science, mathematics &
computing division

senior project poster session

SPRING 2024

Slime Mold the New Civil Engineer?

Raven Atsalis-Gogel

Advisor: Felicia Keesing

The goal of this paper has been to find out how *Physarum polycephalum* (a type of slime mold) pathways change when presented with environmental challenges and/or imbalances of resources. Many studies have demonstrated *Physarum polycephalum's* ability to find efficient and resilient pathways between food sources in a relatively short amount of time (often within 72 hours). Based on previous studies showing that slime mold is extremely good at solving mazes and finding very efficient routes between places, it could be used to implement more efficient transportation systems than we currently have in place in the US or in any other country. In this introduction we will explore the basic biology of *P. polycephalum*, how it has been used in studies, how *P. polycephalum* relates to transportation systems, and where issues within transportation systems arise from.

A Beer a Day Keeps the Doctor Away: A Phylogenetic Analysis of Hops (*Humulus lupulus*)?

Julie Beeman
Advisor: Michael Tibbetts

Hops are a perennial plant that are used in brewing to alter the bitterness and aromatics in beer. In the 1880s-90s hops were grown as a cash crop in the Hudson Valley until the crops failed in the early 1900s. These hops were allowed to grow wildly and reproduce with each other leading to the "feral" or heritage hops that grow in the Hudson Valley today. The lineage of wild hops is important to know because it can determine the value of these plants to local farmers and brewers. Past research has shown that the origins of feral hops can be determined through genetic analysis. There are many places in the country where wild hops grow, but their lineage has not been studied. The lineage of heritage hops in the Hudson Valley have not yet been traced. Accordingly, this study proposes to determine the relationship of the heritage hops of the Hudson Valley. Using methods from a previous study, one non-coding region of the chloroplast (petL) and one of nuclear ribosomal (ITS2) DNA were sequenced and then analyzed to find the differences between each regional hop. A phylogenetic tree was built using the petL region of the chloroplast. This tree related two regional hops to the same common ancestor. This study can assist regional brewers in the knowledge of where historical strains of hops are found.

Dumonym: Crafting and Assessing Lexical Simplification, From Algorithms to Models

Jeremias Brea De Los Angeles
Advisor: Kerri-Ann Norton

Lexical Simplification is the process of replacing complex words with simpler alternatives in a given text. This project aims to use different approaches in the field of Natural Language Processing to create a series of lexical Simplification models. The framework of lexical simplifiers will also be explored and researched, to give more insight of the mechanisms and approaches used to achieve successful text simplification. I will develop a pipeline of steps, based on my research, with the aim to create a framework for a functional lexical simplification model. I will develop a series of distinct lexical simplification models based on my pipeline, with the expectation of creating an ideal lexical simplification model. The models I develop will be tested and compared to one another to find strengths and weaknesses for potential improvements. The performance of my models were measured utilizing the Chi-Squared metric for three hypothesis tests that aim to assess the impact of my models. After analysis the Text Frequency Thesaurus Simplification model was superior in correctly identifying complex terms as well as potentially having the best approach for generation. Although the tests were very insightful, more testing and analysis can potentially yield better results for comparison. I will also discuss potential improvements intended to solve some of the weaknesses of my models for future iterations.

Machine Learning and Natural Language Processing for Crossword Puzzles

Finn Brennan
Advisor: Sven Anderson

The structure and the rules of crossword puzzles impose a unique set of constraints on the problem of designing a system that has the ability to solve them. Crossword puzzles can be tricky. To the totally uninitiated and inexperienced human solver, they can seem next to impossible at first. Crossword puzzles demand that human solvers have a broad base of knowledge that they can draw on in the process of determining each particular word that they want to put down onto the puzzle board.

In a Disturbance Mosaic, High Plant Species Richness Within Plots Is Not Maintained Over Time

Nory Buck
Advisor: Cathy Collins

Diversity of species is unevenly distributed globally and within environments, with some ecosystems containing hundreds of species, and others containing very few. The hypothesis that 'diversity begets diversity' (DBD) states that biodiversity at one point in time creates conditions that enable even more diversity at a later point in time. Research from microbial and plant communities shows that diversity can stimulate further diversification through processes of ecological facilitation. However, community interactions are highly complex. Competition can slow down diversification as new species are out-competed. We still don't fully understand why, across time scales, some sites are so species-rich and others are not. One way to study ecosystem assembly through time is to look at the process of succession and recovery from disturbance. Successional systems offer an opportunity to examine the effects of diversity on future diversity. I asked whether local sites with higher diversity after disturbance (within a single landscape) will maintain comparatively higher diversity through time. To answer this question, I used a long-term ecological dataset from Mount St Helens to explore the effects of diversity on future diversity. I analyzed how diversity changes within and among sites among three disturbance levels at Mount St Helens over the course of three decades.

Based on the 'diversity begets diversity' hypothesis, I expected plots with relatively high richness would accumulate more species, while plots with comparatively few species would see the opposite trend. I explored how richness changed between adjacent pairs of years to determine if high richness in one

year is correlated with an increase (positive change) the following year. Counter to my predictions, the opposite occurred: sites with more species tended to lose species the following year, and sites with low richness tended to increase. However, gains and losses were small, and the number of species per plot often stayed constant year to year. These findings, in context with the body of literature from the Mount St Helens system, can give insight to underlying ecological processes of community assembly following a major disturbance. Different processes, like facilitation and inhibition, may become determining factors at different levels of species richness. This supports a conceptual framework in which many ecological factors work in concert to determine post-disturbance trajectories, of richness is but one part.

LociGraph: AI Agent Framework for Browser-Based Knowledge Graph Construction

Nathan Cho
Advisor: Rose Sloan

This work presents **LociGraph**, an artificial intelligence agent that can autonomously search information on the non-public web, such as email inboxes, online communities, social media, or web applications not searchable on a public search engine. With a given query, the agent will browse the web using the keyboard and mouse to find a webpage containing the relevant information and extract the information in a structured format. For example, if the agent is given the query [Alex, studied at, ?] on your email inbox, the agent will start by typing "Alex" into the search bar, click on email related to Alex, read the content "Alex went to Bard College" and return [Alex, studied at, Bard College]. The framework consists of two parts: an *agent pipeline*, where a group of agents analyze the webpage content and suggest the next action, and a *browser extension*, where the user can enter the query and execute the suggested action. Preliminary evaluations show that Large Language Model (LLM) agents can navigate and extract information from real-world websites, but struggle to extract information from indirectly relevant content. All code, benchmarks, and results are available at https://github.com/ntcho/LociGraph.

Simulating the Spread of Information Among Non-Playable Characters in Video Games

Summer Colon
Advisor: Kerri-Ann Norton

This project attempts to improve Non-Player Character (NPC) realism in video games by using an Agent-Based Model (ABM) to automate their communication and interactions. To evaluate how information spreads through interacting NPCs in video games, this simulation assumes that the main purpose of NPC societies is to provide a context in which NPCs interact with each other to spread information about player-generated events that change the game state. The goal is to successfully identify possible programming methods to automate NPC behavior and create a more realistic gaming experience for players. The simulation incorporates three archetypal types of characters that are present in most Role-Playing Games (RPGs): merchants, guards, and civilians that spread rumors and antirumors. The behavior of the NPCs is changed by incorporating dynamic movement, different probabilities of rumor-spreading and antirumor-spreading, and believability among different NPC types. The data collected from these interactions, such as the ratio of rumor-spreading agents, are compared to a study on social media rumor-spreading. This ensures that the data can be compared to "real world" statistics regarding rumor-spreading; the more similarities that exist between the data sets support the theory that the automated interactions between NPCs in the simulation are realistic. Using agent-based models to automate NPC interactions can be helpful for future game developers trying to optimize NPC behavior in order to create smarter and more interesting NPCs, thus creating a better, more immersive game experience.

Hungry for McMindfullness?
The Effect of Linguistic Framing on Perceptions of *Vipassana* (Insight Meditation)

Sarah Corwith Eckert
Advisor: Frank Scalzo

Linguistic framing shapes the way we conceptualize social matters, moral and causal reasoning, and influences the way we perceive the world by constraining how we gather evidence about people, events and situations. There is a robust history behind the dichotomization of religion and the secular, which manifests in present day linguistic framing of meditation practices as "secular," despite their ties to Buddhism or other religious traditions. This secularization has been criticized for its dilution or total erasure of Buddhist ideals, and conversely, as a form of "stealth Buddhism," a tactic for recruitment of otherwise uninterested parties. The present study aims to assess the ways in which linguistic framing affects the perception of vipassana, one such practice. Based on previous research in cognitive psychology, cognitive linguistics, religious studies, and anthropology, I hypothesize that (1) Participants will perceive vipassana (Insight Meditation) as being more acceptable when it is framed as "secular" (as opposed to "Buddhist"), and (2) Participants will be more willing to engage in this practice when it is framed as "secular." If these hypotheses are supported, the results of this study will contribute to the growing body of evidence which suggests that linguistic framing significantly influences thought. Additionally, such support would raise implications surrounding the ethicality of "secular" v. "religious" framing in regards to the dissemination of vipassana and other meditation practices in Western Europe and the Americas.

A New Methodology for Analysis of Ice-Rafted Debris in End-Triassic Sediments

Glorianne Couey

Advisor: Emily McLaughlin

Analysis of ice-rafted debris (IRD) and other dropstones in sedimentary rock is almost exclusively done using destructive techniques such as grain-size analysis, which requires the rock sample to be dissolved in acid or peroxide to reveal the original sediments locked within the carbonate. Techniques such as this not only destroy samples which are often in limited supply, but also are time consuming and reveal the presence of IRD in only small sections of sample cores at a time. The aim of this project is to discover a geochemical proxy for IRD, allowing for non-destructive and total analysis of individual samples and whole sample cores. Through X-ray fluorescence and X-ray diffraction we are able to find the relative abundance of elements within the sample and compare them against the relative amounts of IRD also present. Using this data and inputting it into computational programs, such as R, we have begun to narrow down on several potential proxies for IRD which can be explored in future experimentation.

P.U.S.H. for Life Among the Stars:
A Scientific and Philosophical Quest for Conceptualizing Uncertainty

Jacinta Creel Vallejo

Advisors: Clara Sousa-Silva & Michelle Hoffman

This senior project tackles how to deal with uncertainty in the search for life. Defining this uncertainty is tricky, and scientific efforts to do so are crucial. Such efforts include analyzing the data and biases of past, present, and future missions searching for exoplanets: planets outside our solar system. From there, the next step would be to infer what exoplanets have an atmosphere. This is a crucial, but not sufficient step, as having an atmosphere is a good sign of encountering life. However, finding an atmosphere is not an easy task, and this step will undeniably come with some amount of uncertainty. Hence, from the point of having an atmosphere, it would be essential to stop and analyze how much uncertainty comes from trying to find life at this stage, as finding an exoplanet with an atmosphere is a good step in finding life but not a sufficient one. The next step is to analyze the planet's atmospheres for their chemical composition. I will do this by using data from my advisor, Clara Sousa-Silva, on the spectra for the presumed biosignatures (RASCALL). This, as expected, also comes with an uncertainty of its own. Data on the search for exoplanet atmospheres and the detection of biosignatures within them would help us measure and navigate the uncertainty in the search for life.

Having found data, although with a fair amount of uncertainty, which will be and has been meshed along all the way, we can furthermore analyze the philosophical implications of the search for life. Uncertainty in the search for life has many philosophical implications, which I will examine as I seek to answer the following questions: On an epistemic note, what is the weight of

values and numbers in this project? Would the uncertainty attached to them make them less pure, or how can we balance the truth with uncertainty and make sure the data is reliable? I will also address a more pragmatic question dealing with uncertainty: how we should handle the risks of being wrong in our inferences, and how should we balance the risk of two kinds of errors, believing a false statement or rejecting a true one? In the context of astrobiology, this would correspond to believing we have found life when we have not, or missing life when it is present. Additionally, methodologically, is this approach, and the uncertainty it carries a good way of doing science, and what would an alternative look like?

Angry Men Versus Happy Women: A Study of Facial Expression Bias in Young Adults and Preschool Children

Adi David
Advisor: Sarah Dunphy-Lelii

Angry-male/happy-female bias is the tendency for people to perceive male faces as angry and female faces as happy. Previous research has shown this bias in adults with both stimulus-driven face tasks and stereotype-driven character tasks. The main goal of the current study was twofold. The first part was to further investigate what is underlining this bias in adults, by replicating previous studies. In particular, the study focuses on whether this bias is due to top-down or bottom-up processing. The second part of the goal was to create a method design that would be able to test young children for this bias. There is not much research that tests this bias on children who have not yet had extensive social experience; this testing could help us understand if this bias is inborn or learned from the environment. Two separate studies were conducted, each focused on a distinct population (undergraduates and preschoolers) and each study consisted of two tasks. The first task was a stimulus face task, where participants were shown a face and asked to identify the emotion. The second task was a stereotype character task, where participants were asked to think about someone who is either angry or happy and then asked a series of questions about their character, the target question being the gender of the character. The results of my project partially support the prevalence of angry-male/happy-female bias in both the adult sample and the preschool sample. The bias is prevalent in the stereotype-driven character task, but not in the stimulus-driven face task. My findings support the notion that the bias is not innate and stems from extensive social experience, which is minimal among preschoolers.

Using the Trolley Dilemma and the Implications of Anxiety to Look at How Interpersonal Relationships Impact Moral Decision-Making

Daniella Dsouza Michaeli
Advisor: Justin Dainer-Best

Personal connections that are established with interpersonal relationships have an impact on moral decision-making. This concept will be tested when considering the trolley dilemma archetype. The trolley dilemma presents a situation where an individual is prompted to choose between a series of options that will save one party yet cause the death or injury of another. The present study will use the trolley dilemma to test whether participants are more likely to make a prosocial decision than a self-serving decision when put in a predicament that forces them to choose between their interests and the greater good of society. To conclude, this study will prompt a pool of online participants to give names of people with whom they have specified personal relationships. Following this, the survey will prompt the participants to interact with a series of curated trolley dilemmas that utilize their interpersonal relationships compared to strangers when measuring their response to close relationships versus situations involving strangers. Results will measure the effect that interpersonal relationships have on individuals when they are making moral decisions. This study hypothesizes that prosocial or selfish choices will be impacted by whether the persons in the dilemma are of significant personal value to the participant. Participants in differing populations, i.e., child versus adult, may be more drawn to saving certain groups. This aspect will also be measured regarding the condition's significance to the participants when choosing who should live in the trolley dilemma. Additionally, these results will consider anxiety's effect on the decision-making process. This will be done by collecting GAD-7 results and relating them to the collected data.

Synergistic Effect of the Antimicrobial Peptide Colistin Sulfate and the β-Lactam Antibiotic Piperacillin Sodium Against *Pseudomonas aeruginosa* Biofilm Production

Isabella Gabrielle Espinosa
Advisor: Robert Todd

Antimicrobial resistance (AMR) is one of the greatest public health crises due to the overuse of antibiotics. High rates of resistance have been found in common infectious human pathogens such as *Pseudomonas aeruginosa*. This bacteria poses a concern due to being present environmentally, agriculturally, and clinically with its ability to form biofilms that aid in the decreased susceptibility to antibiotics. In order to prevent the development of resistance, researchers and clinicians have turned to the combination therapy of anti-biofilm agents, such as antimicrobial peptides (AMPs) that permeate or damage the membrane of bacteria in conjugation with traditional antibiotic therapy. Specifically, the combination therapy of the AMP colistin and β-lactam antibiotics, that inhibit peptidoglycan synthesis in bacteria, have shown a synergistic effect against *P. aeruginosa*. Although the effect of the combined therapy of colistin and β-lactam antibiotics have shown to be effective against *P. aeruginosa*, the effect of this therapy on biofilm production is not known. This study will investigate the synergistic effect of colistin with the β-lactam antibiotic piperacillin sodium against *P. aeruginosa* biofilm production. To determine the effect of this treatment against *P. aeruginosa*, this study will use MIC assays to determine the susceptibility profile of colistin sulfate (colistin) and piperacillin sodium (piperacillin) monotherapy versus their combined therapy. Biofilm assays will also be used to find the effect of monotherapy versus combined therapy against *P. aeruginosa* biofilm formation. A synergistic effect of colistin with piperacillin against *P. aeruginosa* biofilm production was observed. This can lead to the development of new treatments against multidrug-resistant (MDR) bacteria.

Making A Computer Sing: Modeling The Bird Syrinx

Nafis Farhan
Advisors: Sven Anderson & Charles Doran

Birdsong, a captivating biological phenomenon, intrigues me due to its intricate interplay of neurological, physical, and biological processes. My fascination stems from a purely physical standpoint. The components involved- air sacs, muscles, cartilage, membranes, trachea, various chambers, and mouth opening - collaborate to propel air through vibrating issues, generating pressure waves that are perceived as bird calls. In this project, I delve into comprehending the intricate dynamics of air and vibrations within those complex biological systems by modeling their characteristic differential equations. While existing studies rely on numerical methods, this project aims to explore both the numeric and analytical aspects of song production.

From Sliding Blocks to Stumbling Blocks

Milena Feher
Advisor: Japheth Wood

Sliding block puzzles consist of an n-vertex planar connected graph with $n-1$ tiles or blocks and an empty space. The goal is to attain a specific tile arrangement through a sequence of moves, while adhering to the constraint of not lifting or jumping over tiles. Subgroups of symmetric groups are called "`sliding block groups"; if all of their elements are attainable permutations of some sliding block puzzle. This project will establish certain properties to these groups and give a proof establishing that the dihedral group D_4 is not a sliding block group.

Photon Food: Lead-Free Perovskites Enabling Sunlight to Fuel Physics and the Future

Alexandra (Sasha) Fraser

Advisors: Matthew Greenberg & Beate Liepert

Lead halide perovskites are a promising light absorbing semiconductor material for next- generation solar cells. However, there are multiple issues with using these lead-based materials, including exposure during the manufacturing process, the risk of lead leaking from the panels and contaminating the area where they are placed, and the exposure risk during the decommissioning of panels. This project investigates lead-free perovskites which are energetically tuned to target significant wavelengths within the solar light spectrum. Three phases of Cs_xMnBr_y nanocrystals were explored in this work: a red emitting phase ($CsMnBr_3$), a green emitting phase (Cs_3MnBr_5), and a blue emitting phase ($Cs_2MnBr_4 \cdot 2H_2O$) from a hot injection synthesis using Cs^+ and Mn^{2+} oleates and TMSBr as the Br^- source. Additionally, a red emitting phase of $CsMnCl_3$ was synthesized using TMSCl as the Cl^- source. Photophysical characterization of the colloidal nanocrystals including UV-Vis absorbance spectroscopy, photoluminescence (PL) spectroscopy, and photoluminescence excitation (PLE) spectroscopy was conducted. X-ray scattering measurements were performed to confirm the local structure of the 1D perovskite materials. These results show that multiple phases of stable Cs_xMnX_y (X = Br, Cl) nanocrystals can be synthesized under mild conditions, and that phase engineering can then facilitate bandgap tuning across the visible spectrum of light.

In Vitro Interactions Between DHFR and Ruthenium Metal Complexes

Sydney K. Gustave
Advisors: Swapan Jain & Michael Tibbetts

Cancer is the second leading cause of death in the United States, with an estimated 609,820 cancer-related deaths in 2023. In recent decades, researchers have tapped into the potential of metal-based compounds as anticancer chemotherapeutic agents. Researchers have discovered that adding metal centers to common drugs could increase efficacy by improving both activity and properties of inhibition. They have also investigated the possibility of producing drugs with synergistic effects that display potency similar to successful drugs such as Carboplatin and KP-1019, while simultaneously reducing known cytotoxicities. Dihydrofolate reductase (DHFR) is an enzyme involved in folate metabolism, which is an essential component of DNA synthesis. If metal-based compounds inhibit folate production through their effects on DHFR, this might limit DNA synthesis. In turn, cancer cells might not be able to proliferate, mitigating the growth of malignancies. In this project, I aimed to understand the effects Ruthenium-based drugs have on the function of the DHFR enzyme compared to known inhibitors. Targeting DHFR with Ruthenium-based compounds might have unique mechanisms of action and may increase efficacy and reduce toxicity in cancer treatments.

Pumping a Transition

Christopher Hallman

Advisor: Paul Cadden-Zimansky

This thesis is an exploration into the physical mechanism responsible for the acceleration experienced when pumping a ramp on a bicycle, skateboard, or related human-powered vehicle. Pumping is the technique by which one propels oneself on a ramp, which is very similar to the process of pumping a playground swing. It is my hypothesis that the acceleration one experiences when pumping a ramp is primarily due to the conservation of angular momentum, affected by altering one's moment of inertia relative to the focal point of the curve through which one is traveling. This report documents my attempt to accurately describe the process mathematically, experimentally verify my predictions, analyze, and synthesize the results.

Applications of Genetic Algorithms to Chess

Elliot Harris
Advisor: Valerie Barr

This thesis discusses the use of genetic algorithms to tune the parameters of a chess engine, resulting in a significant increase in playing strength. The design of the genetic algorithms builds on the 2008–2011 work of David-Tabibi *et al.* and Vázquez-Fernández *et al.* The overwhelmingly positive result presented in this thesis not only suggests a promising potential for genetic algorithm use to improve computer chess, but also supports the efficacy and potential of applying genetic algorithms to a broader set of use cases.

Assessing the Viability of Zebrafish as Model Organisms for Exercise Physiology Through Moderate Intensity Continuous Training

Rowan Heinze
Advisor: Michael Tibbetts

Zebrafish are commonly used model organisms across many scientific disciplines, such as biomedical and genetic studies. Their use in these studies provides us with relevant information that can be used to save lives. Their utilization in physiological studies is still in the early stages, as their viability as a model for these studies is still in question. They have been shown to produce responses to exercise similar to those of humans in terms of skeletal muscle mass and decline of athletic performance with age. How they react to different kinds of exercise, such as moderate-intensity continuous training, is unknown. This study evaluated the metabolic adaptations to moderate-intensity exercise training in zebrafish by measuring dissolved oxygen consumption. During a four-week training period, the experimental group performed MICT in a customized swim tunnel for 20 minutes, four days per week, while the control group remained in their tank. The rate of dissolved oxygen consumption relative to body weight was measured before and after the training period as a proxy for resting metabolic rate. Results demonstrated no significant change in RMR from the increased exercise. These results are consistent with previous human findings, validating zebrafish as a model organism for metabolic studies. This study provides an avenue for further research into the role of various genes in metabolism, their applications in human metabolic disorders, and disease treatment and prevention.

A Party of Particles: Constructing a Cyclotron to Accelerate Protons

Luke Ingraham
Advisor: Antonios Kontos

The first particle accelerators were developed by Ernest Lawrence at University of California, Berkeley nearly one hundred years ago. Lawrence's creation of the cyclotron has had an everlasting impact on physics and his experiments can be recreated today. A cyclotron is a charged particle accelerator that uses a magnetic field to confine particles to a spiral flight path in a vacuum chamber and an applied electrical field accelerates these particles to high energies. In this senior thesis, I attempted to build a fully functional cyclotron that is capable of accelerating protons to beyond 60keV. The complexity of the project is extensive because each component in the project needs to be manufactured. The components that need to be made are the electric field generator, magnetic field generator, vacuum chamber/pump, ionization source, and particle detector. I was able to construct the cyclotron from scratch and get to the point of testing.

Effects of Animosity on Smoking Stigma: The Moderating Effect of Race

Justyne U. Ingwu
Advisors: Thomas Hutcheon & Elena Kim

Tobacco smoking has been on a steady decline, especially among adolescents, since the early 1980s, a feat which can be attributed to research on the negative effects of tobacco but more importantly, denormalizing smoking. The main and arguably most influential method that caused such a large cultural shift can be attributed to the use of guilt and stigma in smoking cessation methods. Research on stigmatizing as it relates to healthcare and smoking has highlighted that while rates of smoking tobacco products have declined in recent decades, the use of stigma is doing more harm for individuals who smoke cigarettes (IWS). It makes them less likely to quit and for those who are also part of marginalized communities – pushes them further towards social isolation (Antin et al., 2017). Research in the study of smoking and smoking interventions have looked at the effects of guilt and stigma but have rarely looked at the complex interplay between the two modes. Animosity, characterized by intense hostility and resentment, can be a powerful force in shaping attitudes towards IWS. Portraying IWS as social pariahs fuels animosity and increases the divide between the two groups of people, fostering an environment of contempt, disdain, and exclusion. The goal of this study is to understand if animosity induction can affect people's stigma towards individuals who smoke and whether this effect is moderated by the race of the smoker. After being shown two images, one an anti-smoking image intended to elicit animosity and a control, participants were then given two vignettes of women who smoke, one depicting a black individual and one depicting a white individual. They were then asked to respond to an adapted smoking stigmatizing questionnaire. It is hypothesized that animosity will increase the levels of stigma towards IWS, with higher levels of stigma towards the smoker in the black condition.

Breath of Forgetfulness: Respiratory Effects of Memory Suppression

Luka Jijieshvili
Advisor: Justin Hulbert

When confronted with unwanted memories, individuals engage in a cascade of interconnected cognitive, neurological, and physiological responses. While the cognitive and neurologic effects of memory suppression have been well-studied, the physiological responses, most notably respiration, and associated neural correlates remain relatively unexplored. A total of 18 participants underwent the Think No-Think (TNT) paradigm and had their physiological data, specifically respiration rate and depth, collected using a respiration belt. We aimed to observe how this measure changed when they tried to suppress unwanted memories. We successfully replicated key behavioral findings from the standard TNT paradigm. While we did not observe differences in respiratory rate between Think (recall) and No-Think (suppression) trials, we found that participants breathed significantly deeper in No-Think trials compared to Think trials. Additionally, we found that participants breathed relatively faster and shallower in the Think and No-Think trials relative to the Rest trials. Future studies should focus on improving the reliability and generalizability of these findings by using larger sample sizes and more accurate baselines, as well as manipulating the respiration variable without compromising behavioral results. Further research in this area has the potential to inform the development of innovative therapeutic interventions for memory-related disorders and stress management.

Chasing the Dream:
The American Dream Narrative, Motivations, and Well-Being among First-and Second-Generation Caribbean Immigrants

Joanna Jones
Advisor: Anne O'Dwyer

This study explored the relationship between parental endorsement of the American Dream on young adults' academic motivations and psychological well-being, with a focus on first- and second-generation Caribbean immigrants. A review of the literature suggests that many immigrant populations in the United States view it as the land of opportunity and upward mobility. These populations also may put pressure on themselves and/or their children to succeed in these ways. For example, Wallace (2023) found that Caribbean students in New York City can identify with the model minority stereotype of academic achievement and children of Black immigrant parents receive an additional level of distress due to familial expectations towards education (Knight et al., 2016) and education is vital for opportunity and upward mobility (Griffin et al., 2012). The current study explored the relationship between Parental Endorsement of the American Dream Narrative (PEADNS) and extrinsic academic motivations, cultural identity, and parenting style all on well-being (e.g., stress and anxiety). An online survey was completed by 250 participants—including both Caribbean and non-Caribbean immigrants. Results confirmed that the PEADNS is associated with authoritarian parenting styles, extrinsic academic motivations, and greater levels of stress and anxiety. These findings are discussed in light of the particular experiences of Caribbean immigrant families in the United States and the pressures they and their children experience in achieving success in their new country.

Mental Health Stigmas in Formerly-Incarcerated Individuals and the Impact of Solitary Confinement on Their Attitudes Toward Seeking Treatment

Leyli Kangarloo-Foroutan
Advisor: Anne O'Dwyer

Stigmas around mental health include both an individual's stigmas, as well as public stigmas, both of which impact whether or not an individual seeks treatment for their mental health problems. These attitudes toward mental healthcare translate into prison settings as well, where individuals are often afraid to seek treatment because of the way in which they could be stigmatized by the staff and other incarcerated individuals. Between the fear around how they might be perceived if others find out they are getting treatment for their mental health and the lack of reliable and efficient healthcare resources in correctional facilities, individuals in prison have difficulty getting proper care. Given these obstacles, individuals who have spent time in solitary confinement tend to develop health complications as well as mental health problems that specifically result from prolonged isolation. In this analysis, I reviewed the literature on mental health challenges faced by those who are incarcerated or have been in the past. I then proposed an interview and survey study to examine if having been in solitary confinement affects whether or not an individual will seek treatment post-incarceration. To examine what stigmas they might have against mental health treatment, participants would complete the Self-Stigma of Seeking Help Scale (Vogel, Wade, & Haake, 2006), and the The Attitude Toward Seeking Professional Psychological Help Scale (Fischer & Turner, 1970). The results of these surveys, as well as the interview responses, would be analyzed to explore connections between seeking help post-incarceration and prior time in solitary confinement.

How was I, Mom? How was I, Mom? A Study of the Impact of Prenatal Narratives

Aria Komoroff
Advisor: Sarah Dunphy-Lelii

This senior project investigates the enduring impact of prenatal narratives on individuals' lives, particularly focusing on the transmission of maternal experiences from mother to daughter. The study explores how these narratives persist throughout a child's life and how the story of the mother's pregnancy experience influences the daughter's self-esteem and perceived closeness to her mother.Daughters and mothers were asked to share either lived or heard experiences of pregnancy through a free write. Daughters then completed self-report instruments assessing their self-esteem and feelings of closeness to their mother.

The research begins with a review of recent theories and research on life stories, emphasizing their role in self-understanding, self-worth, and autobiographical narratives. The primary objective is to investigate the relationships between individual development and external influences, particularly the input from others in shaping one's self-development. Existing literature underscores the pivotal role of the mother-daughter relationship in shaping a daughter's self-worth, especially within the realm of pregnancy narratives. The study aims to determine how the positivity or negativity of mothers' narratives correlate with daughters' self-esteem and perceived closeness to their mother.

The results did not show a correlation between the positivity or negativity of maternal narratives and daughters' self-esteem and perceived closeness to their mother. Additionally, consistency between the narratives did not correlate with higher self-esteem and perceived closeness scores. That being said, given most

of the stories were coded as being consistent, and daughters did have particularly high scores in Self Esteem and MAD, a correlation may in fact exist that we did not detect, due to small sample size. This research contributes to a deeper understanding of the developmental implications of prenatal narratives, shedding light on the dynamics between maternal storytelling, daughters' self-esteem, and their perceived level of closeness in their relationship.

Using Environmental DNA Assays to Detect Sea Lampreys (*Petromyzon marinus*) in Aquatic Environments

Emma Kuntz
Advisor: Felicia Keesing

The sea lamprey, *Petromyzon marinus*, is an anadromous, jawless fish that is present in much of the waters of the North American northeast, as well as the waterways of Western Europe. It is often dubbed the "vampire fish," due to its parasitic nature during its oceanic juvenile stage, after which it returns to streams to spawn in the spring and summer. Its fascinating life cycle and parasitic nature have made it a subject of study in the Northeast, particularly due to its success as an invader. As anthropogenic activities continue to threaten aquatic ecosystems and life, efficient monitoring and conservation measures are needed to protect and restore habitats. Sea lampreys' rapidly growing populations have prompted lampricide treatments, barriers, and traps, which are used to maintain the populations at a manageable level. Molecular-based environmental DNA assays are useful, noninvasive tools to track population growth and decline. In this study, I supplement previous research with useful and efficient methods that can aid in local conservation and control. Using standard eDNA field methods and real-time quantitative PCR (qPCR) analysis, I provide a baseline assessment of how sea lamprey DNA is amplified in a qPCR experiment to guide future projects and investigate the emerging success of qPCR-based eDNA assays. As we gain a better understanding of sea lamprey populations in local areas, we may be able to untangle their native role better and conserve our already fragile aquatic ecosystems.

Investigating the Visible-Light Mediated [2 + 2] Photocycloadditon of 3-Acetyl Indoles

Emma LaPenta
Advisor: Emily McLaughlin

Photochemical reactions are fundamental in organic synthesis, valued for their functionality, efficiency, and reaction selectivity. Traditionally, UV light has been the preferred activation source for these reactions due to the way organic molecules absorb under it. However, visible light has recently emerged as a safer and more broadly applicable tool for photoreactions. The objective of this project is to explore the influence of different protecting groups on visible light-mediated reactions. To accomplish this, we synthesized a group of 3-acetyl indoles bearing three unique protecting groups to gauge their reactivity in visible light mediated 2+2 photocycloaddition reactions. The resulting photoproducts were reported and characterized using ^{1}H NMR spectroscopy. This research considers the potential of visible light in photoreactions, and expands the knowledge of protecting groups in influencing reaction outcomes.

An Unsupervised Machine Learning Algorithm for Clustering Low Dimensional Data Points in Euclidean Grid Space

Josef Lazar
Advisors: Ethan Bloch & Rose Sloan

Clustering algorithms provide a useful method for classifying data. The majority of well known clustering algorithms are designed to find globular clusters, however this is not always desirable. In this senior project I present a new clustering algorithm, GBCN (Grid Box Clustering with Noise), which applies a box grid to points in Euclidean space to identify areas of high point density. Points within the grid space that are in adjacent boxes are classified into the same cluster. Conversely, if a path from one point to another can only be completed by traversing an empty grid box, then they are classified into separate clusters. GBCN requires two hyperparameters, one to determine the size of the grid and the other to adjust noise sensitivity. I provide algorithms and evaluation metrics to help the user determine appropriate hyperparameter values. I performed experiments on synthetic and real world data sets using GBCN and other clustering algorithms to evaluate GBCN's effectiveness and efficiency. The results of these experiments demonstrate that GBCN can effectively identify both globular and density-based clusters when given the right hyperparameter values, and that these hyperparameter values can be discovered using evaluation metrics.

China's Growth Odyssey: A Model for Optimal Resource Allocation Amidst China's Policy Shift

Eric Lin
Advisors: Dimitri B. Papadimitriou & Stefan Mendez-Diez

Driven by the recent shift in China's economic policy to address decaying demand, both domestic and foreign, this paper offers insights into rethinking the structure of the supply side of China's economy, by constructing a two-sector optimal growth model combining Solow's neoclassical growth theory with optimal control theory. Under the assumption that supply-demand equilibrium prevails in the economy, the model answers the question of how China can optimally allocate physical capital and labor between the production of consumption goods and investment goods to maximize consumer utility from 2007 to 2022. When plotting the optimal allocation ratios against the actual allocation ratios, the visualization indicates that China's resource allocation structure has deviated from its optimal path since 2007. Therefore, this paper argues that, if the supply is sufficiently met by demand, the government should implement supply-side policies to influence its resource allocation structure to move towards its optimal path following the solutions suggested by the model. Since the supply and demand conditions are currently off balance in China, various demand-side policies facilitating the achievement of market equilibrium will also be discussed at the end.

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Polarized Light Vision in Birds Under Terrestrial Context

Chu Liu

Advisor: Bruce Robertson

Birds are renowned in the natural world for their remarkable visual abilities and navigation skills. However, birds' polarized light vision remains largely uncharted territory and the only knowledge we have is that the ability of perceiving sky-oriented polarized light is related to magnetoreception during the migratory navigation process. My study was aiming to test whether birds are able to see terrestrial sources of linearly polarized light of visible range and if they are using such ability to guide their behaviors. I designed a choice field experiment which used two identical bird feeders that are only different in the degree of linear polarization (High and low) when sunlight hits on them. The result showed that both Black-capped chickadees and Tufted Titmouse had a slight preference on the treatment which had higher degree of linear polarization, suggesting that those two species seem to be able to see terrestrial sources of linearly polarized light and might be using the ability to perceive polarized light to obtain information and guide their behaviors apart from navigation.

Transient Absorption of ZnTPP Using a Two Laser Pump-Probe Setup

Katie Lowney

Advisor: Christopher LaFratta

Transient absorption spectroscopy is a time-resolved technique that can be used to study electron photoexcitation and to analyze photochemical reactions. Our system was created using two nanosecond-pulsed lasers, a pump and a probe, at wavelengths 520 nm and 450 nm respectively. The pump laser was used to excite the molecule zinc tetraphenylporphyrin (ZnTPP) while the probe laser was used to measure the change in absorption of the molecule, which is known as transient absorbance (TA). The time delay between the pump and probe is varied electronically allowing the TA signal to be monitored for several microseconds. The addition of C_{70} fullerenes to the ZnTPP solution also enabled charge transfer kinetics to be studied.

Synthesis and Characterization of Pt(II) Compounds with Isocyanide Ligands

Ryan H. Lum
Advisor: Craig Anderson

Cyclometalated Pt(II) compounds with various isocyanide ligands were synthesized and characterized. Two C^N chelate imine ligands were utilized in order to facilitate C-H orthometalation with the tetramethyl platinum precursor $Pt_2Me_4(\mu\text{-}SMe_2)_2$. Sequentially, the dimethylsulfide ligand was easily substituted for with various isocyanides. The target Pt(II) compounds thus contain one chelate C^N imine ligand, a methyl ligand, and an isocyanide in the coordination sphere. The compounds' photophysical properties (absorbance, emission, excited state lifetimes, and photoluminescence quantum yields) were measured and studied as a function of their ligand architecture.

The Joy and Taboo of Menstruation
[Body image and Self-Objectification]

Lola Mainieri
Advisor: Elena Kim

This study strove to understand the correlation between menstrual attitudes, body image, and self objectification. Participants were menstruators that were garnered from the Bard College population. They proceed through a Google Form that was compiled from the the Menstrual Joy Questionnaire (MJQ), the Menstrual Distress Questionnaire (MDQ), the Self-Objectification Questionnaire (SOQ) and finally the Body Appreciation Scale (BAS) (Delaney et al., 1988, Vannuccini et al., 2021, Dahl, 2014, Tylka & Wood-Barcalow, 2015). Participants accrued a score from each questionnaire that was then used to run the four separate correlations. A significant positive correlation was found between the Menstrual Joy and the Body Appreciation scores. Furthermore, a significant negative correlation was found between the Menstrual Distress and the Body Appreciations scores. Although there was no significant correlation found between the Menstrual Joy and the Self-Objectification scores, the correlation between the Menstrual Distress and the Self-Objectification scores approached significance. These findings indicate a direct bridge between menstrual attitudes, body image, and self objectification thus emphasizing the importance of positive preparation, increased education, and encouraged hygienic menstrual health practices.

Adaptation of *Candida albicans* to Morphogenesis-Inhibiting Anti-Cancer Agents Etoposide and Busulfan

Angelina Mannino
Advisor: Robert Todd

Candidemia is a prevalent bloodstream infection in the United States, with an average incidence of approximately 9 cases per 100,000 individuals from 2013 to 2017. One key challenge in finding safe and effective antifungal drug treatments is the shared eukaryotic nature of the yeast pathogen and host human body. Despite ongoing efforts to develop new antifungal drug classes, options remain limited. This study focuses on investigating the potential effectiveness of anti-cancer agents against *Candida albicans*, a prevalent fungal pathogen in humans. Etoposide and busulfan are two anti-cancer agents known for their ability to inhibit morphogenesis in *C. albicans*. Morphogenesis refers to the organism's shape and form, particularly *C. albicans*' ability to switch between yeast form and hyphal forms, which is linked to its pathogenesis. This study also explores whether prolonged exposure to these agents leads to the potential development of resistance. This study uses spider agar plating techniques to initially test etoposide and busulfan's efficacy against *C. albicans* morphological switching. Subsequently, *in vitro* evolution followed by Whole Genome Sequencing (WGS) was used to identify any genomic changes acquired during prolonged exposure to busulfan and etoposide. Results suggested that the anti-cancer-evolved isolates experienced morphogenetic switching, whereas the control group possibly did not, as observed in the colony morphology screen conducted on spider agar. DNA was extracted from the same evolved-isolates and sent for sequencing, and the results showed mutation and possible adaptation to an anti-cancer agent. This indicates that over time *C. albicans* would become resistant to the anti-cancer agents' morphogenesis-inhibiting properties.

Investigating Transition Metal Complexes: Insights into DNA:RNA Interactions

Mariam M. Morsy

Advisors: Craig Anderson & Swapan Jain

This study explores the synthesis and characterization of transition metal complexes, specifically ruthenium (II) and copper (II). Incorporating metformin and phenformin as ligands, the study aims to contribute to the development of novel anticancer therapies based on metformin and phenformin derivatives. To elucidate the properties and potential synergistic effects of combining metal centers with these ligands, a variety of assays/techniques were employed. These include CRISPR-Cas9, gel electrophoresis and UV-vis DNA melting with the goal of investigating the mechanisms of action of the compounds.

GreenGame: Carbon Emissions Game

Maihan Naimi
Advisor: Sven Anderson

The GreenGame project digitizes a paper-based game called Carbon Emissions into a computer game. This transition helps make it more fun and helpful for students to learn complicated ideas about the economy and the environment. The GreenGame project aimed to develop a digital game where students take on roles to be policymakers (regulators) or companies dealing with carbon regulation. This game helps players learn about various ways to regulate carbon emissions, such as taxes and emissions trading. The GreenGame project report discusses how the game was developed, particularly the core functionalities (backend), the user interface (frontend), how the data is handled, and how all these aspects interact. After iterative testing and client feedback, the resulting game satisfied all the requirements and objectives proposed by the client, suggesting that GreenGame is a valuable tool that can be helpful in environmental education. It will allow students and professors to navigate complex policy issues in an engaging and educational environment. The successful implementation and transformation of the paper-based game into a computer-based game will enrich the student's learning experience.

The Effect of Pesticides Glyphosate and Cyfluthrin on the Growth of the Eukaryotic Organism *Candida albicans*

Tim Neumeister
Advisor: Brooke Jude

Pesticides have become ever present in our food, being detected in >70% of all fresh produce. Given the widespread presence of pesticides in fresh produce, their is a high risk of direct exposure to organisms in the gut microbiome, this study aims to elucidate the relationship between pesticide exposure and the growth of *C. albicans*, a common human gut pathogen. An MTT assay was used to understand growth dynamics of *C. albicans* in response to two commonly used pesticides, glyphosate and cyfluthrin. . Our results revealed that glyphosate had an inhibitory effect on the growth of *C. albicans* at all concentrations tested, while cyfluthrin had little effect on the growth of *C. albicans*, and potentially aiding the growth of *C. albicans* in low concentrations. This research underscores the complex interactions between pesticides and gut microbiota, highlighting the need for further studies to fully understand the implications of pesticide residues in our food on human health and microbial ecology.

Thermotolerance and Intrinsic Resistance: A Survey of Environmental Yeast Isolates

Tenzing Neyden
Advisor: Robert Todd

The impacts of climate change are observed globally. The rise in global temperature is one instantiation of these changes. Thus, organisms must be able to adapt as a response to the changing environment. Yeasts are microorganisms that are found all over the natural world including soil, plants, fruit, and mammals. Yeast play a fundamental role in maintaining a balanced ecosystem from decomposition to nutrient cycling, yet some species are opportunistic pathogens. In mammals, the warm body temperature acts as the first line of defense against pathogenic strains of yeast. However, with the current trend in rising temperatures, the environmental yeast strains may evolve to withstand the heat of human body temperatures, posing a potential threat to human health. Additionally, with the limited number of antifungal drug types available, accompanied by the adverse side effects to human health, further raises public health concerns as an outbreak of new fungal pathogens that are resistant to treatment can become fatal. This study surveys environmental yeast species from a high foot-traffic trail on the Bard College campus, through ITS sequencing , thermotolerance assays, and antifungal susceptibility testing using fluconazole on environmental yeast isolates to assess the prospective emergence of novel fungal pathogens able to adapt to mammalian body temperatures.

Comparative Analysis of Nearest Neighbor Search Algorithms

Tony Nguyen
Advisor: Robert McGrail

With the rapid invention of technology and the increasing accessibility of technology, multi- dimensional database has grown rapidly throughout the world. Due to the impact of the multi- dimensional databases, the efficiency of the nearest neighbor algorithms holds critical importance for diverse applications ranging from information retrieval to machine learning. In this research paper, we will conduct an experiment in order to evaluate the contemporary nearest neighbor search algorithms juxtaposed against the 7-monotonic search algorithm [24] - a recently proposed technique claiming better performance based on the Monotonic Relative Neighborhood Graph (MRNG) in Cong Fu's research [12]. We developed a diligent experimental framework including standardized multidimensional datasets and evaluation metrics that captures accuracy, efficiency, and scalability attributes. Leveraging this methodology, we benchmark the legacy algorithms viz. k-d trees, ball-tree, locality sensitive hashing, etc. vis-à-vis 7-monotonic search across pertinent performance axes. Through reproducible experiments and statistical tests, the findings reveal distinct insights into the comparative strengths and shortcomings of these algorithms across pertinent search quality and speed trade-offs. the study intends to provide an impartial and insightful perspective on how to optimize nearest neighbor search performance in the context of multi-dimensional data. Beyond substantiating the functional advantage for 7-monotonic search, we highlight open challenges to inform future advancements in this integral subfield within database systems research.

Hello, Are You There? We Have A Weak Signal... Investigating the Possibility of Ultrasound-Mediated Communication in Plants

Scout Olip-Booth
Advisor: Felicia Keesing

Research has shown that plants respond to sound on a morphological as well as a physiological level. Plants also produce sound, and recent research shows that this sound is airborne and carries information about the plant's identity and conditions. However, most research into plants' responses to sound uses human-generated sounds, and therefore cannot give us insight into an evolutionary benefit of these responses. To my knowledge, there has also been no research to this point into whether plants respond to the sounds of conspecifics. In this paper, I attempt to begin filling in this knowledge gap. I recorded the sounds of drought-stressed and unstressed tomato plants, and played them to conspecifics. I determined whether there was a difference in biomass in those that were exposed to recordings of stressed plants, and those that were exposed to recordings of unstressed plants. I also asked whether plants that were subsequently exposed to drought stress would have a difference in biomass after the stress period to test if being exposed to the recordings of stressed plants had allowed those plants to prepare defenses against drought stress. I did not find any statistically significant results, but the methods that I used were novel and could be applied to further research.

Investigating the Binding Potential of Ruthenium (II) Based Metal Complexes to DNA-RNA Hybrids

Fuadar Omi

Advisor: Swapan Jain

This study investigates the interactions between two ruthenium (II) complexes, namely LM5400 and Compound B, with DNA:RNA hybrids—an area of the human genome primed for exploration. Building upon the Jain lab's insights into Cisplatin's effects on hybrids, our research aims to uncover the therapeutic potential of these compounds. Employing a multidisciplinary approach integrating advanced techniques and assays such as CRISPR, gel electrophoresis, electrophoretic mobility shift assay, and UV-Vis melting studies, we seek to decipher the underlying molecular mechanisms of these interactions. This study may potentially represent a significant advancement in nucleic acid chemistry, with implications for reshaping biomedical research and clinical interventions aimed at diseases where DNA:RNA hybrids play a critical role.

Relative Importance of Olfaction and Local Enhancement in Black Vulture (*Coragyps atratus*) Foraging Behavior

Isaac Pavalon

Advisors: Bruce Robertson & Ben Coonley

Over the past several decades, black vultures (*Coragyps atratus*) have expanded their range from the Southeastern United States to the Northeast. Human-vulture conflict has taken place in their expanded range. There have been reports of predation on livestock, aircraft collisions, and general damage to infrastructure, all of which have monetary consequences and sometimes can endanger human (and vulture) lives. To mitigate and prevent this conflict a better understanding of vulture (and human) behavior is necessary. Through research, I first found that vultures will eat cheese and tofu in addition to meat. I then found evidence supported by previous research for vultures' use of olfaction and local enhancement in foraging. Vultures visited boxes with the scent of meat instead of boxes with no scent 93% of the time, and had increased odds of visiting boxes with rotten meat as the number of vultures surrounding the box they arrived at increased. Finally, bringing together this new research, research from the literature, and my experience through movie making of getting to know people who deal with vulture damages, I speculate as to ways in which coexistence with vultures can be facilitated through potential feeding practices.

Finding Maximal Cap Sizes for Quad Card Decks Using Share Strings

Oliver Pawelek
Advisor: Stefan Mendez-Diez

This project introduces the concept of share strings and how they can be used to figure out maximal cap sizes for different decks of the card game *EvenQuads*. We prove that all caps must map to a share string with respect to a basis and that if no share strings exist for cap size k in a given dimension d, then the maximal cap size of that dimension $M(d)$ must be less than k. We prove the maximal cap sizes up to dimension 7 and show that there are at most 8 possible share strings for 19-caps of dimension 8.

Utilization of Polarized Light to Select Prey Items Among Wild Birds

Emily Peck
Advisor: Bruce Robertson

Light can be described as "polarized" when its waves vibrate through space on the same plane. Many sources emit polarized light (like the sun) and reflect it (like bodies of glass, water, and some organisms). Though not visible to the human eye, large bodies of research have found that organisms such as bees, ants, wasps, butterflies, fish, and squid detect polarized light and use it for a variety of biological functions. Though the exact visual and behavioral impact of polarized light on birds is still unknown, current research is investigating its role in migration, habitat selection, resource detection, and food gathering. This research aimed to determine whether light polarization influences wild birds' prey identification and feeding habits. The investigation of this principle was conducted through a series of feeder experiments involving wild bird populations across 10 local test sites. Experiments were conducted with simulated prey items that linearly polarized light, creating a polarized light cue that could only be detected upon arrival at a feeder. This design aimed to answer whether polarized light cues can influence avian prey selection in small-scale settings. The research found a significant indication that Black-capped chickadees and Tufted titmice may utilize polarizing light cues in food selection, though their effects were opposite of each other. Gaining insight into this process could help to conceptualize the hunting behavior of birds and potentially other organisms, as well as contribute to conversations about the harmful effects of polarized light pollution from manmade urbanization.

ABSURDO! Characterizing a Novel Strain of Pathogenic Nontuberculous Mycobacteria

Anneka Prigodich

Advisor: Brooke Jude

The *Mycobacterium* genus is primarily known for its most famous member, *M. tuberculosis*. Yet, nearly 200 species of nontuberculous mycobacteria have also been identified, most of which can infect humans. Unlike tuberculosis, NTM diseases are not transmissible. Rather, they are acquired from environmental sources, such as drinking water. Historically, the clinical understanding was that cases of NTM disease were rare and almost exclusively occurred in immunocompromised individuals. Accordingly, the overwhelming majority of scientific knowledge on mycobacteria stems from research on *M. tuberculosis*, which kills more people than any other infectious disease every year (except for 2022, when it was narrowly overtaken by COVID-19). However, recent studies have shown that NTM disease incident rates have more than doubled over the past two decades in many countries, including the United States. Furthermore, NTM infections have been found not only in immunocompromised individuals, but also in those with minor anatomical abnormalities or pre-existing conditions who would otherwise be considered healthy. These alarming trends have driven a recent increase in NTM research. The focus of this particular study is a novel strain of *M. intracellulare* isolated from the cervical lymph node of an adolescent patient with acute lymphadenitis. As the work on this strain at Bard originated from a collaboration with Ohio State University, it was given the name "ABSURDO," an anagram of OSU and Bard. Since variability between NTM strains, even within a single species, is known to be exceptionally high, this

study aimed to contextualize its investigation of *M. intracellulare* ABSURDO through comparisons with the species type-strain, ATCC 13950. To do so, both *M. intracellulare* strains ATCC 13950 and ABSURDO were simultaneously characterized by measurement of their long-term growth in liquid culture and tests of their respective susceptibility to ethambutol (EMB), an antimycobacterial drug commonly used to treat *M. intracellulare* infections. Most significantly, strain ABSURDO was shown to be far more susceptible to ethambutol than strain ATCC 13950 is. This results provides a succinct example of the consequences that NTM strain variability can have on clinical outcomes.

Challenges in Combating Antibiotic Resistance: Constructing a pCas9 Vector for the Mutagenesis of *traG* and *trbC* Genes in *E. coli* S17-1, and the Limitations of S17-1 as a Donor in Horizontal Gene Transfer Studies

Nine Reed-Mera
Advisor: Brooke Jude

The escalating threat of antibiotic-resistant infections presents a formidable challenge to global health, with predictions estimating alarming mortality rates. Without urgent innovative action, we are shooting toward a post-antibiotic era, where common infections and minor injuries may become incurable once again. In the pursuit of a sustainable solution, a paradigm shift is imperative, with a search for non-lethal therapies that consider the broader implications of antibiotics on pathogen evolution and align with the preservation of evolutionary health.

Bacterial conjugation, a form of horizontal gene transfer (HGT), has emerged as a primary mechanism through which bacteria acquire resistance to antibiotics. The transfer of plasmids allows bacteria to share and disseminate antibiotic resistance genes efficiently. In this way, conjugation contributes significantly to the spread of resistance in diverse environments. Prioritizing the discovery of targeted conjugation inhibitors (COINs) could be instrumental in combating the resistance crisis.

This study aims to understand the effects of conjugation inhibition on plasmid movement and resistance transfer in *E. coli*. By using CRISPR-Cas9 to target the *traG* and *trbC* genes of the RP4 plasmid in *E. coli* S17-1, this project aimed to reduce plasmid transfer. The *TraG* protein stabilizes the mating pair and links the relaxosome to the type IV secretion system (T4SS), while *TrbC* is crucial for

pilus formation. Modifying these genes was expected to hinder conjugative transfer, thereby reducing the spread of resistance.

However, experimental challenges arose due to the *E. coli* S17-1 strain's unexpected antibiotic resistance profile, which invalidated the results of the conjugation assay. Using CARD RGI, S17-1's diverse resistance profile was investigated. This study underscores the need for improved conjugation donors in this exciting field of research.

Design and Characterization of Laser-Induced Microstructures as Actuating Thermal Sensors

Lucas Rodriguez
Advisor: Christopher LaFratta

In house studies have been conducted in regards with the photopolymerization anomalies observed by photoinitiator ethyl(2,4,6-trimethylbenzoyl) phenylphosphinate (TPO-L). In the process of photopolymerization with a resin of TPO-L and monomer, despite being unable to absorb in the green light region, the region still initiates and polymerizes. In pursuit of this problem, the authors thought it best to determine whether the heat intensity of both an ultrafast Ti:Sa oscillator laser and a Nd:YAG CW laser potentially played a role in TPO-L's relationship with green light. The heat study took place on a macro and microscale using heat sensitive hydrogels as novel thermal sensors. These polymerized hydrogels were measured for structural changes with increasing temperature while suspended in water and resin, and then compared to observed changes when in the presence of the focal point of\ the laser of unknown heat in water and resin.

The Impact of Religiosity and Spirituality on Wellbeing: The Mediating Effect of Positive Emotions and Perceived Control

Luis Jhamil Rondon Trelles
Advisors: Elena Kim & Thomas Hutcheon

Although there is a sufficient amount of literature that suggests that religiosity and spirituality are related to well being, the mechanisms that mediate such a correlation are not entirely understood. Thus, this study explores two possible variables (positive emotions and perceived control) that might mediate the relationship between religiosity/spirituality and well being. Moreover, most studies use the concepts of religiosity and spirituality interchangeably, even though there are several distinctions in how those two terms are conceived. Therefore, this study will evaluate these two constructs as different variables, and explore whether that has an impact on how they are related to well being. A total of 135 participants took part in the study. Participants' ages ranged from 18 to 40, (M= 30 years, SD=6.33). Moreover, 42% of the participants considered themselves religious (n=57) and 58% non religious (n=79); whereas 63% of the participants considered themselves spiritual (n=86) and 37% non spiritual (n=50). Participants completed five measures online (one per variable). Results revealed that positive emotions (more specifically awe, love, and compassion) mediate the association between religiosity and wellbeing; and spirituality and wellbeing. Whereas, perceived control only mediates the association between spirituality and well being. Finally, a strong correlation was found between religiosity and spirituality, suggesting a strong overlap between the variables.

Results on *k*-Covers in the Game *Quads*

Daniel Rose-Levine
Advisor: Robert McGrail

This project explores the k-cover conjecture for the game *Quads*. The conjecture states that for all $k \in \mathbb{N}$, there exists a k-cover if and only if $k = 2$ or $k = \frac{2^n-2}{6}$ for some odd $n \in \mathbb{N}$ with $n > 1$. We show that if k is one of these values, then there exists a k-cover. We discuss partial results in the other direction, i.e., that these are the only values of k for which there exists a k-cover.

Folding Cubical Complexes

Skye Rothstein
Advisor: Charles Doran

In this project we study the folding properties of three special classes of cubical complexes. A cubical complex is a set of points, line-segments, squares, cubes, and their higher-dimensional counterparts. We study 2D polyominoes, 3D polyominoids, and the 4D hypercube. A 2D polyomino is a set of congruent squares arranged edge-to-edge in 2-space. A 3D polyominoid is a set of congruent squares joined at 90° or 180° angles in 3-space.

We develop techniques to construct and fold a fenestrated 2D polyomino (containing holes) into a non-fenestrated 3D polyominoid. We define a notion of "friendship" between two 3D polyominoids if they differ by one "hinge movement" and completely characterize all friendships between 4-square 3D polyominoids. We also prove several structural properties describing the folding relationships between N-square 3D polyominoids for arbitrary N. Lastly, we realize the 4D hypercube as a surface by following precise coloring rules and removing faces incompatible with those rules. We find that under a specific folding operation relevant to supersymmetry physics, this object becomes un-embeddable in 3-space using non-intersecting quadrilaterals.

Interactions of Ruthenium(II) and Copper(II) Metal Complexes with DHFR: Inhibitory Effects on Enzyme Activity and RNA Binding

Sage Saccomanno
Advisor: Swapan Jain

An important target in cancer has been the folic acid pathway in which the enzyme dihydrofolate reductase (DHFR) catalyzes the reduction of dihydrofolate to tetrahydrofolate using NADPH, an essential cofactor for the biosynthesis of purines, thymidylate, and several amino acids. Our project focuses on (i) the binding of ruthenium and copper complexes with DHFR enzyme and subsequent evaluation of DHFR catalytic activity and (ii) direct binding of ruthenium and copper complexes with the mRNA of DHFR gene and subsequent evaluation of RNA function in a translation assay. The in vitro binding affinity of Phenformin, Metformin, Ru79, Cu65 and Ru-cymene were investigated using DHFR enzyme activity assay. Methods included seed cultures, plasmid extraction, restriction digestion, isoamyl:phenol:chloroform purification, transcription, incubation with metal complexes, translation, analysis with a DHFR activity assay, gel electrophoresis and mobility shift assays. It was concluded that there is serious potential of phenformin and metformin based drugs to better hinder the enzymatic activity of the DHFR enzyme and to eventually become successful anti-cancer drugs. Future work will revolve around more studies with additional Ru(II) and Cu(II)metal complexes from the Anderson laboratory and binding studies with DHFR mRNA.

Polarization of Butterfly Wings in Visible and Ultraviolet Light

Sabrina Schettler

Advisor: Bruce Robertson

The role of polarized light in the biological functioning of many insects is a fascinating yet seldom researched topic in ecology. Polarized light–light which oscillates in a single plane–is ubiquitous in the natural world and provides important cues for butterflies' functions, such as detecting water bodies. In my study, I measured the effectiveness of butterfly wings at polarizing visible and ultraviolet (UV) light. While some research has been conducted about the role of polarization in butterfly behavior, research that precisely measures and quantifies polarization by their wings is lacking. Butterflies possess intricate and brilliant colorations, but it is unknown how effective the amazing array of colors are at polarizing light. I measured how the darkness of the colors of butterfly wings affects the quantity of reflected polarized light. Then, I compared the degrees of linearly polarized light (DoLP)–a measurement quantifying the amount of light polarized–in the visible and UV ranges. I found that in visible light, darker colored areas are more conducive to polarization, whereas darkness has no effect on polarization in ultraviolet light.

Colonial Mentality and Queer Fiipino Americans: A Proposal to Adapt the Colonial Mentality Scale

Beau Serrano
Advisor: Elena Kim

The colonized people are told that their heritage, culture, and ethnicity are inferior to their White Euro-American colonizers. Certain colonized people internalize this inferiority and begin to abandon their native identities to mimic and resemble White people and culture. This phenomenon is called Colonial Mentality and has been studied by decolonial theorists since the 1960s (David, 2013). In 2006, Filipino American Psychologist, EJR David, and his mentor, Sumie Okazaki, developed a model for Colonial Mentality in Filipinos. Filipino Colonial Mentality is characterized by being ashamed of Filipino culture, feeling inferior to White people, idolizing American/Spanish culture, discriminating against less-Westernized Filipinos, and making cosmetic choices to meet White beauty standards (David & Okazaki, 2006). It is associated with depression, social isolation, and social anxiety (David, 2013). David & Okazaki (2006) developed the Colonial Mentality Scale to measure these traits in Filipino Americans. Overall the field of psychology has overlooked queer Filipino Americans and this includes research on Colonial Mentality. The goal of this proposed study is to begin diversifying the research on Colonial Mentality by using two methodologies. First, an exploratory qualitative study is proposed to fill the gaps in our knowledge about queer Filipino American experiences and explore queer Filipino American identity and internalized colonialism. This first study will use a constructivist Grounded Theory methodology. Second, the resultant Grounded Theory of Study 1 will be used to develop and validate a queer-inclusive version of the existing Colonial Mentality Scale. This requires testing the new scale for dimensionality, reliability, and validity. The results are expected to propel research on queer Filipino Americans forward and expand the conceptualization of Colonial Mentality.

Resistance or Susceptibility: Does the Response to Fungicide Exposure Vary Across *Fusarium* taxa?

Ella Skinner-Sloan
Advisor: Cathy Collins

Fungicides are used to kill fungal pathogens that cause disease in agriculture. Over time, fungal pathogens have become resistant to many common fungicides ultimately preventing their effectiveness. Fungicide resistance is an ongoing threat in agriculture, causing global crop losses and impacting food security. *Fusarium* species are soil-borne fungal pathogens with the unique ability to cause disease in plants and humans. Most fungal pathogens develop resistance after prolonged exposure to fungicides, but *Fusarium* species have also been shown to have naturally occurring resistance without prior exposure. *Fusarium* species have additionally demonstrated specific resistance to different fungicides depending on the population and strain, preventing the prediction and management of resistance across species and individuals within each species.

I investigated whether two different commercial fungicides impact fungal growth for three *Fusarium* species and whether responses vary among individuals within a species. To determine how fungicide resistance or susceptibility differs across individuals and species. I measured fungal growth after exposing individuals to high and low fungicide concentrations. I detected that fungal species responded differently to the two fungicides. Additionally, although both fungicides reduced growth for all individuals, individuals responded differently to the treatments depending on fungicide concentration. This study ultimately provides a better understanding of *Fusarium* species' response to fungicides and may help influence management strategies in agriculture.

Symmetry and Structures of APN Functions and Sidon Sets

Darrion Thornburgh

Advisors: Robert McGrail & Steven Simon

Let $\mathbb{F}_p^n$ be the n-dimensional vector space over $\mathbb{F}_p$. The graph $\mathcal{G}_F = \{(x, F(x)) : x \in \mathbb{F}_p^n\}$ of a vectorial function $F\colon \mathbb{F}_p^n \to \mathbb{F}_p^m$ can have interesting combinatorial properties depending on varying cryptographic conditions on F. A vectorial Boolean function $F\colon \mathbb{F}_2^n \to \mathbb{F}_2^n$ is almost perfect nonlinear (APN) if there are at most 2 solutions to the equation $F(x+a) + F(x) = b$ for all $a, b \in \mathbb{F}_2^n$ where $a \neq 0$. Equivalently, F is APN if and only if $\mathcal{G}_F$ is a Sidon set, that is, a set in $\mathbb{F}_2^n$ where no four distinct points sum to zero. In this paper, we classify APN functions and important subclasses of APN functions in graph theoretical terms using the Kneser graph of all translations of $\mathcal{G}_F$. We also study the properties of $\mathcal{G}_F$ as a Sidon set. In particular, we introduce the notion of uniform exclude distributions, and we study APN functions whose graphs have uniform exclude distributions.

Assessing the Impact of Draper Deletion and Sertraline on the Locomotor Abilities and Gene Expression of Notch in *Drosophila Melanogaster*

Albright Tuah
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MEGF10 is a gene involved in skeletal muscle regeneration. Mutations in this gene lead to a life threatening and incurable variant known as early-onset myopathy, areflexia, respiratory distress, and dysphagia (EMARDD). EMARDD is also known as MEGF10 myopathy–a disease that affects the muscles that control voluntary movement in the body. Although the exact molecular mechanism of the disease is unknown, recent findings attribute the pathogenesis of the disease to MEGF10's interaction with the Notch signaling pathway–a well conserved pathway involved in skeletal muscle development. To understand the disease mechanism and explore potential therapies, I examined the consequences of deleting *MEGF10*'s ortholog, *Draper (Drpr)-/-*, on the motor function of larvae and adult male *Drosophila melanogaster*; additionally, Sertraline, a selective serotonin reuptake inhibitor (SSRI) used to treat mental conditions, was evaluated for its potential to ameliorate *MEGF10* myopathy in *Drosophila*. Using the Climbing and Larval Crawling assay, I studied the locomotor abilities of treated and untreated mutant flies. *Drpr* deficiency decreased locomotor skills in adult and larval flies. Sertraline had no ameliorating effects on the climbing ability of mutants. However, improvement in crawling behavior by sertraline depended on the genotype of the larvae. My findings suggest that while sertraline holds promise as a therapeutic for *MEGF10* myopathy, its efficacy is limited. Future research could focus on sertraline's mechanism of action while also exploring newer therapeutic drugs.

Synthesis, Characterization, and Photophysical Properties of Pt(IV) Complexes

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Pt(II) complexes are well-recognized for their desirable luminescent properties, but Pt(IV) complexes, though less explored, also hold potential for similar attributes. The octahedral geometry of Pt(IV) complexes provides enhanced tunability through various ligand architectures, allowing for tailored modification of these properties. In this study, new ligands were designed and synthesized with the aim of reacting them with a platinum dimer precursor, Pt2Me4(μ-SMe2)2, to synthesize novel Pt(IV) complexes. The objective was to investigate the photophysical properties (absorbance, emission, lifetime, and quantum yield) of these new complexes, examining how changes in ligand structure influence their behavior.