

Undergraduate Research Opportunity Program 2019-2020 Abstracts Presentations at Virtual RaCAS – CU Denver – May 1, 2020

Efficient Estimation of Hidden Ancestry Substructure in Summary Genotype Frequency Data

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Abstract:

Modern genomic research has advanced at a rapid pace, resulting in ever-expanding online genetic databases. Some of the data has heterogeneous ancestry, such as the African/African-American group within the Genome Aggregate Database (gnomAD). Lack of precise ancestry information can lead to confounding in association studies and incorrect prioritization of putative causal variants. Ancestry differences between the database and a user's sample limits the utility of the database especially for heterogeneous or understudied ancestral groups such as Latinx populations.

We present a method to estimate the proportion of reference ancestry groups within these genetic databases. Our method uses sequential quadratic programming to estimate the mixture proportions in seconds and enables us to estimate error for the ancestry proportion estimates. We use the estimated ancestry proportions to update the database's expected allele frequency to match the ancestry of the user's sample, increasing the utility of these genetic databases.

We evaluate our method in thousands of simulation scenarios and in real data using a reference panel that includes 1000Genomes super-populations (non-Finnish European, South Asian, East Asian, and African) and Indigenous American ancestry. Across all simulation scenarios, we obtain ancestry proportion estimates with 0.05% accuracy and precision. Within the gnomAD African/African-American group we estimate 82.49% African, 15.66% European, 0.84%

Indigenous American, 0.51% South Asian, 0.50% East Asian. We then use these ancestry estimates to provide updated allele frequency estimates for 100% African gnomAD ancestry to allow for better use of this genetic resource for African samples.

Effect of High-Altitude Residence on Placental Trophoblast Invasion of Maternal Spiral Arteries

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Abstract:

Vascular disorders of pregnancy, including preeclampsia and intrauterine growth restriction (IUGR), are important public health issues due to their association with increased perinatal and later-in-life morbidity and mortality. Preeclampsia and IUGR are more common and uterine artery blood flow reduced at high altitude (HA, >2500m) compared to lower altitudes (LA) in Colorado. Extravillous trophoblast invasion is critical in the establishment of uteroplacental blood flow and is reduced in IUGR and preeclamptic pregnancies. We hypothesize that residence at HA also reduces extravillous trophoblast invasion. To test this hypothesis placental samples were collected at term delivery from healthy women residing at LA (<1700m) and HA in Colorado. Placental sections collected from 14 LA and 15 HA were selected for analysis based on the preservation of (maternal) decidual tissue and the presence of spiral arteries. Placental sections were cut, oriented on slides and triple stained using the antibodies for maternal vascular endothelium (CD31), maternal vascular smooth muscle cells (α-smooth muscle actin), and fetal trophoblast cells (cytokeratin 7). To quantify trophoblast invasion, our ongoing analysis evaluates the extent to which extravillous trophoblasts have replaced decidual endothelial and smooth muscle cells of the maternal spiral arteries. For these analyses, trophoblast invasion is quantified in three regions of the decidua: the most proximal 25% portion (closest to the placental villi,) the middle 50%, and the most distal 25% region. We expect that trophoblast signals will be reduced in HA women in the most distal region, and to a lesser extent in the middle and proximal regions.

Estrous Cycle Modulation of Fear Extinction and Relapse

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Abstract:

Women are at a higher risk than men to develop common stress-related psychiatric disorders such as post-traumatic stress disorder (PTSD). Similarly, to humans, female rats experience a 4-day estrous cycle during which the fluctuation of ovarian hormones can impact stress-related behaviors. We have shown that increasing DA signaling in the nigrostriatal dopamine pathway (dopamine neurons in the substantia nigra projecting to the dorsal striatum) during fear extinction can reduce fear relapse. Females in the proestrous phase (Pro) have increased dopamine release in the striatum. We hypothesized that estrous phase influences neural circuits recruited during fear extinction and renders fear extinction memories resistant to relapse in Pro females. 24 Long-Evans rats were used in this study (8 male, 16 female). Female cycle progression was monitored daily. All subjects underwent auditory fear conditioning. The following day, subjects were exposed to fear extinction training. 24 hours later rats were re-exposed to the conditioned tone in either the same or a different extinction context to test for renewal of previously extinguished fear. A week later, rats were placed in their original extinction context and tested for spontaneous recovery of fear. Preliminary results suggest that estrous phase of females during fear extinction can impact fear relapse. Females in pro-estrus during fear extinction had less renewal and spontaneous recovery compared to males rats and not Pro females. These data suggest that Pro females have increased protection of relapse following fear extinction, pointing to a possible mechanism of interest to support exposure therapy for PTSD.

Avoidant Coping Mediates the Relationship Between Mindfulness and Performance-Based Anxiety & Test Anxiety

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Abstract:

The threat of negative social evaluation is a common stressor. In employment or academic settings these threats present during job performance reviews, presentations, and knowledge-based tests. Exposure to, or anticipation of, social evaluative threat can cause significant anxiety. Whereas anxiety can be created, maintained, or exacerbated by avoidance, there is evidence that mindfulness can undermine avoidance. Individuals who are mindful, then, may be less likely to cope with anxiety by using avoidance. The present studies tested the hypothesis that avoidance-based coping would mediate the relationship between mindfulness and two forms of social evaluative anxiety: performance-based anxiety (Study 1) and test anxiety (Study 2). Study 1 included a nationwide sample of adults (N = 342), recruited via Amazon Mechanical Turk. Study 2 included a sample of undergraduate students (N = 120) from the University of Colorado Denver. Both studies utilized a cross-sectional design, identical statistical analytic strategies, and the following measures: three subscales of the Brief COPE questionnaire, the Mindful Attention and Awareness Scale, the Liebowitz Social Anxiety Scale (performance items only; Study 1), and the Test and Examination Anxiety Measure (Study 2). Consistent with hypotheses, avoidance-based coping mediated the relationship between trait mindfulness and performance-based anxiety (Study 1) and test anxiety (Study 2), such that individuals with higher trait mindfulness used less avoidance-based coping and experienced less anxiety. Due to the cross-sectional nature of these studies, future research should aim to verify the causal direction of these relationships.

Does Prenatal Stress Affect Postpartum Depression of Mothers with a GG OXTR Genotype?**Student Author:**

Victoria Beresford (UROP Recipient)
Psychology

Faculty Mentor:

Lindsey Hamilton
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Abstract:

Oxytocin is a neurotransmitter and a hormone that modulates social and emotional behaviors linked to bonding and empathy. Research in the field has indicated that individuals carrying a G allele on the rs53576 gene, which codes for the oxytocin receptor (OXTR) genotype, may be

more adept at inferring the mental state of others and managing levels of stress. However, other sources have indicated that individuals carrying the G allele may be more susceptible to higher rates of depression and antisocial behavior. Unfortunately, these conflicting results could lead to further issues for mothers experiencing prenatal stress, as the interaction between the environment and the mother. OXTR genotype could influence the attachment between the mother and her new infant. In this study, I will address the conflicting research by conducting a literature review to determine if mothers carrying a G allele on the rs53576 gene will be more susceptible to prenatal stress in their environment, and if prenatal stress moderates the severity of the mothers, postpartum depressive symptoms. For new mothers carrying a G allele on the rs53576 gene, it is important to determine the effects the OXTR genotype has on bonding between the mother and the infant in order to ensure the best outcomes for the mother and the child. In the future, these research findings should be referenced in order to identify the best supportive measures for mothers in stressful environments and for mothers experiencing postpartum depression.

Investigating the Effects of Zar2 on Early Development by Using Engineered Mutants

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Biology

Faculty Mentor:

Amanda Charlesworth
Biology

Abstract:

Although a great deal is known about early development in general, there is still so much that is not understood about early development, which includes meiosis, fertilization, and embryogenesis, at the cellular level, such as the mechanisms that regulate the formation of viable eggs, or meiosis, and the development of the embryo, or embryogenesis. The purpose of this investigation was to understand the effects that zygotic arrest 2 (Zar2) protein has on the formation of viable eggs. Zar2 is made up of two functional regions: one region is the translational control domain (TCD), which contains a region conserved across vertebrate species, and the second region is the RNA binding domain, which is where Zar2 binds to RNA. Zar2 has been shown to bind to maternal mRNAs, such as Wee1, and regulate translation. To investigate normal Zar2's function, an engineered mutant that has the TCD deleted but has the RNA binding domain still intact was used. This mutant Zar2 will still bind to RNA, however, won't be able to regulate translation. This mutant was injected into *Xenopus laevis* oocytes, at concentrations I optimized so that it would outcompete endogenous Zar2, and then amounts of Zar2 and MS2 were measured via western blot to assess the extent to which the Zar2 mutant

outcompete wildtype Zar2. When the oocytes injected with the Zar2 mutant were matured, an inhibition of meiosis was observed, indicating that Zar2 plays a crucial role in the formation of viable eggs.

Temporal Analysis of Ecological Responses to Climate Variability in a Subalpine Environment

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Geography

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Geography

Abstract:

This study provides a reconstruction of past changes in forest composition and fire in response to past shifts in climate during the last 6,000 years. The climate events of interest are the Medieval Climate Anomaly (MCA: 850 - 1250 cal yr BP), the Little Ice Age (LIA: 200 - 600 cal yr BP), and a regional precipitation shift ~3,000 cal yr BP.

This was accomplished by retrieving environmental proxy data from an 11 meter sediment core from Beaver Lake in Southern Colorado.

Beaver Lake is at a ecotone between steppe and forest. In the past climate change has significantly influenced the vegetation around the lake and the fire activity. Summer moisture is a significant driver of fire at the site. When summers are cool and wet, forests expand to lower elevations and fire activity increases. However, warm and dry periods cause steppe to expand and fire activity declines.

As the climate continues to change, it is important for us to understand how ecosystems and our climate have changed in the past if we are to understand how they will change in the near future.

Chronic synthetic cannabinoid administration may produce tolerance to the dopamine releasing effects of heroin

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Abstract:

Overdose deaths involving opiates have increased 4 fold over the last two decades (NIDA, 2020). Many have sought to elucidate the underlying neural mechanisms of opiate addiction and the factors which increase susceptibility to the addictive process. All drugs of abuse are thought to increase a neurotransmitter called dopamine. Our lab uses fast-scan cyclic voltammetry to measure subsecond dopamine release events in the nucleus accumbens shell of rats during intravenous (IV) heroin administration. These release events are necessary and sufficient for drug-induced neural plasticity (Oleson and Roberts, 2019). We recently found that repeated self-administration results in a blunted ability of heroin to evoke transient dopamine release events, accompanied by an increase in daily consumption. Our lab has also observed that the synthetic cannabinoid WIN 55,212-2 produces tolerance to its dopamine releasing effects (Gomez SFN, 2017). Reports show that the use of cannabinoids, and hospitalizations related to cannabinoid use, have been growing (Zhu, 2017). Additionally, cannabinoids and opiates are known to produce cross tolerance to some of their shared neurobehavioral effects, i.e. hypothermia, sedation, and antinociception (Manzanares, 1999). Based on this, we sought to investigate whether exposure to cannabinoids produces a cross tolerance to heroin, ability to increase dopamine. Following a period of chronic synthetic cannabinoid exposure we administered heroin and measured dopamine release. Preliminary data indicate that cannabinoid exposure may lead to lower initial dopaminergic activity, and a blunted response to heroin. These findings support that synthetic cannabinoid use may increase susceptibility to the development of heroin addiction.

Disparities in dangerousness: Quantifying differences in threat across race and mental health status groups during police lethal force events

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Abstract:

Research on police use of lethal force has shown that people with mental illness, particularly those of color, are more likely to be killed by police than people without mental illness and are less likely to be armed with a gun when killed. This research assesses whether situation-specific threats beyond weapon type help explain increased lethal force in these populations.

Subject names, incident dates, and locations were gathered for N = 1114 police lethal force events in the United States in 2018 from the Washington Post Police Shootings and Fatal Encounters databases. Area news reports were used to collect data on situation-specific threats like time, location type, and threats or violence. Data were scored based on association with police injury in previous research producing a threat score (6 to 54) for each event. Mean scores were compared for subjects with and without signs of mental illness (MI and NMI) across the entire sample and in subsamples of reported race using independent t-tests. Secondary analysis reclassified MI to include only events known to be mental health crisis before contact.

Preliminary results suggest that lethal force events involving mentally ill people and people in mental health crisis are less threatening to police even when considering a variety of factors beyond weapon type. Threat score disparities appear to be larger in people of color, especially Black subjects in crisis, suggesting that interventions addressing disparities in lethal force should be especially focused on this population.

Resilience: a potential protective factor for acute pain and pain catastrophizing

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Abstract:

Current research investigating resilience and its effect on chronic pain suggests that it may serve as a protective factor by decreasing several pain-related factors such as pain tolerance, pain sensitivity, and total pain. Although the role that resilience plays in the experience of chronic pain has been widely researched, there remains a lack of research exploring the relationship between resilience and both pain catastrophizing (how one subjectively quantifies pain) and acute pain experiences. This study aims to: (1) understand how resilience relates to acute pain experiences and pain catastrophizing and (2) explore potential of resilience serving as a protective factor for acute pain experiences to better adapt pain-related interventions that may protect against future chronic pain. The current study utilized a cold-water task to test the relationship between resilience and acute pain experience, pain-related factors, and pain catastrophizing (PC) in a sample of college students. We found several significant correlations including total resilience scores & total PC scores, pain sensitivity & total pain, pain tolerance & total pain, and sensitivity & pain tolerance. Exploratory analysis revealed the relationship between total resilience scores and total PC scores was mediated by age. What we observed suggest that both resilience and increased age can be a potent predictor of how one catastrophizes their pain. Additionally, we found that several pain-related factors are reliant on one another in many aspects, however resilience could not reliably predict any pain-related factor. Future direction regarding pain-related intervention suggests manipulating resilience to be a mechanism to reduce PC.

Historical occurrence of intersex in Largemouth and Smallmouth Bass**Student Author:**

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Biology

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Abstract:

The widespread occurrence of gonadal intersex (presence of testicular oocytes) has been recently reported in populations of Largemouth Bass (*Micropterus salmoides*) and Smallmouth Bass (*Micropterus dolomieu*) from populations across North America. To evaluate the historical occurrence of intersex in bass species, gonads were examined visually and histologically from museum specimens of the bass collected from 16 States. These fishes were collected between 1823-1965, before the widespread discharge of estrogenic chemicals to surface waters via wastewater effluents. All females examined had normal ovaries. Intersex gonads were identified in 17.8 % of male Largemouth Bass, and in 14.2% of male Smallmouth Bass. The intensity of testicular oocytes in some males was as great as observed since 2000. These results

indicate that the occurrence of this form of intersex in these bass species is not a recent phenomenon.

What do bees eat in resource-limited environments?

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Abstract:

Bees are keystone species that pollinate many of our food crops. Urban and agricultural landscapes are considered to have limited resources for pollinators. There is increasing and needed demand for local food production; however, it is unclear if there is both a diversity and abundance of food resources for bees to sustain healthy populations. The CU Denver Bee Project has been collecting and measuring pollen and nectar resources for honey bees from 30 colonies placed in downtown Denver, suburban Littleton, and a rural and intensely cultivated site in western Colorado. In comparison to suburbia, nectar production was low in downtown and cultivated landscapes, while pollen production was highest in those locations and low in suburbia. While honey bees are generalists, they prefer insect-pollinated plants that produce nutritious pollen and often have a nectar reward for visitors. In suburbia, the bees were sourcing mainly these nutrient-rich pollen types; however, in downtown and agricultural locals, they were bringing in wind-blown pollen which is produced in abundance by many forbs and urban trees in the semi-arid West. Wind pollen is low in nutrients and cannot sustain healthy bees. The results suggest that urban and agricultural regions of Colorado supply bees with copious amounts of low-quality food to sustain their colonies. In suburbia, more open space and gardens supply better quality resources for bees. The study highlights the importance of planting pollinator-friendly resources, but also the use of honey bees, pollen and nectar in determining habitat quality in resource-limited environments.

Understanding the Role of the Unfolded Protein Response on Innate Immune Sensing by RIGI

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Abstract:

The unfolded protein response (UPR) is a highly conserved reaction to endoplasmic reticulum (ER) stress caused by an accumulation of unfolded or misfolded proteins. Activation of the UPR resolves cell stress by proteostasis or apoptosis. Inositol requiring enzyme 1 (IRE1) is an essential ER transmembrane protein that activates the UPR through its RNase activity, which produces anomalous splicing of X-box protein 1 (XBP1) messenger ribonucleic acid (mRNA). IRE1 also functions in IRE1- dependent-decay (RIDD), where ER-associated mRNAs are cleaved to maintain proteostasis. RIDD produced RNA fragments are suggested to cause inappropriate activation of retinoic acid-inducible gene 1 (RIG-I), a pattern recognition receptor (PRR), initiating a type I interferon response. We propose to identify RIDD produced RNA fragments that may activate RIG-I by identifying IRE1 downregulated mRNAs in XBP1-null cells and determine how mutations in RIG-I affect binding and activation with these RNAs. We are generating XBP1 knock-out cells using homology-directed CRISPR-Cas9 editing and have validated ribonucleoprotein complexes in vitro. To identify specific RIDD cleaved RNAs, we will compare IRE1 activated cells with IRE1 inhibitor, 4CE[®]8C, treated cells using mRNA sequencing to identify downregulated RNAs. Concurrently, we are generating plasmids expressing WT or mutant RIG-I through site-directed mutagenesis. We will express these plasmids in cells and activate IRE-1 to determine how RIG-I mutations affect RIG-I activation by RNAs cleaved during RIDD. These experiments will enable us to identify RNAs cleaved during RIDD and determine how endogenous RNAs bind and activate RIG-I.

Sex differences in voluntary exercise behavior**Student Author(s):**

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Abstract:

While various physical and mental health benefits of exercise are well known, this knowledge has not yet translated into increased exercise behavior among humans. In fact, participation in

physical activity is decreasing. Rats provide a useful translational model as they, like humans, engage in voluntary exercise behaviors. Additionally, the positive physiological impacts of wheel running on rats resemble many of the health benefits of exercise in humans. However, very little of this research has been conducted with female rats due to additional work and difficulty in controlling for the estrous cycle, which has a pronounced impact on physical activity. Our research aims to begin to address this deficit by characterizing sex differences in voluntary exercise behavior. Adult male and cycling female Long-Evans rats were singly housed with in-cage running wheels for 4 weeks. Females were lavaged daily to track estrous phase and running distance was collected nightly. Initial results suggest that female rats run greater distances than males starting from the first night of wheel access. This sex difference is most pronounced when females are in the proestrus phase of the estrous cycle, when estrogen levels are highest. Nightly running distance escalates more quickly in females than it does in males, reaching a plateau after only 1 week. The circadian pattern of wheel running behavior is similar between sexes, wherein the majority of running occurs in the active cycle. During proestrus, however, females engage in wheel running behavior prior to the start of the active cycle. Most interestingly, the estrous phase females are in during the start of wheel running has a dramatic effect on later exercise behavior. Females which start wheel running during proestrus display greater running distances during subsequent days, compared to females which started running during any other estrous phase. This difference is most pronounced during later proestrus, suggesting that starting wheel running behavior in proestrus produces a state-dependent priming of exercise behavior. Further analyses of running speed and circadian rhythms of exercise behavior are ongoing. Our data reveal novel sex differences in voluntary exercise behavior, and suggest that ovarian hormones have a profound influence on voluntary exercise. Further, these data suggest that hormones present specifically at the onset of an exercise regime may prime the neural circuits controlling later exercise behavior in a state-dependent manner.

Group B streptococcal surface adhesin protein promotes GBS interaction with cervicovaginal epithelium

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Abstract:

Streptococcus agalactiae, also known as Group B *Streptococcus* (GBS), is a Gram-positive bacterium that colonizes the reproductive tract of up to 30% of healthy women and can infect

newborns. GBS is the main infectious agent of neonatal bacterial meningitis, resulting in 10-15% mortality. Bacterial meningitis is an infection of the central nervous system (CNS) that transpires following bacterial penetration of the blood-brain barrier (BBB). A surface protein on GBS, Group B Streptococcal surface protein (BspC) has been shown to facilitate adherence of GBS to the BBB, advancing meningitis progression.

Since it is known that GBS colonizes the female cervicovaginal tract, we explored the role of BspC in this environment. We infected human vaginal (VK2), ectocervical (ECT1), and endocervical (END1) cells with wildtype GBS and mutant strains lacking BspC and observed that Δ bspC mutants exhibited a reduced ability to adhere to all three cell lines compared to the wildtype strain. This phenotype could be complemented by expressing the bspC gene on a plasmid in the Δ bspC mutant strain. In silico sequence analysis of GBS clinical isolates showed that the presence of a complete bspC gene correlated with increased GBS adherence. Finally, using a murine model of GBS vaginal colonization, we observed that the Δ bspC mutant strain was outcompeted by wildtype GBS and exhibited a decreased ability to cause ascending infection through the cervix and into the uterus. These results demonstrate the importance of BspC to GBS vaginal colonization and infection, and further suggest that BspC may represent an appealing therapeutic target.

Mode of Delivery, Breastfeeding Patterns, and Postpartum Depression

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Abstract:

Background: Due to the surgical nature of cesarean sections, the early relationship between mother and infant is affected by mode of delivery and associated with a lower probability of breastfeeding, which in turn may affect maternal mood. Postpartum depression (PPD) has been linked to delays in infant cognitive development. We examined relations between mode of delivery, breastfeeding, PPD, and infant cognitive development in mothers and 4- to 14-month-old infants.

Methods: Participants (mother and baby) were recruited through Facebook and completed anonymous surveys assessing their depression levels, breastfeeding patterns, and mode of delivery (vaginal vs. cesarean section). We measured child cognitive performance using the Bayley Scales of Infant and Toddler Development, 3rd Edition (BSID-III), which assesses cognitive and communicative development in relation to age-based norms.

Results: Results from 270 mothers showed that mothers who had a caesarian delivery were less likely to breastfeed than mothers who had a vaginal delivery (48.0% vs. 32.4%, $\chi^2 = 5.58$, $p = .06$). However, PDSS scores were nearly identical for mothers who had vaginal versus caesarian deliveries ($M_s = 74.5$, $SD = 27.6$, and 74.2 , $SD = 28.5$). In contrast, breastfeeding mode was significantly correlated with maternal PDSS scores, $r(270) = -.17$, $p = .01$. Neither mode of delivery nor breastfeeding was related to the infant's performance on the BSID-III scales.

Conclusions: Although caesarian delivery was marginally associated with lower likelihood of breastfeeding, mode of delivery was unrelated to self-reported symptoms of depression. However, mode of feeding was significantly related to self-reported symptoms of depression, with fewest symptoms reported by exclusively breastfeeding mothers.

Dynamics of the Villin Headpiece Protein's Subdomain HP-36: Effects on Energy Barrier by Hydration Levels

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Abstract:

Hydrophobic cores are sites of complex protein folding and misfolding patterns, and they often define protein stability and folding overall. A protein subdomain of the protein villin, headpiece-36 (HP36) is a convenient model system to study the hydrophobic core interactions and dynamics due to its small size (36 residues) and cooperative folding. Here, we study the molecular dynamics of HP36 in the solid powder state, with the focus on the dynamics of three phenylalanine sidechains, F47, F51, and F58 belonging to the hydrophobic core under different (100%, 40%, and 10%) hydration levels. We attain the potential mean force (PMF) for the χ_2 dihedral angle that is important to the sidechain rotations of these phenylalanine sidechain. These rotations are computed via umbrella sampling, a type of biased molecular sampling which provides implications on the plasticity and rigidity on hydrophobic core dynamics. These results are compared to experimental solid-state NMR results produced by Dr. Vugmeyster's team.

IAR: An Intelligent Augmented Reality Framework

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Abstract:

The field of Artificial Intelligence (AI) studies approaches to utilize computers to perform human tasks. On the other hand, Augmented Reality (AR) is a technology field where computer graphics is harnessed in a user's view of the real world. On their own, each individual computer science field mentioned above provides powerful aid and utility in improving everyday life. In this project, our ultimate goal is to seek out a framework (i.e., a general-purpose software that can be customized to implement different applications) that would yield the optimal marriage of these two aforementioned fields. Our framework, dubbed IAR (Intelligent Augmented Reality), consists of modules for data preprocessing, data management and organization, data modeling (with machine learning and deep learning models), and data visualization.

There are a plethora of applications that would see great benefit from the integration of AI and AR using IAR. For demonstration purposes, we have implemented three specific applications from diverse areas based on the IAR framework: 1) a tool that serves as therapeutic aid for patients with strabismus, 2) a tool that enables intelligent lane detection on road networks under adverse weather conditions and/or for visually impaired, and 3) a tool that allows for automated classification of garbage to educate the user on the differences between recyclable and non-recyclable trash. We have implemented these applications using both a mobile device (i.e., iPhone) and a Fove headset with a Zed mini camera as augmented reality devices.

Parental Perceptions of a Diverse, Suburban High-School School Based Health Center

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Health and Behavioral Sciences

Abstract:

School-based health centers (SBHCs) are comprehensive health clinics located within school settings that provide services to students regardless of their ability to pay. Community support is critical to the successful funding and operation of SBHCs, and parents of students with access are key stakeholders in this arena. For high-school aged adolescents, the parent-child relationship within the healthcare context becomes more complicated with issues of confidentiality and trust between provider and child. Understanding how parents perceive and think about confidentiality for their children receiving care in a SBHC is important to how the center creates and maintains ties with the community. In Colorado, the first SBHC opened in 1989, and the last decade has been marked by a sizeable expansion of SBHCs within high schools across the state. In this study, we examine parental perceptions of a high school SBHC within a diverse suburban setting of Colorado. This evidence will better the understanding of community perceptions of SBHCs and inform future interventions to improve dissemination of SBHC information, community planning, and community support.

Farm-to-Future

Student Author:

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Abstract:

This program evaluation study identified the dietary behaviors, agricultural knowledge, and job-readiness skills gained by all participants in JC's Journey Green Futures summer program for at-risk foster youth. This study followed a group of foster youth during their summer educational programming and evaluated the impact of the program on participants through qualitative data collection. Farm-to-Future evaluated the effectiveness of Green Futures educational programming for providing foster youth with job readiness training while at the same time promoting healthy eating and environmental/agricultural awareness. By performing an outcome evaluation, through pre-experience and post-experience surveys I was able to measure the impact of the program on the dietary behaviors, agricultural/environmental knowledge, and job-readiness skills of all participants. My presentation will highlight the key findings of my research and provide recommendations for further studies. Through a close examination of the "Green Futures" program other researchers will gain tangible steps for designing their program evaluation studies as well.

Green Revolution: The Emerging American Hemp Market**Student Author(s):**

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Film

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Film

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Faculty Mentor:

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Anthropology

Abstract:

Our documentary film is about how Hemp is a sustainable alternative for up to 50,000 products including; building products, fabrics and plastics, not just for CBD. Hemp has been used for a variety of products for thousands of years, yet there is still a stigma associated with it because of marijuana. European views toward hemp are much more progressive than that of the U.S. The hemp plant is beneficial for farmers, the environment and business. By focusing energy and resources towards research and developing products other than CBD, the U.S. can help build a more sustainable world.

Determining the effect of Polyfluorinated alkyl substances (PFAS) on hepatic and gonadal structures in exposed organisms

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Biology

Abstract:

Polyfluorinated alkyl substances (PFAS), a group of anthropogenic chemicals, were created in the 1930s and are used in both commercial and industrial product production. They are known to bioaccumulate in the environment and, due to their structure, are not suitable for metabolism, thus making PFAS prevalent in exposed organisms. Fathead minnow were exposed to PFAS for 21 days and then dissected, tissue samples were collected and assessed for PFAS exposure damage. The goal of this experiment is to determine the effect PFAS has on hepatic and gonadal structures in exposed organisms. Fathead minnow tissues were collected in 2019. The gonads and livers were embedded in paraffin wax and sectioned on to histology slides in order to analyze the structures from the exposed organisms. Currently, the stains that are being used are hematoxylin and eosin. Hematoxylin is a stain that attaches itself to nucleic acids, while eosin is a stain that attaches itself to the cytoplasm, by using these stains I am able to see the cellular structures of the exposed organism. The histology slides are then scored on the severity of cellular disruption observed in the sampled tissue. The results from this experiment will aid in the development in furthering our understanding of how PFAS exposure effects exposed organisms.

Investigating Phosphorylated CREB and ERK Protein Expressions Within the Prefrontal Cortex of Rats Previously Exposed to Social Buffering of Conditioned Social Fear

Student Author(s):

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Psychology

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Abstract:

When animals of the same species are together during a stressful experience, they exhibit a reduction in fear responses, referred to as social buffering (Kikusui et al., 2006). The social fear response is linked to increased activation of the prefrontal cortex (PFC) (Xu et al., 2019) and may involve neuroplasticity in this brain region. Phosphorylated cyclic AMP response element-binding protein (pCREB) is considered a good marker for neural plasticity (Li et al., 2014). The neural pathways of CREB and extracellular regulated kinase (ERK) have been involved in the formation of fear memories (Glueck et al., 2015; Brewer et al., 2010). In this experiment, immunohistochemistry was performed to assess pCREB and pERK expressions within the PFC of 24 male and 24 female rats previously exposed to social buffering of conditioned social fear. The conditioned social fear paradigm consisted of an experimental rat learning to associate an unconditioned stimulus with a conspecific (same-species) rat, leading to a fear response when presented with the conspecific alone (Reichenberger et al., 2017). Male and female rats exposed to a social stimulus during conditioning showed decreased freezing. Social buffering was seen to have occurred during conditioning and re-exposure to the context (Dawud et al., 2019). Cells positive for pCREB and pERK were counted in subregions of the PFC. A sex difference was observed in pCREB and pERK cell counts, showing a higher number of pCREB and pERK positive cells in female rats. Differences in pERK and pCREB expression were observed in subregions of the PFC.

Anecdotes of the Somali Diaspora Conveyed Through Poetry

Student Author:

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Public Health

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HBS

Abstract:

To know a person is to know their story, to understand a community, the narrative of the individual will not suffice. This distinction is important in that too often, when one seeks to understand a human experience other than their own, they may be comforted by a single narrative that is seemingly representative, but no single account can ever be representative, only reflective. In efforts to represent some of the experiences of Somali immigrants and refugees, I conducted 20 interviews with participants who reside around the globe. I have compiled and transcribed the findings from the interviews, identifying both the trends and nuances, to bring awareness to the varied challenges and insights of the Somali diaspora. The analyzed transcriptions inspired the final project, a poetry chapbook. I hope for the poems to have a breadth of impact, posing an influence at the political level as well as in daily rhetoric. As a storyteller, I prioritize amplifying the voices of communities that are disproportionately marginalized.

Investigating effects of methoxy groups on salicyl alcohol derived photolabile protecting groups**Student Author:**

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Chemistry

Faculty Mentor:

Scott Reed
Chemistry

Abstract:

Protecting groups are useful tools in the synthesis of organic compounds. Photolabile protecting groups (PPGs) can be removed via photo irradiation under neutral conditions. This research presents a new pathway for synthesis of salicyl alcohol derived PPGs with two different functional groups on benzylic positions of the PPGs for carbonyl compounds. The 6-step transformation using inexpensive starting materials has been developed successfully with the yield for each step higher than 78%. This method allowed us to pursue precise structural modification on the PPGs to test the effects of functional groups. By selectively positioning electron-donating methoxy groups in different benzylic positions on PPGs in acetal 1-3, the meta and ortho/para effects were investigated. A phenyl group with a methoxy substituent in meta position in acetal 1 showed the best deprotection yield. In contrast, the introduction of a methoxy group in para benzylic position in acetal 2 showed the lowest deprotection yield. Compared to acetal 1, additional introduction of a methoxy group in para benzylic position in acetal 3 lowered the deprotection yield. By comparing experimental deprotection yield with

computational results, effects of methoxy groups and deprotection mechanism can be understood deeply.

Investigation the influence of Monoamine neurotransmitters on the price that rats are willing to pay for avoidance or reward and their role in determining predictive value

Student Author(s):

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Biology

Faculty Mentor:

Erik Oleson
Psychology

Abstract:

Optimal behavior and overall survival require obtaining highly-valued outcomes from our environment. These action-outcome situations are often driven by either the pursuit of reward or the avoidance of harm. The three primary monoamine neurotransmitter systems that modulate such motivated behaviors are dopamine (DA), serotonin (5-HT), and noradrenaline (NA). We are using selective uptake inhibitors GBR-12909, fluoxetine, and desipramine, to block the uptake of DA, 5-HT, and NA respectively. To investigate how these uptake inhibitors influence the value of avoidance vs. reward, we combined operant behavior with behavioral economic theory. In our avoidance task, rats were trained to respond to avoid electrical foot-shock across a range of prices (response requirement/mA shock avoided); in our reward-seeking task, rats were trained to respond for sugar across a range of prices (response requirement/mg sugar received). We then fit data with demand curves and solved for alpha. Preliminary data suggest that GBR-12909 increased avoidance value; whereas desipramine decreased avoidance value. Investigating whether these pathways produce distinct effects on reward vs. avoidance valuation will provide novel insight into how the brain controls these fundamental aspects of behavior. The implications of this work may also advance our understanding of major psychiatric conditions such as depression and drug addiction. After completing the reward valuation component of this study, we attempt to replicate our findings using chemogenetics to add anatomical specificity to our exploration of this research question.

Deleting the CXCL10 gene in-vitro using CRISPR

Student Author:

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Biochemistry

Faculty Mentor:

Jing Hong Wang
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Abstract:

Gene editing is the targeted modification of an organism's DNA. CRISPR-Cas9 technology utilizes the enzyme Cas9 to bind to gRNA in order to cut a specific region of DNA. This cutting allows for the deletion, or "knock out" of a gene. The gRNA spacer is responsible for targeting the DNA sequence being edited, and the gRNA scaffold is what will bind to the Cas9 enzyme. Once the gRNA spacer is attached to the targeted sequence, and the gRNA scaffold attaches to Cas9, only then will Cas9 proceed to cut the double-stranded DNA and delete the gene.

CXCL10 is a gene responsible for making proteins (chemokines) that help immune cells (CD8 T-Cells) find tumors in our bodies. In order to test the functionality of the gene CXCL10, the gene was deleted in A20 B-cell lymphoma cells to see the difference in chemokine production and T-cell migration between wild type and knock out mice. Before proceeding to in-vivo experimentation, the gene was deleted in-vitro. First, a plasmid was created with both the target gRNA strands and the Cas9 protein. Then, E. coli was transformed for DNA cloning of the plasmid. Lastly, A20 cells were transfected with the plasmid DNA and tested for gene knock-out. The transfected cells were tested for deletion of CXCL10 by using PCR and DNA sequencing. The cells were found to be missing CXCL10, and further in-vivo experimentation will follow to observe the functionality of CXCL10.

iPSC-Derived Cardiomyocyte Model to Investigate Stretch-Responsive Signaling Pathways Involved in Hypoplastic Left Heart Syndrome

Student Author:

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Bioengineering

Faculty Mentor(s):

Jeffrey Jacot
Bioengineering

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Abstract:

Hypoplastic left heart syndrome (HLHS) is a congenital heart defect that results in the underdevelopment of the left ventricle, mitral valve, aortic valve and ascending portion of the aorta. This reduces the heart's ability to pump oxygenated blood through the body and is fatal without immediate intervention. For the majority of cases, the causes of HLHS is unknown. However, at a phenotypic level, cardiomyocyte (CM) deficiencies, such as proliferation rate and cell structure, have been observed in HLHS. Given that CM must respond to biomechanical stretch for proper heart development, we hypothesize that disruption of mechanical signaling pathways in CM are responsible for the defects observed in HLHS. In order to test this hypothesis, we compared the stretch-induced proliferative and morphologic response of human iPSC-derived immature cardiomyocytes from infants with HLHS and controls with typical heart structure. CMs were differentiated using small molecular inhibitors impacting Wnt signaling and purified by glucose starvation with insulin. CM were stretched for 48 hours at 10% strain at 1 Hz. Total cell area and proliferation rates were analyzed using ImageJ (NIH). We predict that the proliferation rate and cell area will be abnormally reduced in HLHS patients as compared to healthy controls. Future planned experiments of specific mechanosensitive pathways will provide insight into how HLHS develops and could lead to new therapies for the treatment or prevention of HLHS.

The Relationship between Mindfulness, Pro-Social Behavior, and Emotional Response

Student Author:

Emerald Saldyt (UROP Recipient)
Psychology

Faculty Mentor:

David Albeck
Psychology

Abstract:

Substantial evidence indicates that the brain recruits more neurons and attention to negatively valenced visual stimuli and that this "negativity bias" can be modulated by both bottom-up and top-down processing as well as individual differences. The variables, altruism, empathy, and trait mindfulness and meditation are positively correlated with each other, yet they tend to cause opposite effects in the brain in response to negative emotional stimuli. High altruism and empathy correlate with increased arousal while high mindfulness correlates with decreased

arousal, both to negative stimuli. This experiment uses the self-reported subjective ratings of valence and arousal, using the Self-Assessment Manikins Survey (SAMs), to determine the variability of a person's response to emotional images when these traits co-occur. Subjective ratings will be examined in relation to self-reported trait empathy and mindfulness, behaviors such as altruism and meditation, and the image valence (positive, negative, or neutral). The aim is to explore relationships between the independent variables of image valence and scores from the Five Facet Mindfulness Questionnaire (FFMQ), the Toronto Empathy Questionnaire (TEQ), the Altruistic Personality Scale, and the Meditation Experience Questionnaire on the dependent variable of subjective arousal. Images are selected from the International Affective Picture System (IAPS). Data will be analyzed using multiple regression. We will examine whether an interaction exists between these individual traits on subjective arousal and we operate with the goal of understanding emotional regulation and processing in the brain. Findings will guide clinical research to promote emotional intelligence and regulation.

Neurogenesis Markers in Diapausing *Rhagoletis pomonella*

Student Author:

Matin Sanaei (UROP Recipient)
Biology

Faculty Mentor:

Gregory Ragland
Integrative Biology

Abstract:

In response to unfavorable conditions, many organisms enter a state of dormancy in which development is suppressed for extended periods. We use the apple maggot fly, *Rhagoletis pomonella*, as a model to understand the regulation of this suppression, termed diapause in insects. Work from the Ragland lab has shown that gene expression changes over time in the brains of diapausing *R. pomonella*. We therefore hypothesize that diapause is a dynamic process, during which development does not stop, but occurs at a very slow rate. To test this hypothesis, I developed methods to track developmental processes in fly brains, such as neuron (brain cell) fate specification, growth, and activity. Specifically, I used immunohistochemistry (IHC) and confocal microscopy to detect biological markers of these processes in fly brains, including the proteins Numb and Prospero (neuron fate), CNS axons (neuron axon growth), and Synapsin (synapse activity). I detected Numb in the subesophageal ganglion, and both Numb and Prospero in the medial regions of the optic lobe of fly brains. CNS axon staining in the ventral nerve cord showed a distinct segmented pattern. Finally, I detected Synapsin in the subesophageal ganglion. Ongoing research will use these methods in *R. pomonella* to determine the location and abundance of each marker at several time points during diapause, measuring changes in the developmental processes over time. Documenting these changes at

the cellular level of proteins will bring understanding to the dynamism of diapause and its importance to developmental biology, with potential implications for insect pest management.

Effects of Makeup on Perceived Personality Traits and Friendliness in College-Aged Women

Student Author:

Laura Seaton (UROP Recipient)
Psychology

Faculty Mentor:

Peter Kaplan
Psychology

Abstract:

Research has shown that visual aspects of a person's face are correlated to first impression judgments regarding personality characteristics. One visual aspect commonly studied has been makeup and its impact on perception of various traits in females including attractiveness, leadership ability, and warmth. It is also known that characteristics such as these are important in forming friendships. In progress is a literature review that seeks to determine if the amount and type of makeup a female wears affects judgments about whether she would be a good friend and why this might be. It seeks to evaluate not only how makeup affects judgement of personality traits, but how it moderates perceptions of threat and jealousy in other females.

Needs Assessment of Comprehensive Sex Education for Physically Disabled Community

Student Author:

Samantha Slawson (UROP Recipient)
Psychology

Faculty Mentor(s):

Lindsey Hamilton
Psychology

Abstract:

Although society has made great strides in shifting its views and supporting sexual identities and expressions, there is still a stigma against disabled people and sexuality. Topics of disability are excluded from comprehensive sex education programs. I will identify the barriers within

comprehensive sex education programs for the physically disabled community. I will cover why disabled people are excluded from these conversations and propose a solution on how we get improve current comprehensive sex education to better support this community. I will utilize journal articles focused on sexual health, intimacy, and disability, as well as, conduct interviews with sexuality experts. This topic is important because the disabled community is a marginalized population and there is an ethical obligation to educate and normalize healthy sexual relationships to ensure disabled people will have a safe but pleasurable sexual trajectory.

Tracking the Excess Proton in Proton Transfer between Water and Titratable Amino Acid Side Chains

Student Author(s):

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Biology

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Biology

Faculty Mentor:

Hai Lin
Chemistry

Abstract:

Proton solvation and transfer is ubiquitous in chemistry and biology. Unlike ordinary ions such as sodium or chloride, a hydrated proton is delocalized, existing in the form of a hydronium in water, a protonated ion, or a protonated functional group. One pressing issue in molecular modeling, e.g. when analyzing the saved trajectory from dynamics simulations, is to track the delocalized proton during the proton relay process that is typically dominated by bond-breaking and bond-forming steps. In this work, we develop a computer program that can track the approximate location of an excess proton in aqueous solution. Extension to proton transfer between titratable amino acids was also attempted.

Tuning halogen bonds and chalcogen bonds for drug capsule functionalization

Student Author:

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Faculty Mentor:

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Chemistry

Abstract:

Chalcogen (Ch)/halogen (X) bonds, which are non-covalent bonds formed between group 16/group 17 elements and nucleophiles (N), are categorized as a type of intermolecular force known as sigma hole interactions. Sigma hole interactions have an emerging role in rational drug design as they can be used as a potential glue to hold drug capsules together, depending on their binding affinities. In this study, we seek to characterize the strength of sigma hole interactions by optimizing chalcogen and halogen bonded molecular complexes using MP2 and the Effective Fragment Potential (EFP) method, a first-principles derived force field. The results indicate that chalcogen bonded dimers are lower in energy than halogen bonded dimers, mostly due to stronger electrostatic interactions. Results also show that both inductive and steric effects need to be considered in order to tune the geometry of the complexes and the strength of the sigma hole interactions.

**Genes important for surviving low temperatures in *Drosophila melanogaster*:
Validation of RNA interference****Student Author:**

Joseph Tucker (UROP Recipient)
Biology

Faculty Mentor:

Greg Ragland
Integrative Biology

Abstract:

Low temperatures are challenging for many animals, especially insects, whose body temperature is similar to that of the environment. Many insects can survive low temperature exposures by modifying their physiology. However, the genes that are important for surviving low temperatures are not well-characterized. The Ragland lab is testing the function of genes in cold tolerance of *Drosophila melanogaster* fruit flies using RNA interference (RNAi) lines that knock down gene expression. The goal of my project was to validate this knock down for eight different genes, determining the relative abundance of RNA for each target gene in the RNAi lines. If RNAi is successful, RNA for a target gene should be absent or much less abundant compared to that target gene in a control line (without RNAi). For each *D. melanogaster* line, I extracted RNA from larvae (juveniles), adult males, and adult females. I treated these samples with DNase to remove contaminating genomic DNA, and then synthesized cDNA to use as a template in PCR. I tested primers that were designed to amplify the target genes using PCR. In future work, these primers and cDNA samples will be used in quantitative PCR, allowing us to determine relative RNA abundance for each target gene in RNAi and control lines. This project is important to ensure we can draw appropriate conclusions from experiments testing the

effect of RNAi on *D. melanogaster* cold tolerance. Overall, this work contributes to our understanding of how genes contribute to the ability of insects to survive environmental stress.

Optogenetic Stimulation of Substantia Nigra Terminals in the Dorsal Lateral Striatum During Fear Extinction Prevents Fear Renewal

Student Author(s):

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Liang He

Faculty Mentor:

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Abstract:

One clinical limitation of exposure therapy is that fear tends to return in contexts different from which exposure therapy is conducted, a phenomenon called fear renewal. Exposure therapy relies on fear extinction, which represents new learning that the previous fear-conditioned stimulus no longer predicts danger. Identification of novel strategies to prevent fear renewal could improve the success of exposure therapy. Previous work demonstrated that activation of substantia nigra (SN) dopamine (DA) neurons during fear extinction enhances fear extinction recall and blocks fear renewal; however, the specific targets in which SN DA acts to enhance fear extinction remain unknown. SN DA neurons projecting to the dorsal lateral striatum (DLS) support the formation of habitual behaviors, which can be resistant to contextual modulation. The goal of this study was to test the hypothesis that optogenetic activation of SN terminals in the DLS during fear extinction learning will reduce fear renewal. Adult, male Long-Evans rats received bilateral intra-SN microinjections of control virus or AAV-Chr2-hSyn-mCherry and optic ferrule cannulas in the DLS. SN terminals in the DLS were then optogenetically stimulated during auditory fear extinction learning. Fear extinction memory and relapse were subsequently assessed in the absence of stimulation. Results indicate that optogenetic stimulation of DLS-projecting SN neuron terminals during fear extinction reduces fear relapse in a novel context while having no effect on extinction memory or spontaneous renewal. These data suggest that novel therapeutic strategies aimed at the SN-DLS circuit could be effective adjuncts to exposure therapy.

Poporodnŷ Deprese- A Visual Exploration of Postpartum Depression

Student Author:

Kaitlin Woodward (UROP Recipient)
Photography

Faculty Mentor(s):

Carol Golemboski
CAM

Abstract:

Becoming a mother is a momentous moment in a woman's life, but many soon experience a dark reality called postpartum depression. Postpartum depression (or "Poporodnŷ Deprese" in Czech) is labeled as depression and anxiety that happens after the birth of a child. Kaitlin Woodward, a photographer of Czech descent, uses digital photography to show the complex emotions and symptoms of this illness, which she personally experienced after the birth of both of her children. The surreal fantasy style of her photographs shows how postpartum depression often feels like a disconnection from reality. This work is intended to encourage awareness and support for mothers who experience postpartum depression by creating a visual representation for how the illness manifests. By drawing attention to the symptoms of postpartum depression, people can create a positive environment for mothers suffering from this common but often invisible illness. Fostering that awareness will create happier and healthier mothers and children by reducing or eliminating fear, doubt, lack of support, and lack of resources. Others will be able to viscerally experience feelings that are not so easy to express through verbal and written narrative. While there is no way to prevent postpartum depression yet, more can be done to help those who do and will suffer from it. Poporodnŷ Deprese is an essential key to helping unlock more help for new mothers suffering from this usually silent illness.

Protein Isoforms in the Aged Heart

Student Author:

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Biology

Faculty Mentor:

Maggie Lam
Medicine, Cardiology, Anschutz

Abstract:

Aging is a high-risk factor for the onset of heart failure (HF) which affects over five million individuals in the United States with a dire ~50% five-year survival rate. Symptoms associated

with aging-related HF include exercise intolerance, frequent hospitalizations, and higher mortality rates, with no long-term treatment beyond a heart transplant. Among many cellular pathways, aging-regulated changes in alternative splicing (AS) have been proposed as one of the primary means that deteriorates the function of the heart. AS is a mechanism which causes more than one expression of RNA and protein molecules (i.e. protein isoforms) to result from one parent gene. Aging-related changes in AS at the RNA level has been shown in the aged heart; however, how AS changes regulate the expression of downstream protein isoforms remains incompletely examined to-date. In this study, we utilized liquid chromatography-mass spectrometry (LC-MS) to systematically examine the expression profiles of protein isoforms in the young (12 weeks) and old (78 weeks) mouse heart. Heart proteins were extracted, digested, tagged, and analyzed with LC-MS, and searched against a custom age-specific database to determine differences in AS protein expression in aged mice. 65 protein isoforms were found to be differentially expressed between young and old mouse hearts. Among these age-associated isoforms, we found several cardiac proteins that have been known to play vital structural or functional roles and are implicated in cardiac dysfunction of the aged heart.

Venner: An American Perspective on Danish Culture

Student Author:

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Painting and Drawing

Faculty Mentor:

Melissa Furness
CAM

Abstract:

While Americans often reference Denmark in political discussions, Danish culture is little understood in the US. In order to foster better understanding and explore international perspective, I undertook an artistic research trip to Denmark. This trip focused on museum and gallery exhibitions as a means of gaining insight into both contemporary and historic elements of Danish culture. It also included interviews with experts in Danish fashion and participation in cultural events. In addition to the trip scholarly research was conducted with Marie Riegels Melchoir and Toke Lykkeberg as primary sources. Ultimately, these experiences formed the backdrop for a series of artworks communicating my findings. Inspiration from Danish artist Dea Trier Mørch was foundational in my aesthetic approach, and Jens Haaning's work helped to guide me conceptually. What I found were the calm, cozy, and communal traditions of a historically pastoral culture melding with contemporary issues such as the integration of refugees. Presiding over everything were the notion of sustainability, and humanity's relation to nature. My intention is that by communicating these Danish elements through my own perspective as an American an insight into both cultures is gained.

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