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*American-Born “Confused” Desi?: An Exploration of Indian-American Biculturalism & Bilingualism*

## Annika Agrawal

Faculty Mentor(s): Makeba Wilbourn

Behavioral Sciences / Psychology

**Abstract:**

Our feelings of social connectedness play a major role in our psychological wellbeing. For immigrants and ethnic minorities, cultural communities assist in developing positive social connections and social identities around ethnicity. Ethnic identity has rarely been studied in second-generation immigrants, who experience biculturalism due to internalizing two cultures from a young age. Even less research has been conducted on Indian-Americans, who are often grouped with other Asian-Americans, despite having extensive ethnolinguistic differences and numbering over four million people in the U.S. The current study aimed to explore the relationships between language proficiency, social connectedness, ethnic identity, bicultural identity integration, and psychological wellbeing in Indian-Americans using validated survey measures (Study 1). The findings revealed that only social connectedness was significantly predictive of psychological wellbeing overall. However, bicultural blendedness and belonging to one’s ethnic group were together significantly predictive of personal growth. Interestingly, Indian language proficiency was unrelated to other measures. Thus, the current study also aimed to explore how cultural experiences are communicated via language (Study 2). Indian-American bilinguals who were proficient in Hindi and English were prompted for cultural and emotional narratives, which were assessed for differences in linguistic structure and themes. The findings revealed that participants spontaneously changed the structure of their narratives based on the language in which it was told. For example, in Hindi, bilinguals used more descriptions and evaluations, but in English, they used more orientations. Hindi narratives also contained more intensifiers (e.g., “very”, “really”) and fewer mental state terms (e.g., “think”, “feel”). Qualitative analysis revealed common themes across narratives, such as action-based expressions of emotions (e.g. offerings of food as apologies) and conflict in reconciling Indian and American values (e.g. independence vs family). It may be that Indian-American bilinguals process and remember things differently as a function of language. Furthermore, our findings suggest that Indian-American bilinguals may experience different specific benefits for psychological wellbeing as a result of being bicultural and/or bilingual. Future directions and implications for language and culture study in this population are discussed.

*Friendship Quality and Mental Health: Bidirectional Associations Over Time*

## Alexis Bamfo

Faculty Mentor(s): Steven Asher

Behavioral Sciences / Psychology

**Abstract:**

The association between interpersonal relationships and overall well-being is well-established. While there is a growing body of literature on friendship quality and mental health specifically, this research typically does not examine within-person fluctuations in these constructs, nor does it study these associations across many years. To address these gaps in the literature, the current study uses autoregressive cross-lagged panel models with random intercepts to investigate the direction of effects between two aspects of friendship quality (positive friendship quality, friendship conflict) and three indices of mental health (depressive, anxiety, somatic symptoms) among young adults during their four years of college. This study utilizes the fall semester data from a four-year longitudinal panel study in which participants (N = 824; M age = 18.44 at baseline, SD = 0.50; 71.3% women; 53.4% White) were students from four Southeastern US institutions. Students completed self-report assessments and reported the qualities of their closest friendship at their university as well as rated their depressive, anxiety, and somatic symptoms. Students who reported higher levels of positive friendship quality also reported fewer mental health symptoms, and students with higher levels of friendship conflict also reported greater mental health symptoms. Friendship conflict and depressive symptoms were the only constructs that demonstrated stability in within-person fluctuations across all four years. Cross-lagged effects revealed that, contrary to expectations, at the within-person level earlier increases in depressive and anxiety symptoms predicted subsequent increases in positive friendship quality during the next year, suggesting that earlier increases in mental health symptoms may have led students to reach out to friends for support, thus increasing their perceptions of the quality of the friendship. Implications for friendship quality and mental health will be discussed.

*Breaking Bad: Creativity and Organic Chemistry*

## Michael Blue

Faculty Mentor(s): Paul Seli

Behavioral Sciences / Psychology

**Abstract:**

Is there such a thing as a “creative person”? The literature on creativity has focused on this question for several decades now, but a clear answer has yet to be provided. On the one hand, some researchers have argued for domain generality within the broad umbrella of “creative activities,” which posits that creative people do indeed exist; that people’s creative talents (or lack thereof) are consistent across all domains of creativity (e.g., painting, problem-solving, music composition, poetry writing). On the other hand, some researchers have maintained that there is no such thing as a creative person, but that people’s creative abilities are instead limited to a particular domain of creative activities (e.g., an individual may be a very creative visual artist, but this talent does not transfer to other domains, such as music composition). While there has been a longstanding debate about the nature of domain-general vs. domain-specific creative talents, whether creativity is domain-general vs. specific remains unclear. To address this gap in the literature, here, I designed a domain-specific measure creativity for organic chemistry (the Divergent Skeletal Formula Task [DSFT]). This study investigated the relationship between the DSFT and two widely used domain-general measures of creativity. Results demonstrated a weak relationship between the DSFT and one of the domain-general measures of creativity but not the other. The results further supported a domain-specific theory of creativity and indicated that broad claims about domain-general creativity may be too strong.

*Effects on Status Striving: Self-Perceived Value, Self-Esteem, and Personality Traits*

## Sua Cho

Faculty Mentor(s): Ashley Harrell

Behavioral Sciences / Psychology

**Abstract:**

Prior research shows that despite the belief that humans universally desire high status in group settings, individuals who have low self-perceived value (SPV) perceive themselves as being unable to make meaningful contributions to the group’s success and thus, accept low status to conform to the external social pressure of other group members’ expectations. Yet internal factors such as self-esteem and personality traits may also shape individuals’ preferred status by buffering the effects of external factors. Two studies were conducted to examine this hypothesis. Consistent with previous studies, results showed that participants with higher SPV preferred and expected higher status than the participants with lower SPV. Moreover, individuals’ personality traits predicted the status they preferred and expected: more extraverted participants preferred and expected higher status than less extraverted participants; participants with higher levels of neuroticism preferred and expected lower status than participants with lower levels of neuroticism. Participants with higher self-esteem were more likely to prefer and expect higher status. Lastly, low self-esteem was associated with lower preferred status for participants with low SPV, but not high SPV. Essentially, low self-esteem has a particularly detrimental effect for those with low SPV, driving individuals to opt out of status pursuit once they perceive themselves as having little value in the groups. As such, the findings of this study point to the significance of the role of self-esteem in status motivation. Because self-esteem is correlated with individuals’ socioeconomic status (SES), this study further highlights the need to address the self-esteem gap between individuals in high and low SES to prevent pre-established social hierarchies from shaping individuals’ self-esteem and resulting status motives to perpetuate the state of socioeconomic inequality in the world.

*Using Video and Handheld Technology to Enhance Responsive Caregiving and Early Childhood Develo*

## Julia Davis

Faculty Mentor(s): Martha Vibbert

Behavioral Sciences / Psychology

**Abstract:**

Prior research has shown that children living in high-adversity communities may be at risk for failing to reach their full neurodevelopmental potential owing to poverty, environmental risk factors, and high caregiver stress levels. Dr. Martha Vibbert, Alice Kabwe, and Christa Nehil founded the Universal Baby Project (UB), a program that collaborates with global partners to create short, shareable, culturally authentic videos. For this specific project, UB is partnered with Kidogo Early Years, a social enterprise that works to improve access to quality, affordable Early Childhood Care & Education in East Africa's low-income communities. Driven by input and feedback from Kidogo, UB is creating a video highlighting positive caregiver-child interactions in one of Kidogo’s childcare centers in Nairobi. This video will be edited—in collaboration with Kenyan caregivers and local experts —and presented to local caregivers for further evaluation and discussion. The purpose of this research is to create culturally informed and culturally contextualized videos that illustrate early brain development, appeal to caregivers, and enhance responsive caregiving interactions with young children.

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*A Survey of Parental Beliefs: Children’s Technology Use in the Digital Age*

## Ana DeCesare

Faculty Mentor(s): Tamar Kushnir

Behavioral Sciences / Psychology

**Abstract:**

Personal technology is ubiquitous in the life of a child: if not encountered at home, technology is found in the classroom and in public spaces. Young children encounter technology in their daily lives, but open questions remain as to the extent in which young children engage with technologies and the extent in which parents think technology is beneficial to their child. Parental monitoring is also of interest to gauge how parents moderate their child’s technology use. We investigated if parents’ beliefs shape their monitoring practices or their child’s technology use.

In this study, we surveyed parents (N=184) on their children’s technology use, their technology monitoring practices and their attitudes towards their child’s technology use. We first asked them to think of their youngest child in the 3–9-year-old age range (M=5.85, SD=2.04) and then asked them to consider this child when answering questions about technology use. Parents reported that their children’s technology use resulted in an average of 9.6 hours per day, with TV and tablets as the primary devices of use.

With regard to parental monitoring, parents used approximately 3-4 monitoring practices (M=3.48, SD=1.76). For practices used, 69.57% of parents place parental controls on devices, 58.82% limit mature content, and 53.48% sit with their child as they use a device. For parental beliefs, we found that 60% of parents “somewhat agree” or “strongly agree” that the benefits of technology outweigh the harms of technology for their child. Moreover, 80% of parents either “somewhat agree” or “strongly agree” that technology is a beneficial to their child’s learning. Yet, when asked if technology benefits socialization, there was no clear majority: 24.06% of parents neither agreed nor disagreed, while 28.88% “somewhat agreed” and 24.06% “somewhat disagreed.”

For our final question about the relationship between beliefs and practices, we found that demographic factors (race and community type), as well as parents’ beliefs about technology use (education and socialization beliefs) impact the amount of time children use technology. Thus, sociocultural factors and parental beliefs may shape how children use technology.

Parental beliefs influence children’s lives in many ways, from the foods they eat, to the medical care they receive. We hope that a comprehensive understanding of how parents perceive technology will help us understand how technology is shaping children's lives.

*Stressed People Don’t Pay It Forward: Detrimental Effects of Stress on Generalized Reciprocity*

## Anna Greenleaf

Faculty Mentor(s): Ashley Harrell

Behavioral Sciences / Psychology

**Abstract:**

Generalized reciprocity, where individuals help others who can pay forward the generosity they receive to a third party, is common in a variety of settings, including workplaces. Stress is omnipresent in these contexts and is becoming more prevalent. Past research has examined the effects of stress on several other key forms of prosocial behavior. What remains unclear is how stress intersects with starting a chain of generalized reciprocity and “paying it forward” – helping others when one has been helped. In an experiment, I find that in line with past work, acute stress reduces the likelihood that people will be generous in a baseline giving decision. Further, I find that stress moderates people’s responses to being treated generously versus selfishly. Individuals are more likely to give when they have received generosity (been given to), and are more likely to keep their resources when they have received selfishness (not been given to). These conclusions, which replicate prior studies, hold true under conditions of relatively low stress. However, when individuals experience high levels of stress, beneficiaries give to third parties at similar rates, regardless of whether they received generosity or selfishness. Thus, stress levels are critical for understanding whether people will pay it forward. The results may be explained by cognitive load: individuals experiencing more stress, and thus higher cognitive load, are unable to deliberate, nor use information to behave strategically. These findings show that stress can be detrimental, as it harms the ability for 1) generalized reciprocity to be perpetuated even when others have behaved generously, and 2) makes it harder for individuals to protect themselves and their resources when they have been treated unfairly.

*Body image in women with PCOS: The relationship between PCOS, Eating Disorders, & Body Mindset*

## Ishika Gupta

Faculty Mentor(s): Nancy Zucker

Behavioral Sciences / Psychology

**Abstract:**

Polycystic Ovarian Syndrome (PCOS), one of the most under-diagnosed endocrine conditions, affects one in ten women in the United States. This condition is mainly characterized by insulin resistance and infertility, but its presentation can vary among individuals. Due to its large impact, recent research has started to reveal the pathophysiology of this condition. For instance, studies have shown that women with PCOS are more likely to report disordered eating behaviors than their non-PCOS counterparts. Additionally, literature has revealed that PCOS women exhibit higher levels of shape concerns, suggesting a relationship between body perception, eating disorders (ED), and PCOS. However, this finding has not resulted in changes in the way we treat PCOS. Therefore, the current study aims to determine whether body mindset acts as a mediator in the relationship between PCOS and EDs. Women aged 18-40 with PCOS were surveyed through a Qualtrics form, which included a body mindset scale, ED symptom scale, and PCOS scale. The results showed that higher scores on a negative body mindset subscale (e.g., body distrust) partially explained the relationship between PCOS symptoms and ED symptoms. This research is crucial not only for raising awareness of the condition and its link with eating disorders, but also for developing tools to treat PCOS in a healthy manner and mitigate the impact food has on the condition.

*Reframing Error Reduces Learning Deficits From Prediction Error in High Anxiety Individuals*

## Alyssa Guthrie

Faculty Mentor(s): Alison Adcock

Behavioral Sciences / Psychology

**Abstract:**

Mistakes are inevitable; however, we can learn from mistakes to refine knowledge. Prediction error (PE) is a surprise signal that drives neural systems for learning. Anxiety can disrupt learning, memory formation, and test performance. We predicted that individuals with high state anxiety would show abnormal patterns of learning from PE, particularly if they experienced failure at the beginning of a task. However, we predicted that a brief pre-learning intervention-a message that reframed mistakes as opportunities for learning-would mitigate the harmful effects of anxiety. To vary whether participants experienced failure before an upcoming task, we manipulated whether the practice questions were easy or difficult. Next, participants read one of three messages: the Positive message described how errors are beneficial for learning, the Negative message was a warning about accuracy, and the Neutral message was the control condition. Afterwards, participants completed a trivia learning task; we defined PE as confidence in an incorrect answer before feedback was revealed. Participants then completed trivia memory tests after a short delay (N=214) and a one-week delay (N=194). Anxious participants struggled to prioritize learning from surprising feedback; the effect of PE driving learning was weakened, especially after the difficult practice trivia. However, the Positive message strengthened the effect of PE on learning, especially for individuals with high anxiety. Overall, we found that anxiety disrupted learning from error, especially after early experiences of failure, but a novel learning mindset intervention rescued these deficits. This study has practical applications for improving learning experiences for high-anxiety students.

*Investigating Children’s Evaluations of the Permissibility of Gossip*

## Elissa Harris

Faculty Mentor(s): Tamar Kushnir

Behavioral Sciences / Psychology

**Abstract:**

Despite its negative connotation, gossip plays an important role in social life by communicating social norms and facilitating social bonds. Even children as young as 5 years old have been shown to engage in gossip. The literature on gossip often focuses on children's evaluations of sharing information that someone told them, such as sharing others' secrets. In this situation, the sharer not only discloses information they cannot verify but may also violate the trust of the person who shared it with them. In these cases, American children do not think it is permissible to share this information. However, there are many instances of individuals gossiping about things they have observed others do. Since they were not voluntarily given that information, is it permissible for someone to report it to others? Although this is a prevalent form of gossip, there is a lack of research exploring children’s evaluations of sharing information one has merely observed. This study examined 5- to 7-year-old American children’s evaluations of when it is okay to share information they have observed and whether the permissibility of sharing depends on the type of information being shared. Each participant (n = 96) was told four stories about two characters who go to the same school and have to follow a certain rule. In each story, one of the children, the actor, does a certain behavior that the other child, the observer, witnesses. To determine the type of behavior the actor exhibited, participants were randomly assigned to one of two conditions: Norm-Following (e.g. throwing trash in the trashcan) or Norm-Violating (e.g. throwing trash on the ground). Children were asked to evaluate whether it was okay or not okay for the character to share this information with the class. Results showed that children overall evaluated disclosing Norm-Violating and Norm-Following similarly. However, for the Norm-Following acts, there is a developmental change in how children evaluate the permissibility of sharing the actor's behavior. Specifically, as children get older they think it is more okay to share others’ norm-following behaviors with third parties. These findings add to the growing literature on when children think it is okay to gossip. Future studies should explore how other social and/or cultural factors can alter children’s evaluations of information sharing and when they may consider gossiping okay.

*Evaluating risk for adolescent anxiety: Sensory over-responsivity and brain volume differences*

## Connor Haughey

Faculty Mentor(s): Kimberly Carpenter

Behavioral Sciences / Psychology

**Abstract:**

Anxiety disorders represent one of the most prevalent groups of mental health disorders and can cause immense problems in psychosocial functioning and overall wellbeing. Sensory over-responsivity, which is typically only evaluated as a symptom of autism spectrum disorder, represents when an individual experiences an abnormally heightened reaction to at least one sensory stimulus. Recent studies have found that sensory over-responsivity at preschool age is associated with many forms of psychopathology at school age, including anxiety disorders. At present, no studies have examined if this relationship continues later in life nor how sensory over-responsivity manifest structurally in the brain. The primary aim of the present study was to evaluate whether preschool sensory over-responsivity is associated with adolescent anxiety, and whether the volumes of the amygdala, hippocampus, and caudate nucleus at school age might moderate this relationship. We conducted a longitudinal follow-up study that has a sample of 210 adolescents ages 15 to 22 who underwent psychiatric assessment at the preschool age, which included a diagnostic screening for anxiety disorders and sensory over-responsivity. A subset of these 917 adolescents also underwent magnetic resonance brain imaging at school age. At the most recent follow-up, they completed an assessment of anxiety, allowing us to investigate mental health changes across their lifespan. First, we found no significant relationship between preschool sensory over-responsivity and adolescent anxiety. Second, we did not find any significant moderation effect of bilateral amygdala, hippocampus, and caudate nucleus volume on the relationship between preschool sensory over-responsivity and adolescent anxiety. However, we found significant interaction between left hippocampus volume at school-age and preschool sensory over-responsivity on total externalizing and internalizing problems. These findings add to the growing literature seeking to understand early life risk factors for anxiety during adolescence. Furthermore, these findings emphasize the role of brain structure, particularly the hippocampus, during early life development in a model of risk for adolescent anxiety.

*Investigating Gastrointestinal Symptoms and Dietary Restraint Among Young Adults*

## Sara Mehta

Faculty Mentor(s): Nancy Zucker

Behavioral Sciences / Psychology

**Abstract:**

Given the immense impact of disordered eating on not just eating patterns, but also affect and impulse control, identifying variables that may precede eating disorders and potential treatment options for eating disorders is extremely important. The overarching goal of this project was to identify why Gastrointestinal (GI) symptoms may be linked to eating disorder symptoms. Three putative associations between GI symptoms and ED symptoms were explored: 1) the presence of GI symptoms decreases trust in the body; 2) GI symptoms are related to ED symptoms due to deficits in the ability to regulate emotions; 3) GI symptoms are related to eating disorder symptoms to the cognitive stress styles, the ways in which symptoms and their consequences are interpreted. One hundred and fifty-two undergraduate students recruited from psychology courses (18 to 22 years [M = 19.2, SD = 0.99]; 63% female, 36% male; 51% White, 28% Asian, 11% Black, 9% Multiracial; 14% Hispanic) received course credit for completing a battery of self-report measures related to eating disorder symptoms, interoceptive awareness, and other symptoms, including GI symptoms, body trust, emotion regulation and cognitive stress styles. In our analysis, we found that a) body trust mediated the relationship between visceral sensitivity and restrictive eating, b) difficulties in emotional regulation were positively associated with GI and ED symptoms, and c) cognitive stress styles moderated the relationship between difficulties in emotional regulation and GI symptoms. Results suggest that rather than engaging in responsive reactions attuned to body signals, restrictive dieting may function to manage low body trust and GI symptoms by providing precise dietary rules that may be perceived as more reliable than ambiguous body sensations. Moreover, improving body trust, emotional regulation, and one’s cognitive stress style may be promising eating disorder treatment targets for individuals with interoceptive concerns.

*Social Mechanisms of Emotion Regulation in Adult Depression*

## Alyssa Nelson

Faculty Mentor(s): Moria Smoski

Behavioral Sciences / Psychology

**Abstract:**

Major Depressive Disorder (MDD) is a pervasive mental health condition with significant adverse consequences across the adult lifespan. It is therefore important to study factors that protect against depression to inform effective treatments and preventative strategies. Social support and emotion regulation are significant factors related to depression outcomes that warrant further exploration, particularly in relation to each other. The aim of this study was to examine the relationship between social support, emotion regulation, and depressive symptoms in adults with and without MDD. 119 participants (77 control and 42 MDD) aged 35-75 were recruited. Participants responded to survey items assessing social support, distraction use, reappraisal use, and depressive symptoms. The results of the present study suggest that social support and depression are negatively associated, social support and emotion regulation are positively associated, and the negative association between emotion regulation and depression is mediated by social support. These results advance the understanding of the underlying processes whereby social support and emotion regulation serve protective roles in adult depression. In particular, these findings suggest that leveraging emotion regulation strategies to diminish negative emotion reduces vulnerability to depression, in part, by helping to preserve important, supportive relationships.

*Analysis of the application of resonance in organic chemistry*

## Reika Shimomura

Faculty Mentor(s): Charlie Cox

Behavioral Sciences / Psychology

**Abstract:**

Resonance is an essential concept in the undergraduate chemistry curriculum, introduced in general chemistry then expanded on in organic chemistry courses. Interviews were conducted where students solved questions that can be answered by applying resonance concept while using a tablet to show their work in real-time. The questions were evaluated based on whether the resonance concept was applied, resonance was interpreted successfully, and reaching the conclusion successfully. The questions included acid-base, hybridization, and NMR for both first-semester organic chemistry students and second-semester organic chemistry students. Meanwhile, the latter had two additional questions on Diels-Alder. Both groups of students showed stronger abilities in drawing and applying resonance structures in acid-base; the weakest was in hybridization where none of the students considered resonance as a contributing factor. The presentation will highlight the common alternative concepts to resonance used by students and how they approach questions in each domain which can contribute to the improvement in longitudinal learning of organic chemistry.

*Dissociating the Effects of Processing Fluency from Aesthetic Experience in Visual Art Viewing*

## Sofia Silvosa

Faculty Mentor(s): Elizabeth Marsh

Behavioral Sciences / Psychology

**Abstract:**

What differentiates an “aesthetic experience” from “liking?” One possibility derives from the cognitive fluency perspective, arguing that perceptual fluency drives liking while achieving an aesthetic experience is a more complex process that involves higher-order influences. We are interested, specifically, in highlighting the differences between being “moved” by a piece of art rather than simply liking it. To see if there is a discrepancy, we predict that manipulating process fluency when viewing art affects liking judgments rather than moved judgments. In the current study, we leveraged a well-known finding in the literature, namely that repetition increases liking (the mere exposure effect). However, we predict it will not affect the aesthetic experience, suggesting a dissociation between the two types of judgments. We showed participants, through an online survey, 32 abstract paintings in an initial exposure phase and then asked participants to rate 64 paintings which also included the 32 paintings from the initial exposure phase. The judgment phase asked participants to assess how much they liked the given painting and how much they were “moved” by the painting. Our study failed to replicate the mere exposure effect, suggesting that this established phenomenon is hard to replicate with complex stimuli. This brings into question whether the "fluency ease" that leads to the mere exposure effect is only elicited through simple stimuli. We also found low agreement in the likeability and movingness of paintings which is consistent with past literature on the subject. Furthermore, our study also revealed that repeated paintings had lower “moving” scores than novel paintings. Future studies should investigate this effect further, to see if novelty bolsters aesthetic experiences.

*Behavioral differences in Dictator Games with money vs. experiences*

## Katherine Zhong

Faculty Mentor(s): Scott Huettel

Behavioral Sciences / Psychology

**Abstract:**

Do people reason about fairness differently, when distributing money, compared to distributing experiences?

In the past two decades, the concept of other-regarding preference, the preference for certain outcomes for another person, was incorporated into a decision-making model to account for behaviors that seem more “fair” but do not yield the maximum reward to the decision-maker. Since then, other studies have corroborated this theory for inequity aversion across various context, most of which uses either the Dictator Game (DG) design or the Ultimatum Game (UG). The basic process of DG includes: the participant receives a certain amount of reward or endowment, and then they choose to distribute that endowment between themselves and another person. It is similar to UG, except that the allocation of the endowment by the participant is final and cannot be refused by the other person receiving it. As the participant’s decision is not influenced by an ulterior motive to increase the chance of the allocation being accepted, as in the UG, DG is a compelling measure of the participant’s preference for fairness.

Due to practical reasons, studies on other-regarding preferences using DG predominantly use purely money as the endowment. This is often not the case in real-life situations, where people distribute not only money but also resources including material and experiential goods, such as sports tickets. Specifically, the distribution of experiential goods is of critical interest, given that studies have shown that people tend to value experiential goods more than money or material goods. It is, therefore, worth exploring whether people would behave differently, for example, more selfishly, when they are allocating experiential goods as opposed to money, and plausible explanations if such behavioral differences exist.

As the first stage of a long-term research project, this study uses the Dictator Game framework and looks at whether people behave differently in making social decisions when the reward is money and when it is an experience.

*Courtroom Cognition: Guilty Bias or Response Bias?*

## Janis Zhu

Faculty Mentor(s): Ruth Day

Behavioral Sciences / Psychology

**Abstract:**

Jurors must process considerable information in criminal trials. Before beginning their deliberation, the judge provides instructions about the criteria for rendering a Guilty or NotGuilty verdict. The instructions include excerpts from the law that covers the type of case involved. Previous studies in the Day Cognition Lab had people read the law excerpt and then apply it to court case scenarios. They performed poorly – they gave Guilty verdicts most of the time, even when the scenario defendant was NotGuilty. There are two possible explanations for these results: 1) participants may have a prior guilty bias, or 2) the construction of scenarios might have introduced a response bias. The criteria in the law statement generate eight possible scenarios where the defendant has some, all, or none of the criteria for a NotGuilty verdict; however, there are more Guilty scenarios than NotGuilty scenarios that are logically possible, which may induce response bias. In the current experiment, we included an equal number of Guilty vs. NotGuilty cases, so that a possible response bias based on scenario frequency was eliminated. Young adults and the general public studied the law excerpt for a specific type of defense and then decided whether scenario defendants were Guilty or NotGuilty. All participants still performed poorly – they gave Guilty verdicts most of the time. Therefore, the guilty bias is not based on scenario frequency. The young adults performed better overall, yet still had a strong guilty bias. The public participants had an even larger guilty bias. Since they were like people typically called to jury service, these results suggest that jurors may assume that defendants are guilty until proven innocent -- the opposite of our legal system, which holds that defendants are innocent until proven guilty.

*UVC-induced PINK-1 mitophagy activation and mtDNA mutation accumulation design in C. elegans*

## Sasha Bacot

Faculty Mentor(s): Joel Meyer

Biological Sciences

**Abstract:**

Mitochondrial DNA (mtDNA) is particularly susceptible to ultraviolet C (UVC)-induced damage due to a lack of nucleotide excision repair (NER) and the potential for erroneous bypass by DNA polymerase gamma. UVC-induced damage may lead to double-stranded breaks or point mutations in mtDNA. However, previous work has not shown a significant increase in mtDNA mutation frequency with UVC exposure, suggesting the selective removal of damaged mtDNAs, perhaps via mitophagy. We assessed the induction of two critical mitophagy proteins, PINK-1 and FNDC-1, at 0, 4, and 24 hours after UVC exposure via pink-1::GFP and fndc-1::mRuby3 reporter strains. Only PINK-1 expression increased in response to UVC exposure; this response was observable immediately after UVC exposure. Interestingly, our results to date have also indicated a developmentally-linked increase in PINK-1 and FNDC-1 expression over time. The functional importance of mitophagy during development was further underscored by developmental delays in fndc-1 loss of function mutants. Our PINK-1 reporter protein findings suggest an as-yet unidentified mechanism for very rapid PINK-1 induction with mitochondrial stress. We speculate that this may allow PINK-1 to engage mitophagy to destroy mitochondria harboring UVC-damaged mtDNAs, possibly conferring mtDNA resistance to UVC-induced mutagenesis. To test this, we developed a mutation accumulation (MA) approach which will employ highly sensitive Duplex Sequencing to measure the effect of UVC on mtDNA mutation rate over 10 generations of bottlenecking in C. elegans.

*Qualitative and Quantitative Characterization of Tumor Microenvironment in Novel Murine Model*

## Alexandra Bennion

Faculty Mentor(s): Gayathri Devi

Biological Sciences

**Abstract:**

Inflammatory breast cancer (IBC), an understudied and most lethal breast cancer, is distinct from other locally advanced breast cancers due to the presence of tumor cell clusters (instead of a solid mass). The diffuse tumor cell clusters migrate collectively in the breast microenvironment via dermal and lymphatic vessels. Another hallmark of IBC tumors is the infiltration of tumor-associated macrophages (TAMs) in the microenvironment. Widely used mammary tumor implantation models with bioluminescence or fluorescence imaging are ineffective for evaluating spatial and temporal changes in growth and migration patterns of individual tumor cell clusters in the lymphovascular system, and their interaction with TAMs. This study aimed to develop two preclinical murine models to simulate IBC features and to assess, qualitatively and quantitatively, local tumor growth, motility, macrophage behavior, and lymphovascular invasion in the local tumor microenvironment. To visualize lymphatic and endothelial vessels along with tumor-vessel interactions, we generated a transgenic nude mice model (ProxTom RFP Nu/Nu) wherein mice exhibit red, fluorescent lymphatics [tdTomato fluorophore under the control of a Prox1 promoter, encoding a transcription factor (prospero-related homeobox 1) necessary for formation and maintenance of lymphatic vessels]. To visualize macrophage-tumor interactions, we generated a transgenic macrophage-receptor nude mice model (Cx3cr1GFP Nu/Nu) wherein mice exhibit green, fluorescent macrophages. We employed a surgical technique wherein a window chamber is placed on the dorsal skinfold of mice, allowing for microscopic examination of implanted tumor cells and dynamic changes of the tumor in its local microenvironment from the time of implantation up to 10 days. Patient-derived IBC cells stably transfected to express red or green fluorescent and/or dual tagged with luciferase reporters were transplanted in mice-bearing window chambers. Intravital fluorescence microscopy and IVIS imaging were used to serially quantify local tumor growth, motility, and macrophage behavior invasion over 0-140hrs. Multichannel optical imaging of the window chamber in the Cx3cr1GFP Nu/Nu demonstrated accelerated macrophage recruitment toward the tumor clusters that we have developed logarithms to quantitatively image the tumor cell clusters and macrophage movement.

*Identifying and Characterizing Inhibitors of Plasmodium Heat Shock Protein 70*

## Elizabeth Boger

Faculty Mentor(s): Emily Derbyshire

Biological Sciences

**Abstract:**

Malaria, a mosquito born disease, is responsible for over 200 million infections causing over 600,000 deaths each year. These infections are the result of microscopic parasites called Plasmodium, with the species Plasmodium falciparum being the main cause for spread and infection of malaria in humans. Certain proteins are essential to each step of the life cycle of Plasmodium, one of which is heat shock protein 70 (Hsp70). Hsp70 is a protein produced by the parasite in response to exposure to stressful environments, like feverish conditions in a host. This protein is hypothesized to play an essential role in the life cycle of Plasmodium, acting as a protein co-chaperone and stabilizing the digestive vacuole (DV) membrane. Hsp70’s C-terminal domain is proposed to bind to lipids on the DV membrane positioning it to facilitate the refolding of proteins and transfer of these proteins into the DV. The DV is an attractive drug target for malaria treatment because of its existence in parasites and not humans, yet no prior researcher has fully understood the role of the DV in parasite viability and the effect of selective Hsp70 inhibition on its function. Over the past year, I have screened a library of roughly 3400 drug-like compounds and selected for four of those that bind to Hsp70 and impact its thermal stability. With this data, I have begun to determine the impact of this drug binding on the viability of Plasmodium parasites, the location of compound binding on the protein, and the effect of different modes of inhibition on parasite fitness. Over the next few months, I hope to continue this project by testing the specificity of the binding to malaria parasites and exploring their phenotypes through proteomics and cellular assays. This project allows for a better understanding of Hsp70 as a druggable target and ultimately how to induce malaria parasite death.

*Evaluating how bone marrow stroma impacts drug resistance development in acute myeloid leukemia*

## Katherine Burkman

Faculty Mentor(s): Kris Wood

Biological Sciences

**Abstract:**

AML is one of the most common adult leukemias and occurs most frequently in elderly patients, whose age and comorbidities often limit curative chemotherapy treatment options. Despite recent improvements in alternate AML drug therapies, roughly 1 in 3 AML patients fail to reach remission or develop therapy resistance. The overall median survival for AML patients is 14 months, only 6-8 months for patients over 65, and only 10 months for patients who do not achieve remission. Recent research indicates that the interaction of AML cells with bone marrow microenvironmental stromal cells contributes to the evolution of resistance and that this interaction is crucially involved in treatment responsiveness. The mechanism by which stromal cells support AML cells is not clear, but a range of possibilities for the role of stroma includes stroma-derived secreted growth factors, mechanical support for the AML cells, and recruitment of other cell types. Despite these theories, the interaction remains poorly understood, largely due to the lack of high-fidelity experimental model systems. I hypothesized that AML acquires resistance more rapidly in the presence of bone marrow stromal via either a secreted factor or by a structural interaction. I generated 6 AML lines that stably expressed luciferase to allow for cell survival tracking without tracking the confounding cell survival of the bone marrow stromal cells. In many of the 6 lines, I demonstrated that AML cells cultured in the presence of bone marrow stromal cells (HS5) had greater survival when treated with the clinical standard drug combination of ABT-199 and 5-azacytidine. To elucidate whether this was due to a secreted factor or to a structural interaction, I repeated these tests either by coculturing the AML and HS5 cells or by culturing the AML cells in conditioned media from HS5 cells. By these experiments, I confirmed that via a primarily mechanical interaction, AML exhibits accelerated resistance to drug when cultured in the presence of bone marrow stromal cells. Next steps for further elucidation of this phenomenon include performing a screen to evaluate how long-term coculturing and repeated drug exposure affect resistance over time, as well as Western blot analysis to assess alterations in the AML lines.

*Characterizing mitotic defects in brain-metastatic lung cancer*

## Julia Caci

Faculty Mentor(s): Kris Wood

Biological Sciences

**Abstract:**

The metastatic spread of lung cancer to distant organ sites is a common, devastating complication of the disease. Therefore, a more complete understanding of the molecular mechanisms underpinning lung cancer metastasis is necessary as it may lead to new, more effective treatments. In order to expose unique vulnerabilities in metastatic cancer cells, we used a genome-wide CRISPR/Cas9 genetic knockout screen to identify differences in genetic dependence between parental and metastatic lung cancer cells. Our screen revealed brain-metastatic cancer cells are uniquely dependent upon a subset of genes related to the cell cycle regulators such as the centrosome, including KIF2A and NEK1. Further analysis also revealed that brain metastatic cells exhibit centrosome amplification. Given this, we hypothesized that this centrosome amplification endows brain-metastatic cells with unique vulnerabilities to KIF2A and NEK1 loss. To test this hypothesis, I used immunofluorescent imaging to visualize the centrosome in KIF2A and NEK1 knockout cell lines and observed distinct phenotypic differences between parental and brain-metastatic cell lines. These preliminary studies found that KIF2A and NEK1 knockout induces a “declustering” phenotype in brain metastatic cells, suggesting that the dependence on these genes may relate to their role in centrosome maintenance. Furthermore, preliminary observations revealed that brain-metastatic cells also exhibit heightened levels of chromosomal instability. Given the observed centrosome amplification in brain-metastatic cells, I hypothesized that brain-metastatic cells may form tripolar spindles, thus contributing chromosomal missegregation and heightened chromosomal instability. Preliminary immunofluorescent and live-cell imaging results support this hypothesis. Therefore, I am currently working to optimize fixed and live-cell imaging experiments that will further characterize these mitotic differences between parental and brain-metastatic cells, both at baseline and upon knockout of important mitotic regulators. Ultimately, this work aims to identify unique mitotic vulnerabilities in metastatic cells that could be targeted pharmacologically.

*What is the function of human acid sphingomyelinase (SMPD1) during the Plasmodium liver stage?*

## Isabel Colon

Faculty Mentor(s): Emily Derbyshire

Biological Sciences

**Abstract:**

Malaria is one of the deadliest diseases in the world. In 2021 alone, there were over 200 million cases and 600,00 deaths. Malaria is caused by the Plasmodium parasite. Plasmodium has two developmental stages in the human host: the liver stage and the blood stage. The liver stage is a promising avenue for drug discovery because it is asymptomatic and has lower parasite growth compared to the blood stage. During the liver stage, Plasmodium resides in the parasitophorous vacuole, which protects the parasite as it undergoes rapid division. Plasmodium must acquire essential nutrients from its host cell and transport them across the vacuole membrane to support its development. One nutrient Plasmodium may acquire from its host cell are ceramides, an important membrane lipid. Evidence supports that ceramide levels of the host during the liver stage of infection increase, and the genes involved in ceramide synthesis are essential, including acid sphingomyelinase (SMPD1). SMPD1 hydrolyzes ceramides from lysosomal membranes and could aid in ceramide trafficking to Plasmodium. Therefore, the purpose of this project is to investigate the function of human acid sphingomyelinase (SMPD1) in Plasmodium liver stage development. Multiple techniques were used to investigate ceramide trafficking including tissue culture work and qRT-PCR to quantify RNA expression during gene knockdown. SMPD1 was also cloned into an expression vector to overexpress in liver cells and immunofluorescent microscopy was used to investigate unknown host-parasite interactions. During our preliminary studies, we found that inhibition of SMPD1 with the small molecule inhibitor Arc39 significantly reduced Plasmodium growth. We also used commercial antibodies and overexpressed our SMPD1 plasmid in liver cells to visualize SMPD1 during parasite development. Future studies will probe the mechanism of SMPD1 and whether it directly supports the transfer of host ceramides to the parasite. Understanding the role of SMPD1 in the Plasmodium liver stage could lead to the development of drugs that target this stage to prevent disease.

*Urban Legacies: Exploring how demographics, canopy cover, and land use affect ground arthropod*

## Sophia Cox

Faculty Mentor(s): Sarah Parsons

Biological Sciences

**Abstract:**

Insects are essential for the mediation of ecosystem function through nutrient cycling, pollination, and providing key food sources both in urban and non-urban spaces. Patterns in non-urban systems suggest that insect biomass is positively correlated with tree canopy cover. Additionally, in urban areas several studies demonstrate a link between current tree canopy cover and historical segregationist policies. We will examine the relationships between arthropod biomass, tree canopy cover, land use, and historical demographic patterns in Raleigh, NC. We hypothesize that areas which have been historically disadvantaged will have less tree canopy cover and less insect biomass when compared to areas that have not been disadvantaged. We also expect that land use will play a significant role in predicting insect biomass in both historically disadvantaged and advantaged areas. To test this prediction, we collected insects across 30 locations in Raleigh, NC, in five different land uses (greenways, parks, commercial areas, residential areas, and industrial areas) using pitfall traps in the summer of 2021. We then sorted and weighed the insects and analyzed insect biomass in relation to National Land Cover (NLCD) tree canopy cover data. Demographic data was sourced from the U.S. Census 2020 and 1960 datasets. Preliminary results show that no relationship exists between racial identity and tree canopy cover data both currently or historically in Raleigh. Furthermore, land use type, not canopy cover was most predictive of ground arthropod biomass, such that parks had less arthropod biomass than other land use types in early summer 2021. These results suggest that canopy cover may not be the only factor to consider when designing cities that support a quality of life for both the humans and arthropods that live in them. Ultimately, we hope our work will provide urban planners with new tools to design more just and ecologically resilient cities.

*Engineering Multi-sensing Biosensor Bacteria with Molecular Biology and Computational Methods*

## Ryan D'Cunh

Faculty Mentor(s): Lingchong You

Biological Sciences

**Abstract:**

Microbial biosensors are valuable tools for detecting specific small molecules relevant to various applications, such as detecting diseases and identifying harmful environmental compounds. However, crosstalk can occur between sensors when a single sensor responds to multiple input signals, making it challenging to distinguish between multiple inputs when sensors are combined. In this project, we developed and tested biosensors that produced a fluorescent output in response to a chemically induced input. I modified the DNA of a pH sensor in E. coli to swap out the green fluorescent protein (GFP) output reporter for mCherry, a red fluorescent protein so that when combined with other sensors each sensor has a unique fluorescent output response. After sequencing the DNA to confirm our modifications, I tested the functionality of the individual pH sensor by exposing E. coli strains with the sensor to varying levels of pH and measuring fluorescent output. We tested two sensors mixed together to characterize crosstalk for each sensor. We then applied machine learning to train a computational model capable of predicting the concentration of individual input signals based on multiple sensors’ output response in a multi-biosensor system, even in the presence of crosstalk. Using computational methods, we were able to distinguish 3 input signals’ concentrations based on the output fluorescence in an engineered bacterial sensor system. The model was run on simulated data and then tested on experimental data. It successfully predicted input signal concentration based on the output signals. The results demonstrate the feasibility of using computational approaches to analyze multi-biosensor systems in bacterial cultures. Our goal is to predict up to 15 different chemical concentrations with 15 sensors. The potential applications of this technology include the detection of inflammation biomarkers in gut diseases.

*The Impact of Tidal Variation on Invertebrate Diversity and Biomass in Seagrass Ecosystems*

## Madison Griffin

Faculty Mentor(s): Brian Silliman

Biological Sciences

**Abstract:**

This project seeks to understand the implications of mesopredator populations (i.e., grass shrimp Palaemonetes) on seagrass ecosystems and how grass shrimp affect seagrass ecosystems by regulating other marine invertebrate populations. In order to effectively assess the impact of nekton exclusion on invertebrate community structure and the cascading implications in seagrass growth, it is integral to determine the best methodology for sampling invertebrates to get a holistic understanding of how experimental treatments are affecting the invertebrate community. We marked 35 plots for an exclusion experiment and took pre invertebrate samples at four different times to compare how the invertebrate community changes with time of day and tides. In the samples, we found amphipods, bivalves, crabs, fish, isopods, shrimp, snails, and unknown arthropods. Snails and shrimp were in the most abundance. There is an effect of tidal cycle on abundance of invertebrate functional groups, but not on average biomass (g). The continuation of this project over the course of the year will allow for more insight into the predators that could be impacting North Carolina seagrass ecosystems.

*A novel link between mitochondrial energy metabolism and ubiquitin conjugase Rad6*

## Sofia Guerrero

Faculty Mentor(s): Gustavo Silva

Biological Sciences

**Abstract:**

Oxidative stress, where cells accumulate reactive oxygen species (ROS), is a harmful phenomenon known to damage biomolecules, foster cell death, and contribute to aging and neurodegeneration. In response to stress, our group found that the multifunctional ubiquitin conjugase Rad6 regulates protein translation via ribosome ubiquitination. Additionally, we found that the deletion of RAD6 (rad6Δ) in yeast results in reduced cellular growth, ROS-accumulation, and an increased expression of mitochondrial genes. In this work, we illustrate that in the absence of Rad6, compensatory mechanisms at the mitochondria are employed to sustain yeast cell viability. We first showed that rad6Δ has greater levels of the mitochondrial protein porin than the WT strain, suggesting that the mitochondria biology in rad6Δ may be altered. Yeast cells primarily undergo fermentation as their main energy source, which does not require mitochondria, suggesting that absence of Rad6 leads to a reprogramming of energy metabolism. Through fluorescence microscopy, we showed that the deletion of RAD6 increases the amount of active and ROS-producing mitochondria, supporting the idea that rad6Δ may be performing cellular respiration rather than fermentation. To test this hypothesis, we incubated WT and rad6Δ with mitochondrial-inhibiting drugs, CCCP and antimycin, and found that rad6Δ growth was more susceptible to both. To investigate whether increased ROS accumulation results in more dysfunctional mitochondria in the rad6Δ strain, we sought to measure the selective degradation of mitochondria through mitophagy. Using a fluorescent mitophagy reporter, we observed higher levels of mitochondrial protein degradation in the rad6Δ strain in comparison to the WT. Corroborating our model, analysis of gene expression profiles further indicates that cells lacking Rad6 switch to cellular respiration for energy production. Because Rad6 is involved in controlling gene transcription and translation, further investigation of Rad6’s role in yeast energy metabolism will yield novel insights into fundamental processes of gene expression and cellular adaptation to dynamic environments.

*Spastin-loss in Drosophila and the effect on axon length and neuronal sensitivity*

## Cierra Harrison

Faculty Mentor(s): Nina Sherwood

Biological Sciences

**Abstract:**

Mutations in the microtubule severing protein Spastin are known for disrupting neuronal function, specifically in the longest axons of the human central nervous system. Even in Drosophila larvae, which are only a few millimeters long, preliminary evidence suggests that the longest axons are most sensitive to Spastin loss. It is difficult to model Spastin’s neurodegenerative phenotypes in normal larvae simply because they are only in this stage for about 3-5 days and are small in size. In order to test if the severity of Spastin phenotypes is increased in long axons with more time allowed for degeneration, I examined the synaptic phenotype in Phm&gt;Smox Drosophila melanogaster mutants which, due to its extended larval stage, are visibly larger than normal, 35 days total. Dissection and staining of larvae occurred at days 5, 9,13 ,16 , 21, 27, and day 31 of growth with death by day 35. Results of the Phm&gt;Smox mutants showed a final result of an increase in the synaptic bouton numbers in muscle four of the larval filets, similar to Spastin mutants. A continuation would allow me to compare the extended larval stage in the Spastin background. Computational analysis was also done to understand whether there is a link between Spastin function and axon length. I initially investigated the hypothesis of whether or not spastin exhibits similar genomic expressions in marine megafauna because of the size differences between organisms. Results of this research revealed that the protein itself is widely conserved across marine species and humans, indicating similar functions. However, the question of axon length and organism size in regard to Spastin and its functions has yet to be evaluated across the genus, Drosophila. Multiple sequence alignments, genome data viewers, and phylogenetic constructs were used to determine that despite noticeable size differences in Drosophila species, 95-100% conservation is still consistent, suggesting that Spastin is similar in its functions, with similarities in regulatory sequences. Together, these approaches contribute to our understanding of the relationship between Spastin function across species and neurons of varying axon lengths, which then allows us to determine if longer lengths of time lead to enhancement of the mutant phenotype.

*Identifying Novel GPCR Signaling Partners with Proximity Labeling*

## Chloe Hicks

Faculty Mentor(s): Sudarshan Rajagopal

Biological Sciences

**Abstract:**

G protein-coupled receptors (GPCRs) are the largest family of transmembrane receptors and comprise an estimated one-third of all FDA-approved pharmaceutical drugs. While current efforts in the development of GPCR-based therapeutics involve modulating the two canonical signaling pathways of GPCRs, which are mediated by either G proteins or β-arrestin, recent studies have illustrated the existence of receptors, such as the Atypical Chemokine Receptor 3 (ACKR3), which retains its signaling ability in the absence of G proteins and β-arrestin. In order to isolate and identify the proteins involved in this non-canonical signaling, we used a proximity labeling technique involving ascorbate peroxidase 2 (APEX2) which can biotinylate nearby proteins. Through engineering an ACKR3 fused APEX2 construct and stably expressing this receptor in β-arrestin 1/2 knockout cells, we were able to collect and analyze proteins which interact with ACKR3 in a ligand dependent manner using mass spectrometry. Upon comparing our protein hits with existing GPCR APEX datasets, we identify Bone Morphogenic Protein 2 Inducible Kinase (BMP2K) as a potential conserved modulator of GPCR signaling. We find that, while BMP2K’s interaction with ACKR3 is β-arrestin independent, its interaction with conventional and well-studied GPCRs relies on the presence of β-arrestin. To investigate whether specific ACKR3 phosphorylation sites are important for BMP2K recruitment to the receptor, we constructed several phosphodeficient ACKR3 mutants. While patterns of receptor internalization similarly reflect BMP2K recruitment, β-arrestin recruitment does not correspond to levels of ACKR3 internalization. Ultimately, our findings indicate that BMP2K shows a conserved ability to interact with numerous GPCRs and that patterns of BMP2K recruitment and ACKR3 internalization are similar to one another, suggesting that the functional role of BMP2K at GPCRs may be related to mechanisms of receptor internalization. Together, our work demonstrates the multitude of other potential effector proteins which may modulate GPCR signaling beyond the canonical G protein and β-arrestin-mediated pathways.

*Identification of a covalent inhibitor to probe ubiquitination in the malaria parasite*

## Xeno Hu

Faculty Mentor(s): Emily Derbyshire

Biological Sciences

**Abstract:**

Malaria remains one of the most serious and devastating public health threats, causing an estimated 568,000 deaths in 2019 (WHO). Plasmodium falciparum, the most lethal malaria parasite, is responsible for 90% of malaria deaths each year. Increasing resistance to current medicines necessitates development of antimalarial drugs with novel mechanisms to fully eradicate malaria. Specifically, the P. falciparum enzymes that mediate protein ubiquitination, an essential post-translation modification (PTM) in the parasite, serve as potential but underexplored malaria drug targets. Ubiquitin is a small 8 kDa protein, and its conjugation to substrate proteins is mediated by an enzymatic cascade consisting of a ubiquitin-activating (E1), conjugating (E2), and ligase (E3) enzyme. Interestingly, the E2 PfUbc13 is a central mediator of Lys63-linked polyubiquitin (K63-Ub), a special ubiquitin linkage type that is associated with essential proteasome-independent processes including DNA repair, protein localization, and signaling pathways. However, the enzyme partners of PfUbc13 and its chemical probes are unknown. Previous studies identified the compound NSC697923 sa a covalent inhibitor of HsUbc13, a homolog of PfUbc13 (80% sequence similarity). Thus, it was hypothesized that NSC697923 also covalently binds to PfUbc13 at its active site Cys86 residue by a Michael addition. Ubiquitin transfer assay monitored by anti-Ub western blot validated that NSC can functionally inhibit the formation of E2-Ub conjugate. Through trypsin digestion of PfUbc13 treated with NSC697923, a peptide at 929 Da was detected, corresponding to the covalently modified peptide. Through fluorescent polarization assay which monitors E1-Ub conjugate by a fluorescent tag, the inhibition constant KI is calculated to be 0.28 for HsUbc13, and 0.36 for PfUbc13. Overall, these assays identified a chemical probe that covalently binds to PfUbc13 and inhibits ubiquitin transfer from PfUBA1, thus providing a powerful tool that can be used to further interrogate PfUbc13 function.

*Refining CRISPR-Cas epigenetic regulation in primary T cells*

## Lucas Humayun

Faculty Mentor(s): Lucas Humayun

Biological Sciences

**Abstract:**

CRISPR/Cas9 technology’s ability to perform epigenetic manipulations has sparked interest in genetically engineering the immune system to better combat diseases like cancer. T cell transfer immunotherapy, an effective tool in cancer treatment, has motivated the study of CRISPR/Cas9 in T cells as epigenetic alteration could enhance the efficacy and adaptability of this cell type. However, previous attempts to translate this technology into primary T cells has been challenging due to the low viral delivery efficiency of CRISPR/Cas9 DNA. To address this challenge, I explored the activity of CRISPR/Cas9 technology in primary T cells. Specifically, I aimed to characterize activation, repression, and multigenic control using three different epigenetic Cas technologies: dsaCas9, dspCas9, and dCas12a. While I found that targets such as TIGIT can be repressed by dsaCas9 in primary blood mononuclear cells (PBMCs) and tumor infiltrating leukocytes (TILs), limited success with activation and multigenic control using dspCas9 and dCas12a suggests that CRISPR/Cas9 activity in T cells must be further characterized. Regardless, my ability to prove that CRISPR/Cas9 technology can induce repression in vitro is promising for future study of CRISPR/Cas9 genetic engineering in human T cells. Therefore, it is important to continue developing CRISPR/Cas9 technology with the aim of improving patient outcomes in the clinic.

*Refining CRISPR-Cas epigenetic regulation in primary T cells*

## Lucas Humayun

Faculty Mentor(s): Charles Gersbach

Biological Sciences

**Abstract:**

CRISPR/Cas9 technology’s ability to perform epigenetic manipulations has sparked interest in genetically engineering the immune system to better combat diseases like cancer. T cell transfer immunotherapy, an effective tool in cancer treatment, has motivated the study of CRISPR/Cas9 in T cells as epigenetic alteration could enhance the efficacy and adaptability of this cell type. However, previous attempts to translate this technology into primary T cells has been challenging due to the low viral delivery efficiency of CRISPR/Cas9 DNA. To address this challenge, I explored the activity of CRISPR/Cas9 technology in primary T cells. Specifically, I aimed to characterize activation, repression, and multigenic control using three different epigenetic Cas technologies: dsaCas9, dspCas9, and dCas12a. While I found that targets such as TIGIT can be repressed by dsaCas9 in primary blood mononuclear cells (PBMCs) and tumor infiltrating leukocytes (TILs), limited success with activation and multigenic control using dspCas9 and dCas12a suggests that CRISPR/Cas9 activity in T cells must be further characterized. Regardless, my ability to prove that CRISPR/Cas9 technology can induce repression in vitro is promising for future study of CRISPR/Cas9 genetic engineering in human T cells. Therefore, it is important to continue developing CRISPR/Cas9 technology with the aim of improving patient outcomes in the clinic.

*Proteomic effects of Acute Intermittent Hypoxia in the medulla of a Pompe mouse model.*

## Meredith Huston

Faculty Mentor(s): Mai ElMallah

Biological Sciences

**Abstract:**

Pompe disease, an autosomal recessive disorder characterized by a loss of functional acid alpha-glucosidase (GAA), exhibits pathological glycogen accumulation in muscles and the central nervous system (CNS). Patients experience muscle hypotonia and neural impairment, which lead to respiratory and limb dysfunction. Acute Intermittent Hypoxia (AIH) is a respiratory therapy that triggers neuroplasticity of the respiratory and limb motor systems. This neuroplasticity, particularly of the phrenic and hypoglossal motor neuron pools, results in improved respiration in models and patients with spinal cord injury (SCI) and amyotrophic lateral sclerosis (ALS). This study seeks to characterize the effects of AIH on Pompe mice. Initial results aim to characterize the inherent differences between the Gaa-/- and WT mice, by comparing the normoxia control mice. 68 proteins were significantly (p&gt;0.05) increased in Gaa-/- mice compared to WT. Most of these proteins are involved in lysosomal, mitochondrial, and immune processes. 53 proteins were significantly decreased in Gaa-/- compared to WT. Most of these proteins are involved in metabolic and protein synthesis pathways.

*Population Survey of Necturus punctatus in a Perennial Stream within the Duke Forest*

## Sarah Kelso

Faculty Mentor(s): Nicolette Cagle

Biological Sciences

**Abstract:**

The Dwarf Waterdog, Necturus punctatus, has unknown population trends with the potential to be declining in much of its range. To protect aquatic caudata, there needs to be accurate and current data regarding lifestyle, threats, and population changes. N. punctatus has not been studied in New Hope Creek since 1969. Urban land cover around New Hope Creek and throughout the Cape Fear River Basin has increased since 1969 and has caused changes in the chemical composition and physical structures of creeks. Aquatic caudata rely on the stability of these stream characteristics to maintain their population health. Considering these environmental changes, it is likely that the N. punctatus population in New Hope Creek has changed since 1969. The goal of this project was to establish a baseline population estimate which can be used in future studies to determine the population trend and to assess whether the New Hope Creek dam changed water characteristics such that it generated different density of animals, particularly N. punctatus above and below the dam. To study the population, we implemented a mark-recapture study using Visual Implant Elastomers (VIE) to mark and identify new/recaptured individuals caught in baited minnow traps from November 2022-March 2023. We also collected data on stream turbidity, pH, dissolved oxygen, temperature, specific conductance, and bycatch. Five N. punctatus, 40 crayfish, and 22 fish were captured over five months. Due to the low salamander capture numbers, with zero recaptures, a mark-recapture analysis was not done. Crayfish, fish, and N. punctatus capture numbers were combined to look at spatiotemporal changes in animal capture rates. Water characteristics were also analyzed for these changes. The data show differences in water characteristics above and below the dam, as well as seasonal patterns, with only the spatial patterns consistent with animal capture rates.

*Characterization of Fibrosis in Diaphragm of a Novel Mouse Model of Duchenne Muscular Dystrophy*

## Davina Le

Faculty Mentor(s): Mai ElMallah

Biological Sciences

**Abstract:**

Duchenne Muscular Dystrophy (DMD) is a fatal degenerative muscular disorder that affects around 1 in 3,000 male births. Progressive weakening of respiratory muscles results in recurrent aspiration and an eventual progression to respiratory failure. Mutations in the gene DMD result in a lack of dystrophin, the protein responsible for expansion and contraction of muscle fibers. In the absence of dystrophin, muscle breaks-down and is replaced with collagen. We characterized the fibrosis in three mouse models: the C57BL/6J (WT) mouse with normal dystrophin protein expression, the mdx mouse which has mutations within the mouse dystrophin gene resulting in a lack of dystrophin protein, and the novel hDMDd52;mdx (d52) mouse which contains the genotype of the mdx mouse but also has a full length human DMD gene with exon52 removed to mimic human genotypes. We hypothesized that the d52 model is at least as pathological as the mdx model. We sought to characterize fibrosis in the diaphragm, the major respiratory muscle of the d52 model in comparison to the mdx and WT models. Mice were euthanized at 6 and 12 months, and diaphragm tissue was cryo-preserved. Then Masson’s trichrome staining was performed on 6μm cross-sections. This technique stains collagen blue while cytoplasm, muscle, and other acidic tissues are stained red. We quantified the ratio of collagen to muscle tissue using a MATLAB script. The script breaks down the images by color into 6 sections, which are quantified and then sorted into collagen or muscle tissue categories based on visual morphology. The average proportion of collagen in each mouse model at 6-months of age is: 0.1028 (WT), 0.3699 (mdx), and 0.3597 (d52). The d52 mice contained ~3.5x more collagen than WT mice but a similar collagen proportion to the mdx mice. This pattern repeated when mice were 12-months of age, with the average proportion of collagen in each mouse being: 0.1493 (WT), 0.4619 (mdx), and 0.4561 (d52). The d52 mice contained ~3.1x more collagen than WT mice and similar collagen proportion to mdx mice. The d52 model displays moderate quantities of collagen, with a higher proportion than the WT model but slightly lower than the mdx model. The 12-month WT model contains a minimally higher ratio of collagen than its 6-month counterpart, but the collagen percentage of the 12-month d52 and mdx models are significantly larger than at 6 months. In conclusion the d52 mouse has roughly the same fibrotic pathology as the mdx mouse.

*The Impact of Age on Ozone Responses in Rodents*

## Kaitlyn Lewars

Faculty Mentor(s): Robert Tighe

Biological Sciences

**Abstract:**

Ambient Ozone (O3) is a criteria air pollutant, which causes increased morbidity and mortality, in part, through increased lung inflammation. As ambient O3 levels continue to rise, mitigating these adverse health effects will require identifying individuals who exhibit different susceptibility to ozone-induced inflammation. One of these susceptibility factors is aging, as prior ozone exposure studies have demonstrated increased O3 induced inflammation in aged rodents. However, the mechanisms driving these aged responses are poorly understood. To address this, we exposed C57BL/6 male mice to O3 (2 ppm) or filtered air for 3h. These mice were studied in 2 groups, young and aged. The mice were harvested at 12, 24, 48, and 72h following acute exposure, where bronchoalveolar lavage fluid (BALF) and lung tissue were collected. BALF was assessed for total cell counts, differentials, total protein, and protein carbonyls. RNA was extracted from lung tissue to generate cDNA that was then assessed by real-time PCR for 17 genes, selected due to relevance to ozone-induced inflammation, epithelial integrity, and oxidant stress. BAL total protein was elevated initially in young mice compared to aged mice, though aged mice had more persistent BAL total protein over time. BALF neutrophils and macrophages increased at 12h and 24h, respectively, in both groups, but were higher in the young mice. At 12h gene expression for zo-1, e-cadherin, claudin-4, and claudin-3 (epithelial barrier proteins) were increased in young and aged mice though they were higher in aged mice. Also at 12h, gene expression of arginase 1 and arginase 2, encoding inflammation-regulating enzymes, was increased in both groups. Pro-inflammatory cytokine gene expression (IL6, TNF-alpha, KC, mip2, and Cxcl10) was more variable between both cohorts. IL6 showed no significant difference between the two groups, while KC, mip2, Cxcl10, and TNF-alpha had increased in gene expression at 12h more prominently in aged mice. Comparison of BAL cell count, total protein and gene expression in young versus aged mice following O3 exposure suggest that there are age dependent effects. However, there is a disconnect between airspace inflammation and inflammatory gene expression. The reason for this is unknown but requires further investigation. Overall, this adds to the scientific evidence supporting a need to consider age as an effect modifier in O3 exposure responses.

*ASD-relevant mutations in Kdm6b affect its role as a chromatin regulator in brain development*

## Rebecca Li

Faculty Mentor(s): Anne West

Biological Sciences

**Abstract:**

Rebecca Li, Urann Chan, Vijyendra Ramesh, and Anne West

Department of Biology, Duke University Trinity College of Arts and Sciences

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Proper brain development requires regulation of gene expression. In turn, regulation of gene expression relies heavily on chromatin regulation. Chromatin regulation involves the deposition and removal of molecular markers, such as H3K27me3. H3K27me3 is a repressive marker that results in closed chromatin conformations, silencing gene transcription. Previously, Kdm6b has been identified as a histone demethylase enzyme that removes H3K27me3, allowing for expression of genes critical for subsequent stages of brain development. Recently, genetic variants in Kdm6b were found to be associated with morphological abnormalities and the neurodevelopmental disease autism spectrum disorder (ASD); however, the molecular mechanisms by which these genetic variants affect Kdm6b function remains unknown. Thus, we were interested in how ASD-relevant mutations in Kdm6b affect its role as a chromatin regulator in brain development. To answer this question, we assessed ASD-relevant mutant forms of Kdm6b for enzymatic function, protein stability, and protein localization. Through computational analysis, immunocytochemistry, and western blot experiments, we found that ASD-relevant mutant forms of Kdm6b exhibit decreased enzymatic function and stability. Through RNA sequencing experiments, we found that expression of wildtype but not mutant Kdm6b was sufficient to rescue knockdown of endogenous Kdm6b. Together, these findings elucidate the novel role of Kdm6b in controlling gene expression and expand our knowledge on how chromatin regulation contributes to neuronal maturation and, ultimately, social behavior.

*Investigating Small Molecule Modulators of β-arrestin and their Potency on T-cell Activation*

## Jason Liang-Lin

Faculty Mentor(s): Alem Kahsai

Biological Sciences

**Abstract:**

G protein-coupled receptors (GPCRs) constitute the most prominent family of cell surface receptors and are the targets of nearly one-third of FDA-approved drugs. Beta-arrestins (b-arr) are versatile proteins that interact with agonist-stimulated GPCRs to promote desensitization, internalization and signaling. Overactive b-arr activity has been associated with neurologic, inflammatory, cardiovascular and oncogenic diseases. Contrasting the numerous clinical drugs targeting GPCRs, there are currently no established small molecule allosteric modulators to address deleterious b-arr activity. Putative modulators previously discovered in the lab along with their analogs were screened using the fluorescent-based thermal shift assay to assess b-arr binding to small molecules. Selected compounds exhibiting b-arr binding underwent both in vitro and cell-based activity assays such as high affinity radioligand coupling, b-arr recruitment, and T-cell activation assays. A range of inhibitors and activators of b-arr were characterized, and compounds C134 and C97 were identified as potentially b-arr1/2 isoform specific. Compound C29 was identified as a putative T-cell activator, leading to ~60% increased activation upon T-cell stimulation. These modulators can serve as insightful research tools and potential therapeutics, especially in conjunction with T-cell immunotherapies.

*Strawberry Notch Homolog required for B cell development in mice*

## Julia Lin

Faculty Mentor(s): Xiaoping Zhong

Biological Sciences

**Abstract:**

T and B lymphocytes are critical for adaptive immune responses against pathogens. Defects in generating these cells can lead to immunodeficiencies in both humans and animals. Research in Zhong lab aims to understand mechanisms that regulate the development of these cells. Previous work has developed multiple knockout mouse models that are not able to generate T and B lymphocytes. The purpose of my project is to pinpoint the developmental stages when severe blockades occur due to the absence of the Strawberry Notch protein homolog, in order to investigate the role and mechanism of Strawberry Notch in the maturation of B cells. Flow cytometry was used to determine the proportion of cells at each stage of development and corresponding levels of transcription factor and mitochondrial markers between pairwise sets of knockout and Wild-type mice. Pure knockout mice had a severe decrease in B220+ B cells, with a developmental block after the Pro-B stage. Chimeric mice used to observe secondary effects of Strawberry Notch deficiency were found to have a significant decrease in the CD45.2+B220+ marked knockout B cells as well, with a blockage at the transition from Pre-ProB to Pro-B cell developmental stage. Downregulation of transcription factors necessary for B cell specification, commitment, and proliferation provides insight into the mechanisms in which Strawberry Notch is involved. Although altered mitochondrial activity and content were observed in preliminary data, investigation into mitochondrial content and membrane potential, apoptosis, and ROS does not have conclusive results due to low cell counts at relevant stages.

*Novel protein for mechanistic control of B cell development*

## Julia Lin

Faculty Mentor(s): Xiaoping Zhong

Biological Sciences

**Abstract:**

B lymphocytes produce antibodies that are critical for adaptive immune responses against pathogens. Defects in generating these cells can lead to immunodeficiencies in both humans and animals. Mechanistic regulations for B cell development are not fully understood, despite significant immunological consequences. The purpose of my project is to use mouse models to investigate a new protein involved in the regulation of early B cell development. Flow cytometry was used to analyze fluorescently stained bone marrow cells at each stage of B cell development between pairwise sets of knockout and wild-type (WT) mice. Pure knockout mice had a severe decrease in B cells, with a developmental block after the Pro-B stage. Mixed bone marrow (BM) chimeric mice reconstituted with a mixture of WT and knockout BM cells were used to determine whether the developmental blockade is due to mechanisms intrinsic to B cells. The knockout BM derived B cells were found to have a more severe decrease in B cells and earlier B cell developmental blockade compared to the pure knockout mice, indicating that the molecule is intrinsically required for early B cell development. Additionally, downregulation of transcription factors necessary for B cell specification and development was observed, which provides insight into the mechanisms involved. Together, the study has revealed a novel protein involved in mechanistic control of early B cell development.

*Finding an Ideal Dose and Incubation Period of Entinostat to Maximize Transfection Efficiency*

## Ashley Lo

Faculty Mentor(s): Fan Yuan

Biological Sciences

**Abstract:**

Initially, the research project sought to investigate what effect cotreating cells with HDAC inhibitors and sucrose had on electrotransfection efficiency. It was hypothesized that cotreatment would result in a multiplicative effect, producing a greater benefit than would be expected simply by combining the two treatments. However, initial experiments revealed that cotreatment showed similar transfection efficiency to treatment with entinostat alone and worse cell viability. This suggested that cotreatment would not yield the desired multiplicative effect, so the research plan was changed to assess entinostat alone. Specifically, the project sought to determine the ideal entinostat dosage and incubation period combination that maximized electrotransfection efficiency and cell viability when used to treat cells after pulsing. Cells were treated with 0, 1, 5, or 10 uM of entinostat after pulsing and incubated for 4, 8, or 24 hours, and all combinations of dosage and incubation were tested. It was found that electrotransfection efficiency and GFP expression level increased with concentration of entinostat, whereas cell viability decreased with shorter incubation times and higher concentrations.

*CRISPR Screen Reveals Microenvironment-Specific Radiosensitizing Factors in Glioma Models*

## Katherine Long

Faculty Mentor(s): Scott Floyd

Biological Sciences

**Abstract:**

The tumor microenvironment affects the morphology, behavior, and malignancy of brain tumors. Maintaining its integrity is essential for ex vivo glioma modeling. In vitro cell culture and in vivo mouse modeling are two standard strategies for modeling tumors; however, brain slice culture has emerged as a brain cancer model that may recapitulate the tumor microenvironment and gene expression profile of the original tumor with greater accuracy and lower cost than in vitro or in vivo models. Radiation is part of the standard of care for glioma, and the brain slice model enables study of microenvironment-specific radiosensitizing factors that are absent in in vitro cultures without the cost and complication of in vivo manipulation. To determine if the brain slice model emulates the original tumor microenvironment and expression of radiosensitizing factors, we conducted RNA sequencing to demonstrate that tumor cells grown on brain slice models are closest in gene expression profile to their original tumor and introduce several candidates as clinical targets for improving glioma response to radiation therapy. Further, we conducted CRISPR knockout radiation-sensitivity screens in brain slice, cell culture, and mouse models. This screen identified several genes whose expression is model-dependent and critical for mediating radiation resistance in glioma.

*The effects of mitochondrial damaging reagents on membrane potential and mitophagy induction*

## Jason McBane

Faculty Mentor(s): Chantell Evans

Biological Sciences

**Abstract:**

Mitochondria are double membrane-bound organelles with established roles in metabolism, biosynthesis, and energy production. Various mitochondrial quality control mechanisms have evolved to maintain the mitochondrial network. One such mechanism is mitophagy, where damaged mitochondria are removed from the cell via autophagosome engulfment and lysosome degradation. Mutations and deficiencies in mitophagy components are linked to Alzheimer’s disease, Parkinson’s disease, and amyotrophic lateral sclerosis (ALS), suggesting mitochondrial function and turnover is vital for cellular homeostasis. As a result, research efforts have focused on understanding mitophagy by inducing the pathway using various mitochondrial damaging reagents. However, these studies have resulted in discrepancies in the literature, highlighting our gap in knowledge regarding whether these reagents are comparable in mitophagy induction. Additionally, further research is needed to understand the type and severity of mitochondrial damage that induces mitophagy, and if this relates to the mitochondrial damage seen in neurodegeneration. This study utilizes quantitative live cell imaging in HeLa cells to compare the depolarizing and mitophagy-inducing ability of four mitochondrial damaging reagents: carbonyl cyanide m-chlorophenyl hydrazone (CCCP), valinomycin, rotenone and deferiprone (DFP). It is shown here that valinomycin is the most potent membrane depolarizer, and only depolarizing reagents induce mitophagy. These results not only aid researchers in selecting effective methods to study mitophagy in vitro, but also shed light on how mitophagy is induced, which will be important in further studies of neurodegeneration, its etiology, and potential therapies.

*Engineering Patient-Specific Menisci Using 3D Bioprinting*

## Kishen Mitra

Faculty Mentor(s): Samuel Adams

Biological Sciences

**Abstract:**

Menisci play a vital role in the knee joint through shock absorption and efficient distribution of load across the tibiofemoral articulation. Meniscal tears are the most prevalent knee injury in orthopaedics. The damage of meniscal tissue, especially in younger patients, may eventually increase the risk of onset of knee osteoarthritis (OA). Surgical options such as meniscal allograft transplantation and high tibial osteotomy are currently the mainstream treatment in clinical practice but still present potential complications including fracture, nonunion, compartment syndrome, and infection. 3D bioprinting is an emerging state-of-the-art approach for tissue engineering and has made significant progress towards the regeneration of transplantable tissues and organs for restoring or repairing the damaged body functions. Employing this technology using computer-aided design to fabricate meniscus constructs could ultimately help patients restore range of motion, decrease pain, and decrease the progression of OA. A cellularized meniscus was fabricated via 3D printing of a scaffold. A patient-specific 3D digital meniscus model was developed by performing micro-CT scanning of a human meniscus. A suitable cell-laden hydrogel bioink to support chondrogenesis were identified. Cell survivability was determined using a LIVE/DEAD Viability/Cytoxicity Kit and AlamarBlue Cell Viability reagent. Real-time polymerase chain reaction (RT-qPCR) was performed to measure expression levels of Col2al, Col1a1, and Sox9. The printed prototype serve as a starting point for optimization of tissue-engineered implants as a clinical treatment approach for meniscal repairs in the future.

*Inducing synthetic lethality using MYC-driven hypertranscriptional activity and BET inhibition*

## Taylor Nguyen

Faculty Mentor(s): Scott Floyd

Biological Sciences

**Abstract:**

Medulloblastoma (MB) is a high-grade malignant pediatric brain tumor, accounting for 20% of childhood brain tumors; however, molecular diversity has rendered generalized treatment insufficient at improving outcomes. Four major subgroups of MB have been identified: Wnt, Shh, Group 3 (G3), and Group 4 (G4). The G3/4 subgroups comprise 60-65% of all cases and are associated with greater incidences of metastasis and drug resistance. Despite this, no molecular drivers have been identified. Recent studies have shown overexpression of the MYC oncogene in G3/G4 tumors, suggesting MYC-driven etiologies, and a correlation between overexpression and poor prognosis. MYC has been associated with a state of increased global transcription, or hypertranscription, resulting in an increase in R-loops (DNA:RNA hybrids), replication stress, and genomic instability. Inhibition of BRD4—a transcriptional regulator of MYC—has become an area of interest for targeted therapy. We hypothesize that G3/G4 MBs result from MYC-driven hypertranscription, and synthetic lethality of G3/G4 MBs can be induced by leveraging MYC overexpression in combination with BET inhibition (BETi). We evaluated the synergistic effects of BETi and MYC overexpression in HeLa cells using the cell viability assay, CellTiter-Glo, which quantifies ATP as a marker of metabolic activity. We assessed the synergistic effects of two drugs: dBET6, a BET inhibitor/degrader, and kenpaullone (KPL), a GSK3B inhibitor shown to stabilize MYC. The lethal dose (LD50) concentrations for dBET6 and KPL were determined to be 100 nM and 10 uM, respectively. HeLa cells were deprived of fetal bovine serum for 24 hours to synchronize the sample population at G0 (or G1/S or G2/M transition) to ensure transcription coincides with treatment. Experimental conditions included single-drug treatments of KPL and dBET6, a combined co-treatment, and a DMSO vehicle control for a full 24 hours. Combined dBET6 and KPL conditions significantly reduced cell viability compared to single-drug conditions, suggesting synergistic effects with a combination treatment of dBET6 and KPL. These results suggest that BETi and GSK3B inhibition could be beneficial in the treatment of MB.

*Next-gen stealth polymer for biofilm-resistant orthopedic implant coatings*

## Ethan Ong

Faculty Mentor(s): Ashutosh Chilkoti

Biological Sciences

**Abstract:**

Traumatized patients with open orthopedic injuries to the upper extremity are at increased risk of hardware-related infection (HRI) given the frequency of wound contamination at presentation. Bacterial colonization of metallic hardware (typically titanium or steel) can progress to formation of a biofilm that shields pathogens from the host’s immune defenses and antibiotics. Treatment is challenging, often involving hardware removal, debridement, and prolonged antibiotics, which is associated with considerable morbidity and cost. My strategy to confront the problem of HRI relies on using surface-initiated polymerization techniques to coat metallic implant surfaces with nanometric “stealth” polymer films pioneered by the Chilkoti laboratory. These polymers are hydrophilic, bottlebrush-shaped constructs with highly anti-biofouling (cell- and protein-resistant) properties, which I hypothesize will be optimal for camouflaging implant surfaces from bacterial adhesion. Polymer bottlebrush (PBB) films are grown bottom-up, directly from solid substrates via surface-initiated atom transfer radical polymerization from poly(oligo(ethylene glycol) methyl ether methacrylate (POEGMA) (a non-toxic, non-fluorinated material). This strategy leads to ~50 nanometer thick conformal thin films with reliable uniformity and chemical stability. Preliminary experiments thus far have shown that I can reliably coat stainless steel and titanium surfaces with PBBs. Analysis of the chemical composition of our surfaces by x-ray photoelectron spectroscopy demonstrates successful growth of conformal POEGMA-based surface coatings on steel and titanium. Functional characterization with contact angle goniometry shows surface wetting behavior consistent with previously reported values. My preliminary in vitro experiments indicate that staphylococcus aureus organisms bind avidly to bare stainless steel and titanium substrates, whereas bacterial binding is virtually eliminated on substrates coated with PBBs.

*Genetic Regulation of STIM1 Gene in Human and Mice Muscle*

## Mihir Patel

Faculty Mentor(s): Paul Rosenberg

Biological Sciences

**Abstract:**

Stromal interaction molecule 1 (STIM1) is an important calcium sensor and activator of store operated Ca2+ entry (SOCE) in muscle. STIM1 is located in the SR membrane where it acts as a Ca2+ sensor and activator of store operated calcium channels. The loss or gain of function of STIM1 has been implicated in various cardio-metabolic diseases. Increased STIM1 expression in human muscle correlates to increased exercise capacity. However, the STIM1’s role in signaling normal human muscle still needs to be elucidated. STIM1 is preferentially expressed in oxidative muscle through a mechanism involving the transcriptional coactivator PPAR coactivator 1alpha (PGC-1alpha). Transgenic mice exhibiting PGC-1alpha in muscle, a model of exercise adaptation, have increased STIM1 and SOCE levels in skeletal muscle. It is hypothesized that STIM1 expression in human muscle correlates with exercise capacity in which STIM1 and PGC-1 exist in the regulatory loop to increase the oxidative capacity of skeletal muscle. The goal of this honors thesis was to elucidate details about this regulatory loop to better understand the mechanism by which STIM1 signaling influences human muscle. Promoter fragments of hSTIM1 with different lengths have been cloned into the pGL3 vector. Successful insertion of the fragments was confirmed via DNA sequencing and gel electrophoresis. Dual luciferase assay systems were used to test for the promoter strength of these fragments. Mutations were then introduced into the promoter sequences predicted to be responsible for binding PGC-1alpha, and further luciferase assays were conducted on these mutated vectors. Results are reported using the ratio of Firefly to Renilla luciferase activity.

*Energetics, behavior, & pregnancy: Cortisol correlates in lemurs with varied life-history paces*

## Jonathan Pertile

Faculty Mentor(s): Christine Drea

Biological Sciences

**Abstract:**

Life-history pace relates to patterns of energetic expenditure during reproduction across species, although how it does so is unclear. Here, we test whether trends in glucocorticoid concentrations (as a proxy for energetic expenditure) across pregnancy vary with respect to life-history strategy (the life-history hypothesis) while controlling for measures of psychosocial stress by comparing urinary glucocorticoid concentrations across pregnancy in two Lemurid genera with disparate life-history strategies (Lemur, with relatively slow life-history strategies, n = 3; and Varecia, with relatively fast life-history strategies, n = 4). Additionally, we tested to see if the genera engage in adaptive metabolic regulation (known as energy sparing) to manage the costs of pregnancy by comparing total energy expenditure across reproductive phases. At the Duke Lemur Center, we began collecting behavioral data and urine samples and completed doubly labeled water dosing during pre-pregnancy periods and continued through late pregnancy. We found no statistically significant trend in total energy expenditure, glucocorticoid concentrations, or displacement behavior (an index of psychosocial stress) across reproductive stages or with respect to genus. We find the first evidence of energy sparing during pregnancy in a nonhuman primate using the doubly labeled water method, considered the best method of measuring energy expenditure. The data did not support the life-history hypothesis, although there is uncertainty regarding our sample size.

*Novel CRISPR technologies to investigate immune cell specification in the sea urchin embryo*

## Zachary Pracher

Faculty Mentor(s): David McClay

Biological Sciences

**Abstract:**

The developmental gene regulatory network (GRN) of the green sea urchin (Lytechinus variegatus) has been extensively investigated to illuminate the genetic interactions underlying embryogenesis and regeneration. Traditionally, discovering the function of a new GRN element requires knockdown of the target using morpholine antisense oligonucleotides (MASOs), which are expensive, take a long time to synthesize, and can sometimes induce toxicity, thus confounding experimental results. To address these problems, we created a novel CRISPR-based system for specific, inducible, and reversible transcriptional repression in the L. variegatus embryo, and are currently conducting in vivo testing of this system. With this system, we hope to advance both the pace and robustness of developmental GRN research in marine invertebrates. In parallel, we used single-cell RNA-seq data to identify new candidates for drivers of epithelial-mesenchymal transitions (EMTs), which we hypothesize separates the two non-skeletogenic mesoderm cell lineages that constitute the urchin innate immune system: pigment cells and blastocoelar cells. in situ hybridization of these candidates supports a potential role in urchin immune cell development. Using our novel CRISPR-based system to perturb these new candidates, we aim to uncover the GRN underlying the complex signaling and morphological dynamics which differentiate pigment cell and blastocoelar cell EMTs. With these new technologies and insights, we hope to enhance our knowledge of immune system development and evolutionary conservation of these complex developmental systems across the animal kingdom.

*CAV1 and Mechanotransduction in Pig Trabecular Meshwork Cells*

## Rashad Rahman

Faculty Mentor(s): Dan Stamer

Biological Sciences

**Abstract:**

Elevated intraocular pressure (IOP) is a primary risk factor for the development of primary open-angle glaucoma (POAG), which affects more than 2.7 million Americans and is a leading cause of blindness worldwide. Increased IOP occurs due to reduced aqueous humor drainage via the conventional outflow pathway, which consists of the trabecular meshwork (TM), the Schlemm’s canal, and distal vasculature. Increased TM contractility is associated with decreased aqueous humor drainage and thus IOP elevation. Caveolin-1 is a scaffolding protein involved in the biosynthesis of caveolae, cup-shaped invaginations in the plasma membrane that play roles in mechanotransduction, mechanoprotection, and signal transduction. Polymorphisms in the CAV1 and Caveolin-2 genes are linked with an elevated risk of POAG. CAV1-knockout mice exhibited elevated IOP and reduced conventional outflow facility, and expression of CAV1 in the TM restored outflow activity. The mechanism by which CAV1 regulates IOP homeostasis is unknown. Previously, phosphorylated CAV1 was shown to regulate Rho/ROCK signaling and focal adhesion dynamics in kidney sarcoma cells. We hypothesize that pig TM cells will respond to mechanical stress by downregulating Rho/ROCK activity in a CAV1-dependent manner. To test this, we will subject pig TM cells to twenty-four hours of cyclic stretch in the presence or absence of Cavtratin, the CAV1 scaffolding domain peptide, and then measure the levels of relative of phosphorylated myosin light chain (pMLC)—a surrogate indicator of Rho/ROCK activity. After six trials, a significant decrease in relative pMLC level was seen with Cavtratin treatment, indicating that CAV1 negatively regulates Rho/ROCK activity in response to cyclic stretch in pig TM cells.

*CAV1 and Mechanotransduction in Pig Trabecular Meshwork Cells*

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*A new enrichment apparatus to encourage suspensory postures during foraging in ruffed lemurs*

## Emily Sandberg

Faculty Mentor(s): Lydia Greene

Biological Sciences

**Abstract:**

Wildlife maintained at accredited institutions are valuable research resources that benefit from enrichment programs to spur natural behaviors. We created a novel enrichment apparatus to encourage suspensory behaviors in ruffed lemurs (Varecia spp.), which are routinely used to forage in Madagascar. Our apparatus comprises a firehose lattice with buckets suspended from the lattice. We conducted 24 feeding trials on four Varecia in two groups from May-July 2022. During trials, we placed their daily diet in the buckets and either lettuce or bush clover on an accessible shelf. The lemurs spent 24% of observation time on the apparatus, with significant differences across individuals. Time on the apparatus was significantly correlated to suspensory postures and did not decrease with successive trials. The lemurs preferred lettuce to bush clover and spent less time foraging on the apparatus when lettuce was available. Thus, our apparatus effectively promoted suspensory postures, moderated by the alternative food available. For ruffed lemurs and other captive wildlife, enrichment is an important component of maintaining behaviorally intact animals to meet conservation and research goals.

*Smelling Fats: Addressing how the olfactory system perceives fatty acids and CD36's role*

## Michael Sheyner

Faculty Mentor(s): Hiro Matsunami

Biological Sciences

**Abstract:**

CD36 is an integral membrane protein that is predominantly located on tongue cells. This protein binds with lipids and related molecules, such as long-chain fatty acids in the mouth and digestive tract. CD36 assists in the importation of these fatty acids into cells, and the molecules are then utilized for various cellular processes. Furthermore, CD36 is co-expressed with a specific set of odorant receptors in the olfactory neurons inside the nose. There is evidence that suggests that CD36 is involved in olfaction relating to fatty acid (and related molecule) detection. However, there is limited knowledge on how CD36 and odorant receptors work together in the olfactory system, and if there is a correlation between CD36 expression and olfactory sensor response. The aim of this project was to ask if these olfactory receptors respond to fatty acids with or without CD36 co-expression in heterologous cells to define the role of CD36 in fatty acid detection in the olfactory system. Using the dual-glo luciferase assay, various olfactory receptors were transfected into cells, and the cells were then exposed to fatty acids so that a response could be observed. We compared: 1) cells transfected only with OR, 2) cells transfected only with CD36, 3) the coupled response of the olfactory receptor in question with CD36 in the same cell, with the same set of odorants. From this study, we were able to identify novel fatty acid ligands for three olfactory receptors. Additionally, preliminary data demonstrated an increased response in the olfactory receptor when CD36 and the olfactory receptor were co-expressed in the cells.

*Investigating Molecular Mechanisms of Toxicity of GenX and PFOA using C. elegans*

## Kate Silver

Faculty Mentor(s): Ryan Baugh

Biological Sciences

**Abstract:**

Environmental pollution is a leading cause of premature death worldwide. Specifically, exposure to a class of chemicals called per- and polyfluoroalkyl substances (PFAS), is associated with various diseases, including cancer, thyroid disease, and decreased fertility. However, there is insufficient research on molecular mechanisms of toxicity of PFAS, nor how genetic variation may alter the response to exposure to these chemicals. For my research project, I use C. elegans as a model system to study how exposure to two different PFAS (PFOA and its “safe” replacement, GenX) impacts growth rate. I hypothesize that PFAS exposure disrupts different cell signaling pathways in C. elegans, and that its toxicity is mediated partially through insulin signaling and other stress response pathways. After extensive literature review, I selected three C. elegans genes as the focus of my research, daf-2, daf-16, and skn-1. I use C. elegans mutants and RNAi to silence these genes, and conduct a 48-hour growth assay for each chemical. This consists of age-synchronizing worms, dosing L1 C. elegans with different chemical concentrations, and analyzing growth after two days. I plan to establish a proof of concept to use high-throughput RNAi screens to identify genes and molecular mechanisms of toxicity, and develop a greater understanding of PFOA and GenX toxicity.

*Introduction of lipids into hyaluronic acid-based hydrogels*

## Arushi Sivasankar

Faculty Mentor(s): Tatiana Segura

Biological Sciences

**Abstract:**

Hydrogels are composed of polymers that are interconnected via a crosslinker. These materials have the ability to hold significant volumes of water and have a wide range of mechanical and physical properties. The crosslinker can be introduced via covalent or physical linkages which are

covalent bonds or supramolecular interactions, respectively. The type of crosslinker or interactions introduced into the polymeric system have direct implications on both the physical

and mechanical properties of the bulk hydrogel. In the Segura Lab, we have established granular hydrogel scaffolds composed of hyaluronic acid (HA) that has been modified with functional handles to allow for covalent crosslinking. These materials have shown promise in both subcutaneous and stroke wound models with significant healing of the wounded

space. In an effort to expand the functionality of these established hydrogel materials, we have incorporated lipids into the backbone molecular architecture of hyaluronic acid to introduce physical interactions (hydrophobic interactions) into the bulk hydrogel system. By introducing lipids into the hydrogel scaffold, we have developed a hydrogel that has significant changes in both the physical and mechanical properties of the gel when compared to the original hydrogel scaffolds. Herein, we highlight some of the key characteristics of these HA-lipid hydrogel scaffolds in both a bulk formulation and a granular formulation.

*Identifying Novel Interactors of UFL1 During Flavivirus Infection*

## Grace Sorensen

Faculty Mentor(s): Stacy Horner

Biological Sciences

**Abstract:**

Flaviviruses such as dengue and Zika virus are human pathogens with a high disease burden worldwide. Understanding the proteins that regulate flavivirus replication is important for developing effective viral treatments and vaccines. The Horner Lab has previously shown that UFL1, a protein involved in regulating cellular stress and intracellular membrane dynamics, is recruited to antiviral innate immune signaling sites in the cell during viral infection. It has also been shown in the lab that UFL1 depletion significantly reduces dengue and Zika viral titer in a manner dependent on interferon signaling, however the mechanism by which UFL1 promotes viral infection remains unknown. In this project, I aim to identify novel interactors of UFL1 during flavivirus infection, with the goal of identifying new host and viral proteins that interact with UFL1 to regulate dengue and Zika virus infection. I will use a proximity-labeling proteomics approach to define novel interacting proteins. Proteins of interest would include unique interactors of UFL1 during dengue or Zika virus infection, especially mitochondrial or innate immune proteins. New proteins that interact with UFL1 during infection will be analyzed for their roles in regulating flavivirus infection using genetic approaches. Overall, this work will identify novel regulators of flavivirus infection, revealing new insights into how these viruses replicate and defining new antiviral targets.

*Muscarinic Cholinergic Influence on Cortical Interneuron Excitability*

## Megan Stone

Faculty Mentor(s): Lindsey Glickfeld

Biological Sciences

**Abstract:**

Visual processing is complex and involves a vast network of diverse cell types and receptors. Previous literature has implicated Acetylcholine (ACh) as a neuromodulator of GABAergic interneurons. That said, there exist many subtypes of both GABAergic interneurons and acetylcholine receptors. Subclasses of GABAergic interneurons have been identified to have particular connectivities, morphologies, and physiologic properties and thereby hold unique roles in cortical networks. Acetylcholine receptors can be subdivided into either nicotinic or muscarinic receptors which bind distinct molecules and have different signaling properties. In particular, muscarinic Acetylcholine Receptors (mAChRs) have been further classified into five subtypes (M1-M5), some of which are excitatory (M1, M3, M5) while others are inhibitory (M2, M4). Thus, cholinergic action on GABAergic interneurons is situated to precisely modulate visual cortical circuits. However, the contributions of specific cholinergic receptors onto specific cell-types are not fully understood. In this project, we investigate the influence of mAChRs on vasoactive intestinal peptide-expressing (VIP) and somatostatin-expressing (SST) GABAergic interneurons in the mouse primary visual cortex. We first analyzed an openly available RNA-sequencing dataset from the Allen Brain Institute to determine the relative distribution of mAChR subtypes on VIP and SST interneurons. Our findings suggest that VIP and SST interneurons in mouse V1 primarily express the excitatory M1 and M3 mAChRs.Therefore, we predict that the net effect of activating mAChRs on SST and VIP interneurons is a facilitation of activity. To test this, we performed in vitro whole-cell recordings in current clamp from fluorescently tagged SST and VIP cells. As a measure of excitability, we determined the cell’s rheobase and input resistance before and after bath application of muscarine, a mAChR agonist. We expect that the application of muscarine lowers the rheobase and increases the input resistance of both SST and VIP interneurons. We further predict these effects are more pronounced in VIP cells than SST cells because, according to our analysis of the Allen Brain Institute dataset, VIP cells have higher M1 and M3 mAChR expression levels than SSTs. Hence, we expect them to be particularly susceptible to muscarinic cholinergic influence. Overall, we aim to gain a more precise understanding of cholinergic modulation of inhibitory visual circuits.

*Total Synthesis of Novel Antiausterity Agents against PANC-1 Human Pancreatic Cancer Cell Line*

## Eric Wang

Faculty Mentor(s): Jiyong Hong

Biological Sciences

**Abstract:**

Human pancreatic cancer stands as one of the most aggressive and lethal types of cancer, with over 400,000 people diagnosed annually with some form of pancreatic cancer across the globe. It is the seventh leading cause of cancer-related death worldwide and despite improvements in treatment and detection, the five-year survival rate of pancreatic cancer still stands at a dismal 9%. The hypovascular tumor microenvironment provides an immunosuppressive and chemotherapy-resistant environment for PANC-1 cells, thereby accounting for the rapid and invasive growth of tumor cells. Thus, antiausterity strategies, which target the ability of cancer cells to survive in these nutrient-starved conditions, have been under investigation as treatments for pancreatic cancer. A novel secondary metabolic sesquiterpenoid isolated from the roots of Ferula hezarlalehzarica was recently found to have potent preferential cytotoxic activity against pancreatic cancer cells. Specifically, the sesquiterpenoid is a ferutinin analog that exhibits antiausterity activity, inhibiting the growth of PANC-1 cancer cells in nutrient-deprived media by 80% at a concentration of 12.5 micromolar. Herein we report the first asymmetric total synthesis of ferutinin and the novel sesquiterpenoid, including the known Jaeschkeanadiol intermediate, with the synthetic hallmark being a radical cyclization to introduce both ring junction stereocenters. Based on the synthetic scaffold, the synthesis and cytotoxic activity of various analogs will also be explored, ascertaining the biological activities of similar molecules not found in nature.

*Executioner caspases restrict mitochondrial RNA-driven Type I IFN induction during apoptosis*

## Rachel Washart

Faculty Mentor(s): Kris Wood

Biological Sciences

**Abstract:**

Apoptosis is a regulated form of cell death designed to reduce inflammation and avoid recruitment of the immune system. However, inflammatory signals have been shown to be an effective strategy in cancer immunotherapy as a way to initiate an anti-tumor innate and adaptive immune response. My work seeks to utilize existing chemo and targeted therapies to induce inflammation through Type I interferon (IFN) signaling during apoptosis. During programmed cell death, mitochondrial outer membrane permeabilization (MOMP) enables mitochondrial nucleic acids to escape into the cytosol. However, the fate of mitochondrial RNA (mtRNA) during apoptosis is unknown. In a 2023 Nature Communications paper, my colleages and I demonstrate that MOMP results in the cytoplasmic release of mtRNA and that executioner caspases-3 and -7 (casp3/7) prevent cytoplasmic mtRNA from triggering inflammatory signaling. In the setting of genetic or pharmacological casp3/7 inhibition, apoptotic insults result in mtRNA activation of the MDA5/MAVS/IRF3 pathway to drive Type I interferon (IFN) signaling. This pathway is sufficient to activate tumor-intrinsic Type I IFN signaling in immunologically cold cancer models that lack an intact cGAS/STING signaling pathway, promote CD8+ T-cell-dependent anti-tumor immunity, and overcome anti-PD1 refractoriness in vivo. Thus, a key function of casp3/7 is to inhibit inflammation caused by the cytoplasmic release of mtRNA, and pharmacological modulation of this pathway increases the immunogenicity of chemotherapy-induced apoptosis.

*A high throughput minibrain production platform for childhood brain tumor drug testing*

## Haipei Yao

Faculty Mentor(s): Yiping He

Biological Sciences

**Abstract:**

Human induced pluripotent stem cell (iPSC)-derived minibrains (also known as cerebral organoids) are ex vivo, 3D structures that recapitulate aspects of human brain microenvironment and have important disease modeling and drug screening potential in cancers related to the brain. For this reason, cerebral organoids have been extensively used for studying brain development and diseases, but current protocols for generating minibrains are time consuming and labor intensive, restraining the throughput of minibrain generation. This is mainly because current protocols rely on manually handling individual organoids, which limits the size and scale of high-content drug screening efforts. In this study, we established a novel high-throughput minibrain generation platform by integrating a microfluidics system, which is commonly used to handle large amounts of cells. We tested the potential of this high-throughput production platform for screening drugs targeting diffuse intrinsic pontine glioma (DIPG), the deadliest brain tumor primarily affecting children. There are currently no effective treatment options available and over 90% of patients die within two years after diagnosis. One of the major challenges of developing treatment for DIPG is the lack of preclinical models because most DIPG patient-derived cancer cells are not capable of forming tumors in mouse models. Research has shown, however, that minibrains can support growth of brain cancer cells in a co-culture system, which motivated this project. In this study, I used a microfluidic droplet system to produce multiple cohorts of iPSC-derived minibrains on a scale of several thousand organoids. The batches of minibrains were co-cultured with patient-derived brain cancer cell lines to provide a testing bed for mimicking human brain microenvironment. A fluorescence-based approach was applied to categorize the complexity and cellular composition of the established minibrains, as well as to evaluate tumor-cell-specific drug response. We further compared the molecular landscape of the microfluidics-generated brain organoids and those generated from the conventional protocol and found that they were highly comparable. The establishment of this high-throughput minibrain production system will significantly improve efficiency of drug screening for DIPGs in an ex vivo model and provide predictive and selective power in constructing personalized cancer treatments.

*Developing an Oligonucleotide Therapy for Alzheimer's Disease*

## Lucy Zhang

Faculty Mentor(s): Cameron Kim

Biological Sciences

**Abstract:**

Alzheimer's disease (AD) affects over 6.2 million people in the U.S. and is the leading cause of dementia. Current treatments target the aggregation of β-amyloid plaques and tau proteins, but fail to address disease progression. Therefore, there is a need for a therapeutic with proven clinical benefits to address the underlying biology of AD and alleviate cognitive decline. Neuroinflammation has emerged as a key feature in Alzheimer's disease and provides a new way to target the disease. Complement proteins activate inflammatory response to Aβ through C3a/C3aR1 signaling. Here, we aim to develop an RNA interference-based therapeutic that downregulates C3aR1 with the goal of stopping AD progression by reducing inflammation-induced neurodegeneration.

*Dock-2 acts as a positive regulator for mast cell degranulation*

## Jeffrey Zhang

Faculty Mentor(s): Soman Abraham

Biological Sciences

**Abstract:**

Mast cells (MCs) are the primary effector cells of IgE-mediated allergy, which is an increasingly common inflammatory disease. When allergens encounter IgE-sensitized MCs, these cells promptly degranulate releasing a large pool of inflammatory mediators. It is known that the release of calcium is critical to the activation and degranulation of MCs and triggers the migration of mature granules. This migration towards the plasma membrane is dependent on exocyst complex downstream of RalB. However, a critical void in knowledge is how this calcium flux promotes MC degranulation. Our previous study suggests that upon mast cell activation, Calmodulin transmits calcium signal to MC granules, while RalB associates with granule and Calmodulin. We hypothesize that there is a signal platform formed on granules, in which Calmodulin and RalB are key components. Our proteomics data on this platform has shown that Dock-2 interacts with both Calmodulin and RalB after MC activation. The goal of my project was to elucidate the role of Dock-2 in MC degranulation. I first found that Dock-2 colocalizes with MC granules employing immunostaining. Then I tested if Dock-2 knock-down would affect MC degranulation levels. Through molecular cloning and cell transfection, I successfully established MC lines with Dock-2 being knocked down. Next, I found that the degranulation level in Dock-2 knockdown MCs was significantly decreased. Taken together, from proteomics data to functional studies, it reveals that Dock-2 is a positive regulator in the signal platform, which promotes degranulation after MC activation.

*Then & Now: My Ancestral History and Jewish Diaspora Identity*

## Lily Levin

Faculty Mentor(s): Dominika Baran

Creative Arts

**Abstract:**

For my English senior thesis, I wrote a creative nonfiction narrative that retraced the steps of my ancestral history, mainly through the story of my maternal great-grandmother and namesake, Lillian Fleishman. My thesis was informed by the role of trauma, grief and memory in the Jewish diaspora. I reflected about what it means to be a Jewish American today—and how my family history and legacies have shaped me as an individual.

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Faculty Mentor(s): test test

Creative Arts

**Abstract:**

teast

*Autonomous Blood Pressure Regulation for Hypertensive Crises: a Software Approach*

## Peter Banyas and Sourodeep Bhattacharya

Faculty Mentor(s): Benjamin Cooke

Health / Clinical Research

**Abstract:**

In critically ill patients, blood pressure (BP) volatility is associated with increased mortality. Current clinical care requires human operators to manually adjust drug therapy in response to BP, introducing delay and error. In engineering, automated control systems are common; a familiar example is a thermostat, which maintains stable temperature in volatile conditions. We developed an automated interface between a simulated BP monitor and drug infusion pump to achieve and maintain a target BP range.

We implemented a drug infusion control algorithm that operated in conjunction with a human BP simulation. Using a prescribed treatment timeline, the algorithm plotted a moving target BP that exponentially decayed to approach the final target. Based on the program’s calculated error (defined as current BP minus moving target BP), the algorithm calculated the medication infusion rate by summing three values: (P) a term proportional to the error, (I) the average of the integrated error over time, and (D) the derivative of the error. The algorithm’s output was bounded by the maximum safe drug dose.

To train the algorithm, the program independently simulated drug effects on BP, pharmacodynamics/kinetics, blood vessel radius and resistance, and ΔBP using the Windkessel model. During testing, the treatment algorithm was challenged with independent patient events (e.g. sustained, rising, or falling BP) and random noise. We modeled a single drug (nitroprusside) for varying conditions of hypertension, reporting the proportion of simulations reaching the target with 95% CI. We simulated 10,000 cases with initial mean arterial pressure (MAP) from 80 to 130 mmHg.

95% of cases (95%CI 94.6-95.5%) reached BP (90 mmHg) ±10 mmHg within 5 minutes. From 10 minutes until the simulation concluded at 3 hours, 100% (95%CI 99.96-1) achieved a target ±2 mmHg.

We achieved and maintained target BP with high speed and consistency. Future studies should simulate a wider range of BP conditions and medications before progressing to animal and human testing.

*Evaluation of Video-Assisted HPV Education in Government-Supported Clinics in Western Kenya*

## Bentley Choi

Faculty Mentor(s): Megan Huchko

Health / Clinical Research

**Abstract:**

Despite prevalent preventative methods of human papillomavirus (HPV), cervical cancer remains the foremost cause of cancer-related death among women of reproductive age in Western Kenya. HPV self-sampling is a preventative measure that can improve accessibility and availability to screening. Education surrounding HPV is crucial to combating stigma and increasing HPV screening uptake. In this study, we sought to evaluate the workflow impact of a video-assisted HPV education to promote self-sampling in clinical settings in Kisumu, Kenya. We conducted a two-part cluster-randomized control trial in six government-supported health clinics in Kisumu County. We observed the workflow of video-assisted and standard health educations, evaluating community and clinic health assistant facilitation (CCHA), duration, and feasibility of the intervention. Thirty HPV screening-eligible women, who participated in the video intervention, were then recruited for three focus group discussions (FGDs) to better understand the women’s experience with the video screening, their impressions on the content, and feedback about intervention logistics. Across 33 observations, 16.5 women per day watched the educational video at intervention clinics, and 14 women per day heard HPV health talks. Out of 307 women, 182 (63%) women screened in the intervention sites, compared to 103 out of 224 (46%) who screened after standard health talks at control sites. The workflow observations identified variable video projection and viewing space, access to power supply, and CCHA availability and ability to utilize the projector as major factors impacting education workflow. Women in FGDs appreciated the video modality, length of video, and education location. Our findings show that the use of video-assisted HPV education to promote HPV self-screening in government supported clinics in Western Kenya was feasible, acceptable, and stigma-reducing. Although HPV video education is suitable, further research is necessary to determine the viability of sustainably implementing the intervention in a clinic environment.

*Home Video Analysis of Affect and Attention at 12 months in Autism and ADHD*

## Annabelle Feibel

Faculty Mentor(s): Maura DeVito

Health / Clinical Research

**Abstract:**

To date, no research has explored the manifestation of autism, ADHD, and the co-occurrence of these conditions in the home environment during the first year of life. We coded home videos at one year of age for 35 subjects who were classified as neurotypical, autistic, ADHD, or autistic with ADHD. With the use of retrospective home video analysis, we aimed to identify the attention and emotion regulation symptoms that differentiate ADHD and autism from neurotypical development at one year of life in the naturalistic home-setting. Additionally, we sought to determine the correlation between symptoms at one year old and later parent-reported measures of attention and emotion in subjects aged 3-8 years old. Results indicate that affective and attention symptoms present in the home setting at 12 months of age are associated with many later behaviors in childhood that are consistent with an autism and/or ADHD diagnosis. Results also suggest that lower levels of positive affective expression and smiling may be integral to the early detection of neurodevelopmental differences. Caregivers and primary-care physicians should pay close attention to early behaviors, especially lack of positive expressivity and smiling, during infancy, as it may be indicative of autism or ADHD.

*Deletion of β-arrestins abolishes the innate immune response in CVB3 myocarditis*

## Daniella Galtes

Faculty Mentor(s): Howard Rockman

Health / Clinical Research

**Abstract:**

B-arrestins (Barrs), are known to function as intracellular scaffolds and signaling transducers mediating a wide array of signaling cascades including immune responses to inflammatory stimuli. Viral pathogens, such as enterovirus coxsackievirus B3 (CVB3) myocarditis, are known drivers of immune cell infiltration and cardiac inflammation. While viral myocarditis is a leading cause of dilated cardiomyopathy, the precise molecular mechanisms for the acute immune response to CVB3 infection are less well understood. Given the important role for Barrs in inflammatory processes, we tested the hypothesis that βarrs are necessary for the activation of the acute immune response and mediate the progression and severity of cardiotropic CVB3-induced myocarditis in mice. 5 to 7-week-old Barr1 KO or Barr2 KO mice were infected intraperitoneally with 1x104 plaque forming units (PFU) of CVB3 per animal. Wild type(WT) C57BL/6 mice infected with CVB3 were used as controls. The survival rate 7 days post infection (dpi) was significantly improved in male βarr1 KOs (80%) and βarr2 KOs (75%) compared to male WT control mice (35%, p=0.013). Female WT, βarr1 and 2 KO mice showed similar survival rates 7 dpi., ranging from 70% to 80%. Early mortality among all groups before 5 dpi was associated with high liver viral titers (~6.0 ± 0.5 log10PFU/mg) compared to mortality after 5 dpi (~2.4 ± 1.7 log10PFU/mg), as determined by plaque assay. Immunofluorescent staining of the heart with the pan-inflammatory marker, CD45, revealed high immune cell infiltration in infected WT mice (34.2% ± 4.5%), whereas immune cell infiltration was significantly blunted in infected Barr1 KO (6.0% ± 1.1%; p&lt;0.0001) and Barr2 KO (8.5% ± 0.9%; p&lt;0.0001) mice. The degree of immune cell infiltration in hearts of infected WT mice directly correlated with an increase in heart viral titer, whereas immune cell infiltration remained blunted across a broad range of viral titers in BarrKO mice. The blunted immune response in βarr KOs compared to WT infected controls was consistent across multiple immune cell markers including CD4 for helper T cells and CD11b for innate immune cells. In conclusion, we demonstrate that Barrs are necessary for immune cell recruitment to the heart in CVB3 myocarditis and deletion of Barrs in male mice may be cardioprotective as indicated by an increase in survival rate. These data suggest that βarrs may serve as potential therapeutic targets in the treatment of acute viral myocarditis.

*Lived Experiences of Young Adults with Type 2 Diabetes in Mysore District, South India*

## Nikhita Gopisetty

Faculty Mentor(s): Sumedha Ariely and Eve Puffer

Health / Clinical Research

**Abstract:**

Type 2 diabetes mellitus (T2D) has been occurring at younger ages of onset around the world. India’s population accounts for nearly 20% of the global diabetes burden. This study aimed to qualitatively examine the pathways between social determinants of health, T2D, and quality of life in young adults with diabetes in Mysore district, Southern India. Between June 2022 and July 2022, 20 in-depth interviews were conducted in the local language of Kannada with young adults living with T2D in rural and urban Mysore district, after the completion of the informed consent process. The social determinants and biopsychosocial frameworks informed the interview guide that was used. Participants were also screened for depression using the Patient Health Questionnaire (PHQ-9). Interviews were debriefed with the research team and data were analyzed using NVivo 12. Participants were aged between 18 and 35 with a mean age of 30.8 (SD ±4.2). Most were female (75%) and 90% had an annual household income below INR 30,000 (≈380 USD). Thematic analysis revealed that young adults with T2D in Mysore district 1) lacked biological understanding of T2D; 2) perceived themselves as burdens to their family members due to the cost and stress of living with the condition; and 3) experienced significant interpersonal and internalized stigma for having T2D at a young age. The PHQ-9 indicated mild and moderate/moderately severe depression in 11 (55%) and 3 (15%) of study participants, respectively. All three participants who screened for moderate/moderately severe depression lived in rural Mysore district. A lack of knowledge along with interpersonal and internalized stigma significantly impacted quality of life for young adults living with T2D in Mysore district. Awareness campaigns and peer support programs may help reduce depressive symptoms and increase self-efficacy in this population and must be accessible to rural residents of Mysore district.

*Utilization of antiviral therapy for patients with hepatitis B-related hepatocellular carcinoma*

## Sahith Kudaravalli

Faculty Mentor(s): Andrew Muir

Health / Clinical Research

**Abstract:**

Although oral antiviral therapy (OAV) is reported to improve outcomes in patients with HBV-related HCC, it is under-utilized. We determined the rate and factors associated with OAV utilization among patients with HBV-related HCC in a US population with health insurance. Patients with HBV-related HCC were identified from the de-identified administrative health claims database for patients with private insurance, Optum® ClinformaticsTM (2003-2021). We identified 2129 patients with HBV-related HCC: 71% male, mean age 62.7±12.5 years, 40% Asian, 72% with cirrhosis, and 37% received OAV. The treatment rate improved over time (40.5% after 2010 vs. 26.3% earlier, P&lt;0.001). Significantly lower treatment rates were noted for females, non-Asians, noncirrhotic patients, and patients without gastroenterology or infectious disease (GI/ID) specialist care (P&lt;0.0001). OAV treatment predictors included Asian (adjusted odds ratio [aOR] 3.6, 95% confidence interval [CI] 2.8-4.5, P&lt;0.001), male (aHR 1.6, 95% CI 1.3-2.0, P&lt;0.001), seeing a GI/ID specialist (aOR 1.5, 95% CI 1.10-1.99, P=0.0091), having compensated cirrhosis (aOR 2.2, 95% CI 1.7-2.8, P&lt;0.001), and treated in 2011-2021 (aOR 2.3, 95% CI 1.8-3.0, P&lt;0.001); being younger (aOR 0.98, 95% CI 0.98-0.99, P&lt;0.001) was less likely for treatment. OAV initiated at or before HCC diagnosis was independently associated with improved survival (adjusted hazard ratio 0.84, 95% CI 0.72-0.99, P=0.037). Among patients with HBV-related HCC, only one in three received OAV despite having insurance coverage. Efforts must continue to develop ways to improve HBV OAV treatment, especially among females, non-Asians, and patients without cirrhosis or not seen by specialists.

*The Impact of COVID-19 On Hunger Relief Organizations and Latina Communities In North Carolina*

## Elaijah Lapay

Faculty Mentor(s): Viviana Martinez-Bianchi

Health / Clinical Research

**Abstract:**

Changes to hunger relief organizations, such as food banks, pantries, and other systems of charitable and non-charitable food distribution, as a result of the COVID-19 pandemic had previously unobserved implications for the food security of North Carolina’s ‘comunidad Latina.’ Seeking to address this gap, this study surveyed 20 hunger relief organizations in the North Carolina Triangle region about the impact of the pandemic as it relates to food assistance for the Latina community. Based on the results of this survey, a listening session was held and interviews were conducted in Spring 2021 with selected organizations to gather qualitative data on unique experiences. Many organizations mentioned immigration as an important concern for their clients. While nearly 9 of the 20 organizations surveyed reported serving undocumented Latina recipients, only one program indicated taking action to inform their recipients about public charge laws. In addition, more programs used help from uniformed law enforcement officers after COVID compared to before in order to assist in long lines and volunteer shortages. Operating as a consistent touchpoint since the start of the pandemic, hunger relief organizations have had the opportunity to forge resilience. Organizations emphasized the importance of investing in relationships with clients to increase trust and empower the community while also reporting that COVID-19 resulted in decreased educational programming and opportunities for community building and recipient autonomy. This study highlights the importance of fostering partnerships and ensuring cultural humility to build sustainable and effective food security resources for the Latina community. This study also sets the groundwork for further community-rooted investigation into the racial and health equity of broader food insecurity policy in Durham County and surrounding areas to be explored in a forthcoming project in the 2023-4 academic year.

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*Art, Fear, & Healing in Medicine: Exploring Health Literacy & Empowerment Through Visual Art*

## Fatima Massare Somers

Faculty Mentor(s): Kearsley Stewart

Health / Clinical Research

**Abstract:**

The healthcare system in the United States is characterized by a power dynamic between physicians and patients that can contribute to healthcare avoidance, especially among college students, who face unique barriers such as fear and reluctance to display vulnerability. Improving health literacy and communication may help to address these issues. Efforts to improve health literacy involve deconstructing and addressing layers of unnecessary complexity through person-centered healthcare design. Patient storytelling, particularly through online resources, can offer valuable information and support, helping individuals prepare for and gain confidence in their own health experiences. The goal of this research is to elucidate the role of engaging with visual narratives of health experiences as a way to promote self efficacy and confidence in individuals to reduce healthcare avoidance or hesitation. I investigated this research question through two approaches with two different programs, first an art gallery with reflective questions to be answered independently on a qualtrics form and a documentary screening with a facilitated group discussion. Data was collected both quantitatively and qualitatively and analyzed by direct comparison and Saladena Coding Schemes for thematic analysis. I found that participants left both programs feeling validated, informed, empowered, while also having developed an appreciation for visual narratives’ power to inform the health experience. My study presents a novel approach to improving the communication and empowerment of health information for college students, primarily as they were the primary demographic of the study. Specifically, it explores the effectiveness of using visual arts to make the process more engaging and enjoyable. Through analyzing the impact of engaging with visual narratives of health experiences created by others, it demonstrates the significant potential of this method in providing information, validation, and motivation for individuals in their personal health journey while also facilitating learning from others' experiences. Moreover, it offers insights on how to encourage discussions around health information and experiences that promote empathy and empowerment. Future research could include replicating this study with diverse groups, such as genuine patient populations, different demographics of college students, or other participants.

*Mechanisms of Tumor-Mediated Endothelial Cell Proliferation Independent of VEGF*

## Kevin Sheng

Faculty Mentor(s): Kris Wood

Health / Clinical Research

**Abstract:**

A hallmark of cancer is dysregulated angiogenesis and blood vessel co-option, which are often driven by vascular endothelial growth factor (VEGF). Despite the key role of VEGF signaling in promoting endothelial cell (EC) proliferation, survival, and migration, the clinical use of VEGF inhibitors has modest success and faces many challenges. In particular, patients demonstrate variable initial responses to anti-VEGF therapy, and many of those who respond to treatment subsequently develop resistance. These challenges suggest that there may be VEGF-independent mechanisms driving EC proliferation in the tumor microenvironment. To study these mechanisms, we established an in vitro model using a dual-reporter system in a co-culture model of ECs and tumor cells. Specifically, we used an immortalized endothelial cell line (SVEC4-10) expressing GFP and Renilla luciferase and a mouse renal carcinoma cell line (RENCA) expressing Tomato and Firefly luciferase. This model allowed us to independently evaluate the growth rates and cell viabilities of both ECs and tumor cells in direct co-culture. Our preliminary data revealed that ECs exhibit increased growth rates when directly co-cultured with tumor cells. Interestingly, this EC proliferation is VEGF-independent and not impacted by VEGF-A knockout in tumor cells or with treatment of a pan-VEGFR small molecule inhibitor (axitinib). To further characterize if our phenotype was due to other tumor secreted factors, we used a transwell setup to eliminate direct contact between ECs and tumor cells and found that EC growth rates were substantially mitigated. These results revealed that tumor cells induced EC proliferation through a physical cell-to-cell interaction that is independent of VEGF. Further characterizing this unknown mechanism may inform therapeutic interventions to overcome the clinical challenges of anti-VEGF therapies for cancer. To expand our understanding of this VEGF-independent EC proliferation, we aim to characterize the cell surface proteome from tumor-conditioned ECs using cell surface mass spectrometry. We will validate hits from this study using our in vitro model and translate these findings to in vivo mouse models. We expect that our current and future research will reveal new insights into tumor co-option of the vascular system and identify novel targets for developing therapies to effectively treat cancer.

*Cross-Cultural Adaptation of Scales Measuring Stigma related to HPV, HIV, and Cervical Cancer S*

## Amber Smith

Faculty Mentor(s): Megan Huchko

Health / Clinical Research

**Abstract:**

Human Papillomavirus (HPV) vaccination and testing greatly reduce cervical cancer rates in high-income communities; yet, cervical cancer remains the most common cause of cancer and cancer-related deaths in many low-resource countries, including Kenya. Understanding behaviors and beliefs around HPV and cervical cancer, including stigma, will help ensure uptake of these effective interventions. A culturally adapted tool to measure stigma will be important to be able to measure the levels and impact of HPV and cervical cancer-related stigma. We used a stigma framework developed from previous in-depth interviews on HPV and cervical cancer knowledge, attitudes, and behaviors conducted in Kisumu, Kenya to develop an item pool. We adapted items from existing validated scales for HIV, HPV, and cervical cancer-related stigma and added additional items based on the qualitative data. Items covered the three dimensions of stigmatizing attitudes, enacted, and internalized stigma across the health domains of Cervical Cancer and HPV. Items were developed in English, translated into Dholuo and then back-translated. Selected items from validated HIV scales were translated into Dholuo for psychometric testing in this setting. Cognitive interviews assessed cultural fit, understanding, and acceptability. A total of 134 items were developed, with 48 about HIV, 52 about HPV, and 34 about cervical cancer. Cognitive interviews were carried out among 101 participants, with 37 conducted in English and 62 in Dholuo, assessing an average of 13.18 questions. A total of 22 questions were eliminated, 9 on fear or judgement, 3 on uncomfortably, 3 on pain, 1 on difficulty understanding, and 6 on other reasons of perceived unacceptability. To our knowledge, this is the first set of culturally adapted items to measure HPV and cervical cancer related stigma in East Africa. After assessment of psychometric properties, this tool holds potential to guide the development and evaluation of stigma-responsive cervical cancer prevention.

*Xeno-proliferative Response in Highly Sensitized NHPs: Implications for Xenotransplantation*

## Ryan Spangler

Faculty Mentor(s): Joseph Ladowski

Health / Clinical Research

**Abstract:**

The increasing demand for life-saving organ transplants far exceeds the availability of donor organs. Xenotransplantation, the use of genetically engineered pigs as organ donors for humans, may address the organ shortage. Highly-sensitized patients, who have developed antibodies against a broad range of human leukocyte antigens, could particularly benefit from xenotransplantation, as they face limited options for compatible human donors. However, there have been limited studies examining the cellular response of these highly sensitized individuals to xenogeneic pig cells. We hypothesized that a naive individual’s cellular response to xenogeneic pig cells will resemble an allogeneic response, but will intensify after becoming sensitized. Our lab has established a non-human primate (NHP) model of sensitization by performing swapping skin transplants. A total of three experiments were conducted. Cryopreserved cells from three rhesus macaques, pre- and post-sensitization, were used in three distinct mixed lymphocyte reactions (MLR) to evaluate the pre- and post-sensitization anti-pig xenogeneic and anti-NHP allogeneic response. Cells were stained with proliferative dyes, CFSE and VPD450, and plated in a 96-well culture plate for a mixed lymphocyte reaction. The reactions were incubated for five days, followed by staining with Fixable Blue, anti-CD4, and anti-CD8 antibodies. Flow cytometry was performed on a LSR Fortessa X-20 and data analysis was done using FlowJo™. Statistical analysis was done using Welch’s two sample t-tests in RStudioⓇ. The results revealed that the mean NHP naive allo-response was 67% ± 25.84 and the mean allo-response post-sensitization was 57.4% ± 24.7 (p = 0.6662). The mean naive xeno-proliferative response was 60.3% ± 29.2 and the mean sensitized xeno-proliferative response was 32.7% ± 16.5 (p = 0.2445). The mean sensitized allo-response to a third-party, unrelated (donor) NHP was 35.6% ± 9.7 (p = 0.2837). Though the difference in mean proliferative responses from pre- to post-sensitization are non significant, there is a trend toward decreased proliferation. This study suggests that the xeno-proliferative response of highly sensitized individuals is diminished to xenogeneic donors, in contrast to the naive xeno-proliferative response. Further studies are needed to corroborate these observations.

*DEVELOPING VIRAL TRANSSYNAPTIC TRACING FOR INTERNEURON TRANSPLANTATION IN A SEIZURE MODEL*

## Peyton Thompson

Faculty Mentor(s): Derek Southwell

Health / Clinical Research

**Abstract:**

Loss of inhibitory GABAergic interneuron populations in the brain leads to abnormalities in cell circuits that can result in numerous neurological disorders including epilepsy. Epilepsy is characterized by recurrent disabling seizures with 30-40% of patients suffering from drug-resistant epilepsy left with surgical intervention to improve their quality of life. These operations have strict selection criteria and may have limited seizure reduction in some patients. Given seizure pathophysiology involves interneuron hypofunction, there is growing evidence in the literature and ongoing clinical trials that are using interneuron transplantation, a novel cell-based therapy, as an alternative to surgical resection to restore inhibitory tone. Previous studies have shown that transplanted immature interneurons derived from a brain region known as the medial ganglionic eminence (MGE) can successfully integrate into synaptic circuits, survive, and modify disease phenotypes in the mouse neocortex and hippocampus in vivo. MGEs are an excellent source of immature interneurons for transplantation due to their heterogenous population and great migratory potential. The mechanism of how immature MGEs integrate into mature circuits lacking complex extracellular developmental cues remains uncertain. Specifically, it is unknown how transplants attract afferents from host neurons and other transplants. To address these uncertainties, this project determined the best method to synaptically trace interneuron transplantation in a mice organotypic hippocampal slice culture (OHSC) model system. OHSCs reproduce key features of epilepsy, including recurrent spontaneous seizures and provide greater experimental accessibility. A G deleted rabies virus (RV) was used to trace afferent inputs because of its exclusively retrograde transmission. To ensure monosynaptic infection, RV requires the addition of G protein to replicate which can be accomplished using a helper virus or a triple transgenic mouse line. This project compared the effectiveness of these two methods. Qualitative and quantitative analysis were done following immunohistochemistry to compare methods and optimize virus titer, volume, method of application, and timing. This project will advance the current knowledge of how immature interneurons augment inhibitory signaling through synapse formation which is crucial to advance the novel epilepsy therapy of cortical interneuron transplantation.

*Friends Coming to the Table: Helpful and Harmful Peer Actions for Eating Disorder Recovery*

## Rafaella (Ella) Zanatti Trovarelli

Faculty Mentor(s): Nancy Zucker

Health / Clinical Research

**Abstract:**

Previous Eating Disorder (ED) literature has focused primarily on familial support. Few studies have focused exclusively on peers as support figures in the ED recovery process. Considering that EDs are highly prevalent among college-aged women and that this population is typically living away from their families and surrounded by peers, further research on peer support actions for this population is warranted. The aim of this qualitative study is to investigate what peer interactions between women are helpful and unhelpful for the ED recovery process in a college setting. The perspective of 66 women who have either had an ED in college (n = 18), supported a friend with an ED in college (n = 21), or both (n = 27) were included and analyzed in this study. Based on participants' responses, we identified 7 themes (broken down into 34 codes) relating to helpful peer actions and 7 themes (broken down into 23 codes) relating to unhelpful peer actions. Participants reported that having meaningful conversations, in which peers listen non-judgmentally and ask thoughtful questions, as well as consistent demonstrations of unconditional care and compassion, were helpful and that talking about appearances, food, and eating habits, as well as forceful support approaches, were generally unhelpful. The findings of this study may be used to inform future studies and the creation of empirically supported resources that guide college women looking to support their peers through the ED recovery process.

*Using Social Risk Associations Between Child Health and Neighborhood Social Vulnerability*

## Anna Zolotor

Faculty Mentor(s): Rushina Cholera

Health / Clinical Research

**Abstract:**

Background: Disadvantage indices combine population-level social, economic, and health data to quantify the overall social vulnerability of a geographic area. While they are often used interchangeably, index choice may influence results due to the population or outcome under consideration. We compared the cross-sectional associations between three common indices (Social Vulnerability Index (SVI), Area Deprivation Index (ADI), and Child Opportunity Index (COI)) and infant well-child check (WCC) attendance and adolescent obesity.

Methods: Electronic health record (EHR) data from Duke University Health System (DUHS) from 2014-2018 was linked to the 2014 SVI, 2015 ADI, and 2015 COI 2.0 (coded so higher scores indicate greater disadvantage) based on patient address at the census tract level. Included patients lived in Durham and were 0-15 months old for WCC and 11-17 years for obesity. Outcomes were: 1) WCC attendance: attending less than six WCC in the first 15 months of life, and 2) Adolescent obesity: BMI &gt;= the 95th percentile at both the most recent encounter and a prior encounter 9-36 months earlier. Multivariate logistic regression models quantified the associations.

Results: Of the 14961 patients in the obesity cohort, 20% (n=2933) were obese. Of the 10175 patients in the WCC cohort, 20% (n=2073) had less than six WCC. The median (IQR) decile SVI, ADI, and COI for Durham County tracts were 5 (2-9), 4 (2-6.75), and 5 (2-9), respectively. All three indices were associated with both obesity and WCC. Each index decile increase was associated with 10-12% greater odds of meeting the WCC measure and 5-8% greater odds of adolescent obesity.

Conclusions: Higher social risk as defined by all three indices was similarly associated with both adolescent obesity and infant WCC. While these results suggest that the indices may be used interchangeably, pediatric population health researchers may still want to consider outcome and population characteristics when selecting an index.

*Agua es vida/Water is Life*

## Chaya Brennan Agarwal

Faculty Mentor(s): Adam Rosenblatt

Humanities

**Abstract:**

Agua es vida is an environmental documentary that centers on the diverse opinions and perspectives of an Indigenous Mapuche community in Neltume, Chile, regarding a proposed hydroelectric plant and its potential impacts on their community and the surrounding environment and ecosystem. In a series of interviews, community members discuss their relationship with the land and respect for its resources, how the hydroelectric plant threatened the natural environment, whether hydroelectricity was cleaner than alternative options, and divisions within the community. Several members illuminate how Endesa, the power company proposing the hydroelectric plant, interacted with the community in ways that were often manipulative and exploitative. In the film, Noemi Catrilaf describes an annual ritual called La Navegación Ancestral that her community engages in every year in a celebration of ancestral connection to the water and land. This tradition has become an annual practice that establishes the significance of the water to the Neltume Mapuche community for generations to come. The film medium offers the possibility to uniquely present a more comprehensive view of the topic that showcases the individual human voices behind the movement, rather than removing the complex emotions and conflicts inherent to the situation. In this film, I employ a critical lens analyzing environmental and economic colonization and the corresponding resistance movement for protecting Indigenous land and resources. I underscore the power and impact of art and culture as effective means of resistance to ecological colonialism.

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*Cajun, Créole, and CODOFIL : Language Policy and Planning in Louisiana*

## Audrey Costley

Faculty Mentor(s): Deborah Reisinger

Humanities

**Abstract:**

Today, linguists consider there to be two varieties of French in Louisiana: Louisiana French (Cajun) and Louisiana Creole. Both of these languages are classified as endangered, with a continually declining population of speakers. Language change occurs naturally, however, there are policies that impact the nature and rate of change. Through the lens of Critical Language Policy (CLP), the research examines how the decline of the French language in Louisiana has been impacted by policy decisions, while considering the structural and ideological factors that influenced these policies. Further, the project examines more recent policies, institutions, and grassroots movements aimed at revitalizing and maintaining the role of French in Louisiana. The project takes a critical lens in analyzing the successes and shortcomings of current language policy in Louisiana with a focus on education.

*Queer Muslim Environmental Futurisms: Introspection, Liminality, Paradox, and Healing*

## Maya Ghanem

Faculty Mentor(s): Maya Ghanem

Humanities

**Abstract:**

Scholars in decolonial studies refer to mainstream environmentalism as a EuroAmerican movement, itself perpetuating Orientalism to colonize humans and nonhumans. Many fundamental ideas in mainstream environmentalism stem from Orientalist justifications of EuroAmerican colonization, claiming that racialized populations are insufficient as civilizations on both environmental and sexual terms. These justifications were particularly salient for Muslim societies– once characterized as too queer and close to nature during the colonial era, now targeted as homophobic and environmentally destructive during the post-independence era. As a result, EuroAmerican hegemony constructs nature and sexuality to control ideas and resources around Muslims and nonhumans. Queer Muslims are uniquely positioned to respond to Orientalized constructions of nature and sexuality. EuroAmerican colonizers introduced to Islamic theology the very association of sexuality with “natural/unnatural.” As a result, claims by numerous Islamic scholars that homosexuality is forbidden in Islam because it is “unnatural” echo Orientalist constructions of nature and sexuality. This thesis draws from intersectional queer Muslim perspectives to question Orientalist constructions of nature at the root of mainstream environmentalism. In this thesis, I advocate for an introspection of our queer, Muslim, and environmentalist histories, one that reorients human relationships to space and time to promote decolonial healing for queer Muslims and nonhuman creation. I then elaborate on these new time-space orientations to theorize a Queer Muslim Environmental Futurism (QMEF) that dismantles Queer/Muslim and human/nonhuman binaries in tandem. I instead imagine nuanced relationalities among all creationthat challenge binaries by embracing paradox and liminality.

*Polarization, denial, and mistrust in the Sunderland cholera epidemic, 1831-1832*

## Lisa Zhao

Faculty Mentor(s): Evan Hepler-Smith

Humanities

**Abstract:**

‘Pandemic denial’ is a popular buzzword and a point of frustration for many, especially during the coronavirus epidemic. Recently, this phenomenon was widely ascribed to misinformation associated with social media, economic interests, and scientific illiteracy. However, this simplified narrative overwrites the dynamics of mistrust and polarizing uncertainty that frequently arise throughout pandemics and other existential threats. In order to study the complexities behind resistance to public health efforts, this thesis looks back to a pivotal episode in the history of disease: the cholera outbreak in the English town of Sunderland in 1831. The northeast port town was the first in England to receive the dreaded disease, making it an interesting case study of the early reactions to epidemic. This thesis follows the ways efforts to make sense of the epidemic and protect public well-being failed to account for individual self-preservation while expecting widespread cooperation. Specifically, this thesis centers around the attempts to discredit the unpopular quarantine policy and the fear-induced aversion to the newly-minted charity hospital. By understanding the apprehensions behind resistance to public health, we may prepare to bridge the gap of mistrust and polarization today.

*Metal Catalyzed Oxidation of Sequential Histidine Containing Peptides*

## Rithik Castelino

Faculty Mentor(s): Katherine Franz

Physical Sciences

**Abstract:**

A specific sequence of residues associated with the binding of copper to proteins is two sequential histidines (bis-His) . Previous studies of bis-His containing peptides under metal catalyzed oxidation (MCO) conditions have observed a novel absorbance at 390 nm. But the exact source of the 390nm absorbance is unclear. In this thesis, the susceptibility of the model peptide Ac-Thr-Glu-Ser-His-His-Lys-NH2 (TESHHK) to MCO reactions is studied. TESHHK was synthesized through FMOC-protected solid phase synthesis. The reactions of TESHHK with varying reagents were monitored with ultraviolet visible (UV-vis) spectroscopy. The reaction mixtures were then purified and characterized by high-performance liquid chromatography (HPLC) and electrospray ionization mass spectrometry (ESI-MS). Oxidation products indicated by +16 m/z and +32 m/z modifications were detected under MCO conditions typically used in literature. Oxidative modifications were also detected in the presence of only H2O2 and atmospheric O2 with H2O2 acting as a reductant. Conditions that produced oxidative modifications were also observed during reaction to develop an absorbance at 390 nm. It was determined that the absorbance observed at 390 nm is attributable to the formation of a Cu-(oxidized-Peptide) complex . MS-MS studies are underway to determine the specific residues that are being oxidized. The exact mechanism by which oxidation occurs remains unclear and further experimentation is required.

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*ATLAS Transient Survey Light Curve Release and Analysis*

## Pranav Charvu

Faculty Mentor(s): Daniel Scolnic

Physical Sciences

**Abstract:**

The Shapley Supercluster is believed to be responsible for the bulk of our local group’s motion, and models centered around this assumption are a critical component of measuring the expansion rate of the universe with Type Ia supernovae (SNe Ia). However, there have never been any SN measured and/or analyzed in the Shapley Supercluster to help affirm our models. We will study 175 SNe Ia with redshifts 0.00330 &lt; z &lt; 0.16 reported by the ATLAS transient survey which has found some transients in the Shapley region, but there has been no confirmations of the types of these SNe or measurements using the light curves of the SNe Ia. We will do a first analysis of the light curves of ATLAS reported SNe Ia, plot their Hubble diagram and analyze it cosmologically, and lay the groundwork for the first measurement of the mass of the Shapley Supercluster using SNe Ia.

*Optimizing over-expression &purification of MenB, protein sensitive to Cu-induced precipitation*

## Diego Diaz

Faculty Mentor(s): Katherine Franz

Physical Sciences

**Abstract:**

Maintaining metal homeostasis is vital in cells as an imbalance can quickly lead to cell death. Of particular interest to the project is the homeostatic imbalance of copper in cells, as copper starvation and copper excess can lead to cell death but the mechanism by which this occurs is unknown. The Franz lab has previously identified 1,4-dihydroxy-2-naphthoyl-CoA synthase (or MenB), a protein responsible for the catalyzing of an intermolecular Claisen Condensation, as a copper sensitive enzyme, meaning it is sensitive to unfolding in the presence of excess copper. The goal of the project is to further understand the mechanism behind Cu-toxicity induced cell death. MenB is over expressed and purified, then Circular Dichroism (CD) is used to examine the secondary structure changes when copper is bound to MenB.

*Multiple Modes of Zinc Binding to Histatin 5 Revealed by Buffer-Independent Thermodynamics*

## Sean Gao

Faculty Mentor(s): Katherine Franz

Physical Sciences

**Abstract:**

Histatin 5 (Hist5) is an antimicrobial peptide found in human saliva and functions as part of the innate immune system. Hist5 can bind several metal ions in vitro, including zinc (Zn), which functions as an inhibitory switch to regulate the peptide’s biological activity against the opportunistic fungal pathogen Candida albicans in cell culture. However, the physical basis for Hist5’s Zn-dependent activity is unclear, and efforts to characterize the thermodynamics of Zn binding to Hist5 have led to seemingly contradictory results. This work provides a detailed thermodynamic analysis of Zn binding to Hist5 to gain insight into the Zn-dependent biological activity of the peptide. We studied Zn binding to Hist5 at four temperatures from 15 to 37 °C using isothermal titration calorimetry to obtain thermodynamic parameters that were corrected for competing buffer effects. Hist5 bound Zn with a buffer-dependent, pH-dependent dissociation constant of ~10 μM and a buffer-independent, pH-dependent dissociation constant of ~170 nM at all temperatures tested. Zn binding was both enthalpically and entropically favorable, with larger entropic contributions at 15 °C and larger enthalpic contributions at 37 °C. Additionally, the Zn:Hist5 binding stoichiometry increased from 1:1 to 2:1 as temperature increased. The enthalpy-entropy compensation and the variable stoichiometry lead us to propose a model in which the Zn–Hist5 complex exists in equilibrium between two distinct binding modes with different Zn:Hist5 stoichiometries. The in-depth thermodynamic analysis and preliminary confocal microscopy data presented herein illuminate the biophysical basis for the Zn-dependent biological activity of Hist5.

*Preparation of Thiol-Containing Benzoxazoles for Metallo-Beta-Lactamase Inhibition*

## Sophia Kuhn

Faculty Mentor(s): Katherine Franz

Physical Sciences

**Abstract:**

Antibiotic resistance has become a progressively more serious global health threat as bacterial strains continue to evolve and acquire multimodal resistance against antibiotics, leading to treatment complications and increasing death tolls for bacterial infections. Within the various acquired antibiotic resistance mechanisms, beta-lactamases are a class of enzymes produced by bacteria that degrade beta-lactam antibiotics, a diverse and widely-used class of antibacterial agents. Although various beta-lactamase inhibitor drugs have been developed for serine-containing beta-lactamases, currently there are no FDA-approved inhibitors effective against metallo-beta-lactamases (MBLs). MBLs have become a major medical threat due to their promiscuous activity allowing them to degrade all classes of beta-lactam antibiotics. Therefore, it is crucial that inhibitors against MBLs are developed as beta-lactam resistance evolves and further complicates medical care. A set of inhibitor agents containing a benzoxazole core have previously been synthesized and proven to be effective against MBL activity in-vitro by chelation of the zinc ions present in their active sites. Previous studies using benzoxazole compounds with a phenol functionality have shown good inhibitory activity. Sulfur-containing functionalities are predicted to improve coordination with zinc ions therefore increasing inhibitory activity. This work presents the ongoing synthesis of two thiol-containing benzoxazole compounds (SAK-1 and SAK-2) and subsequent assessment of their structure-activity relationship using chromogenic bioassays to determine MBL inhibition.

*A novel molecular model for the identification of nanoparticle forming drug-excipient pairs*

## Joe Laforet Jr.

Faculty Mentor(s): Daniel Reker

Physical Sciences

**Abstract:**

Our laboratory has recently conceptualized novel nanoparticles that can encapsulate therapeutics to improve solubility and enhance targeting to reduce side effects and improve efficacy. However, the internal structure and physical mechanism of formation of these nanoparticles remains unknown. Here we propose a novel computational model that aims to model nanoparticle stability to improve our understanding of the molecular underpinnings of nanoparticle formation. Like the candy “jawbreakers” we hypothesize that the nanoparticles are made of a core of active therapeutic surrounded by a thin shell of inactive excipient that is stabilizing the poorly soluble therapeutic molecules. These jawbreaker models were parametrized as all-atom models and were simulated using the Molecular Dynamics engine OpenMM. Over the course of the trajectory, Solvent Accessible Surface Area (SASA) of the drug core was calculated as a proxy measurement for nanoparticle stability. We hypothesized that nanoparticles that were stable in this biased jawbreaker configuration should be stable when synthesized. We observed that drug-excipient pairs that successfully formed nanoparticles in the experiment had a lower increase in SASA values over the course of the simulation compared to pairs that do not form stable nanoparticles. Interestingly, we observed a simulation that had contradictory SASA results compared to its result from the high-throughput screen. This sample was manually re-synthesized and showed the expected behavior based on the simulation, showing the potential of the simulations as a data-free approach to predict nanoparticle formation accurately.

*Identification of E. Coli Protein-Copper Binding Sites Using His H/D Exchange-Mass Spectrometry*

## Aaron Petty

Faculty Mentor(s): Michael Fitzgerald

Physical Sciences

**Abstract:**

Metal ions have a diverse set of functions and interactions in biology, many of which are deleterious. Copper, in particular, has been shown to have strong antimicrobial activity due to its cytotoxicity, such that cells have evolved mechanisms to strictly regulate intracellular levels of copper. Previous work in E. coli has indicated that copper binds and differentially stabilizes specific proteins and in high concentrations can cause specific proteins to precipitate out of solution. Here, histidine hydrogen/deuterium exchange-mass spectrometry is used to investigate the binding sites of protein-copper binding in the E. coli proteome. As part of this work we are also adapting the HDX Workbench software to facilitate the high throughput analysis of histidine HDX-MS data on the proteomic scale.

*Spin Polarized Charge Transport in Stable Organic Radical Polymer Wrapped SWNT Superstructures*

## Xander Wilcox

Faculty Mentor(s): Mike Therien

Physical Sciences

**Abstract:**

Semiconducting single walled carbon nanotubes (SWNTs) can create spin polarized current through chirality induced spin selectivity (CISS). Chiral molecules then act as spin filters for ballistic charge transport through (i) spin-orbit coupling along the molecule, (ii) spin-orbit coupling at the electrode interface, and (iii) solenoid-like induced magnetic fields. These three effects all stabilize one electron spin while destabilizing the other (Zeeman splitting), thus enabling preferential transport of one of the electron spins. By helically wrapping 1D SWNTs with aryleneethynylene polymers containing stable organic radicals at precise increments, we seek to achieve room temperature spin polarization over microns. Strong spin-orbit coupling interactions between the stable organic radicals and charge carriers in the SWNT is key to this effort. Our study will further help elucidate the fundamental mechanisms of spin polarized charge transport by examining the combination of CISS and spin-orbit coupling effects in one polymer wrapped SWNT superstructure. These advances should be transformative for next-generation spintronic devices with low-voltage and high-speed detection and transmission possibilities.

*Elucidating the Impact of Copper on GAPDH Activity and Secondary Structure*

## Isa Williams

Faculty Mentor(s): Katherine Franz

Physical Sciences

**Abstract:**

Mechanisms of copper homeostasis in the cell are essential to avoid malfunction due to excess or inadequate metal ions. Excess copper can be harmful by way of altering protein conformation, thus their function in the cell. Cu-induced protein precipitation is one of the main mechanisms of Cu-toxicity in the cell, however, the mechanism by which protein precipitation occurs is unknown. Other members of the Franz lab developed a method to quantify Cu-precipitation sensitivities using metal-induced protein precipitation (MiPP). Glyceraldehyde-3-dehydrogenase (GAPDH), a glycolytic protein, was characterized as ‘tolerant’ to Cu-induced precipitation using MiPP. In this project, recombinant GAPDH was overexpressed and purified from E. coli BL21 cells. Once the purified GAPDH was obtained, UV-visible spectroscopy was used to investigate copper-dependent enzymatic activity, and circular dichroism (CD) spectroscopy was used to investigate the effect of copper on the secondary structure of the protein. The activity of GAPDH was inhibited when incubated with 0.1, 1, and 10uM Cu. However, Cu shows no evidence of altering the degree of helicity in CD experiments. These findings contribute to the understanding of the protein targets and the biophysical mechanism surrounding copper cytotoxicity.

*Towards a 1,3-Aminodifunctionalization of Cyclopropanes*

## Justin Zhang

Faculty Mentor(s): Qiu Wang

Physical Sciences

**Abstract:**

1,3-aminodifunctionalized motifs are prevalent among biologically-relevant compounds and pharmaceuticals. The field of 1,3-aminodifunctionalization is disproportionately lacking relative to 1,2- and 1,4-aminodifunctionalization reactions of alkenes and dienes. However, due to the similar reactivity between cyclopropanes and alkenes, we can potentially extend alkene difunctionalization reactions to cyclopropanes.

My mentor and I have worked together to create a novel copper-catalyzed 1,3-aminodifunctionalization reaction that can generate synthetically-useful heterocycles. In addition to developing various conditions and testing the scope of this reaction, I have attempted to create a library of N-F reagents that can be used to fine-tune the reaction conditions. We have also developed cyclic voltammetry procedures for measuring the redox potentials of our cyclopropane substrates to gain insight into the reaction mechanism. As we finish this project, we are looking to extend this reaction to electrocatalysis, avoiding the need for external catalysts. This envisioned reaction would expand the scope of accessible heterocycles using cyclopropane scaffolds.

*ESPs: a new cost efficient sampler for expensive posterior distributions*

## Chen Shi

Faculty Mentor(s): Simon Mak

Quantitative Sciences

**Abstract:**

A key computational bottleneck for Bayesian inverse problems is the expensive evaluation cost of forward simulation models, which can require thousands of CPU hours for simulating complex physical processes. While state-of-the-art posterior sampling algorithms (e.g., Hamiltonian Monte Carlo methods) may be “sample-efficient”, i.e., they provide a good representation of the posterior given limited samples, such methods can be highly cost-inefficient, since they require at least one evaluation of the forward model per sample. Given a fixed computational budget, we wish to have a “cost-efficient” posterior sampler which yields a good representation of the desired posterior given limited forward model evaluations. We thus present a new sampler called cost-Efficient Stein Points (ESPs) for this goal. Our ESPs extend the recently-proposed Stein points in Chen et al. (2018, ICML), which makes use of a sequential minimization of the kernel Stein discrepancy for sample-efficient posterior exploration. The key novelty of ESPs is the use of carefully-constructed Gaussian process surrogate models of the kernel Stein discrepancy, which allows for cost-efficient sequential minimization via Bayesian optimization. We demonstrate the cost-efficiency of ESPs over state-of-the-art posterior sampling algorithms via a suite of numerical experiments and a calibration application for a falling object subject to drag.

*A Model Theoretic Approach To Natural Language Inference*

## Dennis Tang

Faculty Mentor(s): Sam Wiseman

Quantitative Sciences

**Abstract:**

We apply a model theoretical approach to natural language inference and introduce a new classification method. To simulate the model-theoretic hypothesis of entailment, we use natural language generated by a backwards language model to describe possible worlds, evaluate these possible worlds with a language model, and then search through them to determine entailment relations. We apply our method on pre-existing NLI datasets and demonstrate that our method shows promise in achieving high-levels of accuracy without requiring model training or the availability of a large corpora of training data.

*Neural networks as graphs: Topological summaries and generalization*

## Jesse Zhang

Faculty Mentor(s): Alexander Wagner

Quantitative Sciences

**Abstract:**

A longstanding problem of neural networks is their ability to generalize well despite their large number of parameters, defying conventional wisdom about overfitting. We approach the generalization problem by treating neural networks as graphs using two distinct constructions: dynamic graphs (Lacombe et al. 2021), which consider how an observation activates the connection between nodes, and static graphs (Rieck et al. 2019), which consider how certain edges between neurons have a larger influence over the output of a layer. We investigate whether or not topological features, specifically the persistent homology of the graphs, encode sufficient information about the training set labels (for dynamic graphs) or the generalization of the networks (for static graphs). Our results from both classification and regularization experiments demonstrate that persistent homology of dynamic graphs allow the recovery of associated labels while static graphs do not differentiate between networks with different generalization behavior.

*Geodesic Complexity of Convex Polyhedra*

## Jesse Zhang

Faculty Mentor(s): Ezra Miller

Quantitative Sciences

**Abstract:**

Geodesic complexity of the d-dimensional boundary S of a convex polytope of dimension d+1 is intimately related to the combinatorics of nonoverlapping unfolding of S into a Euclidean space R^d following Miller and Pak (2008). This combinatorics is based on facet sequences, which are lists of adjacent facets traversed by geodesics in S. The main result here bounds the geodesic complexity of S above by the number of distinct maximal facet sequences traversed by shortest paths in S. For d=2, results from the literature on nonoverlapping unfolding imply that this bound is polynomial in the number of facets. In arbitrary dimension d, reinterpretation of conjectures by Miller and Pak (2008) leads to the conjecture that the geodesic complexity of S is polynomial in the number of facets. The theory and results developed here hold more generally for convex polyhedral complexes.

*How Income and Educational Levels Impact Patient Choice of Doctor: A Systematic Review*

## Brooke Bier

Faculty Mentor(s): Cheryl Lin

Social Sciences

**Abstract:**

As patients become increasingly involved in healthcare decision-making, it is important to examine the drivers behind patient choice of doctor (PCOD), as the initial decision will have lasting impacts on patients’ trust of providers and outcomes. However, limited studies explored PCOD relative to socioeconomic status (SES) and health inequities. This review identifies and synthesizes preferences and priorities in PCOD across SES groups. We searched PubMed, PsycINFO, and Web of Science for relevant articles published between January 2007-September 2022 and screened using Covidence; included studies compared PCOD by income and educational levels. From 3,207 search results, we selected for review 24 articles (12 countries, 14 medical specialties, total of 31,139 participants). Higher SES individuals ranked physician characteristics (e.g., qualifications, empathy) or performance as more important than cost or convenience; lower SES individuals prioritized logistical factors (e.g., insurance coverage, distance) due to time or resources constraints and gaps in knowledge or awareness about options. Such variations in PCOD preferences were relatively consistent across countries, despite differing healthcare systems. Some patients, especially disadvantaged groups, favored same-gender physicians for intimate medical matters; this preference was not limited to conservative cultures. Few researchers investigated the outcomes of PCOD and indicated lower SES patients inadvertently chose, experienced, or perceived lower quality care. Patients’ decision criteria differed by SES even under universal systems with equal access, implicating the impact of social determinants. Health education to support patient decision-making and additional research on how SES affects PCOD are needed to improve health equity.

*Exploring the Role of AI Photo Analyzers in the Reification of Racism*

## Melany Fuentes

Faculty Mentor(s): Crystal Peoples and Nikki Washington

Social Sciences

**Abstract:**

The ever-evolving sphere of technology has caught the attention of sociologists as an increasing amount of person-to-person interactions are facilitated by technological advancements as well as more interactions with technology are taking place. This research is focused on the interactions of technology and society and the role photo analyzers play in the reification of racism. Photo analyzers have evolved from technology only able to recognize whether a face was present into technology that touts its potential to predict race or ethnicity of those analyzed; however, this Facial Recognition Technology (FRT) underperforms when tasked at identifying people from minoritized groups (Buolamwini and Gebru 2018). The risks associated with FRT disproportionately affect individuals from minoritized groups through misidentification and dangerous use of surveillance(Lunter 2021; Perkowitz 202; Stevens and Keys 2021). Furthermore, the computerized labeling of race and ethnicity has yet to be rigorously tested on a diverse population composed of individuals of mixed race and/or ethnicity. In addition, the widespread belief that technology is free from bias poses serious risks for marginalized groups. This study focused on the collection of biographic information from participating individuals, the examination of the role of facial analyzers in society, and research on understanding the algorithms behind the labelling of race and ethnicity by photo analyzers. Future direction includes the analysis and interpretation of participant images.

*Can I Still Trust You? Late Trust Violations Hinder Subsequent Cooperation*

## Megan Gerges

Faculty Mentor(s): Ashley Harrell

Social Sciences

**Abstract:**

Trust is necessary to build and maintain human relationships and for society to function properly. Therefore, being able to rebuild trust after it has been broken is also significant. I conducted an experiment to explore how the timing of a trust violation (whether it came early on in a long-term interaction, before a relationship is established, or later, after a cooperative relationship had been established) impacts subsequent behavioral and attitudinal trust in United States participants, based on whether the interaction partner is an ingroup or outgroup member (using political ideology as the salient social identity). I found that, overall, late trust violations were more detrimental to subsequent trust than early trust violations. However, I did not find a significant difference in trusting behaviors and attitudes between ingroup and outgroup pairings, nor a significant difference in how the timing of the trust violation impacted subsequent behavioral trust between ingroup pairings and outgroup pairings. Nonetheless, there was a significant difference in how the timing of the trust violation affected subsequent trusting attitudes for ingroup pairings: among ingroup members, trust was higher after an early trust violation than a late one. Ingroup partners were also more likely to engage in behavioral trust in the first round, before any trust violation had occurred, suggesting that an ingroup effect was present, but was nullified over the course of the longer-term interaction. Ultimately, this study demonstrates the importance of a pattern of trustworthy behavior over time in building relationships and suggests that an ingroup bias does not preclude similar kinds of cooperation between outgroup members.

*Developing a skin cancer prevention resource for migrant farmworkers in North Carolina*

## William Hayes

Faculty Mentor(s): Dennis Clements

Social Sciences

**Abstract:**

emailing abstract in email thread

*Latinx: Race or Ethnicity?*

## Nicole Izquierdo

Faculty Mentor(s): Sarah Gaither

Social Sciences

**Abstract:**

Despite the fact that one in four children in the U.S. today is Hispanic/Latinx, we still do not clearly know the developmental trajectories that lead to more positive Latinx identification. What factors predict why some Latinx children think “Latinx” is a race and others an ethnicity, and how is that choice influenced by parents? The present study will examine individual differences to understand why some children see Latinx as a race or ethnicity as well as the consequences related to different construals. Children will receive two demographic forms, one identical to the current U.S. standard which includes Latino only as an ethnic category, and another form including Latino as a racial category. Participants will be asked to read over both forms and then choose one. They will be asked why they believe their Latinx identity is a race or an ethnicity. Children will then self-report their skin tone by selecting one of eight Crayola Multicultural Crayons (vary in skin tone from light to dark). Participants will also be asked questions about perceived discrimination, racial-ethnic socialization, and self-esteem. Despite only 19% of Hispanics in the U.S. categorizing their Latino identity as an ethnicity, federal policy still defines “Hispanic” as an ethnicity, which creates an institutional form of social exclusion and threatens one’s sense of belonging, which can then impact one’s psychological well-being. Apart from addressing these previously unexplored ambiguities in categorization, the current research acts as the first step in no longer conflating race and ethnicity, especially within Latinx individuals, reducing identity confusion, and potentially influencing belonging and mental health outcomes.

*Play by the Rules: Three-Year-Olds’ Normative Understanding of their own Games*

## Isabella Larsen

Faculty Mentor(s): Michael Tomasello

Social Sciences

**Abstract:**

Children as young as three-years-old enforce adult-made rules as normative standards that are objective and enforceable across contexts and across agents, and older children, between ages five and seven, enforce their own self-made rules as normative to a third party. There is a gap in the literature as to whether 3-year-olds treat their own rules as normative. The aim of this study was to investigate whether 3-year-old children would enforce their own rules at different frequencies when normative versus non-normative language was used to frame the task. In this experiment, three-to-four-year-old children collaborated with a peer puppet over a video call to either create a way to play (No Rule condition) or a game with rules (Collaborative Rule condition) using materials without a clear, previously-prescribed way of playing. We explored whether children would protest or express surprise when their rules were not followed appropriately and whether they would explicitly state that their rules must be followed as a measure of flexibility to new ways of playing. In response to observing their games played incorrectly, a quarter of the three-year-old participants protested using either normative language, imperative language, or displaying a hint of protest. There were no differences in protest rates, expression of surprise, or flexibility between conditions. Among children who protested, those in the Collaborative Rule condition tended to protest quicker than those in the No Rule condition. At age three, children are at the cusp of acquiring a nuanced, sophisticated, and sensitive view of normativity that applies to even their own arbitrary rules created during a low-stakes game.

*An Evaluation of the Durham DEAR Program: Comparing Participant and Staff Perspectives*

## Katherine LoBue

Faculty Mentor(s): Anna Gassman-Pines

Social Sciences

**Abstract:**

In North Carolina, criminal debt from low-level traffic infractions is a serious issue, and one that disproportionately affects communities of color. Losing one’s license, a typical punishment for these infractions, contributes to a cycle of poverty and imprisonment, in addition to posing barriers to employment, housing, and fulfilling family life. Moreover, restoring a suspended license requires attorney representation, which is typically too cumbersome for individuals unable to pay fines and fees in the first place. In response to these issues, the Durham Expunction and Restoration Program (DEAR) was founded in 2018 to increase access to driver’s license restoration and expunctions in Durham, North Carolina, primarily through mass fee relief. This study explores how DEAR participants access and utilize DEAR, comparing their experiences to DEAR-affiliated professionals’ perspectives of the program. Semi-structured qualitative interviews were conducted with 39 DEAR participants and 11 DEAR-affiliated professionals. Findings from DEAR participant interviews suggest that very few licenses were restored through DEAR, legal issues outside of Durham present barriers to restoration, and participants face confusion, poor communication, and administrative barriers while utilizing the program. Findings from DEAR-affiliated professional interviews show that DEAR staff are overworked, and the program needs more resources; professionals believe that DEAR should be expanded outside Durham to reach more people, that DEAR requires organizational changes to smooth professionals’ complaints, and that challenges with participant communication impede DEAR’s success. Comparison of DEAR participant and DEAR-affiliated professional perspectives display how mass fee relief in its current state may not successfully address the multi-faceted issues related to driver’s license suspension and restoration.

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*The Effects of “We” Framing and Group Participation on Young Children’s Sense of Commitment*

## Maya Provençal

Faculty Mentor(s): Michael Tomasello

Social Sciences

**Abstract:**

Around 3 years of age, young children can reliably collaborate with a peer and experience a normative sense of joint agency, “we”, which results in a sense of commitment to their collaborative partner(s). The present study investigated whether this sense of commitment could be induced in young children, ages 2.5 - 3.5-year-olds, using experimenter verbal framing. Additionally, we investigated whether this sense of commitment manifests differently in dyadic or group situations. Thus, subjects participated in a “we” framing specific condition, where collaborative partners repeatedly structured games with “we” statements ie. “we can go over here”, or a “you” framing condition, where the pronoun “you” was used exclusively. The experiment for all subjects consisted of two online test conditions where all participants played a collaborative game with a partner and a group. The dependent measure was the level of commitment, gauged through the child’s time spent playing with their collaborative partner(s) and when they took leave of this collaborative game to engage in a more “tempting” activity. Bayesian hierarchical models were run on the data, revealing that young children demonstrate more commitment to dyadic partners than a group of partners, and that “we”-framing with an individual partner induced the greatest sense of commitment in young children.

*Why Students Hate Group Projects: Understanding Psychological Barriers to Collaborative Work*

## Alissa Rivero

Faculty Mentor(s): Bridgette Hard

Social Sciences

**Abstract:**

Collaborative learning has many benefits, including preparing students with interpersonal skills necessary for the workplace and increasing student engagement and information processing, encoding, and retention. Within the Psychology major, research methods and statistics courses are especially good venues for collaborative learning. Yet, students frequently dislike group work and approach it in ways that may undermine its benefits. The present study aims to examine student attitudes about group work across semester-long group projects in two undergraduate courses in psychology methods and statistics, to identify psychological barriers to benefiting from group work. We surveyed 72 students enrolled in a psychology methods and statistics courses that required a semester-long group projects at a selective university in the southeast United States. At the beginning and end of the semester, we examined attitudes about group work in general using quantitative (Ludlum et al., 2021) and qualitative measures. Additionally, after completion of project milestones, we examined students’ experiences of cognitive load (Korbach et al., 2018) and feelings of group interdependence and accountability. In addition to surveys, we held focus groups to better understand student attitudes. In analyzing these data, we seek to better understand how students feel about group work in general, whether their attitudes changed throughout the semester, and what aspects of their experience predicted such changes. We were interested in whether students who like group work the least are those who experience low levels of accountability and high levels of cognitive load related to coordinating with group members. Ultimately, identifying psychological barriers that prevent students from benefiting from and enjoying group work will inform future pedagogical interventions.

*Gender Transgressed: Trans vs. Cisgender Felt Pressure, Gender Typicality, and Mental Health*

## Kiran Sundar

Faculty Mentor(s): Nancy Zucker

Social Sciences

**Abstract:**

Gender stereotypes are pervasive parts of our culture, and they can change the way we feel about ourselves. Previous studies in cisgender children suggest that boys and girls experience different levels of (1) felt pressure to conform to gender stereotypes and (2) gender typicality, or self-perceived similarity to gender groups. Studies also find that high felt pressure to conform to gender stereotypes is associated with worse mental health outcomes. However, there is limited research on how transgender individuals experience felt pressure and gender typicality, and whether these experiences are associated with worse mental health. My study aims to fill this gap by comparing felt pressure and gender typicality in cisgender vs. transgender adults and by investigating whether gender moderates the relationship between felt pressure and mental health, as measured by self-esteem and psychological distress. Analyses found that cisgender men felt pressure to avoid behaving in accordance with feminine stereotypes, while cisgender women, transgender men, transgender women, and nonbinary people felt pressure to conform to them. Cis women felt the least pressure to conform to or avoid masculine stereotypes, while all other groups felt pressure to conform to them. Cis men had significantly higher same-gender typicality than cis women and nonbinary people. Trans women and trans men had significantly higher other-gender typicality than cis men and cis women. The negative correlation between feminine felt pressure and self-esteem was moderated by gender. The positive correlation between feminine felt pressure and psychological distress was moderated by gender. The present study finds that transgender people do not always experience gender stereotypes similarly to their cisgender counterparts, so previous findings in cisgender people cannot consistently be applied to transgender people. Nonbinary people did not significantly differ from binary groups in this study, so more research should be conducted on nonbinary experiences of gender stereotypes. The present study also found that gender moderates the relationship between feminine felt pressure and both indexes of mental health, suggesting that different gender groups may internalize and respond to feminine felt pressure differently. This difference could hold implications for identity-specific mental health interventions in contexts where certain gender groups experience heightened levels of feminine felt pressure.

*Game On: Stopping Athletics from Being the Sole Path for Black Male Success*

## Khilan Walker

Faculty Mentor(s): Andrew Nurkin

Social Sciences

**Abstract:**

Lebron James or a lawyer? This question holds weight once you contextualize it. Black boys all across America are being indoctrinated to believe that their greatest asset, their most impressive showing of masculinity, their best chance at prosperity, is their athleticism. Within schools, communities, and even many families, Black boys are being pushed toward sports and away from fields such as academics, the arts, music, and much more. Black athletes are displayed as great, while Black lawyers, doctors, and entrepreneurs are ignored. Within the U.S, Black boys are not given the right resources to pursue success in whichever field they desire. Instead, they are lured into the entrapment of sports, a multi-billion-dollar industry that benefits from Black athleticism at ages as young as recreational leagues all the way to the collegiate and professional levels. Black boys deserve more exposure and encouragement into education and other fields, to the same extent as they are exposed to and encouraged into sports. In my research, I consider this issue at-large and analyze what can be done to combat this. Through analyzing group dynamics, educational discrimination, and sports psychology I arrived at an answer that begins with unity. Within the many communities of the U.S—whether it be in the Metro, suburban, or rural areas— community collaboration is needed to bring about significant change to this dilemma. Such collaboration involves me and you; family members and school staff members; Black men who have succeeded in outside of athletics and Black athletes.

*How Suspicion 911 Calls in New Orleans Reshape Our Understanding of the Power Threat Hypothesis*

## Benjamin Wallace

Faculty Mentor(s): Maria Febbo

Social Sciences

**Abstract:**

Recent high-profile occurrences of 911 activity involving white callers and Black targets have directed scholarly and popular attention toward the racialized nature of 911 call systems. This study adopts the threat hypothesis to assess variation of calls reporting suspicious activity, disturbances, trespassing, and prowling. Using call records from the New Orleans Police Department from 2019 to 2021, this study found evidence contrary to the hypothesis. Neighborhoods with higher percentages of Black residents reported relatively fewer suspicion-related calls per 1,000 residents compared to whiter neighborhoods. In addition, political and economic threat variables did not significantly explain call rates. The methodological limitations and alternative explanations of this study are discussed.

*Reimagining Proximity and Intimacies in Chinese Queer Feminist Organizing*

## Huiyin Zhou

Faculty Mentor(s): Ralph Litzinger

Social Sciences

**Abstract:**

This (auto)ethnographic research is part of a thesis project investigating the strategies of political translation in diasporic Chinese feminist communities. Focusing on PRC feminists who are or have been international students in the United States, this project hopes to understand how multiple geopolitical fissures influence experiences of marginality and political (in)articulation. Theorizing from organizing experiences from the ground, my scholarship centers grassroots groups including the Chinese Artists and Organizers Collective (CAO离离草), the North Carolina Chinese Queer Feminist Group and beyond. Drawing from feminist theories of affect and intimacy, I think beyond a Western private-public dualism, and focus on Chinese feminists’ creative, intimate articulations of what it means to be in proximity and in relation to/with arrested protestors, victims of violence, feminist comrades, and local communities. How do Chinese feminists struggle to translate experiences of being an uprooted non-citizen in diaspora and exile (“nowhere”) into political empowerment in local and transnational social movements (“now, here”)? I hope to understand how political translation across linguistic, cultural, and political borders engenders a Chinese feminist politics that could reimagine a social movement built on relations. My dual identity as a community organizer and researcher will enable grounded participant-observation in activist spaces, dedicating this research to an urgent community need to theorize alternative ways towards collective liberation.

*Asset-Based Approaches and Multilingual Learner Parent-Teacher Relationships*

## Sarah Zimmerman

Faculty Mentor(s): Leslie Babinski

Social Sciences

**Abstract:**

Although strong parent-teacher relationships are pertinent to students’ achievement and well-being, there are many common barriers to effective parent-teacher relationships, such as miscommunication and misalignment of beliefs or expectations. This study investigates one possible way to overcome these challenges: increasing teachers’ understanding of families’ cultural wealth and the application of that knowledge utilizing asset-based approaches. Using pilot study data collected from 23 classroom teachers and 44 parents, this study examined how teachers’ incorporation of families’ cultural wealth- specifically their familial and linguistic capital- into the classroom and their interactions with families impacts parent perspectives on the parent-teacher relationship (as measured by communication, cultural wealth, parental engagement). The results of multi-level modeling showed no significant effects of teachers’ inclusion of familial or linguistic capital into the classroom or relationships on parent sentiments regarding communication, cultural wealth, or parental engagement. The findings showed meaningful medium-sized effects of teachers speaking a little bit of Spanish on all three measured aspects of the parent-teacher relationship. These findings suggest measuring specific components of cultural wealth requires complex and nuanced measures with multiple sources of information (e.g., qualitative interviews, observational data) to capture the complex relationships between multilingual families and teachers.