practices, and weather events.

Data from ten sampling sessions revealed an average infill loss rate of 0.78 mL per player per hour, translating to thousands of individual microplastic granules per session. Additional observations confirmed that rain, runoff, and snow removal also contribute significantly to off-field dispersal, even in the absence of direct use. Thermal imaging showed that turf is, on average, 15 degrees fahrenheit hotter than surrounding surfaces, leading to faster degradation and microplastic breakdown. A predictive model was developed to estimate dispersal under different weather conditions, with total infill loss estimated between 13 - 66 liters per year (dry vs. wet).

Rather than argue against synthetic turf use outright, this project focuses on containment. It proposes low-cost, locally implementable solutions (such as perimeter barriers, shoe cleaning stations, and improved maintenance protocols) to reduce microplastic dispersal at the institutional level. The findings demonstrate that small-scale interventions, informed by data and supported by precedent, can significantly reduce environmental harm. This case study offers a model for how colleges and municipalities can take practical action in the face of widespread synthetic pollution.

Fungicidal Properties of Violacein on *Microsporum Canis*

Margo Ganton
Advisor: Brooke Jude

In veterinary medicine, ringworm, which is known clinically as dermatophytosis, is a fungal infection of keratinized tissue such as the skin, hair, and/or nails (Center (U.S.) 1958; "*Ringworm: A Serious but Readily Treatable Affliction*"). It is caused by a suite of zoonotic fungal pathogens called dermatophytes and the filamentous fungal species *Microsporum canis* is one of the main infectious agents (Degreef 2008, Merchant 2024; Thakur and Kalsi 2019). Unfortunately, there are only three classes of antifungal drugs (azoles, polyenes and echinocandins) that are effective treatments for dermatophyte infections (ESCCAP 2019; Guillot et al. 2002; Moriello et al. 2017; Morellio and DeBoer 1995; Paterson 1999; Sparkes et al., 2000). The main objective of this study is investigating the efficacy of violacein, a purple pigment with antimicrobial properties that is naturally produced by bacteria, as a novel treatment for *M. canis* infections. To determine the minimum inhibitory concentration of violacein for *M. canis* treatment, a Kirby-Bauer (KB) disk diffusion assay was conducted with five working violacein concentrations (100μg/ml, 50μg/ml, 15μg/ml, 8μg/ml, and 4μg/ml) suspended in 100% DMSO and a 100% DMSO negative control. In order to establish a baseline for the efficacy of clinical drugs, a second KB assay was performed using fluconazole (25 mg/mL), terbinafine (30 mg/mL), and imazalil (30 mg/mL) suspended in 100% ethanol and a 100% ethanol negative control. While both of the KB assays did not yield any usable data, much was learned about successful culturing of *M. canis* and directions for future studies are explored. With antifungal resistant *M. canis* strain numbers on the rise, development of novel antifungal drugs is imperative (Abastabar et al. 2019; Aneke et al. 2021; Havilckova 2008; Hsiao et al. 2018; Liang et al. 2025; Prajapati, et al. 2025; Skerlev and Mikliĉ 2010).

Noise as Input:
A Robotic Sculpture's Search for Meaning in Futile Repetition

Nico Goldstein

Advisors: Paul Cadden-Zimansky & Rebecca Morgan

The goal of this project is to create an interactive robotic sculpture that uses the ambient sound levels of the exhibition space it inhabits as a method of guessing a hidden code. The sculpture explores the emotional nuances of interaction between humans and non-humanoid robots, drawing attention to the strangeness and complexity of our relationship with machines that lack consciousness but still exhibit behaviors that invite interpretation. It also serves as a reflection on the nature of industrial robotics—typically efficient and purpose-driven—by placing a machine in a loop of seemingly futile repetition, tasked with solving a problem that's solution, even if achieved, will never be known to the robot.

At the core of this piece is a metal frame standing approximately six feet tall, built with a square base and four vertical rods extending upward. Attached to the frame, about four feet off the ground, is a rail system with a movable mount designed to shift along its X and Y axes in response to the volume of noise generated by the audience.

A microphone and Arduino, both integrated into the body of the robot, continuously monitor and average the incoming sound data. Based on changes in volume over time, the robot will move to one of four possible positions along the rail. Once this occurs, an arm extends outward from the mount to press one of four buttons. This sequence of listening, analyzing, and guessing continues indefinitely, regardless of whether or not the robot stumbles upon the correct code.

The Shape of Stress:
An Applied Mathematical Approach to Mohr's Circles and Stress Matrix Analysis

Martha Gomez
Advisor: Charles Doran

Stress is the measure of internal forces within a material and can be decomposed into two principal types: normal stress and shear stress. Normal stress is applied perpendicular to a surface, whereas shear stress works in the plane of applied stress. From the total stress vector with both normal and shear stress components, a stress matrix can be created, detailing the stress at every possible position within a material. Stress is graphically represented by Mohr's Circles, which intake the stress matrix of a system and outputs circles that define every possible stress value across all axes. Mohr's Circles can represent stress in multi-dimensional systems, and across different mediums.

Understanding the Connection Between Early Maladaptive Schemas, Sleep, and Dreaming

Aleah Goodman

Advisor: Frank Scalzo

The present study investigated the correlation between Early Maladaptive Schemas (EMSs) and both sleep quality and dreaming experiences. Participants (N=75) responded to an online Qualtrics survey containing three questionnaires: the Young Schema Questionnaire (YSQ-S3), which assessed presence and severity of EMSs, the Basic Scale on Insomnia and Quality of Sleep (BaSIQS), which measured sleep quality, and the Multidimensional Dream Inventory (MDI), which quantified differences in dreaming experiences. A statistically significant positive correlation was observed between YSQ-S3 total score and BaSIQs total score, as well as between 5 individual schemas (*Dependence/Incompetence, Abandonment, Vulnerability to Harm or Illness, Self-Sacrifice, Negativity and Pessimism*) and BaSIQS total score. No correlation was observed between total YSQ-S3 score and MDI score, or total BaSIQS score and MDI score. However, the MDI subscale *Dream Importance* was found to be positively correlated with YSQ-S3 total score. One-way ANOVA analyses revealed that poor sleepers had significantly higher mean YSQ-S3 total scores and mean scores on four individual schemas (*Abandonment, Mistrust/Abuse, Vulnerability to Harm or Illness, and Negativity/Pessimism*) when compared with good sleepers. These findings indicate that worse sleep quality is associated with higher levels of EMSs, finding personal importance in dreams may be a quality of people with EMSs, and that negative thought patterns, sleep quality, and dreaming experiences are intertwined.

Hiking Shelters as Vectors of Infectious Disease: Using qPCR as an Environmental Detection Method for Methicillin-Resistant *Staphylococcus aureus* in Remote Locations

Zoe Greenhouse

Advisors: Bruce Robertson & Robert Todd

Each year, thru-hikers spend extended periods of time sleeping at campsites, shelters, and hostels as they travel hundreds to thousands of miles on long-distance trails. Because practicing good personal hygiene is more difficult while living in the outdoors, and because hikers tend to travel in groups, infections such as methicillin-resistant *Staphylococcus aureus* (MRSA), *Caliciviridae* (norovirus), and *tinea pedis* (athlete's foot), are encountered on trail. Research has shown that athletes and the immunocompromised are particularly susceptible to MRSA infections, and because of the antibiotic resistant nature of the bacteria, those infections can be difficult to treat. However, little is known about the transmission of infection and the roles that surfaces play in the spread of pathogens along long-distance trails. I present a review of literature based on infectious diseases and their spread in urban and rural settings, as well as an overview of PCR as a detection method for surface-based microorganisms. Using serial dilution assays and real-time quantitative PCR (qPCR), this research provides an analysis of nucleic acid amplification of MRSA's *mecA* gene compared to DNA concentration. I develop a standard curve that serves as a guideline for future research on the detection of pathogenic bacteria in locations with limited access to healthcare. The findings of this study suggest that qPCR can be used for the detection of MRSA DNA at varying levels in the environment. Based on this work, I propose a framework for a preventative surveillance technique to minimize the spread of infectious disease in remote locations.

Dripping in Defense:
Understanding How Violacein Targets and Inhibits Skin Bacteria In Sweat

Jynaiya Grizzle
Advisor: Brooke jude

Sweat glands are accessory organs that work within the skin's layers for thermoregulation as well as the excretion of wastes in its production of sweat. The perspiring skin environment is the home for microbes on the skin's surface that remove these pathogens and unwanted bacteria. This bacteria, if left on broken skin can increase risk for infections that could lead to diseases. Violacein is a purple-bacteria that has the capability to inhibit microbial growth. While its antimicrobial properties have been successful in other environments, its activity in the presence of sweat microbes has not been tested. In the investigation of violacein's inhibition properties in the presence of sweat-related bacteria, we have found that that growth inhibition was evident in higher concentrations of violacein relative to lower concentrations. Looking into the connection between violacein and sweat microbes, this can open opportunities for violacein to be implemented into practical applications that decrease the bacterial abundance of common hospital and commercial settings.

Synthesis and Structural Characterization of Lead-Free M2CuCl4 ($M = Cs^+, K^+, Rb^+$) Nanocrystals for Blue Emission Applications

Meherin Hossain

Advisor: Matthew Greenberg

As global electricity demand rises, lighting continues to account for nearly 15% of total energy consumption. While light-emitting diodes (LEDs) have improved energy efficiency, they often rely on critical raw materials like antimony, gallium, and indium – elements linked to supply chain vulnerability and human health risks. Metal halide perovskites are emerging as promising alternatives for the emissive layers in LEDs, however, most contain toxic lead, which remains a serious environmental and health concern. Lead-free copper halide nanocrystals offer a safer pathway, particularly for blue emission, which is still difficult to achieve efficiently in perovskite systems. In this thesis, we explore lead-free copper halide nanocrystals as safer, blue-emitting alternatives, focusing on synthesis and characterization of M_2CuCl_4 nanocrystals ($M = Cs^+, K^+, Rb^+$). Using a hot-injection method, we characterized both pure and mixed phases of Cs/K and Cs/Rb. Photoluminescence and photoluminescence excitation measurements revealed distinct, composition-dependent emission profiles. Total X-ray scattering data and real-space pair distribution function analysis of Cs_2CuCl_4 showed well-defined real-space correlations, indicating high crystallinity. This work highlights the promise of M_2CuCl_4 nanocrystals as lead-free, efficient blue emitters, contributing to the development of safer materials for next-generation optoelectronic applications.

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Attitude & Stigma:
Assessing the Intersection of Psychology and Law in Legal Decision Making

Nevaeh Iverson

Advisors: James Hobbs & Kristin Lane

This study addressed the influence of bias and stigma of mental illness on decision making in a legal context. I investigated whether or not knowledge and attitude of mental illness, specifically Schizophrenia had any impact on perceived level of responsibility and verdict. Participants were instructed to answer two questionnaires assessing their knowledge on the Mental Health Knowledge Scale (MAKS) and attitude through the Community Attitudes Toward Mental Illness Scale (CAMI). They read a short hypothetical vignette describing an assault incident with a Schizophrenic woman. They rated the woman's level of responsibility and the sentence length (in years) they'd assign. Results showed that there was a significant relationship when measuring knowledge and attitude together on responsibility and sentence, rather than separately. Participants with higher knowledge and positive attitudes tend to rate a lower level of responsibility and give a lighter sentence.

Access and Effectiveness of PTSD treatment for Central American Immigrants: A Proposed Qualitative Analysis

Oliver Joslin

Advisors: Justin Dainer-Best & Patricia Lopez-Gay

Central American immigrants very often do not receive treatment for mental illnesses, despite high rates of disorders such as PTSD as well as the high potential of experiencing traumatic events prior to or during the process of crossing the US border. This is most likely due to various financial, sociocultural and political barriers that prevent such treatment from being accessible or effective. This study proposal aims to identify the various barriers to access and effectiveness that these immigrants face in seeking treatment for PTSD, through a thematic analysis of qualitative interviews. In addition to identifying barriers, participants would be asked for their suggestions as to how they would change current therapeutic interventions to better suit their needs. Seven potential themes were discussed as possibilities for this analysis, consisting of (1) a fear of deportation, (2) the influence of cultural stigma, and (3) a lack of financial resources for barriers to access, (4) linguistic differences and (5) a lack of trust for barriers to effectiveness, and (6) an integration of medical and (7) mental healthcare as well as a clearer explanation of the therapeutic process were suggestions made to improve current therapy models. The theoretical results of this analysis could draw more attention to the lack of effective therapy for Central American immigrants and lead to improvements in how interventions and other therapeutic models are constructed.

Building a Quantum Interpreter: Implementation and Analysis of Quantum Simulation Algorithms

Yashar Ahmed Khan
Advisor: Valerie Barr

The rapid development of Quantum Computing (QC) has led to several questions on accessibility and the effectiveness of different simulation techniques on classical hardware, given the scarcity of commercial quantum computers. This project aims to answer these questions by creating an interpreter in C that implements three different quantum simulation algorithms---the State Vector Algorithm, Tensor Network Algorithm, and Stabilizer Circuits---on a classical computer, and compares the performance of all three algorithms across various quantum programs. Circuit diagrams and visualizations are provided for any gate operation performed on up to 16 qubits in a command-line interface. Performance metrics are reported and plotted, with a full comparative analysis of all 3 algorithms. We found that the State Vector algorithm performs best for smaller circuits at low qubit counts, the Stabilizer algorithm performs the most consistently, but only for Clifford gates, but the Tensor Network algorithm struggles with entangled states, due to an issue with Singular Value Decomposition (SVD) implementation.

The Front Multicrossing Number of Links

Josh Krienke
Advisor: Caitlin Leverson

A multicrossing projection of a knot is a projection where we allow more than two strands to intersect at crossings. Adams et al. showed in "Knot projections with a single multi-crossing" that every smooth knot is (smoothly) equivalent to a projection with one multicrossing. For Legendrian knots, which are knots satisfying a particular geometric condition, it was shown by Kumar, Murphy, and Naff in "Legendrian knots and multi-crossings" that particular projections (called front projections) with one multicrossing are (smoothly) equivalent to the unknot. We define the front multicrossing number of knots (or links), and classify all links with a front multicrossing number of 2.

Healing Through Expression:
The Impact of Expressive Writing on Mental and Physical Wellbeing in Patients with Amyotrophic Lateral Sclerosis

Paige Labbe
Advisor: Justin Dainer-Best

This project proposes to explore the effectiveness of expressive writing therapy for patients diagnosed with Amyotrophic Lateral Sclerosis (ALS). Those in the experimental conditions would receive writing prompts manipulated to subconsciously elicit different responses. I modeled the writing instructions after Nazarian and Smyth (2013). A 4 (standard, control, cognitive processing, benefit finding) × 3 (baseline, intervention, follow-up) mixed factorial design would be used to predict outcomes. Participants would respond to expressive writing prompts unique to their respective condition over a three week intervention period. Participants' anxiety, depression, and quality of life levels would be assessed at baseline, during the intervention, and one month post-intervention. I predict that for manipulated instruction groups (cognitive processing, benefit finding), depression and anxiety levels would decrease while quality of life levels would increase as compared to the control and standard writing conditions. Participants in the cognitive processing group would evidence increased cognitive insight word use after the intervention period, indicating more cognitive processing in participants. Participants in the benefit finding group would increase their usage of positive emotion words over the intervention. Were these results found, the current study could provide insights into the effectiveness of expressive writing as a form of therapy for those coping with a traumatic experience or extreme emotional upheaval.

Antibiotic Susceptibility of Nontuberculous mycobacteria (NTM) *M. abscessus* and Clinical Isolate using SLOMYCO2 Plates and Resazurin Assay

Yadriel Lagunes
Advisor: Brooke Jude

Nontuberculous mycobacteria (NTM) is a type of bacteria typically found in soil and water that is capable of infecting humans. These bacteria are related to *Mycobacterium tuberculosis*, and mainly cause chronic pulmonary diseases. NTM biofilms are contaminants on surfaces in healthcare settings such as showerheads or medical equipment. This puts patients, especially those who are immunocompromised, at risk of developing healthcare-associated infections (HAI). NTM's thick cell walls and biofilm formation increase its drug resistance and make it more difficult to remove from surfaces. Therefore, NTM antibiotic susceptibility needs to be further investigated in order to reduce hospital contamination and improve patient clinical outcomes. ABSURDO (an anagram of Bard and Ohio State University) is a novel *M. intracellulare* clinical isolate, originally cultured from a pediatric patient's lymph node, that has been recently whole genome sequenced. This study seeks to characterize the antibiotic susceptibility of parent strain of ABSURDO and *Mycobacterium abscessus*. 12 antibiotics at varying concentrations were tested for these two NTM species using SENSITITRE™ SLOMYCO2 plates. A resazurin assay, an established method to determine cell viability but a relatively novel one for NTM antibiotic susceptibility testing, was used to determine minimum inhibitory concentration (MIC) values. This experiment found that this methodology was successful in determining the antibiotic susceptibility of ABSURDO and *M. abscessus*. Overall, the ABSURDO parent had lower MIC values than *M. abscessus* for each antibiotic tested. Future studies could explore the susceptibility profiles of closer related NTM species like the reference strain of *M. intracellulare* or ABSURDO morphologies A, B, and C to expand scientific understanding of the ABSURDO clinical isolate.

The Effect of Common Buckthorn and its Associated Fungi on the Native Plant Species Yarrow and White Snakeroot on Bard College's Campus After Removal

Senowa Leverentz

Advisor: Cathy Collins

Invasive species can be detrimental to ecosystems by outcompeting native species, altering habitat quality and reducing biodiversity. Common buckthorn (*Rhamnus cathartica*) is a small invasive tree originally from Europe, introduced to the United States as an ornamental shrub for residential landscaping. Buckthorn is now widespread throughout Northeastern, Midwestern, and Western United States. Control efforts to reduce the amount of buckthorn in forests around the country involve mechanically cutting down the shrubs and using chemicals to destroy the resilient roots. However, these methods prove strenuous, time consuming and expensive, so research into the complete ways in which common buckthorn affect ecosystems is necessary. My research looks at the effect that common buckthorn have on native understory species based on soil fungi. I collected soil from around buckthorn shrubs and from nearby native control species (oak and maple) at 14 different locations located on Bard College's campus. Soil was potted in containers with half containing soil from around common buckthorn trees and half from around the control species. I applied fungicide treatment to half of all soils to eliminate all fungal communities. I sowed seeds of two native species, yarrow and white snakeroot, and after a month and a half I measured the above ground plant biomass of each individual plant. I found that the presence of common buckthorn and the interaction between the invader and the fungicide treatment had no effect on either yarrow or white snakeroot. However, fungicide treatments had a strong negative effect on white snakeroot, and yarrow showed no effect. My findings are consistent with other studies that did not detect legacy effects of invaders and their microbial communities on the success and growth of native species. My findings are consistent with research showing that plant species benefit from mutualistic fungi. While my project looks at the effect of common buckthorn and its associated fungi, a more controlled study where common buckthorn associated fungi are isolated from other soil fungi and repeated trials are made using different native species and longer experimental durations would be necessary to confirm that there was no effect.

Enhanced Intervention for Conflict-Related Sexual Violence Survivors

Guy Levy
Advisor: Frank Scalzo

This thesis examines a novel intervention designed to support survivors of conflict-related sexual violence (CRSV) in a post-conflict setting. The purpose of the study is to evaluate whether integrating a forgiveness-focused module into a trauma-informed, empowerment-based group therapy can enhance survivors' psychological healing and empowerment outcomes. The research employs a randomized controlled trial with adult female CRSV survivors, who are randomly assigned to either a control group receiving standard Trauma-Focused Empowerment Therapy (TFET) or an intervention group receiving TFET enhanced with a structured forgiveness module (TFET+F). Validated instruments, including the PTSD Checklist for DSM-5 and the Hopkins Symptom Checklist-25, are administered at baseline and post-intervention to assess changes in PTSD symptoms, depression, anxiety, forgiveness, resilience, and empowerment.

It is hypothesized that while both groups will show improvements in trauma-related symptoms, the TFET+F group will demonstrate greater gains in emotional closure, empowerment, and resilience. This study addresses critical gaps in the CRSV intervention literature, where forgiveness and empowerment outcomes have been underexplored compared to traditional symptom-focused approaches. Anticipated findings aim to inform the development of holistic, survivor-centered practices for post-conflict recovery. Implications include guiding NGOs and policymakers in implementing integrated trauma, empowerment, and forgiveness-based interventions, and the study's trauma-informed and ethical design offers a model for conducting research with vulnerable populations in humanitarian contexts.

A Letter To The Inhabitant. Escaping The Virtual

Anna Likhanova

Advisors: Sven Anderson & Julia Weist

This Joint Senior Project examines the interaction of virtual and physical rooms as they come together in one exhibition. The paper goes through the process of developing the VR environment in Unity – from an empty scene to an interactive approximation of a room in a Russian household. It is then followed by the analysis of the results of the exploratory survey conducted (n=16), which examined whether the order in which the viewer experiences the exhibition has an impact on their perception of the work. The results suggest that viewers' perception of interactivity did not change based on the order in which they experienced the installation. The results also suggest the viewer's greater appreciation for VR if they experience the physical exhibit first, as they perceive VR as an extension/supplement of the physical installation.

Assessing Back-Translation and GPT Paraphrasing Augmentations via Geometric-Topological Features of Word Embeddings

Yulia Yueer Lin

Advisor: Sven Anderson

In this study, we compare two techniques, GPT-based paraphrasing and back-translation, for augmenting vocabulary used to train large language models. We examine correlations between classification of sentiment based on the SST-2 sentiment dataset and topological measures such as persistent homology, Wasserstein distance and convex hull metrics. Our results suggest that GPT-based paraphrasing introduces the greatest lexical diversity and yields the most redistribution to the original embedding space, whereas back-translations tend to stay closely to the original wordings and demonstrate a more conservative shift from the original embedding space. These findings suggest that there is a pattern between the geometric/topological properties of the augmented dataset to its downstream model performance, which could serve as an indicator in choosing the best augmentation strategy in the natural language processing pipeline.

Investigating the Antimicrobial Properties of Phenothiazine, Dibenzazepine, and Butyrophenone Derivative Antipsychotic Compounds

Asher Longdon-Stewart

Advisor: Swapan Jain

Antimicrobial resistance is a rapidly worsening global health crisis, contributing to millions of deaths per year. Synthesis, isolation, and general development of novel antimicrobials has stalled within the 21st century due to the high cost of resources, and its investment by pharmaceutical companies has dropped. A new eye has recently turned towards screening and repurposing previously existing compounds for their potential antimicrobial properties. Antipsychotics have antibiotic roots having originated from the antimalarial agent and later discovered monoamine oxidase inhibitor (MAOI) antidepressant, methylene blue. Throughout the 1950s, the phenothiazine core of the dye proved to be especially promiscuous, with neuroleptic derivatives becoming FDA approved within the decade. This study investigates the antibacterial activity of three structurally distinct antipsychotic drugs—thioridazine, clozapine, and haloperidol—against *Bacillus subtilis*, a Gram-positive model organism. While prior research has focused on pathogenic Gram-positive and multidrug resistant (MDR) species such as antibiotic-resistant *Staphylococcus aureus*, these bacteria often contain efflux pumps that obscure potential mechanisms of action. By studying *B. subtilis*, a non-pathogenic species with well-characterized genetics, this project aims to establish a clearer foundation for understanding the antibacterial effects of antipsychotics and support future investigations into their mechanisms of action. A time-based UV-Vis assay, a Kirby-Bauer disc diffusion assay, and PCR/gel electrophoresis were all used to elucidate possible antibacterial activity for the various psychotropic agents.

The Missing Link:
Aging Out and The Role of Parental Support On College Persistence, Emotional Distress, and Social Isolation in Foster Care Alumni and First-Generation College Students

Ysewrantz Lubin

Advisor: Thomas Hutcheon

This study explored how varying levels of parental involvement impact the emotional, structural, and academic outcomes of two high-risk student groups; foster care alumni and first-generation college students. While both populations face challenges in higher education, the findings reveal that foster care alumni experience significantly higher levels of financial insecurity, housing instability, emotional distress and social isolation. These outcomes are strongly linked to their much lower levels of academic, emotional, and financial support from a parent/guardian. In contrast, first generation students, though often economically disadvantaged, generally reported more consistent parental support and better outcomes. The results suggest that relational disconnection has far-reaching effects on students, influencing not only academic persistence but also emotional distress and social isolation.

Stable Action Symbols in PMv Across Recording Sessions & Dynamic Switching of Vision, Planning, And Motor Neural Codes in the Macaque Brain

Xuan Ma

Advisors: Thomas Hutcheon & Theresa Law

Compositional generalization refers to the cognitive ability to create and understand numerous new combinations from a finite set of known symbols and rules (Lake & Baroni, 2018). This capacity is crucial for intelligence, enabling both humans and animals to adapt quickly to novel situations by flexibly recombining previously learned information (Fodor & Pylyshyn, 1988). Although many behavioral studies have demonstrated compositional generalization, its neural basis remains unclear (Suzuki et al., 2016). Previous research identified the ventral premotor cortex (PMv) as a critical area for representing abstract, reusable motor programs, named "action symbols." These symbols can be recombined to perform new tasks efficiently (Tian et al., 2025). However, whether these symbols remain stable over extended periods or across different phases of task execution was unknown. In this study, we explored the stability and dynamics of action symbols in macaques trained in drawing tasks. Our results showed that neural codes representing shape primitives remain remarkably stable across sessions, indicating persistent symbolic encoding in PMv. Additionally, we discovered that PMv dynamically switches between encoding visual shapes and motor plans during different task phases. These findings suggest that PMv flexibly manages multiple symbolic codes, supporting complex and goal-directed behaviors. This research provides significant insights into how symbolic knowledge and compositional behaviors are neurally implemented, with potential implications for understanding cognition and developing advanced artificial intelligence models.

Investigating the Sensitivity of Human Acid-Sensing Ion Channels (ASIC1) to Ibuprofen Using Patch-Clamp Electrophysiology

Amirat Maiyegun

Advisor: Kate Huffer

Pain is a general term that describes uncomfortable sensations in the body that stems from activation of the nervous system. Pain can be relieved by the use of nonsteroidal anti-inflammatory drugs (NSAIDs), a class of medications used to treat pain and fever by inhibiting enzymes that produce inflammatory products (Ghlichloo & Gerriets, 2023). In addition to its enzyme-inhibiting properties, ibuprofen, a widely used NSAID, also inhibits rats' acid-sensing ion channels (ASIC1), which alleviate acid-induced pain, decrease inflammation, and provide neuroprotective effects in rats (Lynagh, et al., 2017; Voilley, et al., 2001). ASICs are ligand-gated ionotropic receptors expressed widely in peripheral tissues as well as sensory and central neurons. They are known to implicate detection of inflammation, tissue injury, and hypoxia-induced acidosis (Ridley et al., 2022). Although studies have shown the effect of ibuprofen inhibition on rat's ASIC1, the specific sensitivity of human ASIC1 to this NSAID remains unknown. This experiment investigates whether human ASIC1 channels are sensitive to ibuprofen using the patch-clamp electrophysiology technique.

The Confidence to Cope:
Self-efficacy as a Predictor of Symptom Severity and Use of Alternative Strategies to Formal Treatment Among Adults with Trichotillomania

Rose Elise Mancuso
Advisors: Natalie Wittlin & Annie O'Dwyer

Trichotillomania (TTM) is a mental health condition for which there is currently no first-line treatment. The unclear etiology of TTM limits healthcare professionals in formulating successful treatment plans, underscoring the importance of looking into factors that influence treatment outcomes and symptom severity and management. Previous research on other addiction disorders has found that highly self-efficacious people more successfully avoid relapse. Thus, the present study considers two factors which I hypothesized to be implicated in TTM recovery: a strong sense of self-efficacy, entailing confidence, resourcefulness, and problem-solving abilities, and a proactive use of alternatives to formal treatment, defined as self-procured coping strategies for symptom alleviation. A total of 52 participants aged 18-68 years (M = 37.3, SD = 12) completed a survey, all of whom reported currently experiencing TTM symptoms. Self-efficacy scores were significantly correlated with both symptom severity scores and the number of alternative strategies that participants had tried, supporting the hypotheses that highly self-efficacious people report less severe symptoms and take a more proactive approach to symptom management. No relationship emerged between the number of alternative strategies tried and symptom severity scores, or between self-efficacy scores and formal treatment effectiveness ratings. Strategies that were characterized by habit replacement and distraction tactics were the most frequently employed by participants. A low average treatment effectiveness rating across the sample corroborates the consensus that current treatment options are unreliable. These results suggest a meaningful role of self-efficacy on TTM recovery and offer insight into the hair-pulling and healthcare experiences of adults experiencing symptoms.

The Relationship Between Negative Experiences, Exposure to Substance Addiction, and Stigma Toward People With Substance Use Disorders

Maia Manta
Advisor: Anne O'Dwyer

It is widely recognized that people's negative stigmas about those with substance use disorders have negative consequences. However, there is little research on how people's own experiences may contribute to such stigmas. This study explored the relationship between negative past experiences, exposure to others' substance abuse, and perceived stigma toward individuals with substance use disorders (SUDs). The seventy-seven participants were recruited via Prolific and completed an online survey that included questions about respondents' prior exposure to substance abuse in other people in their life and the emotional and/or psychological impact of this exposure to addiction, the frequency and intensity of traumatic or negative events in their own life, and a scale that measured levels of perceived stigma of substance abuse. The results showed that increased experience with—especially direct exposure to—negative past events was associated with lower levels of perceived stigma. Contrary to predictions, exposure to addiction did not show a significant association with perceived stigma levels. The results are discussed in light of the gravity of the effects of stigma on people with SUDs, and the importance of understanding the mechanisms behind stigmatizing attitudes as a way to build on creating ways to minimize it and recenter the attention to helping those suffering, rather than isolating and discriminating against them.

How Does a Language Gap Affect Familial Relations? When Children and Older Family Members Can't Communicate

Carolina Martinez-Cruz
Advisor: Sarah Dunphy-Lelii

When immigrant families settle in the United States, they face multiple challenges, such as adapting to a new society, a new culture, and learning a new dominant language. This process of adaptation is often complicated by the differing rates at which family members are able to acculturate. Specifically, the language gap between family members can lead to increased familial conflict and reduced communication in the household. This language disconnect may cause frustration on both sides, as parents may feel disrespected, while children might feel misunderstood and unable to fully relate to their native culture. This study explored the effects of an intergenerational language gap on the perceptions of Family Communication and Family Satisfaction between first-generation Spanish speaking immigrant parents/grandparents and second-generation English-speaking immigrant children. As expected, children demonstrated greater fluency in English than in Spanish, while adults demonstrated greater fluency in Spanish than in English, providing evidence of an existing language gap within these families. My findings show that children were less satisfied with their family communication and family relationship and dynamic than adults. Additionally, anecdotal comments from some adult participants revealed concerns about their children's limited proficiency in Spanish and a perceived disinterest in their native language and culture. This research is important because there is minimal literature exploring intergenerational perceptions of language disparities and their impact on family communication and familial relationships.

Modeling the Extra-Cellular Matrix in Cancer Angiogenesis

Nadia Mehjabin

Advisor: Kerri-Ann Norton

Angiogenesis is a vital developmental process that supports tissue growth and repair; however, in cancer, it can accelerate tumor progression. The extra-cellular matrix (ECM) is a dynamic network of proteins and polysaccharides that provides structural and biochemical support to surrounding cells. The ECM regulates angiogenesis by influencing the direction of tip cell migration. This project builds on Dr. Norton's angiogenesis model by incorporating ECM interactions with endothelial cells through agent-based modeling. Computational analysis reveals significant differences in tip cell behavior across gradients, highlighting the role of the ECM in angiogenesis. These findings improve our understanding of the vascular dynamics driven by ECM in cancer progression.

Measure Equipartitions by Multiple Regular r-Fans

Jasper Miller

Advisors: Steven Simon, Caitlin Leverson & Ethan Bloch

Measure equipartition problems ask, given a set of measures in Euclidean space, whether a partition of the space exists that simultaneously divides each measure equally. A common approach to such problems is the Configuration Space/Test-Map (CS/TM) type setup, which uses results from equivariant topology to ensure the existence of the desired partition. Combining this approach with a connection between measure equipartitions and Fourier analysis for finite abelian groups allows us to use G-equivariant maps to ensure the existence of certain equipartitions. In particular, applying this approach to the group $\mathbb{Z}_r^k$ yields results involving equipartitions by k complex regular r-fans. This project uses a similar approach to prove novel results about equipartitions by multiple regular r-fans.

The Loop Scheduler:
A New Live-Looping Tool For Music Software

Juan Diego Mora Rubio
Advisors: Sven Anderson & Matthew Sargent

Live looping is used by musicians to re-use segments of their performance as they play. it has traditionally been constrained by rigid playback structures, limiting musicians to predefined performance workflows. My senior project presents the development of a novel live-looping application that reimagines the process by adopting a linear rather than stack-based approach, providing greater flexibility in musical arrangement and performance. The software uses principles from digital audio workstations (DAWs) and maintains real-time scheduling and playback capabilities.

Palladium(II) Compounds with N,S-Thioureate Ligands: Synthesis, Characterization, and Use as Single Source Precursors for Palladium Sulfide Nanomaterials

Ben Murray
Advisor: Matthew Greenberg

Palladium sulfide nanomaterials have garnered attention for their unique electronic, catalytic, and electrocatalytic properties. Achieving phase-selective synthesis of various stable Pd_xS_y phases and controlling crystallinity are essential for elucidating structure-property relationships in these materials. In this study, we examined Pd(II) thioureate complexes as potential single source precursors for palladium sulfide nanomaterials. Homoleptic compounds bearing bis-chelate N,S-thioureate ligands were prepared by reacting N,N,N'-trisubstituted thioureas (N=butyl, N'=aryl) with bis(acetonitrile)dichloropalladium(II). Cationic heteroleptic thioureate complexes incorporating tetramethylethylenediamine (TMEDA) as a neutral N,N-chelate were prepared by reacting bis(acetonitrile)dichloropalladium(II), TMEDA, and trisubstituted thiourea proligands, and then isolated as tetraphenylborate salts. The newly synthesized bis-chelate N,S-thioureate palladium compounds were characterized with NMR spectroscopy, single crystal X-ray diffraction, UV-vis spectroscopy, and IR spectroscopy. The structure and bonding of these complexes was investigated with Density Functional Theory calculations. High-temperature thermolysis of these precursors at various temperatures in oleylamine produced Pd_xS_y nanoparticles which were characterized by UV-vis absorbance and photoluminescence spectroscopies. X-ray Total Scattering Pair Distribution Function Analysis was used to characterize the local atomic structure of the amorphous nanoparticles.

Increasing Autonomy in the Classroom: Examining Academic Motivators in ADHD

Jennie Belle Narramore
Advisor: Justin Dainer-Best

Children with ADHD underperform compared to their neurotypical peers throughout their academic careers. Students with ADHD present motivational deficits in academic settings, which may contribute to their academic impairment. Self Determination Theory (SDT) suggests that people with ADHD are motivated by more intrinsic forms of motivation, but classrooms often motivate students externally. Overemphasizing external motivation can be damaging to students' intrinsic motivation, however, which is particularly harmful for students with ADHD. Increasing opportunities for choice in the classroom might be a way to develop students' intrinsic motivation. The current study surveyed 99 American adult participants on Prolific, half of whom had been diagnosed with ADHD. It asked about motivating and demotivating factors in their work life and in their memories of high school. The survey also measured current and retrospective ADHD symptoms, and current depression symptoms. Depression symptoms were positively correlated with ADHD symptoms. Written responses from the ADHD group revealed themes of self-criticism and lack of support. No significant effects concerning choice were found. A potential in-person followup experiment with participants in high school is discussed.

The Ripple Effect of Mindfulness Meditation

Madison Newill

Advisor: James Hobbs

Meditation is highly researched in the empirical literature, most commonly at an individual level. These findings have contributed to the development of many meditation techniques used as personal therapeutic tools. However, little is known about the communal benefit. This is relevant given meditations' roots in Buddhism which emphasizes that the benefit extends to all sentient beings. How does an individual meditation practice cause benefit to others beyond the self? Engert et al. (2023) answers this by exploring how individual meditation practices can extend their benefits beyond the self, proposing a spreading effect of positive change to others. This proposed study plans to examine this question by using a mixed methodology design in which participants go through one of two eight week meditation interventions, a mindfulness practice or a metta practice (a subcategory of mindfulness meditation focusing on loving kindness). Each participant will have three associated social contacts with whom they have a relationship and interact with on a weekly basis. The participants and social contacts will be measured on multiple variables (cognitive functioning, emotional functioning, and prosocial behavior) pre and post intervention. The main hypothesis is that, via the spreading effect, social contacts will have significantly increased scores on all variables from pre to post intervention. It is also hypothesized that the Metta condition will yield a stronger spreading effect from participant to social contact due to its closeness to buddhist framework and emphasis on love and kindness to others. If the hypotheses are supported, this would offer important empirical findings for the concept that meditation's positive effects can extend beyond the individual to others. These findings could lead to new ways for promoting meditation as a way of communal healing, adapting therapeutic practices, and initiating wellness programs in schools or workplaces.

Lights, Dots, Synthesis!
Exploring the Use of Carbon Dots in [2+2] Photocatalytic Cycloadditions

Olivia M. Nguyen
Advisor: Emily McLaughlin

The use of photocatalysis in organic synthesis has continuously gained traction over the years due to its facile nature in elucidating chemically inert pathways towards target organic molecules. Widely studied is the [2+2] cycloaddition of alkenes that can undergo single electron transfers using photocatalytic conditions. Transition metals as photocatalysts have been at the forefront of said processes. The recent discovery of carbon-based quantum dots has opened a new door for the world of photocatalysis. Our research has taken a novel approach to the carbon dot reaction and photocatalyst index. The focus has been placed on utilizing blue-light mediated [2+2] reactions with nitrogen-doped carbon dots to produce four-membered rings. We report our recent findings in the preparation of carbon dots and photocycloaddition products. Synthetic studies, carbon dot characterization, and their function will be further discussed.

Neural Waveshaping Synthesizer

Mikaela Oppenheimer

Advisors: Theresa Law, Sven Anderson & Matthew Sargent

The integration of artificial intelligence into music production is increasingly having an impact on modern sound synthesis and composition. This paper attempts to explore the development of a neural audio synthesis system based on neural source filter architecture, highlighting its use in tasks such as pitch shifting and timbre transfer. While AI-generated music often raises concerns about diminished human agency, this work proposes a collaborative model in which AI tools extend, rather than replace, artistic control. The system uses some machine learning techniques to extract features from input audio and recreate the sound wave with the option to alter its characteristics in a number of ways. Its goal is to demonstrate how different technologies can replicate and expand upon conventional synthesis techniques. The results show that, while the system is still imperfect, there is potentiality for musical use. The paper concludes with a discussion of the system's creative implications, ethical considerations, limitations, and avenues for future work. All code and audio examples are available here:

https://github.com/mikkispaceship3000/neural_waveshaping_synthesizer

The Path of Yeast Resistance: Understanding the Selection for Mutations in *Candida albicans* Treated with the Antifungal Fluconazole

Martha Pasatiempo
Advisor: Robert Todd

Candidiasis, a systemic infection caused by the human fungal pathogen *Candida albicans*, is an urgent threat to global public health that is frequently treated with the antifungal fluconazole. *C. albicans* strains often develop resistance due to this widespread and frequent prolonged use. A previous study found that *C. albicans* develops resistance to fluconazole through different mutational pathways depending on the concentration of drug used (Todd et al. 2023) . In low concentrations of drug, *C. albicans* develops antifungal drug resistance through aneuploidy, while in higher concentrations of drug, *C. albicans* develops antifungal drug tolerance through polyploidy. However, it is still unknown if different concentrations of drug affect the acquisition of point mutations in *C. albicans*.

This project seeks to measure if varying concentrations of fluconazole select for mutations at different rates. To do this, I used a selectable marker to perform a fluctuation assay exposing strains of *C. albicans* to four concentrations of fluconazole and measure the rate of deactivation of the selectable marker. The results of this experiment show a higher number of potentially mutated isolate colonies in cultures exposed to higher concentrations of drug. This indicates that the evolutionary selection for mutations was increased in higher concentrations of drug.

Computational Modeling of Collective Intelligence

William Pilgrim
Advisor: Valerie Barr

Collective intelligence and its emergent behavior is a widely known phenomenon. This senior project presents the development of a computational model for human collective intelligence. With initial research conducted in the field of swarm intelligence, we present an Ant Colony Optimization inspired model for a human collective intelligence capable of working with conceptually challenging problems. After discussing limitations, we present the development of a new theoretical model for human collective intelligence based on Jeff Hawkins' theory of human intelligence. We subsequently discuss the technological requirements needed to implement a version our theoretical model. Finding limitations in the efficacy of applying Deep Learning to the problem, we introduce Stephen Grossberg's Adaptive Resonance Theory as a promising foundation for development of the required technology. We finish with a proposal on how Adaptive Resonance Theory could be applied to implement our proposed collective intelligence theory.

The Cost of Caring:
Work-Life Balance and Psychological Well-Being Among Healthcare Professionals in Palliative Care

Eszter Pokai
Advisor: Elena Kim

This qualitative study explores how healthcare professionals in palliative care experience work-life balance, strive for emotional well-being, and engage in coping strategies to navigate the demands of their jobs. Three palliative care professionals participated in semi-structured interviews. Data were analyzed using reflexive thematic analysis which led to the identification of seven major themes: (1) Work-Life Balance Challenges; (2) Compassionate Commitment to Care; (3) Emotional Repercussions of Repeated Loss; (4) Emotional Spillover and Boundary Struggles; (5) Coping Strategies and Their Limits; (6) Systemic Strain and Unmanageable Workloads; and (7) Provisional Organizational Support. Participants described profound fulfillment in caregiving but emphasized cumulative emotional burdens, blurred boundaries between work and personal life, and struggles with compassion fatigue, secondary traumatic stress, and burnout. Coping strategies such as boundary-setting, therapy, and peer support provided some relief but were often insufficient without stronger organizational structures. Overall, findings suggest that while personal coping efforts contribute to resilience, systemic factors—such as manageable caseloads, mental health resources, and organizational support—are critical for sustaining caregiver well-being and ensuring sustainable, compassionate palliative care.

Developing a Comprehensive Course Recommendation System for Liberal Arts Colleges

Ali Mounim Rajabi

Advisor: Jordan Ayala

This project implements an interactive course planning application designed to assist students, particularly within liberal arts colleges, to navigate semester scheduling. The system guides users through planning their upcoming semester by integrating their academic profile (level, completed courses) with detailed course information (offerings, prerequisites, descriptions). It identifies unmet program requirements for the target semester. It presents eligible courses, verifying prerequisites based on the student's history and current selections. Natural language processing, specifically TF-IDF analysis of course descriptions, powers a keyword search feature. It enables students to discover electives or relevant courses by topic. The application helps in planning by identifying required courses offered in the following semester. It also recommends necessary prerequisites to consider taking now. The user-friendly interface allows students to input their status, select courses from filtered and recommended lists. Finally, they view a merged semester plan, making sure it aligns with program requirements, prerequisites, and user-indicated interests. This results in a flexible, student-driven tool for building personalized semester schedules.

Methodologies of eDNA Technology: Applications of PCR and qPCR for the Detection of *Marstonia lustrica*, A Rare and Threatened Gastropod

Angel Ramirez

Advisor: Bruce Robertson

Environmental DNA (eDNA) detection is an advancing technology in surveying rare and endangered species in conservation biology and ecology. eDNA is the collection of the shedding of skin, cells, tissues, or any physical component from a living organism. This study's main objective was to develop a robust approach to detect the presence of *Marstonia lustrica*, a rare and understudied gastropod in North America, in the Sawkill Creek–a tributary of the Hudson River on Bard College's campus. It is known that *M. lustrica* populations are present in the Sawkill; therefore, I captured live samples of the snail in the wild and designed successive primers targeting the cytochrome *c* oxidase subunit I (COI) gene. I conducted various experiments, including laboratory techniques like PCR, qPCR, and gel electrophoresis, to establish an appropriate protocol to detect rare species, like *M. lustrica*, that are not commonly studied. However, I did not detect any eDNA of *M. lustrica* from the waters around the wild populations, suggesting that my sampling approaches weren't sufficiently sensitive to detecting the gastropods. Instead, this study serves as a preliminary assessment for rare aquatic species in large freshwater bodies, offering future adjustments to the protocol established. Ultimately, the goal is to contribute to the growing knowledge of *M. lustrica* and promote further genetic studying of it to understand its distribution, abundance, and physical characteristics.

Processing Human and Monkey Faces: An Eye-Tracking Study

Clara Retzloff
Advisor: Thomas Hutcheon

The current study investigates the details of how general face processing ability, configural, holistic, and featural face processing types can relate to the "other species effect" or OSE. Data was collected using a Tobii Pro eye tracker and software to measure the processing strategies participants utilized when viewing human and non-human face stimuli. To measure general face recognition ability, participants also completed the 20-item Prosopagnosia test (Shah et al., 2015). While calibrated to an eye tracker participants were asked to complete a recognition task that consisted of two parts: a same-species task that featured human faces and an identical other-species recognition task that consisted of rhesus macaque (macaca mulatta) faces.

Understanding Conflict: Investigating Middle Schoolers with Autism Spectrum Disorder (ASD) and Comorbid Anxiety in Recognizing Social Problems

Denise Irene Rodríguez

Advisor: Sarah Dunphy-Lelii

The proposed study aims to explore how middle school students (ages 12-14) with Autism Spectrum Disorder (ASD) and comorbid anxiety may be impacted by social problems and emotion recognition. Considering the research, an ideal sample of 40 participants is presented, divided equally between two groups: 20 participants with diagnosed ASD and 20 participants with diagnosed ASD and anxiety. Recruitment was based on assessment screenings to determine eligibility using the Autism Diagnostic Interview-Reviewed (ADI-R) and the Hamilton Anxiety Rating Scale (HAM-A) assessment. The procedure after screening consists of all participants watching a series of short conflict resolution videos and then answering questions to determine whether they could recognize emotion and how accurately. My findings will be determined by performing an independent-sample t-test to analyze the differences in scores in each of the two groups. It is hypothesized that middle school adolescents with diagnosed ASD only will have greater difficulty identifying social problems and emotions compared to adolescents with ASD and comorbid anxiety. Actual data final results are unavailable in the current research, as this paper outlines the expected outcomes and implications if data collection occurs. A mock dataset is used to show result expectations.

Cross-Checking the Data:
A Statistical Analysis of Rule Changes and Injuries in Lacrosse

Morgan Ruhle
Advisor: Caitlin Leverson

Lacrosse is a scoring based team sport that was created by the Native Americans. The only rules at the time of creation were that the ball could not be touched and that there were no boundaries. Once the game was adopted by Europeans, more rules were created. Over the last few decades, there has been a shift of focus to safety, specifically in protecting the head, neck, and chest. Using data from the National Electronic Injury Surveillance System, we explore the connection between injury rates and rule changes throughout the last twenty years. Using statistical significance testing, we find which rule changes impacted injury rates.

Investigating *crhr1* Expression and Epigenetic Signatures of Chronic Stress Across Generations in Zebrafish

Ayesha Salman

Advisor: Michael Tibbetts

Chronic stress has been shown to cause long-lasting physiological and psychological impacts, yet its potential to induce heritable epigenetic modifications across generations remains underexplored. This study investigated whether chronic stress in adult zebrafish (F0 generation) could lead to epigenetic modifications, specifically DNA methylation changes, in the stress-regulatory gene *crhr1*, and whether these modifications might alter *crhr1* expression in the F1 offspring. Although unforeseen challenges prevented the completion of assays involving offspring from stressed parents, RNA isolation and RT-PCR from control offspring successfully amplified a 187-base pair *crhr1* fragment, validating experimental protocols. This project establishes foundational methodologies—including RNA extraction, cDNA synthesis, cloning, and in situ hybridization—for investigating intergenerational stress effects in zebrafish. Existing literature supports the hypothesis that parental stress can dysregulate the HPA/HPI axis in offspring, often resulting in blunted or exaggerated stress responses via epigenetic mechanisms. By focusing on *crhr1*, a gene central to stress-axis regulation but not yet well studied in the context of intergenerational epigenetic inheritance, this project contributes to a broader understanding of how environmental adversity can shape gene expression across generations. Future research completing the stressed group assays will be critical to directly testing the proposed model and expanding insight into the molecular basis of intergenerational stress effects.

Body Image Navigation in Kazakh Women of Nazarbayev Generation

Alua Samat

Advisors: Elena Kim, Michael Martell & Kyle Mohr

Body Image Navigation of Young Kazakh Women of Nazarbayev Generation studies body image navigation in the context of Kazakh women born between 1991 and 2006, who are Kazakhstan's first generation without any direct memory or experience of socialism, Kazakh Soviet Socialist Republic (Kazakh SSR), or the Union of Soviet Socialist Republics (USSR). As the first market economy generations, they witnessed the economic and political structures of independent Kazakhstan shift drastically. The rule of Kazakhstan's first President Nursultan Nazarbayev was characterized by cultural pluralism, change in gender order, and political & economic transition from centralized command economy in the Kazakh SSR to market economy and democratic rule. (Laruelle, 2019). All of this is known to have a wide range of effects on the local population's lives, including in particular those of women. This qualitative study is interested in how young Kazakh women of the Nazarbayev generation navigate these external expectations with their internal selves, and some potential coping mechanisms they might employ in order to fulfill those external expectations.

Control & Noise Estimation in a Michelson Interferometer

Prottoy Mohammad Mahdi Samir
Advisor: Antonios Kontos

Gravitational wave detectors use Michelson interferometry to measure tiny spacetime disturbances, but their sensitivity is limited by various noise sources. This project investigates backscatter noise from a black-glass baffle in a table-top Michelson interferometer. We simulate the noise spectrum for a simplified one-baffle geometrical Michelson setup and implement a Proportional–Integral–Derivative (PID) controller to actively lock the interferometer, reducing path length fluctuations. Our setup is sensitive up to 100 Hz, and the experimental noise spectrum matches expected environmental noise sources. Results show that backscatter from baffles does not significantly affect interferometer stability at low frequencies.

An Automated Approach to Nanocrystal Structure Solution and Refinement

Farman Hossain Sayem

Advisors: Valerie Barr & Matthew Greenberg

The project focuses on automating the nanocrystal structure solution and refinement process using X-ray total scattering measurements and real-space atomic Pair Distribution Function (PDF) analysis. This method improves on traditional X-ray diffraction (XRD) phase analysis by addressing the complications posed by broad reciprocal peak shapes in nanocrystalline materials. The developed algorithm retrieves Crystallographic Information Files (CIF) from the web-based structural database name Materials Project, calculates real-space PDFs for these structures, and refines them for optimal fitting against experimental data without human intervention. Benchmark testing has been performed on various known and unknown nanocrystals to show the effectiveness and robustness of the algorithm in finding the correct atomic crystal structure. This tool reduces manual structure searching and refinement work and paves the way towards automating the PDF analysis for multi-phase nanocrystals.

Cyclobutane Synthesis by Visible Light-Catalyzed Intermolecular [2+2] Photocycloaddition Reactions of Indole Derivatives

Maximus Schultz
Advisor: Emily McLaughlin

The efficacy of visible light-mediated photocatalysis reactions, specifically the [2+2] photocycloaddition of 3-acetyl-1-benzoylindole and various olefin coupling partners under varied conditions of solvent, photocatalyst, and molar ratio, is presented. [2+2] cycloaddition reactions, ubiquitous in molecular design, have been traditionally catalyzed by high-energy ultraviolet light. However, recent photochemical advancements have proven visible light as a more optimal energy source. Our work is centered on observing and understanding the regioselectivity and stereoselectivity of intermolecular [2+2] cycloadditions of 3-acetyl-1-benzoylindole with alkenes, yielding isomeric products. With the end goal of optimizing all procedures to be speedy, effective, and selective, we report the synthesis of various cyclobutane derivatives and the optimal conditions for such reactions, including molar ratios, solvents, and catalysts, as well as the regioselective [2+2] photocycloaddition with vinyl acetate as a coupling partner.

Communication as Connection:
A Dialogic Approach to Engagement, Comprehension, and Trust in Psychology

Quinn Seger
Advisor: Thomas Hutcheon

Effective science communication is essential for fostering public understanding, trust, and meaningful engagement with scientific knowledge. This proposed study will investigate how different modes of communication—one-way informational video versus two-way dialogic exchange—affect non-experts' comprehension, engagement, and trust in science, specifically in the context of psychological information. Using a between-subjects design, 80 participants from Bard College, all with non-STEM academic backgrounds, will be randomly assigned to either a video or dialogic condition, where they will be exposed to the same content on Cognitive Load Theory. Outcomes will be measured using a comprehension quiz, self-reported engagement scales, and the Public Trust in Science Scale (PuTruS), administered both pre- and post-intervention. It is anticipated that participants in the dialogic group will report a significantly higher likelihood of applying what they learned to their daily lives, reflecting deeper internalization of the material. A significant interaction between time and communication format is also expected in trust scores. These findings would suggest that dialogic communication more effectively supports internalization and trust compared to traditional informational delivery. This research will contribute to the growing field of science communication and provide insight into more effective ways of sharing scientific information with lay audiences.

All Systems Go:
A Thematic Analysis of the Tumblr Plural Community

Syd Senft
Advisor: Elena Kim

This study explored the "plural" community on Tumblr.com, whose members experience multiple identities within one body. While this experience is normally associated with dissociative disorder presentation, plurals define their identities beyond the clinical definition of dissociative disorders. This study sought to better understand plurals as they define themselves within their community. Thematic analysis was used to explore five interviews conducted with plural Tumblr users. This analysis elicited three major themes: (a) plurals construct two distinct but interrelated continuums of "normal" versus "abnormal" identities, upon which they place themselves dependent on which affords more legitimacy to their identity; (b) Tumblr is attractive to plurals because it allows neurodivergent identities to thrive; and (c) there are benefits to plurals engaging in the Tumblr plural community. The findings of this study suggest that plurality is a distinct social identity and subculture beyond dissociative disorder symptomatology. This has implications for possible future changes in clinical engagement with plural therapy-seeking patients.

Fabrication and Application of Platinum-Silver Thermocouples for Temperature Measurement in Direct Laser Writing

Harper Serringer

Advisor: Christopher LaFratta

This study investigates the use of direct laser writing (DLW) for fabricating electronic components, with a focus on developing and characterizing a platinum-silver thermocouple. Accurately measuring temperature at the site of DLW remains a significant challenge in microfabrication, and this work aims to address that limitation. Using multiphoton absorption and photo-reduction techniques, micron-scale platinum and silver wires were fabricated to construct thermocouples. These devices were calibrated and employed to measure the localized temperature at the focal point of an 800 nm femtosecond laser, the same laser used for their fabrication.

Mastering the Art of Influence:
Persuasion Knowledge and Credibility: Understanding Their Impact on the Decoy Effect in Advertising

Elene Shamanadze

Advisors: Guatam Sethi & Kristin Lane

This senior project explores how consumers respond to influence the decoy effect, a marketing tactic where an additional "decoy" option is introduced to sway the consumer's preference towards an option preferred by advertisers called the "target." While the decoy effect is well-studied in the literature, there is no research on how persuasion knowledge (how aware someone is of marketing tactics) and source credibility (perceived trustworthiness of a source) mitigate or enhance its impact. Using a sample of 150 participants, I measured their extent of persuasion knowledge through a series of XYZ questions before presenting participants with a fictional energy drink featuring either non-credible, credible or no source at all. Contrary to my expectation, persuasion knowledge did not have a significant effect on the decoy effect, nor did it increase decision stability. Source credibility was found to be a significant predictor for change likelihood and direction. These findings can be used to explore every day decision making, how consumers resist influence and how marketers can learn to make better strategies.

More Than Just Cold:
The Role of Fluctuating Temperature in Regulating Insect Diapause

Hanson Shang
Advisor: Bruce Robertson

The reproductive strategy of diapause in Drosophila melanogaster depends heavily on environmental cues, especially temperature. This study investigates how constant versus fluctuating cold temperatures affect the initiation and maintenance of ovarian diapause. Female flies were exposed either to continuous low temperatures or to temperature conditions simulating natural winter fluctuations. Results showed that constant cold exposure led to significantly higher rates of diapause entry and maintenance compared to fluctuating temperatures. These findings indicate that both low temperature and uninterrupted exposure are necessary for effective diapause regulation. In contrast, temperature fluctuations disrupted diapause development, likely by prematurely activating reproductive pathways. This study highlights the importance of temperature pattern and stability over average temperature in determining diapause outcomes. Furthermore, it suggests that temperature variability acts as a key developmental cue for seasonal transitions across species. As climate change increases environmental variability, understanding how organisms respond to these shifts is essential for predicting ecological and evolutionary consequences

Nature or Nurture:
Investigating the Genetic and Environmental Foundations of Musical Prodigies

Yangxin Song
Advisor: John Halle

The extraordinary abilities of musical prodigies have long fascinated scholars and the public alike, raising questions about the origins of their exceptional talent. Are prodigies born with innate abilities, or are their skills the result of intensive training and environmental support? As a violin student myself, I have always been intrigued by the concept of prodigious talent, particularly in classical music. My own experiences, along with watching my peers who have different levels of musical talent, have inspired me to study how genetics and environment contribute to the making of musical prodigies.

This senior project aims to investigate the interplay between nature and nurture in the development of prodigious talent, with a focus on classical music prodigies who perform within the 18th and 19th-century standard repertoire. By examining the cognitive, neurological, and environmental factors that contribute to prodigious abilities, this research seeks to provide insights that could help me and others improve our musical skills and better understand the conditions that foster exceptional talent.

This research employs a mixed-methods approach, combining quantitative cognitive and psychological tests with qualitative interviews and surveys. The proposed study will include three participant groups: (1) young classical music prodigies aged 8–18, identified through prestigious music competitions and conservatories; (2) a control group of non-prodigy musicians with comparable training backgrounds; and (3) a subgroup of prodigies diagnosed with autism spectrum disorder (ASD) or schizophrenia. Cognitive tests will assess abilities such as working memory, perfect pitch, and rhythm recognition, while interviews and surveys will explore environmental factors such as family support, practice routines, and cultural

influences. Psychological testing will measure general intelligence, emotional intelligence, and personality traits.

Given that this is a proposal, the results presented are based on expected findings and hypothetical data. The study anticipates that prodigies will exhibit superior cognitive abilities, including higher IQs and advanced working memory, compared to non-prodigy musicians. Environmental factors, such as structured practice routines and strong family support, are expected to play a critical role in nurturing prodigious talent. However, the study also hypothesizes that individuals with congenital amusia will show limited improvements in auditory processing and motor coordination, even after intensive training, underscoring the importance of innate abilities in musical talent development.

Additionally, the proposal explores the unique profiles of prodigies with autism and schizophrenia, hypothesizing that these individuals may possess exceptional musical abilities but face distinct challenges in emotional regulation, focus, and consistency. These expected findings have significant implications for education and talent development, suggesting the need for tailored interventions that address the unique needs of prodigies, particularly those with neurodevelopmental conditions.

In conclusion, this proposal aims to contribute to a deeper understanding of the genetic and environmental foundations of musical prodigies. By examining the interplay between nature and nurture, this research seeks to inform educational practices, guide parental support strategies, and promote inclusive environments that allow all children, including those with special needs, to develop their talents to the fullest extent. While the study is based on hypothetical data, it provides a robust framework for future empirical research on the origins and development of prodigious talent.

Plasmids for Survival, but at What Price? Modeling Evolutionary Trade-offs

A. Serra Sonmez

Advisors: Robert Todd & Kerri-Ann Norton

The rapid emergence of antibiotic-resistant bacteria represents one of the most pressing public health crises of the 21st century, threatening to plunge the world into a post-antibiotic era where common infections become deadly. As bacteria evolve resistance, the efficacy of antibiotics like ampicillin diminishes, demanding a deeper understanding of the evolutionary mechanisms driving this resistance. A key aspect of this challenge is understanding how resistant and susceptible bacterial populations compete under varying antibiotic selective pressures. This project aims to address this by focusing on the competition assay of *Staphylococcus aureus* populations, with an emphasis on how fitness costs associated with resistance plasmids influence their growth and survival.

To tackle this problem, we employ agent-based modeling (ABM), a powerful computational tool that simulates interactions between individual agents—bacteria in this case—within a defined environment. ABM enables us to capture the complex dynamics of bacterial population growth, movement, death, and resistance acquisition, providing a more granular understanding of how resistance spreads in real-world conditions. We aim to predict the competitive index of resistant versus susceptible bacteria. This approach offers a novel way to visualize evolutionary pressures in bacterial populations and could yield significant insights for antibiotic research, advancing the development of strategies to mitigate resistance. Also, in the lab, we focus on how varying concentrations of ampicillin affect the growth and competition dynamics of resistant (plasmid +) and susceptible (plasmid -) bacteria, with the broader aim of exploring the evolutionary fitness of resistance plasmids. The project is particularly important for the field of antibiotic research as it merges evolutionary biology with computational modeling, offering a quantitative framework to predict how resistance spreads. The findings could inform better antibiotic usage protocols and help design interventions to curb the spread of resistant bacteria, thereby contributing to the global fight against antimicrobial resistance.

A Caring Project:
An Examination of Bard College Seniors' Subjective Experiences of the Senior Project and the College's Approach to Care Ethics

Roo Tarantino

Advisors: Elena Kim & Kathryn Tabb

It is common for colleges and universities to use senior theses as an assessment of whether students have learned the intended lessons of their degree program. At Bard College the senior thesis is instead a Senior Project, which is more expansive and varied in its formulation than a written thesis. This study investigated students' experiences of working on the Senior Project and attempted to answer the research questions "How do seniors at Bard College experience working on their Senior Project?" and "Where do they experience care? Where do they experience a lack of care?" Participants (N= 6) were gathered using a self select method by responding to a poster asking for participants for a psychology study about Senior Project. Participants were sorted based on a desire to represent a wide range of experiences, meaning someone from each academic division. Participants engaged in hour long qualitative interviews with me, the researcher, at the midway point of their Senior Projects and their interview transcripts were analyzed using the Listening Guide method (Gilligan & Eddy, 2017). Findings reported that students felt cared for when their passions were supported by their advisor and students felt a lack of care when they experienced their passions as being denied or shut down. Findings suggest that the student-advisor relationship is a largely moderating factor in the students' experiences of the project and that a failure to develop a caring relationship between them could result in the student becoming disengaged from their project. These results lead me, the researcher, to conclude that care is necessary for a successful Senior Project experience, and that the way to guarantee the presence of care is to structurally integrate the ethics of care into the institutional systems of the college. A preregistration of this study was completed before data was gathered or analyzed.

Player Logic for Optimal Resource Gathering in a 2D Ectomycorrhizal Mining Game

Clement Tarpey

Advisor: Kerri-Ann Norton

This study explores optimal player logic for resource gathering in a 2D ectomycorrhizal mining game developed in Godot. First, the mining game was developed utilizing a modified marching squares algorithm to power semi-continuous terrain deformation providing a mechanical environment in which players dig for buried macronutrients. Then, three Python-based autonomous agents, leveraging computer vision and input automation via PyAutoGUI and PyDirectInput, were implemented with varying levels of intelligence. These were the RandomMiner, BranchMiner, and VisionMiner. Efficiency was evaluated based on nutrients collected, distance traveled, and terrain removed, and the most effective strategy was determined to be the VisionMiner, whose mean resource collection and economy of movement and excavation were well in excess of its siblings.

A Review Examining the Consistency of Temporal Orientation Among Rumination and Worry Questionnaires and Subscales

Mikhal Terentiev

Advisors: Justin Dainer-Best, Kristin Lane & Elena Kim

Repetitive negative thinking (RNT) is commonly evaluated in the contexts of assessment and treatment of psychological disorders. Rumination and worry, two forms of RNT, have been extensively studied and compared. Although the terms do not have a standardized definition, they have been found to differ in temporal orientation. This review examines the application of this knowledge in practice by coding N=20 rumination and worry questionnaires and subscales for past, present, and future using Linguistic Inquiry and Word Count (LIWC-22). A regression analysis showed a significant effect for tense and a significant interaction between tense and construct (rumination/worry). Additional differences between the constructs were observed during post hoc and exploratory analysis. The implications of the findings and future directions are discussed.

Social vs Media:
Exploring Associations Between Passive Instagram and TikTok Use and Well-Being In Gen Z

Jack Timoney
Advisor: Joshua Nelson

The distinction between active social media use and passive social media use has been widely regarded as genuine and important in psychological research, however despite its apparent relevance to research which specifically examines how social media use relates to mental health and well-being, inconsistent definitions of passive use vs active use across studies have contributed to similar behaviors being classified differently. In numerous cases, passive social media use has been linked to decreased well-being, however the full body of research is unconvincing in any direction. The current study proposes a design which aims to gain a sense of how total usage rates of Instagram and/or TikTok as well as habits in regard to active vs passive use, correlate with a few variables of well-being, in Gen Z students at an American College. Empirically reported amounts of time spent between Instagram and/or TikTok, as well as estimates of time spent using one or both of the platforms passively, are correlated to respective participant scores on questionnaires which roughly operationalize their levels of depression, anxiety, social anxiety, self-esteem, and contingent self-worth. Wide ranges of data and relatively weak correlations across variables reflect what is most often found to be the case in research. The current study aims to investigate a generation, and therefore places its emphasis on sample size and participant turnaround, however the unique nature of individual experiences on social media, including Instagram and TikTok, as well as the unique nature of individual well-being, suggest that deeper, more individual-focused research, may be most helpful in terms of providing an accurate, full picture.

Spectral Signatures of a Molecular Farewell: A Molecular Analysis of the Circumstellar Disc of IRC+10216

Vera Topcik
Advisors: Clara Sousa-Silva & Harold Haggard

IRC+10216 (CW Leonis) is the nearest and one of the most well-studied carbon-rich asymptotic giant branch (AGB) stars, known for its dense, molecule-rich circumstellar envelope. In this project, we analyze mid-infrared spectroscopic data of IRC+10216 obtained with the Echelon-Cross-Echelle Spectrograph (EXES) aboard the Stratospheric Observatory for Infrared Astronomy (SOFIA). High-resolution spectra were processed through standard reduction steps, including sky subtraction and continuum normalization. A preliminary molecular analysis was started given the results of the sky subtracted spectra. This work contributes to the understanding of molecular chemistry and wind dynamics in evolved carbon stars. Ongoing analysis will include using absorption cross sections from spectroscopic databases like ExoMol and HiTRAN and comparing them to peaks in the sky subtracted spectra to detect molecules. Further analysis will include modeling the abundances of the molecules detected in these observations.

Mindfulness and Emotional Regulation: Predictors of Cognitive Flexibility in University Students

Gloria V. Tucker
Advisor: Sarah Dunphy-Lelii

Mindfulness techniques use present moment awareness that aims to be non-judgmental. Mindfulness has gained recent recognition, particularly in academic and high-pressure performance environments, as it critically supports cognitive functioning. Cognitive flexibility and dispositional mindfulness are examined in this study. My experiment proposes a further investigation into the details of this relationship. My research looks at the mechanisms behind how university students handle their emotions when they feel pressure to perform academically. Cognitive flexibility will be assessed using the Stroop Test, and baseline mindfulness levels will be measured with the 15-item version of the Five Facet Mindfulness Questionnaire (FFMQ-15; Baer, Carmody, & Hunsinger, 2012; Gu et al., 2016). The Stroop Test presents both congruent and incongruent conditions: in congruent trials, the word meaning and ink color match, whereas in incongruent trials, they conflict, requiring participants to inhibit automatic responses and manage cognitive interference. Reaction times and error rates will be recorded as indicators of cognitive flexibility. The FFMQ-15 assesses mindfulness across five dimensions: observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience, providing a trait-based measure of participants' dispositional mindfulness. It is hypothesized that higher reported scores on the FFMQ-15 will exhibit a positive correlation with improved Stroop performance through faster reaction times and lower error rates, suggesting improved cognitive flexibility in stressful situations. From this, the relationship is anticipated to be more pronounced in participants that exhibit that they are able to regulate their negative emotions and control present-moment attention at relatively higher levels, as evaluated by the FFMQ-15. My goal from this research is to inform and expand upon existing research for the development of mindfulness

interventions in universities for the betterment of student mental well-being and academic performance. Mindfulness can be implemented as a validated therapy technique for students, as a way to increase cognitive flexibility, emotional resilience, and overall academic performance. I hope to build contributions to a broader discussion on the improvement of mental health and academic success by way of integrative psychological strategies through preventing cognitive rigidity within stressful academic settings through the use of mindfulness interventions.

Inscribed Squares in Lattice Curves

Oliver Vanderploeg

Advisor: Ethan Bloch

The square peg problem asks, given a simple closed curve, are there four points on the curve that are the vertices of a square? We ask this question in the discrete setting of lattice curves. The motivation for this paper is to find a proof built entirely from discrete mathematics that all lattice curves contain inscribed squares. We work with a discrete object called the cloud, a collection of lattice points constructed from a curve. This construction connects inscribed squares with lattice curves nicely and so is the main focus of the paper. We find bounds on the size and shape of the cloud, define densities of curves, and prove that lattice curves with certain properties are guaranteed to contain inscribed squares.

The Gender Socialization of Children Pertaining to Household Labor in Different Family Dynamics

Lily Vaughan

Advisor: Sarah Dunphy-Lelii

Children are commonly assigned chores, whether it be for an allowance or just to help around the house, but the types of tasks given to them may differ depending on both their gender and their family dynamics. Past research has concluded that children of single parents are assigned more household labor tasks, and are given the sex role type of androgynous. Research has also found that daughters are typically assigned more housework compared to their male counterparts. The purpose of this study was to investigate how the division of household labor in single and two-parent households can potentially affect a person's gender socialization. Two surveys were given out in order to collect data. First, a pre-test survey titled the "Vaughan Household Labor Task Measure", or VHLTM, was distributed, asking participants to categorize a list of 31 common household tasks as feminine, masculine, and neutral. From there, a gendered categorization was assigned to the tasks with significant results. The main survey of this survey titled "Growing Up in a Single Parent VS Two Parent Household". After completing a set of demographic questions about participants' upbringings, they were asked to complete two questionnaires: the VHLTM and a Rasch Adapted Version of the 30-item Bem Sex Role Inventory. The results found did not indicate a relationship between chores completed and a participant's sex role type. There was also no relationship found between participants' sex role type and if they grew up in a single parent household or not. A significant relationship was found between boys and the completion of all labor tasks, as well as masculine tasks, when compared to girls who completed less. My study brings in a new perspective about how gendered labor and family dynamics can shape a child's gender socialization. More research is needed to fully explore the relationship between these variables.

Turkey Tail Mushroom Derived Polysaccharide-Krestin Induces Necrosis in Canine Mammary Carcinoma in vitro

Ananda Vidal-Burgie

Advisor: Michael Tibbetts

Canine mammary cancer is the most common form of cancer in female dogs, especially those who are unspayed and over seven years of age (Vazquez, 2023). Many homeopathic remedies for cancer are overlooked, however, a Turkey tail mushroom (*Trametes versicolor*) extract called polysaccharide-Krestin (PSK) has been well documented in Japanese cancer research to have tumor suppressing properties in humans (Sullivan et al. 2006). PSK has been approved for use in tandem with chemotherapy as a cancer therapy in Japan since the 1970s (Medicinal Mushrooms PDQ Integrative, 2002). Although modern scientific research on *Trametes versicolor* is fairly new, this mushroom has been used as a natural remedy in China and Japan for over 2,000 years (Dou et al. 2019). However, many other countries have yet to commonly incorporate *Trametes versicolor* as a cancer therapeutic, making information and materials for research on the mushroom more difficult to find. This experiment explores whether or not *Trametes versicolor* polysaccharides have tumor suppressing effects, specifically on canine mammary gland carcinoma without the use of immune cells. This was done using a cell line culture model in which canine mammary carcinoma cells were cultured with varying concentrations of *Trametes versicolor* polysaccharide extracts in a sterile environment. The results of this study showed that PSK dose-dependently decreases the viability of canine mammary carcinoma cells in vitro through necrosis, however further research is necessary to understand the mechanism by which this occurs.

A Somatic Experiencing Approach in Unpacking Racial Trauma

Yarissa Villarreal

Advisor: Justin Dainer-Best

The constant exposure to race-based violence and prejudice is often internalized and causes psychological effects in African Americans. Race-based stress is a chronic and ongoing stressor in African American life. The accumulation of these stressors can lead to racial trauma. The symptomatology of racial trauma relates to symptoms of Post Traumatic Stress Disorder (PTSD), however, PTSD diagnostic guidelines do not fully capture the pervasive and ongoing nature of racial trauma. I aim for a culturally informed somatic approach, using Somatic Experiencing therapy, in processing racial trauma, which acknowledges the body as a central point of trauma and healing. In this proposal, I review the literature on racial trauma, its impact, and how it is stored in the body. I propose an experiment to analyze the effectiveness of Somatic Experiencing therapy in reducing symptoms associated with racial trauma. The predicted results should be analyzed to explore interventions that address racial trauma. The goal of this proposed study is to fill the gap in trauma research and reconsider the ways in which to help African Americans process and unpack racial trauma.

Journey to the Ivory Tower:
Making Links' Polymorphism Ad Hoc

Henry Wandover
Advisor: Robert McGrail

This paper outlines the philosophy and general rationale behind multiple contributions to the Links programming language, a language that attempts to ease the tribulations of designing modern web applications via the removal of "tiers." Both improvements tackle ad hoc polymorphism, one in an ad hoc way and the other through the addition of \textit{subkind classes} to the Links type system.

Exploring Surreal Numbers

Yixin Wang
Advisor: Japheth Wood

Surreal Numbers were invented by Mathematician John Conway in 1972. They are denoted $\boldsymbol{No}$. Since they are built recursively, we start our investigation by considering the first few numbers to be born. Conway then define the field operations of addition, multiplication, and order recursively on $\boldsymbol{No}$, and confirm that $\boldsymbol{No}$ form a totally ordered field. Conway represented the numbers as $\{L|R\}$, in which L and R are any two sets of numbers, and no element of L is greater than or equal to any element of R. Conway also provided additional definitions for operations such as reciprocals, and credited Clive Bach for the definition of square roots. Gonshor's 1986 construction of $\boldsymbol{No}$ gave a totally different definition but ultimately connected back to Conway's ideas.

This paper aims to study how the surreal numbers are built, how these definitions are constructed, with an emphasis on understanding the definition of square roots and how it is connected to the secant method. Building upon that knowledge, we define the cube root which does not appear in the literature.

"Finding Out Where I Feel Comfortable:" A Thematic Analysis of Nonbinary and Gender Diverse College Students' Experience of Gender and Masculinity

Olivia Weeks
Advisor: Natalie Wittlin

The majority of psychological research on masculinity only investigates specific masculinities: masculinity in men and masculinity that is anti-feminine. Previous research has explored diverse masculine experiences among different communities of men, yet masculinity outside of manhood is largely unexplored. Just as different men and women experience masculinity in unique ways, the present study investigated how nonbinary people may experience and interact with masculinity. The current project aimed to explore: how masculinity is understood, felt, and performed in college students with nonbinary gender identities; the role of race, sexuality, and community connection in masculine experience; and how masculinity is positioned in relation to femininity. Ten participants were interviewed about their experiences with masculinity and gender more broadly. The resulting transcripts were analyzed using qualitative thematic analysis. The coding process resulted in five themes: 1) navigating gender presentation to find comfort, 2) understanding gender and masculinity as an indescribable feeling, 3) interacting with social perceptions of masculinity and femininity, 4) (re)learning gender from social environments, and 5) finding LGBTQ+ friendships as support systems. The resulting data offer a range of masculine experiences that involve both personal and social meanings of masculinity reported by participants, which both complement and challenge existing literature on masculinity that maintains masculinity must be anti-feminine.

Antimycobacterial Activity of Violacein

Annie White

Advisor: Brooke Jude

Nontuberculous Mycobacteria (NTM) pose an increasingly pressing health concern as incidences of infection, primarily in elderly and immuno-comrpmised individuals, are on the rise (Adjemian et al., 2012; Bryant et al., 2017; Dahl et al., 2022). The emergence of drug-resistance in *Mycobacteria tuberculosis* (Mtb), the causative agent of tuberculosis (TB) exemplifies the increasing threat of drug-resistance (Mojib et al. 2010). This emergence of multi-drug resistance of Mtb is concurrent with the increase in prevalence of NTM infections and is representative of the rising global threat of antibiotic-resistance (MacNair, 2023). Violacein is a bacterial pigment known for its wide-ranging biological activities (Choi et al., 2017). Numerous studies have demonstrated violacein's pharmacological potential to be used as anticancer, antibacterial, antifungal, immunomodulatory and antiviral drug (Duran et al. 2016). Some studies have even indicated the antimycobacterial potential of violacein (Mojib et al., 2010). NTM species, *M. abscessus* was cultivated and violacein from violacein-producing strain BJB312 was extracted and purified to assess the antimycobacterial capacity of violacein.

Development of the Foodborne Pathogens *S. aureus* and *B. cereus* on Pizza

SeanMichael Wilcox
Advisor: Michael Tibbetts

Foodborne illnesses are a public health problem worldwide. The World Health Organization estimates that 600 million people get sick from foodborne illnesses each year with 420,000 people dying. Leaving food out of temperature control is one of the many ways foodborne illnesses can be spread, and pizza is more frequently out of temperature control than most other foods. This makes it more likely to carry bacteria that cause foodborne illnesses. A higher abundance of microorganisms and certain pathogens is linked to a higher risk of foodborne illness. Leaving pizza at room temperature after cooking causes the growth of microorganisms. It is also known that refrigeration prolongs the shelf life of foods. There is a short, recommended time frame to eat pizza in after it has been left at room temperature. However, many people have eaten pizza hours after this time with no signs of illness, so the answer is a bit more complex than that. This study evaluated how long pizza can be left out of temperature control before it becomes infectious and thus too risky to consume. This was accomplished by growing two common bacteria that a pizza might be exposed to: *Staphylococcus aureus* (*S. aureus*) and *Bacillus cereus* (*B. cereus*). The bacteria were then placed on pizza and had their growth tracked over the next 48 hours in intervals. One group of pizzas were not temperature controlled, while the others were kept in a refrigerator and checked at the same intervals. *S. aureus* reached its infective dose by 4 hours at room temperature and by 16 hours when refrigerated. *B. cereus* only reached its infective dose by 8 hours at room temperature. This project can aid future research on foodborne pathogens, especially as it relates to pizza. It can also assist in the decision-making process of whether or not to eat that forgotten slice of pizza.

The Impact of Calming Music vs. Mindful Practice and Art-Making on Anxiety

Miala Wilkerson

Advisors: James Hobb & Kristin Lane

Research has shown that mindfulness and art-making are successful tools that can reduce anxiety. It allows for emotional regulation and stress reduction, which is helpful for a college student who feels the weight of anxiety. Out of curiosity and to add to the literature on mindfulness and art-making, this study aims to examine how the two interact with each other to produce a calming effect compared to calming music alone and art-making. Specifically, this study examines the impact of two 45-minute art-making interventions—Mindful Art-Making (MA) and Calming Art-Making (CA)—on anxiety levels in college students. Amid rising mental health concerns on campuses, particularly related to anxiety, this research explores accessible, low-cost coping strategies that can be practiced independently. The MA group participated in a short mindfulness body scan before watercolor painting, while the CA group listened to a calming instrumental track ("Weightless" by Marconi Union) while painting. Using a pre-post design and paper-based assessments adapted from the State-Trait Anxiety Inventory (STAI), participants reported their anxiety levels before and after the session. Results indicated that both interventions led to reductions in self-reported anxiety, with participants in both groups showing improvements following the session. These findings may support the use of structured creativity for managing anxiety in college students and contribute to a growing body of literature on mindfulness-integrated art therapy.

Constructing a Micrometer-Scale Graphene Resonator

Ethan Young

Advisor: Paul Cadden-Zimansky

Graphene was first isolated by Konstantin Novoselov and Andre Geim at the University of Manchester in 2004, initiating a rush of graphene research. Its remarkable physical properties, including its extreme strength, flexibility, and potential as a semiconductor, have led researchers to explore its uses in fields ranging from medicine to electronics to the automotive industry. Graphene has allowed for further miniaturization of electrical components, and this project explores the use of graphene in microresonators. Microresonators are devices that can trap light in an optical cavity with a length on the order of magnitude of one micrometer. The goal of this project was to fabricate one such resonator and to explore its uses, including its potential as a light detector of singular wavelengths of visible light. A procedure was developed to fabricate a graphene microresonator, laying the foundation for future research, and simulations were written to characterize the behavior of the chosen resonator design.