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Developing Physiologically Relevant *in vitro* Models for Cardiac and Pulmonary fibrosis

**Akinola Akinbote** Department of Biomedical Engineering, Department of Macromolecular Engineering, Case Western Reserve University

In the injury and disease setting, the native tissue is remodelled as a reparative attempt in the wound healing process. Hallmarked by fibrosis and angiogenesis, post-injury remodeling results in reduced function and often whole organ failure. As fibrosis is prevalent in most cardiac and pulmonary pathologies, such as myocardial infarction and idiopathic pulmonary fibrosis, understanding the underlying fibrotic pathology is essential for the development of therapeutics. However, present day approaches utilize 2D culture models, which have limited physiological and clinical relevance. To meet this need, we propose the development of physiologically relevant *in vitro* fibrotic models that mimic *in vivo* conditions using our macroscale devices. Co-culturing induced pluripotent stem cell-derived endothelial cells (iPS-ECs) with stromal cells in fibrin hydrogels, we developed vascularized tissues—identified by the formation of microvascular networks (MVNs)—to mimic either a cardiac or lung microvascular environment. The formation of these MVNs was monitored using phase microscopy prior to administering TGFβ and TNFα to induce fibrosis. Samples were stained and imaged using confocal microscopy. The morphology of these MVNs was characterized using custom-designed ImageJ macros. Our results indicate that: 1) iPS-ECs co-cultured with stromal cells result in the formation of perfusable MVNs; 2) narrowed morphology of the MVNs occurs when co-cultured with stromal cells in comparison to monoculture of iPS-ECs; and suggest that: 3) fibrosis can be induced by using TGFβ and TNFα, 4) increased TNFα disrupts the integrity of these networks. The development of these vascularized tissues can provide more physiologically relevant models for the investigation of pathological fibrosis.

*Project mentor: Kristina Haase, Department of Mechanical Engineering, Massachusetts Institute of Technology*
*Faculty mentor: Roger Kamm, Department of Biological Engineering, Massachusetts Institute of Technology*
Investigation of Age-dependent Extracellular Matrix effects on inflammatory TGF-β1 induced myofibroblast differentiation

Akinola Akinbote, Department of Biomedical Engineering; Dr. Samuel Senyo

There is limited cardiac regenerative capacity with age in mammalian animal models. Experimental myocardial infarction in adult mice and pigs results in a low regenerative response characterized by increased fibrotic response (marked by activation of fibroblasts to scar producing myofibroblasts) and decreased cardiomyocyte proliferation compared to neonatal mammals of the same species. Based on compositional and mechanical properties in the aging heart, our team hypothesizes that extracellular matrix (ECM) factors and mechanical properties of the microenvironment regulates the regenerative response including cardiomyocyte proliferation and myofibroblast activation. To test the hypothesis, we are investigating the biochemical and biomechanical roles of the native ECM in modulating the fibrotic response (marked by fibroblast activity) and cardiomyocyte cell cycle activity. Fibrosis was modelled using Transforming Growth Factor Beta-1 (TGF-β1) to activate the myofibroblast state. Primary rat ventricular cardiac cells (fibroblasts or cardiomyocytes) or mouse explants were cultured in age-dependent lyophilized ECM sourced from (from fetal and adult) porcine ventricles. Fibroblasts were treated with TGF-β1 for 24 hours prior to staining for α-smooth muscle actin and vimentin to identify myofibroblasts. Our study confirmed that TGF-β1 induced fibroblast differentiation and demonstrated a dose dependent activation of myofibroblasts. Early evidence suggests that fetal ECM treatment alters cell cycle activity in cardiomyocytes and myofibroblast formation both in isolated cells and in explants. Present work is being conducted to generate physiologically relevant mechanical cues using polyacrylamide gels of varying stiffness and tuning stiffness in micro-tissue explants. Our polyacrylamide library of varying stiffness was characterized by gel rheometry. Our current results indicate that Polyacrylamide hydrogels can be tuned to achieve similar physiologically relevant stiffness values.

Project Mentor: Dr. Samuel Senyo, Cardiovascular Tissue Engineering.
Other contributors: Xinning Wang (PhD Candidate), Elizabeth Schubert(Undergraduate), Margaret Kilbane (Hathaway Brown), John Bradford(Undergraduate), Samuel Senyo PhD

The Wagner Wheelchair Transfer System

Patricia Alfaro, Sean Cuda, Anthony Dispirito, Andrew Kew, Andrea Lu Department of Biomedical Engineering, Case Western Reserve University, 11100 Euclid Ave, Cleveland, OH, 44106 USA

Every year there are two million new wheelchair users who are forced to rethink the way they perform daily activities. These activities can be as simple as getting into a car, getting out of bed, or taking a bath. Transferring to and from a wheelchair is one of the greatest challenges associated with these tasks. Current transfer devices are dependent on the presence of another person, which limits the possibility of an independent lifestyle. Our wheelchair transfer device offers a portable and lightweight solution to minimize reliance on another person. The device is based on an automatic scissor jack, which can raise and lower the user between ground level and 3.5 feet. A smooth plastic seat allows for easy maneuverability on and off the device, while handles provide extra support for the user. Wheels have been added to help position the device, and rubber stoppers lock them in place once weight is applied. The rubber stoppers help increase stability and ensure that the device does not move during the transfer process. The device is able to be compressed into a flat box shape for easy storage and portability. This next generation transfer device has great potential to grant wheelchair users more independence in their day-to-day lives.

Project Mentors: Dr. Colin Drummond, Dr. Matthew Williams, Department of Biomedical Engineering
Project Sponsor: Greg Wagner, Benjamin Mroz
Project Consultants: Emma Baker, Jocelyn Cheung

Intersections: SOURCE Symposium and Poster Session
YMCA Nutrition Education Series.

Jesse Alger, Department of Nutrition; Logan Dufek, Department of Nutrition; Raquel Linevsky, Department of Nutrition; Meagan Rowley, Department of Nutrition

Cleveland has some of the highest rates of nutrition-related chronic diseases including type 2 diabetes, hypertension, and heart disease in the older population. During a six week series of workshops at the Warrensville YMCA we were able to provide education to help increase awareness about improved dietary intake that can lead to fewer adverse health outcomes. The topics included the following: Nutrition Facts Label, Reducing Food Waste, Healthy Home Cooking, Grocery Shopping, Fad Diets and Healthy Holidays. At each of these workshops data was collected as a pre and post test to assess knowledge retention and teaching performance. The workshops were highly interactive due to our efforts and the enthusiasm of our audience. Based on our data analysis of the pre and post tests this is an effective model for educating the public on nutrition topics. In the future these teaching methods can be used for similar projects.

Project Mentor: Professor Tamara Randall MS, RDN, Department of Nutrition

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Explore Correlation Between Body Balance and Sensory Systems Using Mobile Health Technology

Ridaa Ali, Department of Biomedical Engineering, Department of Electrical Engineering and Computer Science; Jia Chen, Department of Electrical Engineering and Computer Science; Jianian Zheng, Department of Electrical Engineering and Computer Science; Diliang Chen, Department of Electrical Engineering and Computer Science; Quan Liu, Department of Electrical Engineering and Computer Science; Haoyou Cheng, Department of Electrical Engineering and Computer Science; Dr. Ming-Chun Huang, Department of Electrical Engineering and Computer Science

Body balance and perception have been shown to be linked in a number of studies, ranging from mice plasma membrane calcium ATPase isoform PMCA2 deficiency causing both balance and hearing problems to MS (multiple sclerosis) patients’ loss of foot sole sensitivity correlating with compromised balance. This project involved developing an application that tests balance as well as hearing using Microsoft HoloLens and mobile health technology. Four balance tests are included in the HoloLens application, three from BalanceMaster (Limits of Stability, Rhythmic Weight Shift, Sit to Stand) and the fourth is a modified Single Leg Stand with 32 sensory conditions. Hearing is tested within the same application; beeps are played sequentially at frequencies of 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, and 8000 Hz for each ear. The first volume level they are played at is less than 10 Hz and this can be sequentially increased in increments of 10 dB until the player can hear the beep; this volume level is recorded; the maximum volume is 100 dB. The application is meant to be used with Wearable Gait Lab, developed in SAILAB@CWRU, which is an insole equipped with sensors for measuring balance parameters. The user wears HoloLens (which displays test information and instructions) and the Wearable Gait Lab (which records balance data); experimental data is analyzed for a correlation between perception and balance in young, healthy adults as a proof of model.

This project is built on top of the Smart Living Lab (https://thedaily.case.edu/senior-care-meets-scientific-research/) projects: Wearable Gait Lab and PainMarker App using HoloLens.

Project Mentor: Dr. Ming-Chun Huang, Department of Electrical Engineering and Computer Science
Synchrony: A Synchronized Music-Streaming Service that Provides a Shared Listening Experience

Jacob Alspaw, Computer Science; Alex Hemm, Computer Science; Owen Helmstetter, Computer Science; Ted Timbrell, Computer Science; Bobby Wagner, Computer Science

The music industry and the ways in which we listen to music are rapidly evolving. The development and introduction of music-streaming services has given music listeners a new form of easy access to any and all types of music. However, the current ways in which we listen to music are flawed. Standalone speakers often subject others to forced listening conditions. They carry a stigma in public areas where peace and quiet are expected thereby limiting their use. Headphones have reduced the need for standalone speakers but they create a barrier between listeners and degrades the shared listening experience that standalone speakers promote. Improving upon the current music-streaming services is just one way in which we can ensure a shared experience amongst listeners. Music-streaming providers, like Spotify, have simply overlooked the needs for synchronously playing music amongst multiple users.

The next evolution in how we listen to music is Synchrony, a synchronized streaming service provided by a dedicated team aiming to enhance the music listening experience of users through shared playlist collaboration and discovery. Synchrony acts as a wrapper to mainstream music providers, captures their streams, and then relays the stream to Synchrony users. Our service allows users to collaboratively listen to music in groups (even when wearing headphones), and enables control over the current song queue for each person in the group. Synchrony will allow users to keep using their individual devices and streaming services while effortlessly and seamlessly sharing their experience with friends.

Project Mentor: Dr. Soumya Ray, Department of Electrical Engineering and Computer Science

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The anxiolytic effect of Cannabidiol (CBD) and its potential use as a treatment for Social Anxiety Disorder (SAD)

Akaisha An, Department of Psychological Sciences

Social anxiety disorder (SAD) is one of the most prevalent anxiety disorders with very limited treatment or management resources. In the United States, the lifetime prevalence rate of SAD is approximately estimated as 7%-12%, and only half of those patients seek treatment. A large proportion of patients uses medication to manage SAD symptoms, while current available medications usually cause serious side-effects such as addiction, sleeping problems and nausea. Recent research has been focused on finding a medication for SAD with fewer side-effects. Cannabidiol (CBD), a nonintoxicating component found in cannabis, was found to have anxiolytic effect in both animal and human studies. This review summarizes existing knowledge of the anxiolytic effect of CBD and its effectiveness for SAD; historical and legal background and research barriers related to cannabis. The majority of the research are preclinical studies done on animals to find the neural basis of CBD’s anxiolytic effect. A significant amount of studies shows that CBD influences 5-HT1A receptors in the brain region bed nucleus of the stria terminalis to reduce anxiety in rats (Gomes et al, 2012). A few human studies have also found a significant association of lowered anxiety symptoms in SAD patients after given one dose of CBD before public speaking (Bergamaschi et al, 2011). The results from existing literatures suggest that CBD has anxiolytic effect on animals but more research with larger sample sizes is required to determine whether CBD is safe, sufficient and effective for patients with SADs. Future studies are suggested to experiment on the efficacy of CBD for SAD management, with large sample size, and to look for possible side effect and drug interactions based on observations and self-report. The anxiolytic effect of CBD would provide strong evidence support its therapeutic effect on SAD and a great discovery for a better pharmacological treatment specific targeting SAD with less side-effects.

Project Mentor: Professor Anastasia Dimitropoulos, Department of Psychological Sciences
A Quantitative Analysis of Pudendal Nerve Regeneration via Immunofluorescent Intensity

Tessa Askew, Department of Biology; Dr. Margot Damaser, Cleveland Clinic Lerner Research Institute, BME; Brian Balog, Cleveland Clinic Lerner Research Institute, BME

We focus on female pelvic floor dysfunction (FPFD), including stress urinary incontinence (SUI), which is the unintentional loss of urine on exertion, coughing, or sneezing. SUI affects 30% of women over the age of 40 and 50% of women over the age of 50, and is most commonly associated with the injuries sustained during childbirth, the external urethral sphincter (EUS) and the pudendal nerve (PN). Within a year most women will recover, but after five years symptoms can re-present themselves indicating that the injuries do not heal properly or fully. In this project we are attempting to develop a protocol for performing a quantitative analysis on the regeneration of the PN after a simulated childbirth injury in a rat model of SUI. The rats received either a pudendal nerve crush (PNC) or sham PNC; all sham PNC animals received saline treatment, while PNC animals receive either saline or tyrosine kinase b (TrkB) for 3-week time periods. TrkB was administered to bind active brain derived neurotrophin factor, an important neuroregeneration protein, which should delay regeneration. Three-week animals underwent functional testing and tissue harvesting. The PN tissue was sectioned and immunofluorescently stained for neurofilament proteins, an axon structural protein. Mouse anti-neurofilament 200 and 68 were secondarily labeled with donkey anti-mouse AlexaFlour 488. Images were then analyzed using Image J software for fluorescent intensity. We hypothesize that following an axonal injury, immunofluorescence intensity will be greater than after a sham injury due to an upregulation in neurofilament, which is necessary for axonal regeneration, and that treatment with TrkB will decrease intensity. Previously, a qualitative analysis was used to assess immunofluorescent intensity, but should this project be successful we will have developed a quantitative assessment of nerve regeneration. This method could then be used to evaluate PN regeneration in future rodent SUI treatment studies.

Project Mentor: Dr. Margot Damaser, Cleveland Clinic Lerner Research Institute, BME
Faculty Sponsor: Dr. Rebecca Benard, Department of Biology

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Module Redesign: Rockwell Automation Project Management Co-Op

Tino Bagnoli, Systems and Control Engineering

The work completed during my Co-Op with the Project Management Group at Rockwell Automation in Mayfield Heights involved serving as the project manager to facilitate multiple hardware continuation projects meeting schedule, cost and quality goals. Each of the projects was predominantly either a module redesign effort or a firmware update project, either for the purposes of cost reduction or resolving an issue for a high profile customer. Personal weekly work for each project included scheduling-related tasks and running regularly occurring status meetings. Additional personal work included collaborating with various functional groups to respond to different problems encountered during the course of the project, such as sourcing issues, in order to make decisions about how to proceed in a manner that would meet evolving cost, technical and quality requirements. Finally, there was some opportunity to consider relationships between each of the individual projects as they related to higher-level organizational objectives and processes. Overall the work completed during my Co-Op was successful, as all of the projects were able to reach key milestones and proceed in spite of the different problems encountered.

Project Mentors: Joseph Feigenbaum, Senior Project Leader, Rockwell Automation, jmfeigenbaum1@rockwellautomation.com & Anne Poorman, Project Management Team Lead, Rockwell Automation, afpoorman@rockwellautomation.com
Faculty Sponsor: Gregory Lee, Department of Electrical Engineering and Computer Science
Quantifying Pressure When Diagnosing Pelvic Pain Disorders

Jess Powell, Department of Biomedical Engineering; Scott Muller, Department of Biomedical Engineering; Juana Barrera, Department of Biomedical Engineering; Iulia Barbur, Department of Biomedical Engineering; Pablo Ochoa de Eribe Delgado, Department of Biomedical Engineering; Emma Baker, School of Nursing; Jocelyn Cheung, School of Nursing; and Dr. Joseph Henderson, MD, Department of Reproductive Biology, Division of Female Pelvic Medicine and Reconstructive Surgery, School of Medicine.

Pelvic floor disorders (PFD), such as incontinence and prolapse, are common in the population, especially among women. Although there is a standard pelvic floor exam, assessing pain can be difficult. Currently, there is no method for quantitative correlation between perceived pain and the pressure a physician applies to the pelvic floor muscles during the exam. As a result, it can be difficult for a physician to consistently gauge a patient’s response, which makes diagnosis less effective and determining the efficacy of treatment challenging. We propose a device that will record and display the pressure that is applied in real time to facilitate quantitative pain correlation during a pelvic exam. This device will be based around a pressure sensor that will sit on a physician’s index finger over a standard nitrile glove. This sensor will be connected by a small wire to a watch-like device on the physician’s wrist that will display the pressure that is sensed in real time. The watch-like device will house an arduino, which functions as an analog-to-digital converter (ADC) and a microcontroller, and a thin-film-transistor liquid-crystal display (TFT LCD).

Project Mentors: Colin Drummond, Department of Biomedical Engineering; and Matthew Williams, Department of Biomedical Engineering

Hand Activity Monitor for Assessing Daily Hand Use

Angelina Batty, Department of Biomedical Engineering; Michael Douglass, Department of Biomedical Engineering & Department of Physics; Noel Jeansson, Department of Engineering; Bridget Rabaglia, Department of Biomedical Engineering; Colin Drummond, Department of Biomedical Engineering; and Matthew Williams, Department of Biomedical Engineering

In the United States alone, there are approximately half of a million individuals who use upper limb and hand prosthetics on a daily basis, with that number expected to double by 2020. There exists a lack of data regarding the characteristic movements and general length of time that a person’s hand is in motion throughout the day. Current hand prosthetic devices generally have an arbitrary active battery life of 30 minutes in the laboratory. So far, this arbitrarily assigned battery life is the accepted standard for daily use in the field of medical devices, with no data to support this value. To achieve a future where prosthetics are optimized for continued use throughout the day, or about 16-18 hours of use, engineers need a way to record all daily functions. The hand activity monitor device aims to record the hand function of the average individual by capturing changes in position throughout the day. The device has strain sensors across the back of the hand at major points of interest to measure finger positional data during hand movement, including open/close of the hand. Gyroscopes allow for the analysis of angular acceleration and movements of the wrist for daily tasks. A microcontroller will record data at the device’s wrist junction, storing position data within an SD card for transfer to the user’s computer at the end of each day through a microUSB port. The key tenets of our team’s physical design optimize comfort, durability, and ease of use in order to maximize efficiency through the general wear and tear of daily life. In clinical practice, the device will allow for clinicians to more accurately monitor able-bodied daily hand use with minimal interference, gathering vital data that can be used to improve current prostheses.

Project Mentors: Dr. Colin Drummond, Dr. Matthew Williams, Department of Biomedical Engineering
Motor Controller Device for the Modification of Ride On Cars for Children with Physical Disabilities

Emily Budziszewski, Department of Biomedical Engineering; Takayuki Suzuki, Department of Biomedical Engineering; Jacob Morand, Department of Biomedical Engineering; Nicholas Bean, Department of Biomedical Engineering; Yueying Lao, Department of Biomedical Engineering

For children with spinal cord injury and other forms of disability, the use of electric toy cars is an efficient method to enable them to gain greater spatial awareness. Toy cars can be used in both the clinic and the home to improve the independent mobility of the children through examination and treatment of cause-effect learning, head UE control and trunk LE control. These cars also allow children to socially interact with other children and provide a low-cost alternative to other mobility devices. However, these cars do not accelerate steadily, which can cause problems for the children with disabilities that use them. Most cars accelerate suddenly when a specific button is pressed, and decelerate sharply when the button is released. This can cause children with spinal cord injury or weak trunks to suffer injury. To solve the problem, RePlay for kids has worked to develop a circuit design that will allow the car to gradually accelerate. Our team plans to improve the circuit currently in use in a way which will allow for an even smoother acceleration while also providing care takers and physical therapists of the children with the ability to control the maximum speed reached by the car and the rate at which they accelerate. A pulse width modulator, microcontroller and H-bridge chip will be introduced to the existing circuit to allow for the smoother acceleration, while two external switches in combination with a kill switch will be installed in order to allow for control of acceleration and top speed and to allow caregivers to stop the cars immediately if need be. The secondary goal of this project is to make installation as simple as possible to ensure that non-engineering volunteers will be able to make the necessary modifications.

Project Mentors: Professor Colin Drummond, Department of Biomedical Engineering; Professor Matthew Williams, Department of Biomedical Engineering
Esophageal Protection Device for Atrial Catheter Ablation

Wyatt Becicka, Department of Biomedical Engineering, John Bradford, Department of Biomedical Engineering, Stephanie Davis, Department of Biomedical Engineering, Kenji Miyazawa, Department of Biomedical Engineering, Joel Rand, Department of Biomedical Engineering, Dr. James Reynolds, Harrington Discovery Institute, Colin Drummond, Department of Biomedical Engineering.

Atrial fibrillation is a common heart condition that can lead to major complications such as heart failure and stroke. Approximately 2.7 million people live with atrial fibrillation. The most widely accepted procedure for treatment is ablation of the unhealthy atria tissue. During these catheter atrial ablation procedures, a small proportion (0.05%) of patients experience extreme complications such as fistulas or embolisms in the esophagus. While rare, complications of this type have a high mortality rate of 71% [1]. The current standard to minimize these instances is the use of a thermistor lodged onto the end of a catheter and that is placed in the esophagus. This, however, is not the most effective way to prevent injury to the esophagus due to temperature latency and improper placement [2]. Therefore, the goal of this project is to create an improved esophagus protection device for atrial ablation procedures. The device will work using three modalities: temperature sensing, pressure sensing, and mechanical displacement of the esophagus. The first two modalities will be combined in a mathematical model of tissue damage to provide feedback to the physician and eventually automatically shut off the ablation catheter. In this project a model for studying heat transfer rates is created and verification of our feedback loop from the thermistor to the heat source is shown. The utilization of a more advanced monitoring device will significantly reduce the risk of esophageal injury. In addition, the device may actually improve patient outcomes by allowing for more thorough ablations during a single session, particularly of atrial tissue in close juxtaposition with the esophagus.


Project Mentor: Colin Drummond, Department of Biomedical Engineering

Postr: Efficient Social Media Management

Adam Beck, Department of Computer Science; Daniel Grigsby, Department of Computer Science; Tommy Lu, Department of Computer Science; Rachel Pavlakovic, Department of Computer Science; Dominique Owens, Department of Computer Science

Social media apps and websites are an integral part of the daily life of a content creator. Unfortunately, there does not exist a free, open-source product to manage media posting and data analytics across all social media platforms. Our desired product will allow individual content creators, as well as small businesses, meet these needs. Postr is a tool that enables efficient management of one’s social media presence. It controls the posting of materials across all social media based on various criteria, such as user interactions or public information updates. This tool is targeted at budding media creators who need to scale up their marketing, but don’t have the resources to purchase an enterprise solution or hire someone else to do it. Additionally, Postr is meant to automate and prevent duplication of effort when performing the same or similar actions across one’s social media platforms. This includes making a text/image post, updating a bio, responding to real-time triggers, and tracking performance of user profiles. Postr also supports a social media scheduler, allowing users to schedule these events on custom dates, intervals, and frequencies.

Project Mentor: Professor Soumya Ray, Department of Computer Science
The effects of haltere mass on fly head orientation during flight

Chenxin Bi, Case Western Reserve University Biology Department

The object was to explore how changes of inputs detected by the mechanosensory system are received by the animal’s brain and therefore influences its behaviors. Since flies can detect both visual and mechanical information during flight, this research can also examine how inputs from multiple sensory systems are integrated and then lead to the animal’s behaviors. In this research, the relationship between the fly’s head movement and the mass and force that the haltere was investigated. Halteres are a kind of special mechanosensory organ of flies, which take place of flies’ hind wings. Inside of this dumbbell-shaped organ, there are a large number of mechanosensory cells that are highly sensitive to strains during flight. According to the previous investigation conducted by Bender, the fly’s wing counter-steering behaviors, which are used to control body turning, are triggered by inertial cues generated from the haltere. By adding weight to the haltere end knob, the increased inertia triggers counter-steering turns earlier than untreated controls. Therefore my hypothesis was that by adding weight to the endknob to one side of haltere, the amplitude of head movements will be reduced due to the earlier trigger of similar counter-steering behaviors. There were one control group of intact flies and two experimental groups of flies treated with glue and iron filings, respectively. In each group, the fly’s head angles, haltere movements, and added mass were collected by fast-motion cameras from both top views and side views. At the same time, a circular LED arena surrounded the flying fly and provided visual stimulation. The result indicated that with increasing added mass on the haltere, the amplitude of head movements also increased, which didn’t agree with the hypothesis. It could imply that fly head movement behaviors are controlled through a different mechanism of influencing the fly’s wing behaviors.

Project Mentor: Dr. Jessica Fox, Biology Department; Michael Rauscher, Biology Department

Optical-based Prosthetic Hand Control

Sydney Lindner, Evan Cummings, Siyuan Hu, Natalie Bick, Hayden Koerwer, Department of Biomedical Engineering

To live a more comfortable, convenient life, people with amputations need reliable prosthetic hands with higher degrees of freedom and more concise control. Many technical advances have been developed towards this goal, including neural interfacing, EMG etc. These technologies made impressive contributions to the evolution of prosthetic hands, but even these new advancements still present different challenges for the user. Further advancement in the areas of these existing techniques could mitigate some of their disadvantages, but for now another tool is needed to push the boundary of prosthetic hand capabilities forward. Thus, we are proposing a new idea to solve the problem: integrating an optical imaging system. Ideally, a camera attached to the prosthetic hand will be able to scan the nearby environment, and identify shapes of all objects which the user potentially wants to capture. The prosthetic hand could adjust to the best gesture to grasp or hold the targeted object. This new strategy may yield several advantages: action accuracy could be enhanced significantly since it is a smart, self-correcting, auto-control system; because a computer is employed to help control prosthetic hand, no learning or adaptation is required for user. This project is working to develop a functional control system from a camera located on the prosthesis as well as EMG signals from the residual limb. This input data will be fed into a convolutional neural network, allowing the computer to determine the size and shape of an object. From this information, the prosthesis will determine the optimal method for grasping the object, and will be ready to grasp when the EMG is triggered.

Project Mentor: Matthew Williams, Department of Biomedical Engineering
Faculty Sponsor: Colin Drummond, Matthew Williams, Department of Biomedical Engineering
Trauma-Focused Cognitive Behavioral Therapy as the “Golden Standard” of treatment for Children who Develop Posttraumatic Stress Disorder Symptoms: A Systematic Review

Sarah M. Bingle, Department of Psychological Sciences

Trauma-Focused Cognitive Behavioral Therapy (TF-CBT) has long been considered the “golden standard” for treatment of PTSD in children, however it earned this title between 1980 and 1990 when research on child sexual abuse was booming. Few other types of trauma were considered at that time, which compromises the generalizability of TF-CBT to PTSD as a treatment for children with a variety of trauma experiences. A meta-analysis of randomized control trials that compared Trauma-Focused Cognitive Behavioral Therapy (TF-CBT) and other conventional treatments was unsuccessful due to a lack of sufficient research. A systematic review of the literature resulted.

Project Mentor: Allison L. Baier, Department of Psychological Sciences
Faculty Sponsor: Dr. Amy Przeworski, Department of Psychological Sciences
Financial Support: AHSS Grant, Case Western Reserve University, SOURCE Office

Case Western Conserve: Microgrid Modeling and Feasibility

Sean Black, Department of Electrical Engineering & Computer Science, Karyn Ludewig, Department of Electrical Engineering & Computer Science, Benjamin Shrager, Department of Electrical Engineering & Computer Science

In a world where clean, renewable energy solutions are essential to increasing power needs and very large power grid infrastructure raises reliability and security concerns, microgrids provide a solution for a small area to be removed from the whole power grid allowing it to function as its own entity. This project analyzes the feasibility of creating a microgrid for the campus of Case Western Reserve University (CWRU) by investigating a solution that handles CWRU’s power consumption needs for a reasonable cost while having the potential to operate independently of the Cleveland power grid and make use of renewable energy sources. To begin with, we gain an understanding of how power is distributed on CWRU’s campus. Next, data from every campus building are used in analyzing load requirements, as gaining an understanding of how loads differ depending on the time of day, time of the week, and by season is important in looking at microgrid possibilities. Also taken into consideration for the microgrid recommendation are regulations and policies governing energy generation and consumption in the city of Cleveland, the state of Ohio, and the United States as a whole.

Project Mentor: Professor Kenneth Loparo, Department of Electrical Engineering & Computer Science
**Fibroblast Derived Matrix as an In Vitro Model of Diabetic Cardiomyopathy**

**John Bradford,** Department of Biomedical Engineering, Omar Cardona, University of Central Florida, Marlee Dingle, Department of Biomedical Engineering, Clarence Noronha, University of Akron, Stephan Nieuwoudt, Department of Biomedical Engineering, Sam Senyo, Department of Biomedical Engineering

The role of the extracellular matrix on the progression of diabetic cardiomyopathy is not well characterized. We devised a series of experiments to test the effect of high glucose on extracellular matrix synthesis and the influence of the matrix on the insulin sensitivity of cardiomyocytes. These studies used primary cardiomyocytes, primary fibroblasts (the matrix generating cells), and cell lines. Fibroblasts generated matrix with different glucose treatments and were then removed from the matrix using chemical treatment (NH4OH). Cardiomyocytes were then plated on top of the cell-free substrates in low glucose media. The experimental model required design of CNC routed plate inserts to anchor the fibroblast-derived matrix. Preliminary evidence suggests cardiomyocytes that are grown on a matrix produced in a high glucose environment show an increased resistance to insulin. The phenomena were verified with phospho-AkT, an index of insulin sensitivity. In addition, high glucose impacts the activation of fibroblasts to an injury state and alters the structure of the extracellular matrix.

_Project Mentor: Professor Sam Senyo, Department of Biomedical Engineering_

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**Learning to Group and Order Abstract Meaning Representation Semantics for Discourse Planning**

**Anneliese Braunegg,** Department of Electrical Engineering and Computer Science, CWRU; **Fangze Liu,** Department of Electrical Engineering and Computer Science, CWRU; **Jonathan Pfeil,** Google; and **Soumya Ray,** Department of Electrical Engineering and Computer Science, CWRU

A key task in discourse planning is learning to organize semantic components of a complex communicative goal. We present an approach to this task when the semantics are expressed through the Abstract Meaning Representation (AMR). Our approach uses machine learning methods to learn how to group complex communicative goals into sentential units and how to order them appropriately. Given a new complex goal, we then use local search to find a good grouping and ordering. We produce experimental results and evaluate them both quantitatively and qualitatively. Most recently, we have implemented hyperparameter tuning, two new grouping heuristics, a new set of ordering features based on previous literature, and conversion of AMR sentence graphs to plain-text English.

_Project Mentor: Professor Soumya Ray, Department of Electrical Engineering and Computer Science_
Improved Joystick Control System for Caregivers and Patients in Motorized Wheelchairs

Sacheth Chandramouli¹, Andrew Santulli¹, Daniel Brenner¹, Garrett Sang¹, Molly Chabowski², Elaine Ahn²

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Approximately 131.8 million people around the world require wheelchairs due to disability or debilitating injury. Thirty percent of all wheelchair users use a motorized wheelchair. While extremely beneficial to individuals with disabilities, the ownership of a wheelchair is not synonymous with regaining full control over performance of day to day activities. Studies have shown that people in motorized wheelchairs are sometimes incapable of moving themselves around due to several complications including weak motor control or impaired cognitive functions. To alleviate some of these problems, these handicapped individuals often require the assistance from family members or external caregivers. Due to its size/weight, motorized wheelchairs are largely incapable of being moved manually, and the caregiver must use the built in joystick to move the wheelchair. This places both the caregiver and patient in an awkward position and increases the likelihood of injury. To eliminate this problem, we intend to create a method by which a caregiver need not be placed in harm’s way to mobilize the patient. By using a mechanical construct composed of a system of motors and sensors, we are able to create a detachable joystick that can be integrated into existing motorized wheelchairs. Our joystick easily fits in one hand so that it is minimally inconvenient for the caregiver. The controls on it are also intuitive so that the learning curve of the caregiver is minimized. The mechanical interface on the motorized wheelchair is designed to cause minimal discomfort to the patient. Several error pathways have been analyzed to minimize the severity and occurrences of hazards. The overall aim of this product is to provide patients and caregivers more freedom in their day to day activities.

Project Mentors: Sydney Song, Dr. Colin Drummond, Dr. Matthew Williams, Department of Biomedical Engineering

How divided should the prefrontal cortex be?

Function of the orbitomedial and medial prefrontal cortex with respect to anxiety disorders

Kim Browne, Department of Biology; Dr. Sondra Bland, Department of Psychology, University of Colorado Denver; Dr. Richard Drushel, Department of Biology, Case Western Reserve University

Regions of the prefrontal cortex (PFC) are commonly investigated in research pertaining to anxiety disorders, with researchers often distinguishing which specific sub-division they conducted research on. Instead of simply stating the PFC, researchers may say orbitomedial prefrontal cortex (OFC) or medial prefrontal cortex (mPFC). However, this terminology can become confusing when researchers choose to specify the numerous subdivisions within the OFC and mPFC. Common examples of this include specifying the ventral orbital (VO) and lateral orbital (LO) of the OFC and specifying the infralimbic (IL) and prelimbic (PL) regions of the mPFC. Are there certain instances where researchers may be over-focusing their research by choosing to look at a very specific region instead of the PFC as a whole? This literary review looks into the question of the importance of specificity of brain region identification, focusing on the previously stated PFC regions in regards to anxiety disorders and treatment methods to these disorders.

Project Mentor and Faculty Sponsor: Richard Drushel, Department of Biology, Case Western Reserve University
Hand-Motion Actuation for Hexapod Robot

Katherine Koning, Department of Electrical Engineering; Alex Bukovinszky, Department of Electrical Engineering; Ariel Foss, Department of Electrical Engineering; Nicole Graf, Department of Mechanical and Aerospace Engineering; and Alexander Behr, Department of Computer Science

The current state of robot payload delivery can easily navigate aquatic or land-specific terrain, however existing technologies have critical difficulty transitioning between the two. For the purpose of debris and fuselage retrieval from surf zones, it is therefore critical to develop a remote robotic retrieval method that can navigate both dry land, sand, and aquatic spaces. In order to develop a technology that addresses these needs, the crab style robot offers an excellent biologically inspired solution. This robot is ideal for maneuvering in its terrain, however, its control method needs to be improved because controlling legs with many degrees of freedom via tele-operation can be cumbersome and non-intuitive for users. Therefore, we are developing a wearable glove control unit for intuitive user control. The robot leg motions will be actuated through the use of sensors on the glove. These will measure the degree of finger flexion, in order to determine the position of the user’s fingers, and thus mimic their motion in a one-to-one motion paired manner. In addition to direct limb control, we are developing linear locomotion patterns which allow the user to switch from individual limb control to a continuous walking pattern, when discrete obstacle maneuvering is not required. In this way, our device tackles this issue of surf zone remote robotic navigation.

Project Mentor/ Faculty Sponsor: Dr. Kathryn Daltorio, Department of Mechanical and Aerospace Engineering

An alternative PEG tube system to improve patient care

Investigation of viability of a silicone collapsible anchoring design to replace balloon anchors used in percutaneous endoscopic gastrostomy feeding tubes

Katherine Burelbach, Biomedical Engineering

Percutaneous Endoscopic Gastrostomy (PEG) feeding tubes are widely used as a route of feeding in patients with impaired swallowing who require long-term nutritional support. Current feeding tube designs use an inflatable balloon to anchor the tube in the stomach. However, the balloon device mechanically fails through bursting and leakage of the balloon and requires regular volume monitoring. The current study investigates the technical characteristics of an alternate PEG feeding tube design compared to the current state of the art balloon device. The presented design features a silicone collapsible anchor to replace the need for a balloon.

Project Mentor: Dr. Colin Drummond, Biomedical Engineering
Neural Ninja

Noah Crowley, Computer Science and Cognitive Science; Anna Burkhart, Computer Science; Justin Green, Computer Science; Jack Donnelly, Computer Science

Machine learning is a popular class of AI algorithm that learns from experience. One of the major learning algorithms is the artificial neural network. The basic idea behind artificial neural networks is that many simple units can connect together to perform much more complex tasks, like in a biological brain. While biological brains are much more complicated than these analogs, ANNs have already found a great number of applications in every field from automated stock trading to oncology. While the basic idea behind an ANN is fairly intuitive, the actual implementation can be fairly complex, thus limiting their usage only to those who are familiar with computer programming. This project is designed to change that. Our goal is to create an intuitive application that can create, train, and modify neural networks through a visual interface. We will be writing an Electron app with a Python backend for our project. The interface will be laid out into 4 main pages: a start page, a creation page, a network page, and a weight matrix page. The start page will allow users to choose between opening an existing network or creating a new one. The creation allows for the creation of a new network. The network page will allow users to add and edit layers. The weight matrix page will provide a visual for the connection between two layers. The backend supports the usage of fully connected layers and 1-D and 2-D convolutional layers. The backend will also allow the user to choose between using logistic sigmoid and rectified linear unit as an activation function. It is our hope that by creating tools to help people create ANNs without a background in programming, we will increase technological literacy and improve the quality of conversation we have on these topics.

Project Mentor: Soumya Ray, Department of Electrical Engineering and Computer Science

iOS ePantry Application to Track Grocery List, Pantry Inventory, and Fetch Recipes

Caleb Cain, Computer Science; Savita Medlang, Computer Science; Owen Gibson, Electrical Engineering

The ePantry application, is the virtual representation of everything a user has in their pantry at home. This application provides quick access, whether at the grocery store, on the way there, or even at home before, to what a user has in their pantry. This provides a mechanism giving users the ability to never have to wonder what they have in their pantry at home. Users are always able to check whether or not they have a certain ingredient in their pantry, as well as keep track of a grocery list of things that they do need for their pantry at home. Our application provides an easy way to then transfer everything a user bought that was on their grocery list into their virtual pantry, with the click of one button. With the application we have developed users can only track what they have in their pantry and on their grocery list, they can utilize these items to then search for recipes on the web that they have the ingredients to make. This allows users to not only get quick access to recipes they can make at that moment, but also allows the user to see what ingredients they would need, and what they already have, to make a certain recipe. Our recipe search will allow users to create meals tailored to the ingredients they have at home, or it will allow users to see what ingredients they need to purchase tailored to whatever they have an appetite for that day.

Project Mentor: Professor Gregory Lee, Electrical Engineering and Computer Science Department
Project Mentor: Professor Soumya Ray, Electrical Engineering and Computer Science Department
Association Between Eating Disorder Inventory and Musculoskeletal Injuries in Collegiate Female Athletes

Jane Carsey, B.S. Nutritional Biochemistry and Metabolism, Department of Nutrition; Dr. Lynn Kam, Department of Nutrition

An athlete’s goal is to optimize their performance. In low body weight and aesthetic sports, some athletes may restrict caloric intake in order to achieve an “ideal” body composition. These pressures can develop into disordered eating behaviors which can worsen over time into a more severe eating disorder. Female athletes face additional challenges such as social pressures and participation in low body weight sports that put them at increased risk for developing eating disorders. Eating disorders can lead to chronic negative energy balance which has a number of associated problems such as impaired performance, poor immune health, and increased risk for musculoskeletal injuries. These and other outcomes are results of what is known as Relative Energy Deficiency in Sports (RED-S). This study investigated how Eating Disorder Inventory, a quantitative measure that assesses risk for developing an eating disorder, was associated with prevalence of musculoskeletal injuries in varsity female athletes at CWRU. Understanding how disordered eating behaviors are associated with musculoskeletal injuries in female athletes will allow insight into how the severity of disordered eating behaviors and risk for eating disorders influences health and performance, even at subclinical levels. This will help us better detect problems earlier on so that healthcare providers and sports nutritionists can help treat these issues before they are more severe.

Project Mentor and Faculty Sponsor: Dr. Lynn Kam, Department of Nutrition

Novel Portable Electromyogram for Multipurpose Clinical Research Use

Edward Carson, Department of Biomedical Engineering, Alex Ghorishi, Department of Biomedical Engineering, Joseph Spittalii, Department of Biomedical Engineering, Yixuan Wang, Department of Biomedical Engineering, and Marina Yu, Department of Biomedical Engineering, Matthew Williams, Department of Biomedical Engineering, Colin Drummond, Department of Biomedical Engineering

Electromyography (EMG) is a way for clinicians to assess the activation of muscles through the use of electrical signal detection. Surface electrodes are placed on the skin over the area of interest to collect signals that are sent to the EMG device. Currently, these devices are large and not made for transportation, causing patients to be bedridden or limited to a small area in order to be monitored by clinicians. Typically, the place in which EMGs can be carried out is in a hospital or research setting, where the device is located. In addition, the most common option for an EMG is one that always needs to be plugged into a wall. A portable EMG device will allow for remote monitoring of patients via a portable, lightweight, wireless EMG device with at least 8 hours of battery life and 8 feedback channels. The device will be comparatively inexpensive to current available devices and capable of storing the data in the form of specific numbers. It will also be able to transfer the data to an external computer storage device. Currently in the prototyping and verification stage for senior capstone, a partial representation of the device and plan for completion have been established, but the full device will be assembled in the Spring 2019 semester.

Project Mentors: Professor Matthew Williams, Department of Biomedical Engineering, and Professor Colin Drummond, Department of Biomedical Engineering
Case LFG: An all-purpose looking for group web application

Vishal Patel, Department of Computer Science; Isaac Ng, Department of Computer Science; Nikhil Chakravarthy, Department of Computer Science

For many activities, it is difficult to find a general group on short notice unless you otherwise already know several people. Our goal is to create an all purpose looking for group (LFG) site where people can actively seek out other groups to join/create their own group for other individuals with similar interests. Our project seeks to basically streamline the process of looking for groups via multiple sites into one such page. Currently, our target audience will be the Case Western campus and its associated members. The Case LFG website is an online webpage used to find other people of similar interests via their posts. It will offer an environment for people to quickly find groups/members to conveniently add to their groups. Given the website, a human user may log in to the website. They will also be allowed to post a looking for members/group announcement which will show up in the feed of the main website. Users will have the ability to comment and respond to lfg posts sent by other users. This feature allows the users to communicate things like contact info/logistics relating to the respective post. The multiple feeds will be sorted by their respective categories. There will be a search bar where the user will be able to parse their feed for the relevant posts according to their keywords. After a certain time, various looking for group/more posts will be archived so that the user will be able to view new announcements if they visit the website at a later date. They will also be able to access their account settings page and change their account info. The frontend is built using React with Material UI and the backend is built over a MySQL database with a Java-coded server. The whole project is hosted on an EC2 instance in the Amazon Cloud. The website can be found at https://caselfg.com.

Project Mentor: Doctor Soumya Ray, Department Electrical Engineering and Computer Science

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Mixed-Method Analysis of Engagement on a Social Media-Based Weight Loss Study

Sandhya Chari, Department of Nutrition; David Cavallo; Department of Nutrition

A social media based weight loss intervention was conducted to increase physical activity by using Facebook as a source of engagement among participants. The pilot study aimed to examine Facebook engagement among the participants using a randomized controlled promotion trial (n=67). This research is concerned in describing data obtained from the weight-loss pilot intervention. The overall study is a secondary data analysis of Facebook posts from the intervention and the study design is a mixed methods design. We will perform a descriptive analysis test on the comments and reactions of all the Facebook posts by the participants and the moderator to determine which post types created the most engagement in the weight loss intervention. The analysis plan for this study involves intensive coding and the creation of specific themes to organize all the comments and emoticon reactions from various posts. The purpose of this analysis is to gauge the level of engagement on the Facebook page, and to examine what types of posts (weight-loss related, poll votes, food recipes, nutritional information, or requests/suggestions) differentially impact engagement (emoticon reactions, comments, poll votes, and views).

Project Mentor: Dr. David Cavallo, Department of Nutrition
Consequences of Genetic Mutations in Thoc6: Characterizing Phenotypic Changes in a Mutant Mouse Model

Monica Chavan, Department of Biology; Katherine Johnson, Department of Genetics and Genome Sciences; Dr. Ashleigh Schaffer, Department of Genetics and Genome Sciences.

Mutations in the human THOC6 gene have been shown to result in intellectual disability in multiple individuals over the past few years. The THOC6 protein is a component of the THO sub-complex in the larger transcription export complex (TREX). TREX, serving in cell nuclei as a facilitator of mRNA processing and export to the cytoplasm, is necessary for life and regulates embryogenesis, cell differentiation, and gene expression. The exact function of THOC6 in the cell, however, and its role in neurodevelopment, has yet to be elucidated. We developed mouse models for Thoc6 by generating a knockout and hypomorphic allele for the Thoc6 gene. Western blots to characterize protein expression across control, knockout, and two different hypomorphic genotypes show that decreased levels of protein expression are indeed observed in the disease models, while the knockout shows no protein expression. To determine at which stages in development Thoc6 mutants demonstrate differences in neurogenesis, we analyzed mouse embryos by immunohistochemistry. First we assessed neural progenitor cells (NPCs) by sectioning and immunostaining Thoc6-mutant and control brains over a range of embryonic ages. Using NPC markers Sox2 and Pax6, we measured the number of proliferating and dying cells by co-localization with Ki67 and TUNEL respectively. We observed no change in NPC localization or abundance through time point e14.5. TUNEL staining for apoptosis and Ki67 staining for proliferation also revealed no significant phenotypic changes between wild-type and Thoc6-mutant mice by this stage in development. Later embryonic ages have yet to be collected and sectioned to see when differences in proliferation and cell death first become apparent in Thoc6-mutant mice. My early results suggest hypomorphic THOC6 expression does not affect NPC proliferation or survival, and reduced THOC6 expression may instead impact other cell types which differentiate from NPCs later in development (neurons) to drive the disease phenotype.

Project Mentor: Dr. Ashleigh Schaffer, Department of Genetics and Genome Sciences
Faculty Sponsor: Dr. Susan Burden-Gulley, Department of Biology
Comparing Handgrip Strength in Healthy African-American and Asian-American College Students to Establish Normative Values

Cindy Chen, Department of Nutrition; Oluchi Onyeukwu, Department of Nutrition

Nutrition professionals have found the collection of handgrip strength values to be an indicator of functional status, or the ability for a subject to perform daily tasks. However, previous studies to establish normative values have not been diversified enough. Through this study we began to establish more diverse normative values for widespread use, and compared the values between Asian and African-American college students age 18-29 to determine if there are differences between ethnic groups. We hypothesize that African-American subjects, both male and female, will have higher handgrip strength values in comparison to their Asian-American counterparts and it will be statistically significant at p<0.05. Subjects were recruited by the research assistants using social media, posted flyers, and word of mouth. Cross-sectional data collection occurred over the course of 3 sessions at Case Western Reserve University. The study was IRB approved and subjects provided verbal informed consent. Demographic and health information was obtained via a questionnaire. Anthropometric measurements (height, weight, palm length, and wrist, mid-upper arm, and hand circumferences) were obtained using a portable stadiometer, scale, and measuring tape. A Jamar hydraulic hand dynamometer was used to measure handgrip strength a total of 6 times alternating in both hands. A t-test was conducted to compare the maximum handgrip strength of African-American men and women to that of their Asian-American counterparts. Data were collected from 25 subjects. Analysis is pending but will be completed by the time of Intersections. If the grip strength of African-American and Asian-American college students is significantly different, it is important to continue to gather these data and thus further diversify normative values for grip strength.

Project Mentor: Professor Rosa Hand, Department of Nutrition

Controllable RF Clock Signal Generator

Ruoyan Chen, Electrical Engineering, EECS Department; Hangxing Liu, Electrical Engineering, EECS Department; Jie Wu, Electrical Engineering, EECS Department; Alex Roman, EECS Department; and Prof. Soumyajit Mandal, EECS Department

The overall purpose of this project is to design and construct a controllable radiofrequency clock signal generator with a frequency spectrum from 20 MHz to 80 MHz for the use of a receiver and an analog-to-digital converter of an ultrasound scanner in Prof. Mandal’s Integrated Circuits and Sensor Physics Lab. The frequency is to be adjusted and controlled in accordance to the need of users. This clock signal generator is designed to be cheap and portable, in order to replace the heavy and expensive function generator which is currently providing the clock signal to the system. The signal generator is controlled by De1-Soc FPGA board through serial communication protocol. This design incorporates AD9913 Direct Digital Synthesizer, featuring 10-bit DAC operating up to 250 MHz with 100 MHz maximum output. The on-board phase lock loop utilizes 25 MHz crystal oscillator, the incoming reference clock, and outputs 250 MHz reference to the DDS. The DDS is powered by the 3.3V FPGA output, which is then converted to 1.8 V by a linear regulator. The design utilizes other electronic devices such as low-pass filters, level-shifters, buffers and a digital comparator that could convert the DDS’s sine wave output into a square wave output.

Project Sponsor: Prof. Soumyajit Mandal, Department of Electrical Engineering & Computer Science
Faculty Mentor: Prof. Gregory Lee, Department of Electrical Engineering & Computer Science
How does Region and Soil pH Affect Redback Salamander Populations?

Catherine Chervenak, Department of Biology; Dr. Michael Benard, Department of Biology

Abstract: Human actions are causing massive species extinctions on a global scale. Climate change, habitat destruction, invasive species introduction, and pollution are all contributing to this decline in biodiversity and to changes in species distributions. Still, there are few species whose distributions have been studied in detail and many species that have not been documented at all. Surveys document the ecology of a specific area at a specific time. This information can help establish conservation goals in the long-term by recording what baselines are necessary to provide certain functions such as balancing invertebrate populations and contributing to ecosystem resilience. This study focuses on the salamander populations at the CWRU University Farm. We surveyed the amphibian species at the CWRU university farm over several months with the goal of answering two questions. The first is how salamander abundance, color type and tail damage differ in three regions of the farm. The second is if any of these variables are correlated with soil pH. Increased atmospheric deposition of sulfuric and nitrogen oxides due to fossil fuel burning have led to increased acidification of the environment, which might be harmful to amphibian populations. Furthermore, previous studies found that salamander abundance can be correlated with soil pH. Redback Salamanders (Plethodon cinereus) were by far the most abundant species observed and thus the focus of our analysis. If the salamander populations vary by region, we will investigate how additional variables, such as plant community composition and invasive earthworm abundance, may provide mechanisms causing this difference. If low soil pH is found to negatively affect salamander populations, it will suggest that increased acidification is a threat to the P. cinereus population at the University Farm.

Project Mentor: Dr. Michael Benard, Department of Biology

Coded Familial Genomic Data Privacy Processor

Yennmay Chia, Electrical Engineering; Shangran Li, Electrical Engineering; Tianyi Wu, Electrical Engineering

Human-genome sequencing has rapidly progressed and with it there is a growth in access and release of personal ancestry and genetic information. Genetic information is sensitive, stable, and highly correlated amongst family members. An individual’s genomic privacy is vulnerable to attackers who are able to infer single nucleotide polymorphisms (SNPs) with the use of statistical relationships in regards to Mendelian Law and genomic variants from the available data of family members. This project addresses the implications of familiar correlation on genomic privacy through a coded inference algorithm that evaluates the effects of such dependencies on personal privacy. Based on an algorithm created by Professor Erman Ayday, we have developed a visualization tool for individuals to assess their genomic privacy risk based on the relationship and amount of familial SNP data available. Tested on publically available familial data, a junction tree calculates the SNP genotype of an individual based on the released family SNPs and minor allele frequencies of those of similar ethnic background. Producing a visual platform, users are able to view specific SNP probability distributions for various scenarios of released and inferred data based on user input.

Project Mentor: Professor Erman Ayday, Department of Electrical Engineering & Computer Science
Faculty Sponsor: Professor Gregory Lee, Department of Electrical Engineering & Computer Science
Monitoring Heart Rate and Galvanic Skin Response to Assess Patient Stress in the Intensive Care Unit

Stephanie Chin, Department of Biomedical Engineering; Martin Domondon, Department of Biomedical Engineering; Jeshrene Enerio, Department of Biomedical Engineering; Turner Montgomery, Department of Biomedical Engineering; Zoe Nykaza, Department of Biomedical Engineering

At least 4 million patients require intensive care unit (ICU) treatment every year; the ICU environment often involves a variety of intravenous connections, procedures, repeated clinical examinations, in addition to a general lack of privacy. Such a foreign environment may lead critically ill patients feeling distressed and anxious, fostering individual emotional and physical stress that is believed to impact or delay patient recovery. This is especially true in the ICU due to the lack of restful sleep, constant visitors, and multiple alarms throughout a patient’s stay. The current standard of stress measurement used in ICUs is through conversations with patients and nurse observations. However, these measurements are subjective, making the treatment of patient stress difficult. A standardized, quantified stress measurement will aid nurses in evaluating patients in the ICU and improve their recovery. The proposed solution is designed to utilize two physiologic parameters: heart rate (HR) and galvanic skin response (GSR). The patient’s HR and GSR will be used in conjunction a machine learning algorithm to produce a quantifiable stress index. The machine learning algorithm contains training data of both features that is used to calculate a regression to determine the patient’s stress level. The patient’s stress level will be displayed on a monitor capable of being attached to the vital signs monitor display in order for nurses to check during routine rounds.

Faculty Sponsor: Professor Colin Drummond, Department of Biomedical Engineering; Professor Matthew Williams, Department of Biomedical Engineering

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Improved Resection and Retrieval of Flat Polyps for Early Detection and Prevention of Colon Cancers

Rajiv Trehan1, Jasmine Sondhi1, Chao-yi Lu1, Doe Choi1, Sebastian Pino-Peralta1, Amitabh Chak2, and Colin K. Drummond1
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Colorectal cancers are currently the third most prevalent cancer within the United States. The vast majority of these colorectal cancers stem from polyps which are abnormal tubular or villous growths or lesions that can be found throughout the alimentary tract. Currently, polyps are frequently resected using a snare tool and then retrieved using a Roth Net®. Failure in retrieving these polyps is about 10% which can be correlated to 3 factors including (1) the size of the polyp with polyps smaller than 5 mm frequently lost from the line of sight, (2) height of the polyp with the snare unable to encapsulate some polyps, and (3) a difficulty to manipulate the Roth Net® past the right colon loop. The morphology of these polyps can vary between raised or flat. The raised polyps’ height profile allows easier encapsulation of the snare and net leading to a lower failure rate of treatment. However, an improved method for resecting and retrieving flat mucosa and polyps is required. This study serves to propose a new design for both the resection and capture of flat polyps. The proposed design combines the action of the snare and net system into a one-pull method to avoid loss of visual contact of the resected polyp into the alternating contracting folds of the intestines. Additionally, through the use of a polymer with the modulus properties of interest, the net’s durability has been improved to avoid leaving low density polyethylene in the patient’s GI tract. The net ring’s polymer functionalized surface with the addition of a linker molecule allows for effective capture of the flat mucosa causing the flat polyps height profile to increase during resection.

Project Mentor: Dr. Amitabh Chak, M.D., Gastrointestinal Health Institute University Hospitals
Faculty Sponsor: Dr. Colin K. Drummond, Department of Biomedical Engineering
Motorized Knee Orthosis with Phase of Gait Detection to Aid with Toe Clearance in Stroke Patients with Leg Weakness

Christina MacAskill¹, Emily Molinich¹, Elizabeth Schafer¹, Rachel Loeff¹, Nathaniel Choo¹, Kevin Yang¹.
Jessica McCabe², Colin Drummond¹, Matthew Williams¹
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Every year about 795,000 people in the United States have a stroke, with only about 10% of those patients making a full recovery¹. The consequences of a stroke can include muscle weakness and loss of fine motor control. As a result, one of the biggest challenges is toe clearance while walking, causing patients to trip and fall during daily activities. Additionally, knee stiffness and poor balance affect patients following a stroke. In healthy individuals, the primary propulsion forces for walking are generated by the ankles; however, after a stroke that results in leg weakness, the ankle musculature is frequently paralyzed. Most current solutions for this problem are for advanced physical therapy, but there are a limited number of available devices for use in daily activities. To address leg weakness in stroke patients, our group proposes a device that aids the patient in lifting their leg off of the ground to avoid “toe catch” in the swing phase of gait coming out of the push off phase. This device detects the phase of gait with force sensing resistors (FSR) inserted under the sole of the foot, and an integrated motor to assist in knee bending. Shown in this symposium is a proof-of-principle prototype that uses lights to demonstrate our device’s accuracy in predicting the phase of gait and its ability to activate the motor at the correct times during toe-off and heel strike. Future development will include an integration of the motor to our proof-of-principle prototype, which will generate a moment at the knee to actively lift the leg.

Project Mentors: Professor Colin Drummond and Professor Matthew Williams, Department of Biomedical Engineering


Effects of Gemcitabine on EDB Fibronectin Expression in Pancreatic Cancer Cells

Samuel Chou, Department of Biology; Peter Qiao (Graduate Student), Department of Biomedical Engineering

Extradomain B fibronectin (EDB-FN) is an extracellular matrix (ECM) oncoprotein that is commonly overexpressed in pancreatic cancer cells. Overexpression of the protein is associated with poor prognosis and aggressiveness. The Case Center for Biomolecular Engineering is currently developing new methods of detecting pancreatic cancer early on by targeting EDB-FN using synthesized peptides. This research project would contribute toward the said development by providing information on how chemotherapeutic agents, such as gemcitabine, can affect the expression of EDB-FN and the overall behavior of pancreatic cancer cells. It is hypothesized that gemcitabine would decrease the expression of EDB-FN in pancreatic cancer cells and decrease cell aggressiveness. Two specific aims have been devised to support this hypothesis. Aim 1 would establish that cancerous cell growth is inhibited by gemcitabine. This would be accomplished through obtaining and analyzing the IC₂₅, IC₅₀, and IC₇₅ values of the agent. Inhibitory concentrations would be determined through MTT assays. Aim 2 would establish that EDB-FN expression changes with varying concentrations of the agent. In vitro expression of EDB-FN would be examined using western blot and confocal microscopy.

Project Mentors: Dr. Zheng-Rong Lu, Department of Biomedical Engineering and Peter Qiao (Graduate Student), Department of Biomedical Engineering
Faculty Sponsor: Dr. Ronald Oldfield, Department of Biology
TLE3 May Repress EMT to Promote Luminal Breast Cancer Cell Properties

Marian Chu, Chemistry and Biology; Dr. Lindsey Anstine, Department of Pharmacology; Dr. Ruth Keri, Department of Pharmacology

Breast cancer is a heterogeneous disease with multiple subtypes including luminal and basal. Luminal breast cancers (LBC) are associated with less aggressive phenotypes and better patient outcomes compared to basal breast cancers (BBC), which are more aggressive, leaving patients with poor prognoses. This difference is partially due to the high cancer stem cell (CSC) content within basal tumors. CSCs express markers associated with epithelial to mesenchymal transition (EMT) and have the ability to migrate from the primary site and seed new tumors in distant locations, a process referred to as metastasis. Thus, identifying factors that control the expression of CSC genes will provide new knowledge about the aggressive nature of breast cancer subtypes. Our lab has identified a co-repressor protein, TLE3, that represses CSC genes in LBC cell lines. As CSCs are associated with EMT markers, we hypothesize that TLE3 also represses EMT genes in LBC. EMT is the process by which epithelial cells lose their polarity, cell-to-cell adhesion, and tight junction proteins including E-cadherin and ZO-1. Cells then upregulate mesenchymal proteins including N-cadherin and Vimentin, promoting a migratory cell phenotype. To examine whether TLE3 represses EMT markers in LBC, I will silence TLE3 using siRNA in MCF7 cells. Next, I will determine if protein expression of N-cadherin, Vimentin, and E-Cadherin change using western blots. Additionally, I will perform immunofluorescence staining for ZO-1. I expect N-Cadherin and Vimentin to increase and E-Cadherin and ZO-1 to decrease in response to TLE3 silencing. As these assays are not currently used in the lab, I have optimized ZO-1 staining in MCF7 cells and western blot analysis of Vimentin and E-cadherin. These studies will help to understand whether TLE3 represses genes associated with EMT and CSCs, providing insight into how aggressive phenotypes in breast cancer are controlled.

Project Mentor: Dr. Ruth A. Keri, Department of Pharmacology
Faculty Sponsor: Professor Dianne Kube, Department of Biology

RoadPrintz: Precision Robotic road painting systems

Sean Morrison, Electrical Engineer; Kjay Shieu, Electrical Engineer; Kevin Coe, Electrical Engineer

The street painting industry is roughly worth $400 million in the United States, and as more and more drivers enter the streets there will be a need for accurate street signs for their safety. Today’s street painting is done by hand and is relatively slow and cost inefficient. This research explores the possibility of using an alternative in the form of a vehicle mounted with a robotic arm that can precisely measure its location and paint an accurate street sign. This is done by using a precise GPS device combined with localized odometry, taken from the vehicle CANBUS, to measure the position in space of the vehicle. Using this data, we can feed it to the robotic arm to accurately paint the street signs. When fully developed, the vehicle would be able to paint the street signs accurately while on the move as well as being able to paint more complex figures.

Project Mentor: Professor Wyatt Newman, Department of EECS
A Radio Frequency Tracking Device for In-Home Monitoring of Autistic Patients

Amber Colley, Department of Biomedical Engineering; Anshul Dhingra, Department of Biomedical Engineering; Samantha Magliato, Department of Biomedical Engineering; Neil Orton, Department of Biomedical Engineering

Individuals with autism, especially children, have a high tendency to wander away from secure places in their environment. Unsupervised wandering can place a tremendous amount of stress on caretakers, as these individuals have the sole responsibility of caring for and protecting the child. Without the ability to perceive danger and communicate basic information, the child can easily wander out of the house toward a busy street or even find themselves too close to the hot stove. Radio-frequency identification (RFID) uses radiowave technology to determine the presence of a radiofrequency tag, and based on signal strengths can monitor relative distances between specific tags. The potential to place multiple tags and readers throughout a patient’s home can be used to monitor the relative location of the child. Using this technology combined with a central monitoring system, a caretaker can have direct access to the movements of a child. With the child also wearing a device that can communicate to the central control system, if the child were to approach a dangerous location an alarm can be triggered on the monitoring system to alert the caretaker. Thus, if the child got too close to a dangerous part of the home, or managed to get out of the house and head towards the street, the caretaker would immediately be notified. The goal of an RFID tracking device is to enable the real-time monitoring of an autistic child, thus keeping the child out of harm’s way and giving caretakers peace of mind knowing their child is safe in their own home. Children with autism should not feel trapped in their own environment. They should have the potential to explore and experience their environment as a form of mental and physical enrichment, and as such, a radio frequency tracking device can help achieve this purpose.

Project Mentor: Hendrik Dewald, Department of Biomedical Engineering
Faculty Mentor: Professor Colin Drummond, Department of Biomedical Engineering

Hidradenitis Suppurativa Underarm Drainage System

Prerana Jaikumar, Department of Biomedical Engineering; Hee Seung Son, Department of Biomedical Engineering; Jin Young Kim, Department of Biomedical Engineering; Kenneth Conover, Department of Biomedical Engineering; and Paul G. Hazen, MD, FAAD, Clinical Professor of Dermatology, Case Western Reserve University School Of Medicine

Hidradenitis Suppurativa (HS) is a debilitating illness linked to inflammation and scarring of the sweat glands. HS is defined by recurrent, sterile abscesses increase areas of the skin such as the underarms and groin. These abscesses can leak up to 2 cups of fluid per day. Our solution will target HS at Hurley Grade II, at which there are multiple inflammatory nodules with moderate leakage. Current treatments are crude and involve basic compression of affected areas with diapers or towels. This disease causes physical discomfort and pain in doing everyday activities in which movement of the afflicted areas are needed. Beyond physical effects, this disease causes many emotional effects such as embarrassment of the smell and dealing with people's misunderstanding of the disease (people may think it is contagious). Our goal is to make a garment not only helps alleviate the physical discomforts of HS but help people with this disease live their everyday lives. Our solution to this problem will improve the quality of life of the patient by implementing a shirt-esque design to contain the fluid leakage while preserving the dignity of the patient. We utilize a modular design that allows for customizability - both in the profile of the patient and the amount of fluid leakage. Patients will be able to replace the disposable absorbable pads in the device at their convenience. By wearing our device underneath their day-to-day wear (which is often loose and not form-fitting), HS patients can live a more dignified and comfortable life.

Project Mentors: Professor Colin Drummond, Department of Biomedical Engineering; Professor Matthew Williams, Department of Biomedical Engineering
Use of a Neural Network for Respiratory Navigation to Enable Free-Breathing Abdominal MRF

Evan Cummings1, Kathleen Ropella-Panagis2, Wei-Ching Lo1, Vikas Gulani1,2, Nicole Seiberlich1,2
1Department of Biomedical Engineering, 2Department of Radiology

Magnetic Resonance Fingerprinting (MRF) is a method for generating quantitative maps of tissue parameters, primarily relaxation times. MRF has been demonstrated as a powerful tool in cardiac and abdominal imaging (Hamilton, MRM, 2017 and Chen, Radiology, 2016). Respiratory motion can cause inaccuracies in the parameter maps, but the effect of motion can be reduced by binning the data appropriately using an image-based navigator. Traditional approaches to image-based navigators can be challenging to employ with MRF data due to the high levels of undersampling and continuously changing contrast of the images. In this study, an artificial neural network was trained to differentiate contrast changes from respiratory motion in MRF images to effectively determine the respiratory phase.

Training data were generated using a 3D abdominal phantom with realistic respiratory motion by simulating a 2D MRF sequence (Hamilton, MRM, 2017). A total of 38,400 images were generated with varying respiratory motion curves at eight different slice positions through the abdominal volume. These images were sorted into five bins, separated based on motion of the phantom data. This dataset was partitioned into training and cross-validation datasets, with approximately 90% of the data used for training and 10% used for validation. The network was composed of 3 hidden layers, with batch-wide normalization and ReLU activation. The network was trained over 8 epochs with a minibatch size of 10 and an initial learn rate of 0.001, which was reduced by a factor of 10 every 4 epochs.

This network is currently able to correctly identify the phantom validation data with 90% accuracy. Research is still being conducted to extend this network’s effectiveness to in vivo data.

Project Mentor: Nicole Seiberlich, Department of Biomedical Engineering

Connecting Medical Devices in the ICU

Jay Gokhale, Department of Electrical Engineering and Computer Science; Adam Davis, Department of Electrical Engineering and Computer Science; Chris Hadiono, Department of Electrical Engineering and Computer Science

Medical devices in the ICU do not have a single protocol for communications, and synchronization of patient data with a uniform timestamp from different devices is not guaranteed. The objective of this project is to build a solution that facilitates the collection and synchronization of real-time patient data in the ICU, so that clinical personnel can visualize, review, and analyze past and current patient data to improve clinical decision-making.

The ICU contains many medical devices that connect to a patient and collect data over an extended period of time. Clinical personnel visualize the numeric and waveform data for each patient on specific devices to evaluate a patient’s condition. After the data is displayed the observed trend disappears from the device screen and is not accessible except in summarized numeric format in the Electronic Medical Record. Dealing There is no standard communication protocol that used for all medical devices, and data from different devices is not synchronized with a consistent timestamp that would enable clinical personnel to go back and review all of a patient’s data as it was collected in real-time. Our research aims to design and build a combined hardware and software solution that allows patient data from different devices to be collected, synchronized and archived. The system includes custom software that enables communications with the patient monitor and an Arduino-based data acquisition system to collect data from other devices in the ICU. Clinical personnel with interact with the system through a user interface to mange the acquisition of the multimodal data and well as to record and review all of the data be acquired from the medical devices. The system will also synchronize the data so it can be used and interpreted by clinical personnel.

Project Mentor: Professor Kenneth Loparo, Department of Electrical Engineering and Computer Science.
Chronic kidney disease (CKD) is a major health outcome in the United States affecting more than 13% of the general adult population. The prevalence of CKD is higher among African Americans compared with other racial and ethnic groups, and the rate of progression to end-stage renal disease (ESRD) is disproportionately faster among individuals of African ancestry compared with individuals of European ancestry. This health disparity observed among African Americans cannot be fully explained by access to health care or higher rates of co-morbidities, such as hypertension or diabetes, compared with European Americans. In fact, to date, the only major factor associated with the observed disproportionate prevalence of CKD and rate of ESRD among African Americans compared with other groups is APOL1 and its common genetic variants G1 (rs73885319) and G2 (rs71785313). We are interested in characterizing known and identifying novel genetic variants that impact disease progression, including modifiers. To accomplish this, we ascertained 135 patients with CKD from MetroHealth linked to electronic health records. Consented patients donated biospecimens, and DNA was extracted for genome-wide genotyping of approximately 2 million markers using Illumina MegaEX. On average, the study population is 63.5 (13.9 standard deviation) years of age and more than half is female (58%). The majority of participant patients with race/ethnicity data available in the electronic health record (n=115) is either African American (45%) or European American (44%). Among the 135 genotyped samples, 133 passed initial quality control for APOL1 renal risk variants G1 and G2, including 57 and 52 African American and European American participants, respectively. As expected, G1 and G2 minor alleles were frequent among African American participants (0.28 and 0.12, respectively) but either absent (G1) or rare (G2; 0.01) among European American participants. African American participants were more likely to carry one (RA1; 38.6%) or two (RA2; 21%) renal risk alleles (RA) compared European Americans (RA1; 1.9%). Analyses are ongoing to further characterize the patient populations, including estimating genome-wide and local genetic ancestry. Individual genetic variants and ancestry will be tested for association with clinical markers of disease, disease progression, and co-morbid outcomes such as cardiovascular disease.

Project Mentor: Dr. Dana Crawford, Department of Population and Quantitative Health Sciences
Faculty Sponsor: Professor Barbara Kuemerle, Department of Biology
Daily Doctor

Sarah Deng, Department of Electrical Engineering and Computer Science; Christina Gallishen, Department of Electrical Engineering and Computer Science; Tiffany Nguyen, Department of Electrical Engineering and Computer Science

Many people, especially the elderly, tend to forget whether they have taken their daily medication. This can lead to either completely forgetting, or taking a double dosage on accident. To target this problem the Daily Doctor was created to remind its user to take their daily-prescribed medication, dispense the proper dosage for its user, and implement safety mechanisms that prevent overdosing. The proof of concept will accurately dispense the correct dosage of four different pills, have an alarm that will sound once a day, and will require a PIN to have the medication dispensed. At this time, the proof of concept will only receive four types of pills shaped like M&Ms at a time. It will also be assumed that all the pills are only taken once a day and every day of the month. The end goal of this proof of concept is to begin the path of preventing errors in medication consumption in both elderly patients, and potentially at long-term care facilities.

Project Mentor: Evren Gurkan Cavusoglu, Ph.D, Department of Electrical Engineering and Computer Science; Faculty Sponsor: Gregory S. Lee, Ph.D, Department of Electrical Engineering and Computer Science

Developing Verification Methods for an Integrated Optical Coherence Tomography Radio Frequency Ablation Catheter

Deniz Dosluoglu, Department of Electrical Engineering and Computer Science, Xiaowei Zhao, Department of Biomedical Engineering, Dr. Andrew Rollins, Department of Biomedical Engineering

Radiofrequency ablation (RFA) of conductive pathways in the heart using fluoroscopic guidance is a standard of care for arrhythmias such as atrial fibrillation (afib). However, ablation-targeting methods are limited due to the indirect means of evaluating lesion quality and culprit tissue substrates, and lack of direct, real-time assessment is a contributing factor to sizable afib late recurrence rates. Optical Coherence Tomography (OCT) has been shown to be effective in distinguishing treated and untreated tissue and identifying different cardiac regions and tissue substrates. These findings have motivated the development of an integrated RFA/OCT catheter that has the potential to improve the outcomes of cardiac arrhythmia patients by producing high-resolution, real-time images that will aid electrophysiologist (EP) practitioners to better target structures and pathways that are responsible for the onset and persistence of arrhythmias like afib. Results obtained from recent experiments using a combined catheter prototype pointed to the need for standard methods to verify that current and future fabricated custom OCT probes are uniform and operational. Several verification methods were identified and investigated, including development and imaging of a birefringent phantom for system calibration, monitoring signal output from the utilized dual detectors using LabVIEW, and creation of a jig to measure the focal length of the GRIN lens at the distal tip of the imaging probe.

Project Mentor: Dr. Andrew Rollins, Department of Biomedical Engineering
Building a Precision Analog Matrix Tester

Deniz Dosluoglu, Department of Electrical Engineering and Computer Science, Michael E. Gentry, Rockwell Automation Inc.

The Precision Analog Matrix is a grid of relays that provides a series of connections from the system side to the user side of the A2Z Test Platform at Rockwell Automation, Inc. so that the devices under test can be stimulated and measured to ensure they are performing optimally. If, in the case of a system malfunction, the matrix is identified as the culprit during self-test, the platform is only able to pinpoint the error to one of the six switching PCBs, which have 144 relays on each. Removing the matrix from the platform, attempting to identify the faulty components, replacing them, and re-installing the entire device is a time costly procedure that can be performed several times by technicians with the assistance of engineers before the matrix is deemed to operate normally, which reduces factory output levels and efficiency. This project addresses the need for a robust, efficient way to test the matrix. A full functional prototype benchtop tester was developed that would allow technicians and engineers supporting the A2Z test platform to debug the matrix with a Digital Multimeter and desktop and view the results in a generated spreadsheet.

Project Mentor: Michael E. Gentry, Manager (Product Validation & Test), Rockwell Automation Inc., megentry@ra.rockwell.com
Faculty Advisor: Gregory Lee, Department of Electrical Engineering and Computer Science

Particle Ball

Brendan Dowling, Department of Electrical Engineering and Computer Science; Nikil Pancha, Department of Mathematics, Applied Mathematics and Statistics; Megan Robinson, Department of Electrical Engineering and Computer Science; and Henry Zheng, Department of Electrical Engineering and Computer Science

Particle Ball is a turn-based strategy game that allows users to move a ball and score points using Catalysts. Unlike in traditional strategy games, players take their turns synchronously and all actions that they take are resolved together. Additionally, instead of being able to directly interact with the ball, the only interaction is by way of using Catalysts to manipulate the ball through simple forces, such as attraction and repulsion. A user connects to the game through a desktop application, and is able to play against remote opponents by connecting to a server, or against a trained AI locally.

Project Mentor: Professor Soumya Ray, Electrical Engineering and Computer Science
Variable star classification with crowd sourcing

Nicholas Easton, Department of Physics; Adam Miller, Northwestern University CIERA; Aaron Geller, Northwestern University CIERA, Xander Hall, Illinois Math and Science Academy

We present a Zooniverse citizen science project in development aimed at classifying variable stars in the LSST Big Data era. Currently we make use of data from the Atlas and PTF catalogs, mapped to Gaia DR2. We plan to expand to additional data sets (including that of LSST) in the near future. The addition of Gaia data enables Zooniverse volunteers to not only view the light curve for an individual source, but also an H-R diagram showing a particular star’s location relative to all stars in the catalog. This, in combination with the shape of the light curve and the inferred variability period and amplitude, provides volunteers with information necessary to classify variable stars into a finer grid than with the light curve alone. On the back end, we will use volunteer classifications to train a machine learning algorithm to help vet the (large) catalog of available variable stars prior to entry into the Zooniverse workflow. In this poster we present our current Zooniverse workflow, initial results, and our plans for the future.

Project Mentors: Adam Miller, Northwestern University CIERA; Aaron Geller, Northwestern CIERA
Faculty Sponsor: Professor Rolfe Petschek, Department of Physics

Hardness-Depth Profiling Using Digital Image Processing and Machine Learning

Ethan Field, Department of Materials Science and Engineering, and Frank Ernst, Department of Materials Science and Engineering

The purpose of this research was to investigate hardness of metals by means of machine learning and other data science approaches. Using various sample preparation, we were able to better understand the process of scratching materials. My research group has been working on the cutting edge of surface engineering by concentrated interstitial solute (SECIS) for many years and this presented the need for newer, faster, and cheaper methods of hardness testing. SECIS involves using low temperature carburization, a process where a metal is heated to relatively low temperatures to inhibit substitutional diffusion but enhance interstitial diffusion which allows carbon and nitrogen to penetrate into the metal’s surface and enhance the properties exhibited including hardness, wear resistance, fatigue life, compressive stress, and corrosion resistance but doesn’t allow the movement of other elements within the material, notably iron and chromium. Some of these properties can be enhanced by 100x the original material’s properties. Under these special SECIS processing conditions, it is possible to obtain nitrogen and carbon atom fractions of 0.15, corresponding to 100,000 times the room-temperature equilibrium solubility. These processing conditions were developed with the Swagelok Company. A successful treatment can be measured by obtaining the cross-sectional hardness-depth profile of the material. This is the onus for my project.

Project Mentor: Professor Frank Ernst, Department of Materials Science and Engineering
A Portable Thermoacoustic Stirling Calliope with Automated Playback

Meaghan FitzGerald, Department of Electrical Engineering and Computer Science; Alexander Trimbach, Department of Electrical Engineering and Computer Science; Matthew Zyle, Department of Electrical Engineering and Computer Science; and Dr. David Kazdan, Department of Electrical Engineering and Computer Science

A calliope is a musical instrument similar in construction to an organ which generates high volume sounds using flowing air and pipes. We present a design for a thermoacoustic calliope using electric Stirling engines (as an alternative to standard airflow pipes) for producing tuned sounds. Our device has been designed with particular attention given to portability and usability. The instrument uses a series of engines constructed from glass test tubes and ceramic insulating buffers to generate tunable sounds in order to play a selection of previously encoded songs. The device uses a Raspberry Pi computer as its main control unit for processing note selections and triggering switching circuits to power each individual engine. The computer also provides an integrated graphical user interface for allowing non-technical users to operate the system with ease. All of these components are powered by an integrated power supply system requiring only a single AC wall connection.

Project Mentor: Dr. David Kazdan, Department of Electrical Engineering and Computer Science
Faculty Sponsor: Professor Gregory Lee, Department of Electrical Engineering and Computer Science

Matlab Software to Record and Stimulate in Aplysia californica

Johanna Fritzinger, Department of Electrical Engineering and Computer Science

Current neuron recording and stimulating techniques require stiff electrodes that damage cells and are not conducive to recording behavior of an animal in vivo. Technology being developed by the Chestek Lab at the University of Michigan uses flexible carbon fiber electrode arrays as an alternative to stiff glass electrodes to record signals from individual neurons. This has several advantages when studying behavior of Aplysia californica, including being less damaging to cells and more forgiving with movement while executing behavioral in vivo experiments. Specifically, this technology can further research into the roles individual neurons play in feeding behavior in Aplysia californica. This project is a Matlab program that records carbon fiber electrode arrays in ganglia and hook electrodes on nerves simultaneously in one program through two hardware systems. Current problems with data analysis, recording, and stimulating via two different programs include errors in syncing data and cumbersome data collection, which will both be solved with implementation of this Matlab software. This software will be used specifically for carbon fiber electrode array experiments and includes impedance testing of the array to ensure the array is in working condition before use.

Project Mentor: Dr. Hillel Chiel, Department of Biology
Faculty Sponsor: Dr. Gregory Lee, Department of Electrical Engineering and Computer Science
Uncovering the Role of FMO3 in Obesity and M2 Macrophage Mediated Beiging of White Adipose Tissue

Kevin Fung (B.S. in Biology), Dr. Rebecca Schugar, Dr. Anagha Kadam, Chelsea Finney, Department of Cellular and Molecular Medicine at Lerner Research Institute

Flavin Monooxygenase 3 (FMO3) is a hepatic enzyme that converts the gut microbial metabolite trimethylamine (TMA) into trimethylamine n-oxide (TMAO). Clinical studies have shown that elevated TMAO levels in plasma are also associated with cardiovascular disease (CVD) and obesity in humans and mice. The Brown lab has also previously demonstrated that the knockdown of FMO3 in mice attenuated weight gain from high fat diet when compared to controls. This decrease in weight gain was partly attributed to an increase in beiging of their white adipose tissue, which many researchers are targeting as a therapeutic strategy for weight loss. Beiging of white adipose tissue involves the activation of the uncoupling protein 1 gene (UCP1), which increases energy expenditure by switching mitochondria to thermogenic respiration. However, the exact mechanism by which the TMA/FMO3/TMAO pathway affects the pathogenesis of obesity and the beiging of white adipose tissue is unknown.

UCP1 is activated through a pathway that involves the binding of catecholamines to beta-3 adrenergic receptors (ADRB3). Previous studies have found that an important source of catecholamines in adipose tissue is resident M2 macrophages. These alternatively activated immune cells thus play a key role in the beiging of white adipose tissue. Therefore, we hypothesize that the activity of the FMO3 enzyme regulates beiging in adipose tissue by affecting immune cell function. Experiments will investigate difference in how the M2 pathway is activated when FMO3 expression is either up or downregulated in mouse models. By understanding the pathway that FMO3 knockdown acts to reduce weight gain, we can develop better strategies for inducing beiging of white adipose tissue in order to combat obesity.

Project Mentor: Dr. J. Mark Brown, Department of Cellular and Molecular Medicine at Cleveland Clinic Lerner Research Institute
Faculty Sponsor: Dr. Arnold Caplan, Department of Biology at Case Western Reserve University

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Building a Modular Framework for Exploring Agent Organization Problems in Reinforcement Learning

Micheal Menart, Dept. of Electrical Engineering and Computer Science; Zicheng Gao, Dept. of Electrical Engineering and Computer Science; Sibi Sengottuvel, Dept. of Electrical Engineering and Computer Science; Ayush Karnawat, Dept. of Electrical Engineering and Computer Science

Imeiro is a Multi-Agent Reinforcement Learning (MARL) framework. Despite rising interest in alternative schemes of Reinforcement Learning (RL), in current Computer Science research, most Reinforcement Learning frameworks only natively support, single agent learning or specific, narrow formulations. For example, BURLAP (Brown-UMBC Reinforcement Learning and Planning) which is focused to Object-Oriented Markov Decision Processes (OO-MDP). Other popular frameworks mostly address specific portions of RL environments without providing a cohesive and integrated interface for all aspects. For example, OpenAI gym focuses on the environment aspect of reinforcement learning and does not support multiagent environments without modification. The Imeiro framework is intended to provide a holistic and integrated Python 3 framework to enable users to consistently and entirely conduct multi-agent and single-agent reinforcement learning experiments, as well as extend it with maximal code reuse to alternative RL approaches. We mediate the interaction between the learning environment, algorithm and policy via a novel Agentsystem object which can be extended for use in other RL formulations. To provide addition extensibility, we also implement a callback system to allow for extraneous modification to experiments to be conducted and recorded in a consistent fashion.

Project Mentor: Soumya Ray, Dept. of Electrical Engineering and Computer Science
Utilizing the Electronic Health Record to Standardize Pediatric Obesity Management Practices

Madeline Garb, Department of Nutrition

The objective of this study was to describe the electronic health record (EHR) features attending and resident physicians at the University Hospitals Rainbow Center for Women and Children outpatient clinic, Rainbow Pediatric Practice (RPP), believe would better support identification and management of pediatric patients with obesity. We invited all practicing physicians at RPP (n=113) to complete a 20-item survey administered electronically. Descriptive statistics were performed to describe current obesity related practices and EHR preferences of participants based on number of years practicing medicine. The survey response rate was 23% (n=24). Nearly all of the participants were residents (96%;n=23). Of the residents, 48% were in their first year (n=11), 43% were in their second year (n=10), and 9% were in their third year (n=2). 54% (n=13) of participants reported documenting an obesity-related diagnosis in the EHR less than 50% of the time for a child who has obesity. Participants reported most frequently referring patients to the clinic’s registered dietitian (RD) by calling/paging the RD (63%;n=11), flagging the RD in the hallway (54%;n=13), and providing the patient with information to call to make the appointment (50%;n=12). Only 17% (n=4) of participants reported placing a referral order in the EHR. Irrespective of years practicing medicine, few participants (17%; n=4) were familiar with the Expert Committee Pediatric Obesity Guidelines. Across all years in practice, the majority of participants were in favor of prompting referral to the clinic’s RD (79%;n=19) and automatically including the expert committee guidelines in the patient discussion section (88%;n=21). Based on the results, the EHR may be effectively used to standardize the referral process to the RD as well as recommendations provided to patients in the discussion section. Future researchers should investigate the efficacy of this technology in standardizing the management of obesity as well as how this standardization impacts patient outcomes.

Project Mentor: Dr. Rosanna Watowicz, Department of Nutrition

Divergent environmental adaptation in acorn ants (Temnothorax curvispinosus)

Matthew Garvin, Department of Biology, Dr. Lacy Chick, Department of Biology

With the spread of urban development and the growing effects of global climate change, an important aspect of physiological ecology is to understand how organisms are responding to these rapid changes in their environments. One of the major changes associated with these factors is an increase in average temperature, beyond historical conditions. The goal of this study is to examine the relative adaptive abilities of acorn ant (Temnothorax curvispinosus) populations from different climate and land use backgrounds. We collected ant colonies from rural and urban sites surrounding the Cleveland area and conducted a reciprocal transplant experiment to test for divergent adaptation capabilities between colonies. The experimental data has been recorded and we are in the process of analyzing it to test the significance of our results. We expect to see that rural colonies will express lower levels of fitness (measured as brood production/colony survival) when exposed to urban environments and vice versa.

Project Mentor: Dr. Lacy Chick, Department of Biology
Faculty Sponsor: Dr. Sarah Diamond, Department of Biology
Welding Monitoring System

Jay Gokhale, Department of Electrical Engineering

The Lincoln Electric Company, the world leaders in providing welding solutions, have a lab on the factory floor in which they use a multi-step timing program to prepare weld samples in accordance with the American Welding Society’s specification A4.3: Standard Methods for Determination of Diffusible Hydrogen Content of Martensitic, Bainitic, and Ferritic Steel Weld Metal Produced by Arc Welding. The current monitoring system was run on an outdated software that posed a security risk to the company network.

My research was focused on designing a more robust weld monitoring application to prepare weld samples. The monitoring system starts timing immediately upon the termination of a weld, and directs the operator through a series of steps via audio queues to complete the weld samples in an accurate and repeatable fashion. The system needed to be modern, cheap, and able to handle the variations in welding current experienced across the full range all arc welding processes. The solution increases operator efficiency by giving clear and concise instructions. To solve this problem we first investigate National Instruments data acquisition hardware and the LabVIEW software environment. Next we explore several algorithms for most effectively monitoring a weld and being able to load customizable steps for the operator. Finally we explore how to connect this project to the larger error logging and data management software systems used at The Lincoln Electric Company.

Project Mentor: Ben Schaeffer, Group Leader New Products Development, The Lincoln Electric Company, Ben_Schaeffer@LincolnElectric.com
Faculty Advisor: Dr. Gregory Lee, Department of Electrical Engineering

An Event Management Solution for the Android Mobile Platform

Kevin Griesser, Department of Computer Science; Heather Schmidt, Department of Computer Science; and Kalli Schumacher, Department of Computer Science

The planning of large-scale, recurring events involves an unacceptable amount of repetitive and time-consuming bookkeeping effort. From a high level perspective, the organizers already have an understanding of the major objectives that need to be completed, but their time is wasted on mapping out specific deadlines and adjustments. The purpose of this android mobile app is to assist the organizers of events in scheduling and delegating tasks that need to be completed for their upcoming event. By providing automation for the solely administrative responsibilities, as well as tools for improving intra-organizational communication, the application will produce a noticeable time savings for event planners.

The application is intended for users and organizations with events that reoccur multiple times, whether that be yearly, monthly, or any other frequency. Users will be able to create an organization and design a general template of the tasks that need to be completed leading up to the final event. These tasks will be associated with a role in the organization, and will be given a time they need to be completed by, relative to the date of the final event. Once the user sets or changes the date of the event, the application will automatically generate a new schedule of tasks based on the input date. Users will also be able to filter their tasks to see them based on who they are assigned to, by which event/sub event they are for, and by the date they need to be completed. The application will also provide a feature to assist users in sharing external resources across their organization, and a discussion section to facilitate communication within the planning team.

Project Mentor: Professor Soumya Ray, Department of Computer Science
Coursework Website

Ding Gu, Department of Electrical Engineering; Yiming Pan, Department of Computer Science

In Case Western Reserve University, there are tons of resources to help students with entry level course. For example, there are si session weekly and students can find peer tutor online. However, when students took the high level course, it is hard to find someone who can help students with the class. There are no peer tutors and si sessions for most upper level courses. The office hours of professors is not enough to answer students’ question about lecture and homework. In addition, some students may meet difficulties about which course should enroll next semester. A group of students who would like to discuss the hard part in the class and share the thoughts of how to solve homework problem would be helpful to study the upper level course. A clever guide on course suggestion based on friends choice and required course for graduation will be useful. We would like to make a website that help students make group in the same course and recommend the course to students. We will use package named Django and its subpackages in Python to implement our functionality.

Project Mentor: Professor Soumya Ray, Department of Computer Science

Released Product Engineering Co-op at Keithley Instruments

Paul Guativa, Department of Electrical Engineering and Computer Science

During my eight months at Keithley Instruments, I was tasked with supporting products after their release. This included a wide variety of tasks such as failure analysis, obsolete component replacement, and cost reduction. This translated a variety of experiences such as determining the root cause of failure in a surface mount transformer, and testing less expensive power supplies for use in products. The most time consuming project I worked on was with a product able to measure both sensitive low voltages, and hundreds of volts. This required multiple voltage ranges. The lower voltage ranges required current limiting to protect the more sensitive circuitry when the measurement node was above the other ranges. At the time, the product used a configuration which caused production failures due to a wide range in saturation currents of a JFET. Unfortunately, there were not any higher quality parts with less variance in saturation current that would have worked for the application. This meant that the current limiter needed a complete redesign. With the assistance of several different co-workers, I developed a promising prototype. The test and measurement industry requires high quality products and thus I had a list of potential problems to test for. I was not able to fully test all concerns because of my short time as a coop at Keithley Instruments. Therefore, I ended my coop making detailed documentation so the project could be completed at a later date.

Project Mentors: John Wadolowski, NPI Program Manager, Keithley Instruments, john.wadolowski@keithley.com
Faculty Sponsor: Gregory Lee, Department of Electrical Engineering and Computer Science
User Interface for Spinal Cord Injury Patients

Chen Guo, Department of Biomedical Engineering; Brenda Rodriguez, Department of Biomedical Engineering; Jeffrey Shen, Department of Biomedical Engineering

Spinal cord injury (SCI) currently affects around 300,000 people in the United States. This type of injury can result in partial or complete loss of muscle movement from the neck down and affects roughly 25% of those with a SCI. Those with SCI often struggle to perform common activities of daily life (ADL) such as feeding, grooming, and using computers. To address this last issue, recent technological advances have allowed for development of new methods to interact with computers and potentially help to improve these individual’s independence. The current work focuses on a user interface comprised of an insertable mouthpiece to detect selections (similar to a mouse click) and an eye tracking system to provide computer cursor navigation. This device was tested with individuals doing ordinary computer tasks such as checking emails, reading news articles or playing solitaire. We believe our approach and design provides a practical and economical solution, contributing to a patient’s quality of life.

Project Mentor: Dr. Matthew Williams, Department of Biomedical Engineering, Dr. Colin Drummond, Department of Biomedical Engineering
Exploring the Link Between Media Representations of Women and Men’s Attitudes Towards Violence Against Women

Nandita Gupta, Departments of Psychological Sciences and Sociology

Violence against women is a pervasive global issue. The World Health Organization classifies violence against women as a, “major public health problem” (“Violence Against Women”, 2017). Globally, 1 in 3 women have experienced such violence (“Violence Against Women”, 2017). Studies have implicated portrayals of women in media in influencing negative attitudes towards women. In particular, the persistent sexualization and objectification of women in the media has been linked to perceptions of women as possessing fewer human qualities, such as competence and morality (Heflick, Goldenberg, Cooper, & Puvia, 2011). It has also been shown to affect gazing behavior, such that more time is spent looking at sexual body parts rather than the faces of women (Karsay, Matthes, Platzer, & Plinke, 2018). The purpose of this comprehensive literature review was to summate whether a link exists between the objectification and sexualization of women across a multitude of media genres, and attitudes accepting of violence against women among men who consume this media. Collectively, findings indicate that consuming media that objectifies women is associated with greater rape myth acceptance and greater likelihood of rape proclivity. These findings apply across multiple genres, including television, music, pornography, and magazines. If this thesis were confirmed, these findings of greater rape myth acceptance and rape proclivity would have implications for the content put forth by the music, television, and print publication industries. These findings might call for a critical examination of the portrayal of women in these industries, and efforts for changing these negative images. Ultimately, such findings could provide grounds for understanding a contributing factor to this global issue, and a new target for preventing such violence.

Project Mentor: Professor Anastasia Dimitropoulos, Department of Psychological Sciences

Key References:


Benefits of Synthetic Surfactant for Individuals Suffering from Chronic Obstructive Pulmonary Disease and Respiratory Distress Syndrome

Rohun Gupta, Department of Biology

Neonates born before 30 weeks of gestation suffer from respiratory distress syndrome (RDS). Lack of treatment for neonates undergoing RDS leads to death. One of the main causes of this disorder is the lack of surfactant in the alveoli of the lungs. Pulmonary surfactant is a complex lipoprotein mixture that prevents the collapse of the alveoli and increases the surface area and decreases surface tension of the alveolus membrane. Current therapies for surfactant deficiency rely heavily on treatment of the lungs with animal derived surfactant. However, there are many advances in process to form a synthetic surfactant to combat a deficiency in the distribution of animal derived surfactant. This review will focus on the creation of an effective synthetic surfactant, alternative methods of surfactant instillation, and major issues associated with the use of synthetic surfactant. Current researchers have seemingly produced an effective synthetic surfactant that contains the vital surfactant proteins (SP) A, B, C, and D along with other lipoprotein complexes. However, instillation of surfactant in neonates and adults is a complex process requiring medical equipment, complex techniques, and costs that continue to increase. To overcome these issues, researchers have developed a surfactant that can be administered through a noninvasive procedure. This noninvasive process can be effectively utilized by individuals in underdeveloped areas. In addition, animal derived and synthetic surfactants are costly products, and its long term effects are still unknown.

Project Mentor: Dr. Leena Chakravarty, Department of Biology

Investigation of Dietary Iron on Tumorigenesis with TUNEL Assay Stained Intestinal Cells from ApcMin/+ Mice

Sebastian Osorio, Pranav Hegde, James Swain Department of Nutrition, Case Western Reserve University, Cleveland, OH

Iron is needed to undergo normal bodily functions such as oxygen transportation through the blood, DNA synthesis, ATP production, and cellular respiration. There is no way for iron to be excreted, it can only be lost through sweat, blood loss, and the sloughing of intestinal cells. Since there is no way to excrete it, problems such as toxicity, oxidation of lipids, hydroxyl radical formation, and damage to cells/DNA occur. Iron is also responsible for the survival of cancer cells by contributing to DNA replication and repair. There are clear associations between red meat intake and colon cancer risk. We looked at a series of small intestinal tissue samples stained using TUNEL Assay and observe whether or not excess iron affects intestinal tumorigenesis in the different villi and crypts of intestinal cells. We looked at TUNEL Assay IHC stains and count the number of cells per villi. A light microscope (Leica DM6000) was used to analyze the intestine sections. A whole slide scanner was used to make high-res images. Data analysis was done using the statistical package SAS and Minitab Express 1.3.0. The goal was to compare the # of cells stained for TUNEL Assay with that of a healthy villi. We found that a heavy quantity of dietary iron increased the growth rate of tumors as well as the size. There was an abnormal amount of nuclei in the villi in the heavy dietary iron group compared with the low dietary iron/control.

Project Mentor: Dr. James Swain, Department of Nutrition
Life and health outcomes of justice-involved youth as a result of targeted racial discrimination and criminalization

Isabella Hu, Department of Psychological Sciences

Nearly 53,000 youths are held in correctional facilities every day as a result of juvenile or criminal justice involvement (Sawyer, 2018). One in ten of these youths are held in an adult jail or prison. One in five juvenile-justice involved youth are held in detention facilities before they have even been found guilty. Unsurprisingly, adolescents of color are grossly overrepresented in the juvenile incarceration population. Even though black youth make up less than 14% of all youth in the U.S, 43% of boys and 34% of girls in juvenile facilities are black (Sawyer, 2018). The purpose of this capstone project is to review the literature regarding the mechanisms by which youth of color are targeted by the justice system and its agents, in addition to the life and health outcomes of incarcerated youth. Findings indicate that justice-involved youth were likely to come from violence-prone low socioeconomic neighborhoods. Research suggests black youth were more likely to experience police discrimination and harassment than their white counterparts. Additionally, incarcerated youth were subjected to additional harassment and discrimination while being held in detention facilities. According to the literature, juvenile discrimination and incarceration were found to be contributing factors to negative life and health outcomes, such as chronic unemployment, housing instability, PTSD, and depression. This comprehensive literature review briefly discusses potential policy reform; however, further research on this current societal problem will contribute to a more comprehensive understanding of how to address the institutional mechanisms that foster inequality in our justice system, in addition to providing effective and rehabilitative treatment for incarcerated youth.

Project Mentor: Dr. Anastasia Dimitropoulos, Department of Psychological Sciences

Investigating the Mechanisms of Oligodendrocyte Damage in Hypoxia-Induced White Matter Injury

Lucille Hu, Department of Biology and Anthropology; Kevin Allan, Department of Genetics and Genome Sciences; Drew Adams, Department of Genetics and Genome Sciences; Paul Tesar, Department of Genetics and Genome Sciences

Communication through the body’s central nervous system (CNS) requires the efficient propagation of electric signals across neural axons, which are surrounded by a fatty protective sheath called myelin. Heavily myelinated fibers form the white matter of the brain, marking its key communication centers. Myelin is generated by a type of glial cell in the brain called the oligodendrocyte (OL). Oligodendrocytes, in turn, are formed from the differentiation of oligodendrocyte precursor cells (OPCs), which are present in both the developing and adult brain. These OPCs are capable of responding to white matter injury by proliferating and migrating to necessary sites where they then differentiate and replace damaged oligodendrocytes. However, in many white matter diseases these OPCs are unable to properly regenerate oligodendrocytes, leading to impaired white matter recovery.

Myelin formation is significantly hindered in low oxygen conditions (hypoxia). Previous work has shown that hypoxia leads to the death of developing oligodendrocytes in preterm infants; in response to the injury, OPCs proliferate and migrate to lesioned areas of the brain but are unable to differentiate, leading to delayed white matter acquisition. A family of transcription factors called Hypoxia Inducible Factors (HIF) have been implicated in this differentiation blockage, but the mechanism remains unknown. While HIFs are degraded under normal oxygen conditions via enzymes in a cascade, HIFs are unable to be degraded during hypoxia and instead enter the nucleus where they bind to and alter the transcriptome.

Here, we examine key HIF targets to analyze which downstream genes mediate the inhibition of OPC differentiation under hypoxic conditions. Using CRISPR activation technology, we identify two key genes that, when individually overexpressed, cause a significant decrease in oligodendrocyte formation. These findings lead to further studies which will investigate the in vitro interactions of these transcription factors.

Project Mentors: Dr. Paul Tesar and Dr. Drew Adams, Department of Genetics and Genome Sciences
Neural Network Dynamics Controlling Egestive Feeding Behavior in *Aplysia californica*

**Yu Huan**, Department of Biology; Jingyi Yang, Department of Biology; Nathan Kodama, Department of Electrical Engineering and Computer Science; Hui Lu, Department of Biology; Dr. Roberto F. Galán, Department of Electrical Engineering and Computer Science; Dr. Hillel J. Chiel, Department of Biology

The constantly changing activities in neural network contribute to the dynamics of the neural network and allow the animals to adjust their behaviors to the environment. The motor expression of feeding behavior in *Aplysia californica* is controlled by the buccal ganglia consisting of relatively large and accessible neurons. Therefore, the feeding behavior in *Aplysia* serves as a valuable model for studying neural circuitry dynamics. In previous studies, the identity and behavioral function of individual interneuron or key motor neuron involved in the feeding motor pattern have been characterized. Yet understanding the correlated activities within a large population of neurons is as critical as individual neural activity. In this study, we simultaneously recorded the nerve activities in I2 nerve, radular nerve (RN), buccal nerve 2 (BN2) and buccal nerve 3 (BN3) via hook electrodes, and activity from a large population of key neurons via microelectrode array (MEA, 120 electrodes) over time. Several key neurons such as interneurons B4/B5, motor neurons B6/B9 and B44 were identified through their one-to-one projections to the nerves by individual neural stimulation through microelectrodes. In response to the stimulation of a sensory nerve branch BN2-a, the nerve activity of these key neurons was consistent with egestive motor pattern program. We also investigated the effect of interneurons B4/B5 on other motor neurons and on motor output. Our data showed that B4/B5 has an inhibitory effect on several motor neurons such as B6/B9 and B44, suggesting its dominant role in shaping the pattern. Our data also suggested that activation of B4/B5 activity at the start of an egestive motor pattern results in less activity on I2 and RN during protraction phase and prolonged activity of B4/B5 during retraction phase, providing preliminary evidence of pattern modulation by B4/B5.

*Project Mentor: Dr. Hillel Chiel, Department of Biology and Dr. Roberto Galán, Department of Electrical Engineering and Computer Science*
**Targeting Diabetic Retinopathy with Peptide Therapeutics**

**Fanny Huang**, Department of Nutrition, David Lodowski, Department of Proteomics and Bioinformatics

Chronic inflammation is an underlying cause for the advancement diabetic retinopathy, allowing for the prevention of the inflammatory process to be a therapeutic target for treatment. Neutrophil inhibitory factor (NIF), a 17 amino acid leader sequence followed by a 257 amino acid residue, is a glycoprotein derived from the canine hookworm, *Ancylostoma caninum*, and exhibits activity to block the interaction between neutrophils and endothelial cells at the CD11b/CD18 binding domain. The underlying mechanism of the inhibitory activity of NIF on neutrophils is due to the high affinity of this molecule to bind with the A domain of the $\beta 2$ integrin, Mac-1, by binding divalent cations. Although NIF is an effective antagonist of the I domain ligand-binding site, this protein has not been seen to inhibit binding of ligands to other active sites which contain CD18 within the subunit, such as CD11a/CD18. Thus, the selectivity of NIF’s mechanisms allow for an advantageous approach to downstream inflammatory events, and the proposed theory of potentially preventing ligand binding on the CD11b/CD18 active site by NIF begs further investigation. In order to fully understand the underlying molecular mechanism of NIF on CD11b/CD18, a high-resolution, three-dimensional protein structure must be obtained by performing x-ray crystallography. In this investigation, we successfully expressed NIF on transgenic yeast, *Pichia pastoris*, in which we followed up with setting up crystal trays to prepare for X-ray crystallography screening. Upon obtaining the molecular structure of the CD11b/CD18 binding domain (the I domain) we may then be able to test the binding of NIF to the I domain as a technique to inactivate the pro-inflammatory response as therapy for inflammation-related diseases. This experiment will use x-ray crystallography to determine the structure of the cellular receptor bound to NIF expressed in *E.coli* and elucidate interactions between CD11b and NIF using co-crystallization with peptide-based inhibitors based upon the sequence of NIF.

*Project Mentor: Dr. David Lodowski, Department of Nutrition and the Center for Proteomics and Bioinformatics*

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**Mechanisms and Detection of Glioma Progression Revealed Using Multiscale Interrogation**

**William Huang, Department of Biology;** Haley Gittleman, Department of Population and Quantitative Health Sciences, Case Western Reserve University School of Medicine; Warren Coleman, Dartmouth University; Dr. Jill Barnholtz-Sloan, Case Comprehensive Cancer Center, Case Western Reserve School of Medicine

Lower grade gliomas (LGG) can progress to become higher grade tumors leading to high morbidity and mortality. Recent glioma studies from The Cancer Genome Atlas (TCGA) have categorized LGGs by specific key biomarkers: IDH mutation, 1p/19q codeletion, and TERT mutation. A pathologists review of a piece of brain tumor tissue could be enhanced using quantitative information derived from digital pathology slides that is predictive of clinical outcomes. Hence, we employ a machine learning model for quantification of digital pathology images in order to better understand LGG prognosis, heterogeneity of disease and disease progression. The model will be categorizing digital pathology images and clinical data from 262 GBM patients from The Cancer Genome Atlas (TCGA) with images available through The Cancer Imaging Archive (TCIA). The discovery set contained half of the patients selected randomly. The validation set contained the other half of patients. R and Linux programming were used to create three different algorithms that categorize digital pathology images from TCIA. The first algorithm detected the edge of nuclei on the pathology slide to focus on individual cells. The second algorithm identified the dominant direction of the nuclei in the tissue. The third algorithm identified the malignant nuclei on the slides through entropy calculation. R and Linux programming will be used to develop one algorithm that uses the patient clinical data to further differentiate GBM subtypes. All algorithms need further testing to validate their usefulness for clinical care. These algorithms will also be expanded to include relevance for other types of brain tumors and other types of cancer.

*Project Mentor: Dr. Jill Barnholtz-Sloan, Professor, Case Comprehensive Cancer Center, Case Western Reserve University School of Medicine*
Holden Arboretum Remote Transmission Unit Design and System Integration

Dylan Humphrey, Electrical Engineering, Elyh Lapetina, Electrical Engineering, Allie Meier, Computer Engineering

The Holden Arboretum is seeking a cost-effective solution to collect air temperature and humidity, soil temperature, light available for photosynthesis, and soil moisture data throughout their grounds in Kirtland, Ohio; somewhere between 30 and 50 data-collectors are required for full coverage. Existing market solutions are both overly complex and expensive at a large scale since these products employ very expensive sensors and require periodic physical access for downloading data. In order to address this problem our team designed a low-cost, low-power wireless sensor network. Our solution collects air temperature and humidity data, soil moisture and temperature data and foliage light-exposure data from various electrical sensors. A low-powered, long range IoT sensor network relays data from each data-collection station to a primary server using a Lora network. The air temperature and humidity as well as the soil temperature sensors are off-the-shelf sensors. A low cost foliage exposure sensor was designed by our team, and the soil moisture sensor will be designed at a future time. The design for the foliage exposure sensor included collecting data through a photodiode as well as creating a system that could easily be calibrated using a monochromatic light source. The overall system consists of several Remote Transmission Units and a singular Gateway server. Each Remote Transmission Unit consists of an 8-bit microcontroller paired with a Lora hardware module with one of each of the sensors defined above. The server consists of a Raspberry Pi, acting as the server controller and Lora Concentrator module acting as the Lora Bridge.

Project Mentor: Lawrence Sears, Electrical Engineering and Computer Science

Selective, Reversible Inhibition of Small Diameter Axons Using Glucose

Elizabeth Jackson, Department of Biology; Junqi Zhuo, Department of Biomedical Engineering; and Dr. Hillel Chiel, Department of Biology, Department of Biomedical Engineering, Department of Neurosciences

Many diseases affecting the peripheral nervous system can be treated through neuromodulation. Patients suffering from diabetic neuropathy, heart disease, rheumatoid arthritis, and other conditions would benefit from improved selectivity and targeting in their treatments. Small diameter axons throughout the peripheral nervous system carry sensory information and, if properly modulated, could provide a way to manage many symptoms of these diseases. We are investigating glucose blocking as a passive method of neuromodulation that seeks to preferentially block signals from small-diameter axons. Using the model organism *Aplysia californica* we stimulate and record compound action potentials (CAPs) from the pleural-abdominal connective nerves. Using a chamber built with three separate adjustably-sized sections, data is collected to show the effects of the glucose applied over different lengths of nerve. Bathing a segment of the nerve in an isotonic glucose solution while the other two nerve segments are perfused in normal *Aplysia* saline inhibits the signal, blocking the CAP entirely when the glucose is applied over large distances. At very small gaps the glucose solution does not produce a blocking effect. At intermediate distances, it is possible to identify a selective block of small units, showing the specificity of the mechanism. After the blocking is observed, we replace the glucose solution with normal *Aplysia* saline, allowing for recovery of the nerve and showing that the CAP does not shrink or change significantly after being rinsed in glucose. The implications for use in the peripheral nervous system are significant, where it may be possible to develop a mechanism of glucose application that leads to sustainable pain management without nerve damage.

Project Mentor: Dr. Hillel Chiel, Department of Biology, Department of Biomedical Engineering, Department of Neurosciences
Effect of labor status and intrauterine infection on density of immune cells at the maternal-fetal interface

Divya Jasthi, Department of Biology; Rachel Wilson, Department of Reproductive Biology; and Sam Mesiano, Department of Reproductive Biology, Department of Physiology & Biophysics

It is well established that human parturition is an inflammatory process. The onset of labor involves an increase in pro-inflammatory cytokines within the tissues of the uterus. It is hypothesized that an inflammatory load threshold exists below which the uterus is quiescent and above which the uterus transitions to the laboring phenotype. Leukocyte infiltration of the myometrium is thought to have a pivotal role in the onset of labor. Accumulating evidence demonstrates that myometrial inflammation is a consequence rather than a cause of labor, suggesting it may be leukocyte infiltration of the decidua at the maternal-fetal interface that triggers the inflammatory cascade of parturition. This study examines leukocyte localization in human and Rhesus myometrium and its correlations with chorioamnionitis (inflammation at the maternal-fetal interface). We found that inflammation was primarily localized to the decidua in both Rhesus and human samples. The leukocytes observed in the myometrium were primarily located in perivascular areas and not within myometrial bundles. These findings suggest that leukocyte infiltration of the myometrium is not a requirement for parturition; however, inflammation in the decidua may be key in causing the onset of labor. There may be a signaling mechanism between the decidua and myometrium that triggers the inflammatory cascade.

Project Mentor: Professor Sam Mesiano, Department of Reproductive Biology, Department of Physiology & Biophysics
Faculty Sponsor: Professor Barbara Kuemerle, Department of Biology

Design and Analysis of a 3D Printed Magnetic Breakaway Connector for Use in Implanted Stimulation Devices

Noel Jeansonne, Biomedical Engineering & Pre-Medicine; Ivana Cuberovic, B.S., Department of Biomedical Engineering; Dustin Tyler, Ph. D., Department of Biomedical Engineering

The Magnetic Breakaway Connector (MBC) is designed to reduce the risk of injury during at-home use with a neural prosthesis system. The neural prosthesis system contains percutaneous leads from the limb of the subject which are connected to various sensors on the prosthetic surface. Snagging of these cables could pull the percutaneous leads out of the skin, causing injury to the subject, and potentially harming the implanted system. Tension on the wires of the neural prosthesis system causes the MBC to open, thus disconnecting the internal electrical components by counteracting the magnetic connective force. The internal magnetic system is composed of a ring of magnets around the electrical components to compress the internal connector spring pins with 2.0 pounds of pull force required for complete separation of the electrical components. The MBC has a 2-keyed directional design to prevent improper connection of the male and female pieces when used by the subject at home. The housing was printed in Think[box] using the 3D printers to create a cost-effective and easy to manufacture housing.

Project Mentor: Professor Dustin Tyler, Ph. D.
The Association Between Diet Quality and Energy Status in Collegiate Female Athletes

Chaewon Jeong, Department of Nutrition - Nutritional Biochemistry and Metabolism; Jane Carsey, Department of Nutrition; Esme Hendrickson,

Introduction: Athletes are often expected to have proper exercise regimens and healthy diets; however, college athletes often face challenges in balancing these elements alongside a hectic schedule. Female athletes, in particular, are more likely to face negative health consequences due to these challenges in the form of menstrual dysfunction and impaired bone health among other risks such as increased risk of injury.[1,2]

Purpose: The purpose of this study was to determine if there was an association between diet quality and energy status in collegiate (DIII) female athletes.

Subjects: Female varsity athletes at Case Western Reserve University (CWRU), a Division III athletics school. The subjects were from basketball (n=10), swimming (n=11), tennis (n=18), and track and cross country (track/cc) (n=17).

Methods: Three day food and physical activity logs, as well as body composition measurements, were used to calculate energy availability (EA) and Healthy Eating Index-2010 (HEI-2010) scores. EA is the amount of dietary energy that remains after exercise that can be used for the rest of the body’s metabolic processes. The HEI-2010 was chosen to determine diet quality over other analysis methods because the HEI-2010 gives a percentage of the relative dietary guidelines the diet abides by in respect to the 2010 Dietary Guidelines for Americans, with a total score out of 100. [3] The HEI-2010 also provides a more holistic view of the diet compared to other methods of analysis.

Project Mentor: Lynn Cialdella Kam, PhD, MBA, RDA, LD, CWRU School of Medicine, Department of Nutrition

Effect of Polyhydroxy Fullerene Nanoparticles on 4T1 Cancer Cells

[1]College of Arts and Sciences, Case Western Reserve University
[2]Department of Biomedical Engineering, Cleveland Clinic Lerner Institute

Cancer is the second-leading cause of death, affecting approximately one million people in the United States alone. Treatments of cancer include surgery, chemotherapy, radiation therapy, and immunotherapy. However, there are significant side effects associated with each type of current treatments; thus, novel approaches in cancer treatment is dire. Cancer is characterized by malignant proliferation of abnormal cells and is induced by genetic mutations. Nanotechnology is a promising approach as it deals with manipulation of materials in nano-scale, in which genetic mutations occur. Dr. Krishna’s lab has been working with polyhydroxy fullerenes (PHF) for cancer prevention and treatments.

PHF is a water-soluble and biodegradable antioxidant. Further, other groups have shown that PHF exhibits anti-tumor and antimetastatic activities in EMT-6 breast cancer model. The goal of this research is to utilize the anticancer properties of PHF and study its effect on 4T1 cancer cells. PHF will be encapsulated in different polymers and inorganic particles, such as chitosan and silica, in order to enhance the anticancer properties. PHF encapsulated particles will be characterized for size using dynamic light scattering (DLS) and scanning electron microscopy (SEM). 4T1 cells will be exposed to PHF and PHF nanoparticles and assayed for survival and oxidative stress using commercially available fluorescent kits.

Project Mentor: Vijay Krishna, Department of Biomedical Engineering, Cleveland Clinic Lerner Institute
Faculty Sponsor: Radhika Atit, Department of Biology, Case Western Reserve University
Automation of Dog Toy Processing

Bowen Jin, Department of Electrical Engineering; Rohan Sinha, Department of Electrical Engineering; Christopher Tam, Department of Electrical Engineering

Automation of factory jobs can prove to help both factory workers and the companies that hire them. For simple and tedious jobs, keeping long-term employees can prove extremely difficult for companies since many people do not enjoy uninteresting work and therefore will leave these positions often. With the assistance of robotic automation, companies can eliminate the need for these tedious positions and have a greater level of efficiency in production because these machines will be able to run without breaks. Additionally, these robots would require much cheaper maintenance than the average human worker. However, there are certain tasks that robots do not have the capability to perform just yet. Instead of these tedious and uninteresting jobs, the human workers would be able to oversee the automation progress as well as create an additional layer of product verification to ensure quality before shipping. This project is specifically designed to cut the flashing off of molded KONG dog toys. While there are several other tasks that can be automated throughout the post processing of the dog toys our work was built as a design for providing an overall proof of concept design of automation for the full automation project that is the dog toys can be visible and reachable to the robotic arms.

Project Mentor: Dr. Wyatt Newman, Department of Electrical Engineering

Octopaminergic Modulation of Wing and Haltere Behavior in Drosophila Melanogaster

Tasha Johnson, Department of Cognitive Science; Dr. Jessica Fox, Department of Biology; Noah DeFino, Lab Technician; Michael Rauscher, Graduate Student; Chenxin Bi, Undergraduate Student

Changes in behavior are often associated with changes in levels of neurotransmitters. OA is a neurotransmitter that is release in all arthropods during various physical activities, metabolic activities and flight and fight situations (Li, 2016). OA receptors are found in several neurons of fruit flies (Drosophila melanogaster) including but not limited to their neck motor and visual neurons (Suver, 2012). In three experiments the role of OA was tested through its effects on how it helps fruit flies balance visual stimuli and fly at normal amplitudes in regards to their wings and halteres. From the analysis that we conducted through the three different experiments, we were able to see that without OA, Drosophila Melanogaster lose the ability to increase their wingbeat frequency in response to visual stimulus, and that the amplitudes of their halteres and wings were decreased. As a result, our findings show that octopamine plays an essential part in visual responses as well as in maintaining an effective amplitude range for their halteres and wings.

Project Mentor: Dr. Jessica Fox, Department of Biology
Transitioning to Adulthood: Evaluating Childhood and Adolescent Victimization as Predictors of Adult Maladjustment

Ann Jung, Department of Psychology

Bullying and victimization has drawn the attention of families, schools, health professionals, and researchers alike. With an increasing rate of school shootings, suicide, and mental health issues, much research has been done on the topic of victimization and its effects during childhood and adolescence. Studies that have tracked children and adolescence found that peer victimization has a lasting impact on both physical and mental health. In addition, bullying and peer victimization has been linked to poor social developmental skills. Poor academic performance has also been associated with cumulative instances of peer aggression and victimization. Overall, however, few studies have actually focused on the lasting and serious ramifications in the lives of adults who experienced the trauma of peer victimization and bullying as a child. Thus, the purpose of this capstone project is to examine the impact of the development of children and adolescents who have been victimized, offering significant identifying factors that can be used to help predict and address adult maladjustment.

Keywords: peer victimization, bullying, adulthood, maladjustment

Project Mentor: Dr. Anastasia Dimitropoulos, Department of Psychological Sciences

WWV Frequency Tracker

Tyler Keen, Department of Electrical Engineering and Computer Science

The next total solar eclipse to occur in the United States occurs in April 2024 with Cleveland in the path of totality. The Case Amatuer Radio Club wants to collect data leading up to the solar eclipse as well as during. One of the instruments that they requested is a WWV received frequency tracker. The tracker listens to and measures the Doppler Shift of the radio station WWV’s radio beacon located in Fort Collins, Colorado and collects the frequency deviations received in Cleveland, Ohio. The data will be used to track trends leading up to the solar eclipse and see how the received frequency changes due to changes in the ionosphere caused by the solar eclipse. The WWV Frequency Tracker automates a manual process and converts all times to Coordinated Universal Time (UTC) to avoid the issues of daylight savings time.

Project Mentor: David Kazdan, Adjunct Assistant Professor of Electrical Engineering & Computer Science
Faculty Sponsor: Dr. Gregory Lee, Department of Electrical Engineering & Computer Science
Variations in the electronic structure during chemical exfoliation of LiCoO$_2$ into CoO$_2$

Lee Kendall, Department of Materials Science and Engineering; Kevin Pachuta, Department of Materials Science and Engineering; Emily Pentzer, Department of Chemistry; Alp Sehirlioglu, Department of Materials Science and Engineering

LiCoO$_2$ (LCO) is a widely utilized cathode material for commercial Li-ion batteries, and its bulk properties have been extensively studied. LCO is a layered oxide material and can be exfoliated into two-dimensional nanosheets through a two-step chemical exfoliation: (i) protonation and (ii) intercalation with bulky molecules. Presented in this poster are the changes in the electronic structure determined by X-ray Photoelectron Spectroscopy (XPS). Core peaks (Co 2p, Co 3p, Co 3s, O 1s, C 1s) and valence spectra have been analyzed throughout the chemical exfoliation treatment process as a function of varying processing parameters. In addition to the reactant powders during each exfoliation step, the supernatants have also been characterized to determine the mass and charge balance for the whole system. A low-spin state is determined for Co and although the Co $t_{2g}$ orbitals are considered non-bonding in first approximations, it is likely that the oxygen experiences the decrease in electron occupancy via an increase in covalency between O 2p and Co $e_g$. It is found that cobalt, as well as oxygen, undergo a partial oxidation process during the exfoliation of bulk LiCoO$_2$ into CoO$_2$-nanosheets.

Project Mentors: Emily Pentzer, Department of Chemistry; Alp Sehirlioglu, Department of Materials Science and Engineering

Novel Aramid Polymer Brushes for Water Desalination Membranes

Alison Kennedy, Department of Macromolecular Science and Engineering; Caleb Reese, Colorado School of Mines Department of Chemistry; Dr. Stephen Boyes, Colorado School of Mines Department of Chemistry

Polymer brushes are emerging as a method to make high performance polymeric coatings since they consist of polymer chains covalently bonded to a substrate. The chemical attachment allows for superior mechanical properties over traditional polymeric coatings. This work focuses on using polymer brushes to fabricate membranes for water desalination since they have increased strength and stability and can also be tailored to address issues such as fouling. The monomer synthesized for this work consists an aromatic backbone for rigidity, a trifluoro leaving group to increase the rate of polymerization, and a polyethylene glycol (PEG) side chain to aid in anti-fouling. The monomer was polymerized through chain growth condensation to allow for control over brush thickness and a high grafting density, both of which are important to create uniform films. These polymerizations were done on both silica nanoparticles and wafers that had been previously initiated. The silica particles and wafers were analyzed with gel permeation chromatography, thermogravimetric analysis, ellipsometry, goniometry, and GATR-FTIR. Copolymers with protecting side chains were also synthesized and successfully deprotected which will allow for hydrogen bonding between the brushes. Hydrogen bonding would increase the strength of the membranes while also increase their ability to remove ions from water. Future work includes optimizing the copolymer ratios and fabricating membranes with this polymer and analyzing their desalination capabilities.

Project Mentor: Stephen Boyes, Colorado School of Mines Department of Chemistry
Digital I/O Control Panel with Demo Board

Andrew Kirby, Department of Electrical Engineering

This project was completed during my time working for Keithley Instruments. The new models of Digital Multimeters, the DMM6500 and DAQ6510, have a large touchscreen user interface. This can be used to increase the functionality of the instrument using Applications. These Apps are run on the firmware of the instrument. The Digital I/O Control Panel App was written to aid engineers who use the instrument’s digital I/O lines, but do not wish to write their own interfacing and control code. It migrates control of the I/O lines on the rear of the instrument to its touchscreen in an intuitive and easy to use interface. The app can both write to and read from the digital port and line states can be toggled both individual with the push of a button, and all at once by entering a binary word. The second half of this project was to create a demonstration circuit board to show that the application was functioning properly. The board includes a DB9 input for the digital lines. It uses the digital line states to toggle relays which in turn power LEDs. This is to provide visual and audible feedback to show that the app is indeed functioning as intended. Two of the digital lines are also shorted together. This shows the line reading functionality as one line can be set as an output and one set as an input to read the other.

Project Mentor: Josh Brown, Applications Engineer, Keithley Instruments
Faculty Mentor: Greg Lee, Electrical Engineering and Computer Science

Töst: A Smarter Breadboard

Tyler Kohrt, Department of Electrical Engineering; David Lituchy, Department of Electrical Engineering; Ethan Smilg, Department of Electrical Engineering;

Töst is a new tool for prototyping and learning about electronics in an interactive, intuitive, and shareable way. It is targeted at students, hobbyists, and those with little background in electronics, and is an improvement over the traditional breadboard. Töst is a system that integrates a breadboard layout tool on the computer with custom-designed hardware that uses LEDs to indicate where components should be placed, visually guiding the user as they build their circuit and removing many of the frustrations associated with constructing and troubleshooting circuits on traditional breadboards. The desktop software is a standalone Windows application that leverages components of the open-source Fritzing software package, and the hardware is controlled with a TI MSP430 microcontroller. Users are able to share their project files with others who have the Töst software installed.

Project Mentor: Professor David Kazdan, Department of Electrical Engineering
Faculty Sponsor: Professor Gregory Lee, Department of Electrical Engineering
Imaging Mechanical Properties of Embryonic Heart Development

Katherine Koning, Department of Biomedical Engineering; Brecken Blackburn, Department of Biomedical Engineering; Michiko Watanabe, Department of Pediatrics; Michael W. Jenkins, Department of Pediatrics and Biomedical Engineering; Andrew M. Rollins, Department of Biomedical Engineering.

As more developmental relationships between structure and function are discovered, there is an increasing need for the study of the mechanical properties of embryonic tissues. A superior understanding of the mechanical function and characterization of small biological tissues present a variety of potential applications including 3-dimensional tissue modeling and simulation for the purpose of individualized diagnosis and evaluation. However, there are no appropriate tools currently available to study mechanical properties of soft, millimeter-scale structures like embryonic heart valves. One potential solution that might fill this technological gap is Optical Coherence Tomography, which leverages low-coherence interferometry using near-infrared wavelength light. Here, we present work utilizing OCT in a mechanical characterization context, where semi-static forces are applied to very small biological tissues, and the relative compressibility of the sample tissue is compared to the relative response of a substrate of known Young’s modulus. Based upon this relative degree of compression, the Young’s moduli of embryonic tissues are evaluated at varied degrees of development, based upon the Hamburger Hamilton stages preceding, during, and after the epithelial-to-mesenchymal transition, thereby evaluating the mechanics of endocardial cushion formation and the extracellular matrix maturation. By applying C-OCT to these cohorts, we aim to determine mechanical properties of embryonic heart tissue, and in future apply these findings to develop a more complete mechanical model of heart development.

Project Mentor: Professor Andrew Rollins, Department of Biomedical Engineering

The Role of Mechanical Stimuli in Inflammation-Associated Malignancies

Darby Kreienberg, Biology major, Samaneh K. Sarvestani, Department of Stem Cell Biology CCF, Robert Fisher, Department of Stem Cell Biology CCF, Emina Huang, Department of Stem Cell Biology CCF

Colitis-Associated Cancer (CAC) of the colon is a devastating consequence of the chronic inflammatory bowel disease (IBD) called ulcerative colitis (UC). About a million Americans have UC, and their risk factor for developing CAC is as high as 18% by 20 years, thus 3- to 5-fold higher than the rate of sporadic colorectal cancer in the general population. Multiple episodes of acute inflammation and bleeding in the patients with UC result in a commonly observed complication, fibrosis. Fibrosis comes with the alterations of extracellular matrix (ECM) stiffness as a response to a combination of the mechano-sensing pathways including the Hippo pathway. The dominant transcription factor in this pathway includes Yap1. Previous challenges to the advances in the field include the absence of 3D, human-derived, in vitro or in vivo models.

This research took advantage of the recent advances in stem cell biology to perpetuate induced human intestinal organoids (iHIOs) from non-IBD and UC colon. The organoids were placed into hydrogel matrices of varying moduli to study the effect of matrix stiffness on both non-IBD and UC organoids. Experiments have shown that UC iHIOs compared to non-IBD iHIOs reveal colitic features and biological functions. Additionally, iHIOs are responsive to the mechanical stimuli in terms of the growth and malignant morphology. These are important discoveries when determining if iHIOs with the optimal range of microenvironmental stiffness may be applied as an improved in vitro and in vivo model to investigate the effects of various disease mediators in the formed non-IBD and UC colon.

Project Mentor: Dr. Emina Huang, Department of Stem Cell Biology CCF
Faculty Sponsor: Professor Richard Drushel, Department of Biology
**Ketamine rapidly increases mature dendritic spine density on excitatory cortical neurons in a mouse model of Rett Syndrome.**

Saloni Lad, Cognitive Science and Biology

**Project Contributors:** C. James Howell, Department of Neurosciences; Anmol Gupta, Samichhya Aryal; Karthik Ravichandran; Fatimah Abouelsoud; David M. Katz, Department of Neurosciences

Rett syndrome (RTT) is a neurodevelopmental disorder caused by loss-of-function mutations in the X-linked gene encoding the methyl CpG-binding protein 2 (MeCP2), a master regulator of transcription. Common features of RTT include loss of motor skills, respiratory dysregulation, and cognitive deficits (Katz et al. 2012). The MeCP2 mutant mouse model recapitulates many phenotypes of the human disorder, including respiratory abnormalities and dendritic spine reductions (Katz et al. 2012). The medial pre-frontal cortex (mPFC) is of particular interest given its importance in cognitive, behavioral, and physiological functions that are disrupted in RTT (Katz et al. 2016). The mPFC of MeCP2 mutant mice demonstrates reduced neuronal activity and reduced excitatory synaptic connectivity associated with a reduction in postsynaptic spine density on excitatory pyramidal neurons (Kron et al. 2012; Sceniak et al. 2015). This study was designed to determine 1) which specific dendritic domain(s) of the excitatory pyramidal neuron are affected by MeCP2 mutations and 2) the effect of low-dose ketamine, an NMDA receptor antagonist and potential RTT therapeutic, on dendritic spine density in the mPFC. To answer these questions, dendritic spine morphology was compared among wildtype and MeCP2 mutant mice treated with saline or ketamine. Our results demonstrate that MeCP2 mutant mice exhibit a deficit in mature dendritic spine density on the oblique branches of pyramidal neurons. These deficits are reversed twenty-four hours following single or repeated intermittent treatment with a low, sub-anesthetic dose of ketamine. Within 72 hours after treatment, spine density returns to baseline values. Our finding that low-dose ketamine can reverse structural synaptic defects caused by MeCP2 deficiency supports the therapeutic potential of ketamine for the treatment of RTT.

*Project Mentor: Dr. David M. Katz, Department of Neurosciences*
Using Crowd-Sourcing to Evaluate the Effectiveness of Visual Biofeedback Speech Treatment

Xiguang Liu, Department of Psychological Science; Dr. Jennell Vick, Cleveland Hearing and Speech Center; Dr. Rebecca Mental, Cleveland Hearing and Speech Center; and Dr. Gregory Lee, Department of Electrical Engineering & Computer Science

INTRODUCTION: Errors on, the North American English /r/, are the most common errors to persist into later childhood and adulthood. Individuals who are over 8 years of age and still present with /r/ errors are considered to have Residual Speech Errors (RSEs), and about 5% school-aged children and 1-2% adults are affected both socially and academically by errors (Byun & Preston, 2015; Flipsen & Sacks, 2015; Flipsen & Sacks, 2015).

OBJECTIVES: Mental (2018) found that after treatment with the visual biofeedback software Opti-Speech, variants of /r/, improved in single words. The primary objective of this study was to evaluate the treatment effect of Opti-Speech on /r/ sound in more complex contexts, from word to sentence.

METHODS: 12 participants with RSEs with errors on /r/ sound participated in 10 sessions of Opti-Speech treatment. Their /r/ pronunciations in words, phrases, and sentences from the Entire World of R (EWOR-AS; Say It Right, 2006) were recorded before, immediately after the completion of treatment, and two months after the completion of treatment. These productions were later evaluated by 10 naïve listeners per context per participant recruited through the crowd-sourcing platform, Amazon Mechanical Turk (AMT). Full data set was later ipsatized and tested in Matlab and R.

Results: Ipsatization reveals the trimodal distribution of the data with three peaks for each treatment sessions. A two-way ANOVA test, and a Tukey multiple comparison test had been performed through R, which revealed the significant evaluation score difference between each treatment session, but neither between each participant nor between each word usage.

Conclusion: These results support the hypothesis that Opti-Speech is an effective treatment of /r/ sound RSEs patients, as significant improvement in the target sound was observed in word, phrase, and sentence. Later comparative studies of Opti-Speech treatment effectiveness on other persisting RSEs sounds could lead to better understanding of this newly developed visual biofeedback treatment.

Project Mentor: Dr. Jennell Vick, Psychological Sciences, Cleveland Hearing and Speech Center
Socialization and Academic Achievement Attained Through Youth Sports

Jason Lockamy, Psychological Sciences

Children in America have an abundance of free time at their disposal after school hours. Much of this time is spent engaging in leisurely activities like watching television or other less stimulating activities. Engagement in sports separates itself from both school and leisurely activities. Sports are not a required task like school but they do stimulate the brain, unlike leisure. This provides the ideal environment for active engagement. It is common for kids to play sports or a sport, not only to pass the time but also to learn to engage with other people similar in age. However, for some kids, these options are not available to them. Approximately 19 percent of youth in America are living their lives below the poverty line, unable to access resources required to lead relatively successful, even ‘normal’, lives. For many years, studies have shown that underprivileged children are at risk of early introductions to the illicit natures of lives full of drugs, crime and other negative influences. It is universally recognized across all disciplines that youth involved in out-of-school activities are less likely to engage in negative behaviors like alcohol and drugs at an early age due to structured programming. Research evidence suggests that sports are a constructive means for young people to utilize time to invest in the social skills that contribute to human capital (Hermens, Verkooijen & Koelen, 2018). Should funding be provided to some of these impoverished areas in America, small sports programs can be created and provide outlets for these children. The hope then, for these children, would be that the implicit attitudes and lessons they are introduced to during their time playing sports translates to school and life overall, as they contribute to breaking the cycle of poverty.

Project Mentor: Professor Anastasia Dimitropoulos, Department of Psychological Sciences

Multi-parametric MRI of Kidney Disease Progression in a Mouse Model of Autosomal Recessive Polycystic Kidney Disease (ARPKD)

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Autosomal recessive polycystic kidney disorder (ARPKD) is a rare but lethal genetic disorder characterized by diffuse renal microcysts.1,2 While new therapeutics are being developed for similar diseases, clinical trials for ARPKD patients are not currently possible due to the absence of sensitive measures of ARPKD kidney disease progression and/or therapeutic efficacy.1 In this initial study, multiple, translational, and quantitative MRI techniques (T1 and T2 relaxation times and Apparent Diffusion Coefficient (ADC)) were evaluated for their sensitivity to detect ARPKD progression by comparing these MRI metrics in the bpk mouse model of ARPKD that closely mimics human disease.3-5 Quantitative T1, T2, and ADC maps were obtained for the excised kidneys from bpk mice (n=8) and wild type (WT) control mice (n=8) on a Bruker Biospec 7.0T MRI scanner. For both groups, kidneys were scanned excised at ages of 8, 14, and 21 days of age for this rapidly progressing disease model. T1, T2, and ADC data were acquired using conventional spin echo MRI acquisitions with varying diffusion weightings (b-values), repetition time (TR), and echo times (TE), respectively.6-8 All MRI maps were reconstructed using least-squares fits to established mono-exponential models.6,9,10 A region-of-interest (ROI) analysis was used to calculated mean kidney T1, T2, and ADC values for each animal’s kidney. Mean T1, T2, and ADC values for the bpk mouse kidneys were all significantly increased in comparison to the kidneys from WT control mice (p<0.002). A significant linear correlation was also observed between mean kidney T2 for the bpk mice as a function of volume (R=0.84, p = 0.009) and age (R = 0.97, p = 0.00007). No significant correlations were observed for either T1 or ADC (p > 0.17). These initial ex vivo MRI studies suggest that renal T2 relaxometry may be a viable marker for ARPKD kidney disease progression.

Project Mentor: Chris A. Flask, Department of Biomedical Engineering and Radiology and Pediatrics
On the Road to Sports Medicine: Meta Analyses Driven Device Specification

Samantha Magliato, Department of Biomedical Engineering; Dhruv Seshadri, Department of Biomedical Engineering; James Voos, University Hospitals Sports Medicine Institute; and Colin Drummond, Department of Biomedical Engineering

Over the last decade, there has been an expansion and development of wearable technology within the field of sports medicine to monitor human performance. The recent technology drive has enabled the application of biomechanical, biovital, and biochemical monitoring of athletes in real-time to help guide clinical decision-making through the translation of the acquired data into actionable protocols for team physicians and athletic trainers. Quantitative analysis of biomechanic sensor data has shown promise in the field of sports medicine to drive patient specific recovery and rehabilitation protocols to maximize performance while minimizing the risk of injury. The recent emergence of technology in this direction makes it an exciting area for research. From our perspective, over-engineering of biomedical sensors has drastically limited their clinical utility. Thus, to circumvent such inefficiencies and develop technologies to complete the bench-to-bedside paradigm, we sought to assess the utility of current wearable devices and identify critical path elements to enable such translation. Thus, the objective of our team-centered work is two-fold: 1) build collaborative relationships with key opinion leaders in the sports medicine field and 2) develop testable hypotheses leveraging emerging IOT technology utilizing our expertise in materials science, big data, and engineering. Work disseminated from this abstract has resulted in the emergence of projects reflecting our team-centered approach utilizing wearable sensors for sports medicine, cardiology, and emergency medicine. In short, this work builds upon our unique collaboration with the University Hospital Sports Medicine Institute to developed crosscutting application thrusts.

Project Mentor: Professor Colin Drummond, Department of Biomedical Engineering

ARRL Newsfeed Decoder and Display

Caleb Main, Electrical Engineering; Benjamin March, Electrical Engineering; Benjamin Robinson, Electrical Engineering; David Kazdan, Department of Electrical Engineering and Computer Science

The Case Western Reserve University Department of Electrical Engineering and Computer Science lacks an interesting display with which to hook students and touring university guests into exploring a career in electrical engineering. Currently, there exists only static displays outside the Sears Lab in the Glennan building. This project aims to solve that problem by producing an electronic display that shows interested readers news bulletins from the American Radio Relay League station (ARRL). To achieve this, we have researched the signal encoding types ARRL uses to send its bulletins. These include binary phase shift keying (BPSK), multiple frequency shift keying (MFSK), and the Baudot teletype. Once these signals are received by our antenna, they run through a software defined radio which converts the analog signal into a digital one. To work with this digital signal, we have researched different tools and methods of manipulating a radio signal. We have decided to utilize a software tool called Fldigi which was designed specifically to allow a computer to be used as a two way radio. This software, in combination with a python module named pyFldigi, allows for us to automate the process of setting up Fldigi, receiving the signal, and saving the received message. After the signal is saved, we have developed python scripts to clean the message of any potential errors caused by noise in the signal. Then the scripts display the corrected message. Once completed, the Sears Lab display case will have a dynamic exhibit showing the newsfeed broadcasted by the ARRL station. It will additionally show educational information explaining the process of signal encoding. This will provide interested parties with a visible application of an education in electrical engineering.

Project Mentor: Dr. David Kazdan, Department of Electrical Engineering and Computer Science
Medical Marijuana: Is it Doing More Harm than Good?

Jodie Makara, Department of Chemistry

Pot, Weed, Reefer, Dope, and Stinkweed: a handful of names from a very long list, none of which refer to a more professional view of the Asian plant strongly debated for its growing use in the medical field. Cannabinoids, derived from hemp or cannabis, are the active chemical compounds found in marijuana. This literature review analyzes tetrahydrocannabinol (THC), the active ingredient in marijuana, to break down the chemical reactions that occur when administered in the body. This review compares the chemical differences in marijuana when used medically versus recreationally to examine the cost: benefit ratio. As a growing choice of treatment for chronic illnesses, marijuana has a growing reputation of being harmless. However, various social and physical problems, like impaired perception and judgment, raise the question of how safe and beneficial cannabinoids are in the medical field.

Project Mentor: Professor Rekha Srinivasan, Department of Chemistry

Flow cytometry analysis of inflammatory cells isolated from the sciatic nerve and DRG after chronic constriction injury in mice

Charvi Malhotra, Department of Neuroscience; Dr. Jianguo Cheng, Department of Neuroscience; Liping Liu, Department of Neuroscience

Cellular responses to nerve injury play a central role in the pathogenesis of neuropathic pain. However, the analysis of site specific cellular responses to nerve injury and neuropathic pain is limited to immunohistochemistry staining with numerous limitations. We proposed to apply flow cytometry to overcome some of the limitations and developed two protocols for isolation of cells from small specimens of the sciatic nerve and dorsal root ganglion (DRG) in mice. We found that both the non-enzymatic and enzymatic approaches were highly effective in harvesting a sufficient number of cells for flow cytometry analysis in normal and pathological conditions. The total number of cells in the injury site of the sciatic and its DRGs increased significantly 14 days after chronic constriction injury (CCI) of the sciatic nerve, compared to sham surgery control or the contralateral control. The enzymatic approach yielded a significantly higher total number of cells and CD45 negative cells, suggesting that this approach allows for harvest of more resident cells, compared to the non-enzymatic method. The percentage of CD45+/CD11b+ cells was significantly increased in the sciatic nerve but not in the DRG. These results were consistent with both protocols. We thus offer two simple and effective protocols that allow for application of flow cytometry to the investigation of cellular and molecular mechanisms of neuropathic pain.

Project Mentor: Dr. Jianguo Cheng, Department of Neuroscience, CCLCM
Drink Beyond the Possible using Django

Kavan Mally, Department of Electrical Engineering and Computer Science
Kaius Reed, Department of Electrical Engineering and Computer Science
Toshiki Nazikian, Department of Electrical Engineering and Computer Science

Drink Beyond the Possible is a web application that provides the users with a list of mixed alcoholic drinks based on the ingredients you give it. The name is a play on words for the university’s motto of Think Beyond the Possible. Our application runs on a Django framework and is hosted on Amazon’s servers. We’ve configured Amazon’s server to run as an Nginx server, which is used as a production web server. Our project utilizes account management to save the user’s ingredients and favorite drinks. We also incorporated a social system to further encourage development of mixology skills such as a comment system on drinks and a tagging system to associate traits of the drink such as bitterness or sweetness.

Project Mentor: Professor Soumya Ray, Department of Electrical Engineering and Computer Science

Mixing Technique with an Additive Allows for Optimal Refillable Bone Cement Drug Delivery System

Dylan W. Marques, Department of Biomedical Engineering; Erika L. Cyphert, Department of Biomedical Engineering; Greg D. Learn, Department of Biomedical Engineering; Chao-yi Lu, Department of Biomedical Engineering

The use of bone cement in orthopedic surgery is common practice with more than 50% of arthroplasties utilizing PMMA bone cement. In previous studies we have explored the use of a drug delivery system made from polymer microparticles of cyclodextrin (CD), which uses molecular “pockets” to load and release drug. In surgical settings bone cement is mixed by hand or in a vacuum chamber. Additives, such as CD microparticles, and mixing technique effect the mechanical properties and drug refilling of the bone cement. In order to observe the effects of these additives we have quantified different aspects of the cement including depth of refilling, compressive strength, interfacial shear strength, and porosity. Samples were analyzed for diffusive properties, mechanical strength, and porosity using stereomicroscope, compression loading and micro-computed tomography respectively. Samples were tested in two conditions dependent on the mixing technique (hand mixed vs. vacuum mixed), in groups with increasing amounts of CD microparticles (5, 10, or 15wt%), resulting in 6 different testing groups. We found strong correlations between amount of CD and diffusion depth as well as mixing type and pore volume. Concurrent analysis of mechanical strength and refilling properties of cylinders prepared with different amounts of CD microparticles and mixing techniques allows for the confirmation that cement has the necessary strength for clinical use while exploring its refilling capacity. Thus, allowing for the optimization of synthesis parameters for the eventual development of a “refillable” antibiotic bone cement delivery system for treatment of chronic or hard-to-treat infections.

Project Mentor: Horst A. von Recum, Department of Biomedical Engineering
Familial Adenomatous Polyposis: Genetic Background and Clinical Considerations

Kaitlin McCormick, Department of Biology; Dr. Audrey Lynn, Department of Biology and University Hospitals Center for Human Genetics

Familial Adenomatous Polyposis (FAP) is an inherited type of colorectal cancer that is caused by a mutation in the adenomatous polyposis coli (APC) gene. My research involved an in-depth literature review of FAP, with a focus on the underlying genetic mechanism, the clinical presentation, available treatment options, and new areas of research. The APC gene is involved in regulating the Wnt signaling pathway, which is a biological pathway that plays a crucial role in cell development and tissue regeneration. A mutated APC gene is unable to properly regulate β-catenin, which is the protein responsible for transducing a signal to the cell nucleus directing it to transcribe Wnt-specific genes. When β-catenin is not degraded properly, unregulated transcription of the target genes results in uncontrolled cell proliferation and tumorigenic transformation. The clinical presentation of FAP is marked by the presence of hundreds to thousands of adenomatous polyps in the lining of the colon that develop in adolescence. Without intervention, adenomatous polyps inevitably become cancerous. Thus, early intervention and treatment is critical for disease outcomes, and methods include colon resection surgery and early screening via colonoscopy and sigmoidoscopy. FAP has many accompanying disease variants that range in severity, the most prominent being attenuated familial adenomatous polyposis wherein affected individuals develop only 10-100 adenomatous polyps, which are less likely to develop into colon cancer when compared with FAP polyps (~70% compared with ~100%). Innovations in treatment are ongoing and include advances in chemoprevention (drug therapy) and immunotherapy. Of particular interest is the use of monoclonal antibodies to allow the immune system to recognize cancer cells as foreign and boost the response against them. Research into this disease is important to raise awareness about the condition, encourage genetic testing among affected families, and provide information about the importance of colon cancer screening.

Project Mentor: Dr. Audrey Lynn, Department of Biology and University Hospitals Center for Human Genetics
Faculty Sponsor: Dr. Jessica Fox, Department of Biology
Evaluating the Effects of Iron Oxide Nanoparticles in the Growth, Biomass, and Chlorophyll Production of Garden Cress (*Lepidium sativum*)

**Ariel McWhorter;** Nutritional Biochemistry and Metabolism, Department of Chemistry; Monica Navarreto-Lugo, Department of Chemistry; Minseon Ju, Department of Chemistry; Anna Cristina S. Samia*; Department of Chemistry

The remediation of iron deficiency in plants has been a centripetal agronomic issue for many decades. Iron deficiency has proven to be a major factor of chlorosis, as well as having a direct negative effect on plant growth. This issue has been addressed by the incorporation of chelated Fe as fertilizers. Unfortunately, incorrect or over application of fertilizers under aerobic conditions lead to the formation of damaging oxygen-based radicals within the plant as by-products of Fenton reactions. These oxygen radicals can lead to cell death, affecting the production of healthy crops. Recent efforts, have brought the attention to iron oxide nanoparticles (IONPs), as possible substitutes to current commercial iron fertilizer additives, with the potential of enhancing plant growth. The large directed concentration of Fe contained within the nanoparticle structure, makes it possible to significantly decrease the total amount of fertilizers needed, while slowing down the iron release rate for controlled iron plant uptake; owing to the protected and stable structure afforded by optimized capping ligands. This Fe release mechanism from engineering IONPs in turn decrease the risk for formation of damaging oxygen radical species to the plants and associated organisms. This work focuses on the study of the effect of different sized IONPs on the phenotypic traits of garden cress (*Lepidium sativum*) plants: growth, biomass and chlorophyll production. Our results showcase a significant enhancement effect on the phenotypic traits of the garden cress plants when treated with IONPs vs the traditional Fe-chelated fertilizers. These results suggest the potential of IONPs as fertilizer additives for the cultivation of healthier food crops.

*Project Mentor: Monica Navarreto-Lugo, Graduate Student in Chemistry*
*Faculty Sponsor: Professor Anna Cristina S. Samia, Chemistry*

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Developing Antibiotic Wound Dressing through Templating with High Internal Phase Emulsions

**Alexandra Meglio,** Department of Chemical and Bimolecular Engineering; Kristen Rohm, Departments of Chemical and Bimolecular Engineering & Macromolecular Science Engineering

Infection and blood loss are two major problems that affect surgical or combat wounds. There have been many advancements in surgical procedures, sterilization techniques, antibiotics, and wound dressings to address these problems. Despite these advances, current approaches do not meet all the requirements of an ideal wound dressing. A need exists for an easily fabricated wound dressing that can create a warm, moist environment with low adherence to the wound while preventing infection and hemorrhaging. Polymerization of the oil phase within water-in-oil emulsions can lead to highly porous, open-celled polymer foams that have a morphology templated by the original emulsion. These polyHIPEs (high internal phase emulsions) can address these requirements, including high absorption, low adherence to wound, and a simple one-pot process of fabrication. Further, polyHIPE foams can allow drug encapsulation within the matrix and the pores to prevent infection. In this research, we tested the release of antibiotic from polyHIPE foams. We researched the effect of different foam process conditions: shear mixing speed, cross-linking additives, porosity, and sonication on foam properties such as drug release kinetics and mechanical strength. Our results show that polyHIPE is a material that can absorb wound exudate along with a sustained antibiotic release. PolyHIPE can be used to create a more ideal dressing for wound treatment.

*Project Advisors: Dr. Harihara Baskaran and Dr. Donald Feke, Department of Chemical and Bimolecular Engineering*
Portable Neonatal Hypothermia Therapy Device

Eloise Miller, Biomedical Engineering; Joshua Rosenberg, Biomedical Engineering, Electrical Engineering; Samuel Skora, Biomedical Engineering; Dante Velasquez, Biomedical Engineering; Zhihan Wang, Biomedical Engineering

We are currently developing a portable neonatal hypothermia therapy device to slow the progression of brain damage in infants with hypoxic ischemic encephalopathy. Hypoxic ischemic encephalopathy (HIE) is a potential consequence of birth asphyxia, or lack of oxygen in neonates. Perinatal asphyxia is a condition that affects six out of one thousand live full-term births and is the third most common cause of death in neonates. HIE is diagnosed when the brain is deprived of oxygen, resulting in brain damage. If left untreated, HIE can lead to debilitating, lifelong disabilities such as cerebral palsy and seizures. Currently, the most effective treatment for HIE is to induce hypothermia within six hours of birth, preferably earlier. The majority of neonatal hypothermia therapy devices make use of water-cooling, so they are not portable in the case of an emergency. They are also only available in select tertiary neonatal intensive care units, so babies often need to be transported between hospitals for treatment. Since treatment is most effective when applied immediately after birth, a portable system that can induce hypothermia in EMS trucks and LifeFlight helicopters is critical to slowing body processes early in the progression of the condition. To eliminate the barriers to treatment, our team is developing a portable device to induce therapeutic hypothermia without the need for a water source. The cooling system uses thermoelectric coolers and heatsinks to regulate internal body temperature. Our device will be equipped with a battery backup so, during transit, the device can be constantly powered. Creating a hypothermia device that is portable and more available has the potential to increase the quality of life of neonates afflicted with HIE.

Project Mentors: Professor Colin Drummond, Department of Biomedical Engineering; Professor Matthew Williams, Department of Biomedical Engineering

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HIF1α-2α cerebral knockout effects on cognitive gains following environmental enrichment in mice

Viral Mistry, Department of Physiology and Biophysics; Dr. Kui Xu, Department of Physiology and Biophysics; Alireza Abdollahifar, Department of Physiology and Biophysics; Sahej Bindra, Department of Physiology and Biophysics

Summary: Hypoxia-inducible factor-1α & 2α (HIF1α-2α) are transcription factors critical to the neurobiological response to hypoxia, a condition when the body is low in oxygen, by inducing short-term vasodilation and long-term angiogenesis. Angiogenesis is also strongly related to cognitive improvements made through environmental enrichment in mice. Since HIF1α-2α are crucial to angiogenesis, it is of interest if cerebral knockouts for the HIF1α-2α transcription factors would prevent gains in cognitive function from environmental enrichment. Experiments are currently underway to see how the HIF1α-2α knockout mice, which have been bred in-house, perform on a Y-maze working memory test compared to control HIF1α-2α floxed mice prior to and after one week of environmental enrichment. After the behavioral experiments are complete, relevant regions of the brain will be compared for differences in capillary density, to establish quantitative differences in capillary density as it relates to rodent activity and cognitive performance.

Project Mentor: Joseph LaManna, Ph.D, Department of Physiology and Biophysics
Tangible Individual Feedback in a Large Musical Ensemble Setting

**Ryan Xie**, Department of Electrical, Computer, and Systems Engineering; **Trino Mitra**, Department of Electrical, Computer, and Systems Engineering

Conductors and the ensemble they lead will often face problems in giving and receiving feedback, usually seen less in other forms of pedagogy. There tends to be a lack of physical exchanges between the members and the conductor, thus individual feedback in an ensemble is given verbally rather than through written records, meaning that information must be remembered mentally. This will often lead to the conductor’s advice being forgotten or ignored. Our project will create a conductor’s stand (titled Sonoro) which will record the ongoing rehearsal and allow the conductor to send individual feedback containing small sections of the recording via email so that any advice given by the conductor is digitally recorded. It is our hope that this project will further reduce the strain on an ensemble's ability to improve and refine overall sound by developing an electronic conductor's stand using a Raspberry Pi as the heart. By connecting the Raspberry Pi to a microphone array, a touchscreen, and a physical keyboard, we will fashion the Raspberry Pi into a powerful audio processing station featuring a simplistic graphical user interface to interact with the recording and send clips of the recording through email. By doing so, the ensemble members will then have a tangible record of the material the conductor has requested them to improve in addition to a short, typed note from the conductor that addresses the section.

*Project Mentor: Professor David Kazdan, Department of Electrical, Computer, and Systems Engineering  Project Sponsor: Professor Gregory Lee, Department of Electrical, Computer, and Systems Engineering*

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Effects of the Intestinal Microbiome on Postmenopausal Osteoporosis

**Elizabeth Molnar**, Department of Biology

Osteoporosis is a metabolic disease in which the structural integrity of the bone is compromised, leading to an increased risk of fracture. Postmenopausal women are at particularly high risk for developing osteoporosis due to decreased estrogen levels. Due to severe complications and morbidity of this disease, prevention and treatment of postmenopausal osteoporosis are highly-researched topics. Current treatment for those with the disease and prevention for high-risk individuals includes hormone replacement therapy. While short-term hormone replacement therapy is safe, long-term use is associated with increased risk of endometrial cancer, breast cancer, cardiovascular disease, blood clots, and inflammatory biomarkers. Furthermore, due to preexisting health conditions or history of disease, women may be ineligible for hormone replacement therapy. Recent research has investigated the role of the intestinal microbiome on osteoporosis. Studies in postmenopausal rodent models and postmenopausal women have shown that the intestinal microbiome can affect various bone parameters that may cause osteoporosis. The first part of this review will focus on findings in studies conducted using postmenopausal rodent models and postmenopausal women. The second part will investigate potential mechanisms underlying the effects of the intestinal microbiome on bone parameters, specific to estrogen-depleted individuals. The goal of this review is to make a case for the intestinal microbiome’s regulatory role in bone health in order to move closer to understanding how this system can be manipulated for the treatment and prevention of postmenopausal osteoporosis.

*Project Mentor: Dr. Leena Chakravarty, Department of Biology*
**Tuberculosis Meta-Analysis: The Role of IFN-γ**

Deepika Narayanan, B.S. Candidate Nutritional Biochemistry & Metabolism; Bonnie Thiel, Tuberculosis Research Unit; Dr. Gurkan Bebek, Department of Nutrition

The immune system consists of many cell types, an important one being macrophages or differentiated forms of monocytes found in specific tissues known to play a role at sites of infection. It is known that there are two types of macrophage activation: M1 and M2 activation. M2 activation seemingly antagonizes inflammatory response associated with the Th2 cell type and cytokine IL-4. M1 activation deals with a pro-inflammatory response associated with the Th1 cell type with the primary cytokine being interferon-gamma, IFN-γ. IFN-γ plays a protective role in the prevention of tuberculosis infection, but there has been recent findings that suggest an IFN-γ-independent mode of protection. Previous differential gene expression data gathered for IFN-γ stimulated monocytes served as a good starting point to analyze the effect of IFN-γ on gene expression. Using previous research, five gene lists were created with Type I interferon genes, Type II interferon genes, Type I (minus the overlap with Type I), Type II (minus the overlap with Type I), and Similarly Expressed (the overlap between Type I and Type II). GSEA was used to analyze the enrichment between the previously collected DGE and the created gene lists. A positive enrichment was obtained in all cases. After completed a leading edge analysis, the IFN-γ specific genes were able to be isolated. Next, a differential gene expression analysis was completed for human tuberculosis data of latent and active TB patients to be analyzed with these IFN-γ-dependent genes first and then the IFN-γ-independent gene lists to see enrichment in either. Assessing this enrichment will show the possible protection of IFN-γ-independent pathways in tuberculosis protection. Further studies would involve validating these results through various other bio-statistical approaches.

*Project Mentor: Dr. Gurkan Bebek, Department of Nutrition/ Center for Proteomics and Bioinformatics*

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**Examining HIV Risk Behaviors in Johannesburg, South Africa**

Jennifer Nielsen, Department of Population and Quantitative Health Sciences

South Africa has one of the highest prevalence rates of HIV in the world. The history of HIV in South Africa is intimately linked to the history of the apartheid in South Africa. During apartheid, citizens were geographically, economically, and socially separated based on the color of their skin, creating vast inequality and forcing black South Africans into overcrowded, poor slums were HIV could fester. This research looks at how this history has impacted the current state of HIV in South Africa. We administered a community survey in 3 neighborhoods within Johannesburg- Soweto, Alexandra, and the Central Business District. Each of the areas were impacted uniquely under apartheid and have changed rapidly since the end of the regime 20 years ago. The survey contained questions regarding basic demographics, living standards, neighborhood cohesion characteristics, HIV testing history, and HIV risk behaviors (including multiple sexual partners and condom usage). Our results indicate that risk behaviors are still a significant problem in each of the three neighborhoods but impacts Alexandra most acutely. Further research needs to be completed to determine what the barriers are to behavior change in these areas.

*Project Mentor: Professor Peter Zimmerman, PhD, Center for Global Health and Diseases*
Reducing Cortical Seizures with Low Frequency Stimulation in the Rodent Brain \textit{In-Vitro}

\textbf{Nrupen Pakalapati,} Department of Biomedical Engineering, Rajat Shivacharan, Department of Biomedical Engineering, Nicholas Courtier, Department of Biomedical Engineering and Dr. Dominique Durand, Department of Biomedical Engineering

\textbf{Summary and Background}

Epilepsy is a neurological disorder that causes patients to experience recurrent seizures accompanied by symptoms that range in severity; on the mild end of the spectrum patients may experience epilepsy with auras but in more severe cases, patients may experience complete loss of consciousness. Current methods of reducing seizures such as therapeutic drugs and vagus nerve stimulation are partially effective. About 40% of patients taking the relevant therapeutic drugs are afforded complete control over their seizures. Additionally, 50% of patients who received vagus nerve stimulation over the course of three years were able to gain complete control over their seizures. Even with the success of current methods reducing epileptic events, the discovery of potential alternatives is crucial to provide relief to those who are still suffering.

\textit{In-vivo} experiments conducted in the cortex of rats show that low frequency stimulation (1-30 Hz) reduces cortical seizures by almost 90%. This is almost twice as effective as conventional methods of reducing seizures. However, \textit{in-vivo} experiments leave some questions unanswered. What is mechanism of stimulation that reduces seizures? What is the exact stimulation paradigm to obtain maximum seizure reduction? To answer these questions, \textit{in-vitro} studies need to be conducted in order to completely understand the effectiveness of low frequency stimulation. Doing so will obtain information that will be assist in the creation of medical device that has a higher effectiveness in reducing seizures.

\textit{Project Mentor: Dr Dominique Durand, Department of Biomedical Engineering}

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\textbf{The Influence of the Chemist in the Current Opioid Crisis: An Exploration of their Influence on the Causes, Recovery Measures and Prevention}

\textbf{Nicholas Pallas,} Department of Chemistry

Much of the United States has experienced a sharp rise in the illicit use of opioid medications and subsequent dependence associated with their long-term use. With the ever-present role of chemistry in developing new medications, there exists some role in the discipline for working to combat the issues presented by the widespread use of this class of drugs. This review serves to look at the issues caused by use of the current classes of opioid medications and causes of the current state of the crisis, as well as the role of the chemist in working to combat the problem. The data explored in this review serves to explain the advancements in chronic pain treatment made through the development and exploration of new classes of drugs that can either act on different opioid receptors in the brain or work in tandem with current drugs to reduce the addictive potential of the current drugs used. This review also explores other chemical pain treatment methods and their potential effects in widespread chronic use. Also explored are future chemical developments that can work at quelling the widespread use of opioid medications.

\textit{Project Mentor: Professor Rekha Srinivasan, Department of Chemistry}
Role of TSP-1 in regulation of inflammation in adipose tissue

**Anjlee Panjwani**, Department of Biology; **Dr. Olga Stenina-Adognravi**, Department of Molecular Cardiology, Cleveland Clinic Foundation

Insulin is a peptide hormone important for the regulation of fuel storage in adipose tissue, skeletal muscle, and the liver. When desensitization of the insulin receptors occurs, insulin resistance (IR) develops. Without insulin to control the normal metabolic processes, AT begins to release free fatty acids (FFA) and inflammatory cytokines, which further impair the signaling of insulin. As AT contributes to the progression of inflammation, the metabolic syndrome occurs. The metabolic syndrome is involved in a cluster of symptoms, such as increased blood pressure, increased blood sugar, and abnormal triglyceride levels, which increase risk for vascular complications such as stroke, cardiovascular disease, diabetic nephropathy and diabetic retinopathy. In adipose tissue with IR, thrombospondin-1 (TSP-1) is also overexpressed. TSP-1 is an extracellular matrix (ECM) glycoprotein. Among its many roles, TSP-1 acts as an anti-inflammatory protein and an activator for transforming growth factor beta (TGFβ). TGFβ, involved in fibrosis, also acts as an anti-inflammatory protein. Evidence shows that in TSP deficient mice treated with a high fat diet were protected from IR and inflammation. This indicates that TSP-1 plays a role in suppression of IR and secretion of inflammatory cytokines. Understanding the mechanisms by which IR is caused is important to maintain delivery of glucose throughout the body and prevent diabetic complications. In this paper, we examine the role that TSP-1 plays in regulating inflammation in adipose tissue with insulin resistance.

*Project Mentor*: Dr. Olga Stenina-Adognravi, Department of Molecular Cardiology, Cleveland Clinic Foundation  
*Faculty Sponsor*: Dr. Sarah Diamond, Department of Biology

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Characterize Cells Showing Conditioning Lesion Effect in Axon Regeneration Using TrkC, TH, NF200, and Parvalbumin Markers

**Sanika Paranjape**, Department of Biology and Department of Cognitive Science; **Jeong Seo**, Department of Neurosciences; **Richard Zigmond**, Department of Neurosciences

The central nervous system (CNS) exhibits minimal axonal regeneration because mature adult CNS neurons have a very low growth capacity. However, in the peripheral nervous system, axons have the ability to regenerate after damage more easily. If a conditioning lesion is performed before an injury in the peripheral axons of dorsal root ganglion (DRG), that regeneration ability is improved and there is a greater growth capacity. The conditioning lesion effect is seen when previously injured neurons have an increased ability for new axonal growth compared to neurons that have not been injured before. Our study aims to differentiate between and characterize the cells that display this conditioning lesion effect versus those that do not. To do so, we tested markers such as tropomyosin-related kinase C (TrkC), tyrosine hydroxylase (TH), neurofilament 200 (NF200), and parvalbumin, which are each known to characterize subpopulations of sensory DRG neurons. Through immunocytochemical staining and imaging, we analyzed the data by observing cell staining and measuring neurite growth. In the future, this research can hopefully be used to increase axonal regeneration in the peripheral nervous system, and ultimately in the central nervous system as well.

*Project Mentor*: Richard Zigmond PhD, Department of Neurosciences
Regulation of Cytokine Production by TLR2 Engagement on CD4+ T Cells in a Murine Model

Kyle Parker, B.S. Biology Candidate; Scott M. Reba, Division of Infectious Diseases and HIV Research; Dr. W. Henry Boom, Division of Infectious Diseases and HIV Research

Tuberculosis (TB), a respiratory disease infecting approximately one-third of the world’s population, is caused by infection with the bacterium *Mycobacterium tuberculosis* (MTB). Immune cells, specifically CD4+ T cells, are crucial in the immune response to TB infection. Prior work has demonstrated that CD4+ T cells express a receptor known as Toll-Like Receptor 2 (TLR2), able to recognize MTB ligands. Co-stimulation of the TLR2 receptor via bacterial ligands has been shown to lead to more effective immune control of infection. In this study, the mechanism underlying the effects of TLR2 co-stimulation on CD4+ T cells was studied. More specifically, the regulation of two key cytokines, or immune signaling molecules, Interleukin-10 (IL-10) and Interferon-γ (IFN-γ), was compared across three different conditions: a wild-type mouse with normal TLR2 expression on CD4+ T cells, a genetically-engineered conditional knockout mouse lacking TLR2 on its CD4+ T cells, and a control mouse with partial genetic modification but normal TLR2 expression. Stimulated and unstimulated cytokine production was quantified via enzyme-linked immunosorbent assays (ELISA). Results indicated that production of both IFN-γ at 48 hours and IL-10 at 72 hours within the wild-type and control groups increased in a dose-dependent manner with increasing amounts of TLR2 ligand Pam3CysKKKK (P3CK4). However, the same effect was absent from the conditional knockout model. These results imply that the production of both these cytokines by CD4+ T cells is co-regulated by TLR2 co-stimulation. Thus, this project provides evidence that TLR2 co-stimulation on CD4+ T cells regulates MTB infection by means of increased expression of IL-10 and IFN-γ at differing time points.

Project Mentor: Dr. W. Henry Boom, Division of Infectious Diseases and HIV Research

*Sensitivity of kiloton-scale directional detector to CNO-cycle solar neutrinos*

Nicholas Parrilla, Department of Physics

In order to study elusive physics processes and particles such as proton decay and neutrinos, modern large scale physics projects propose construction of underground, low background sites for kiloton / megaton sized particle detectors. These enterprises accumulate cost, requiring expensive excavation and highly pressurized mining environments that are dangerous for manned construction projects. Newly proposed low-cost experiments consider solution based mining in salt caverns as an economical alternative, which would provide same quality physics experiments at a fraction of the cost. The solar neutrino detection capabilities of a salt cavern-based detector were tested using Geant4 particle physics simulation software. This detector, 16 m in diameter, 65 m in height, and placed in a salt cavern salt-water brine solution, utilizes a 100 bar Ne gas enclosed in an inflatable polymer encapsulant as a photodetector for scintillation. The simulation records electron and photon energy deposition in the detector and provides tracking capabilities, allowing simulation of the expected background signal, dominated by ⁴⁰K beta and gamma decays. The significance of this project is a gained understanding of the testing environment of the proposed detector and realization of the ideal detector design given this environment for the purpose of detecting CNO-cycle solar neutrinos.

Project Mentor: Benjamin Monreal, Department of Physics
Faculty Sponsor: Rolfe Petschek, Department of Physics
Degradation of perfluoroalkyl compounds by interfacial reactions between a non-equilibrium plasma and water

Kevin Pataroque, Department of Chemical and Biomolecular Engineering; Ryan Hawtof, Department of Chemical and Biomolecular Engineering, Christine Duval, Department of Chemical and Biomolecular Engineering, R. Mohan Sankaran, Department of Chemical and Biomolecular Engineering

Perfluoroalkyl compounds such as perfluorooctanoic acid (PFOA) are attractive because of their chemical inertness and are found in diverse applications such as firefighting foam for inflammability or fast food wrapping to prevent grease leakage. Unfortunately, this inertness has led to the persistence of these compounds in the environment when improperly disposed, which, through human exposure, can cause liver damage. Conventional wastewater treatment methods have thus far failed to degrade PFOA. Recently, advanced oxidation processes (AOPS) have been studied. However, these techniques are energy-inefficient and/or produce toxic byproducts. Plasmas are electrical discharges in gases including air that are a source of ultraviolet radiation, electrons, ions, and other non-equilibrium species. The potential for producing oxidative species such as ozone has in particular made systems comprising plasmas an emerging solution to water treatment. As compared to AOPS, plasmas can be low-energy and cost-efficient and, critically, produce radicals \textit{in situ}, eliminating the need for additional chemicals or catalysts.

In this project, we designed and studied a non-equilibrium plasma formed at the surface of a liquid solutions containing perfluoroalkyl compounds such as PFOA. The degradation of PFOA was measured by the released fluorine ions using an ion-selective probe. Our preliminary results showed that the PFOA was degraded increasingly with time reaching a maximum of 29%. To understand the mechanism for degradation, we developed a control involving radical species generated from hydrogen peroxide by an iron catalyzed reaction.

Project Mentors: Professor Christine Duval, Department of Chemical Engineering; Professor R. Mohan Sankaran, Department of Chemical Engineering

W8EDU Lunar Antenna Control

Brian Rupp, Department of Electrical Engineering and Computer Science; Jordan Pfaff, Department of Electrical Engineering and Computer Science; Joshua Rosenberg, Department of Electrical Engineering and Computer Science

W8EDU is CWRU’s amateur radio station operating on the roof of Glennan building. The station’s current setup utilizes a 2-meter antenna to broadcast signals that can be reflected off of the moon for Earth-Moon-Earth communications (EME). However, in order to maintain alignment with the moon as it traverses its path, station operators must make manual corrections to the orientation of the antenna. Due to the current antenna configuration of the ham station, it is difficult to determine the direction of the antenna and to make accurate, granular adjustments manually. This research project is concerned with providing the W8EDU station with a system that will automatically track the moon’s path using ephemeris data. A Raspberry Pi is implemented and used to run a predetermined algorithm. The Pi is connected to the station’s Yaesu G-5500 rotator controller in order to direct the antenna towards the moon, or in the case of a jog command, in the direction desired by the station operator. A camera is attached to the antenna to provide visual feedback of the antenna’s orientation directly back to the Raspberry Pi UI. This system tracks the moon along its path is above the horizon and will eventually become a permanent part of the ham station to allow for easy EME long-distance communication.

Project Mentor(s): Dr. David Kazdan, Department of Electrical Engineering and Computer Science; Instructor John Gibbons, Department of Electrical Engineering and Computer Science
Thermal Capabilities for Miniaturized Multiple Motor Driver Board

Alexander Pietros, Department of Electrical Engineering and Computer Science

Motors currents can be considerably large depending on the application. These high currents produce a lot of heat energy, which in turn can mean disaster for a small high density printed circuit board. The situation in which motor currents can spike due to motor failure, stall, present themselves as benchmarks for how resistant one’s printed circuit board should be. Thus, thermal management becomes a critical aspect of any motor control design confronting the serious risk of thermal failure. Orbital Research Inc. wanted to develop a miniaturized printed circuit board capable of mimicking the output of four motor drivers for the purpose of determining the thermal capabilities of a high component density motor control module. The reasoning was to demonstrate electrical survivability, even under extended worst-case scenarios — complete and sustained motor stall. The essence of the test was to perform basic I/O manipulations to the motor drivers to create a simulated stall scenario and record the expected temperature increase of the drivers and “motors” in the form of equivalent resistors by means of thermocouples. This project represented a verification of the analytically determined temperature span that Orbital Research found previously. Not necessarily intended for industrial competition as this was an endeavor to provide physical proof of an already simulated result. As for alternatives, the only alternative would have been to trust the aforementioned data set without conducting a live test.

Project Mentor: Tony Opperman, Lead Mechanical Engineer, Orbital Research Inc., opperman@orbitalresearch.com

Faculty Sponsor: Gregory Lee, Department of Electrical Engineering and Computer Science

DoorViewer: An Apartment Reviewing Platform

Siying Wang, Computer Science; and Xiaocheng Qian, Computer Science and Economics

Door Viewer is a reviewing platform for apartments, as there is a need to make the rental market more transparent to protect the consumers. The goal of this project is to let potential tenants gain access to the current or former tenants’ genuine reviews on the apartment, avoiding any surprise after signing the lease and yet cannot break the liability without paying the buyout fee. Users will be able to use this web application to review ratings as well as submit evaluations. The user would be able to view a list of the apartment complexes nearby, with automatic sorting from the highest overall rating to the lowest. The order of the list can also be customized; it can be sorted by average reported price per sq, size, noise level, pet-friendly, etc. There would also be a map view using the Google Maps API if time permits. A detailed review will be available when clicking on an estate from the list view. The user can check out individual reviews about the property from the amenities to package receiving services to security deposit refund after move-out, along with the price specified in the lease initially signed and other price increases when renewed. If a user wishes to submit a review on a specific complex, a questionnaire will pop up and prompt the user to follow the guide and complete all the detail ratings. If there is no current entry in the database about this property, a new entity will be generated. In order to ensure the quality of the review, there will be verification process that user would need to upload the first page of the lease with all sensitive personal information wiped out.

Project Mentor: Professor Soumya Ray, Department of Electrical Engineering and Computer Science
Role of Olfaction and Vision in Predator Detection by Green Frog Tadpoles (*Rana clamitans*)

**Joseph Redinger,** Department of Biology; Dr. Michael Benard, Department of Biology

Predator detection is important for the survival of prey species as the appropriate response is required to accurately determine risk from predation. Proper interpretation of predator cues is vital to determining correct antipredator behavior and is necessary for effective investment into predator defenses. The behavioral responses to predator cues include spatial avoidance and decreased foraging. In aquatic environments, chemical cues and visual cues are two important sensory stimuli for predator detection. Frog tadpoles use both chemical and visual cues to detect predators, but the extent to which visual cues alter tadpole behavior is unclear. Previous behavioral research has largely ignored visual cues, and so the prior analysis of tadpole responses to nonlethal predator signals could be inaccurate. We investigated this problem by observing the behavioral changes of green frog tadpoles (*Rana clamitans*) exposed to combinations of visual and chemical cues from predatory dragonfly larvae (*Aeshna spp*). We predicted that tadpoles receiving predator cues would reduce feeding and position themselves further from the cue origin. Although tadpoles can use visual cues, we predicted that tadpoles will rely more heavily on olfaction and therefore would alter their behavior to a greater extent in the presence of a predator chemical cue.

_Project Mentor: Dr. Michael Benard, Department of Biology_

Chemical Remediation of Organic Contaminants in Wastewater

**Helen Sanderson,** Department of Civil Engineering; Kuan Huang, Department of Civil Engineering; Joe Huang, Department of Civil Engineering; Dr. Judy Zhang, Department of Civil Engineering

Human consumption inadvertently introduces a variety of pollutants into wastewater. Many of these, including pharmaceuticals and fertilizers, are organic chemicals, and are not addressed by current wastewater treatment techniques before being released into the environment, where they accumulate in sediments and harm wildlife through toxicity, spread of antibiotic resistance, hormone imbalance, and other effects. Some research has been done previously regarding chemical degradation of organic pollutants in waterways, and this research aimed to further the investigation with the production and testing of iron and manganese oxide materials that could be used to oxidize pollutants or catalyze oxidation reactions. Testing of different concentrations of standard iron materials with a fertilizer as a representative pollutant was done in an anoxic glovebox, which simulated the oxygen free conditions of river sediments where the reactions would take place during pollution remediation in the field. Then, a published procedure was used to synthesize manganese nanorods doped with iron in different ratios through calcination of a sol gel. Initial activity testing of the nanorods as an oxidizing agent shows that iron inhibits the reaction, but further testing has yet to be done to confirm these results and determine the effect of iron in the nanorods when they act as a catalyst in a similar reaction that uses oxone as the oxidant.

_Project Mentor: Dr. Judy Zhang, Department of Civil Engineering_
A Method of Recording and Distributing Rehearsal Audio with Conductor Feedback

Elizabeth Schafer, Department of Electrical Engineering; Lawrence Wright, Department of Electrical Engineering; Jeremy Zalles, Department of Electrical Engineering

In orchestral settings, listening for mistakes and paying attention to how instruments blend is important for effective practice. Since instruments are grouped in different locations, musicians hear a different perspective than the conductor. Our project, the Etude: Smart Rehearsal System, proposes a solution for conductors to record rehearsal audio, and to distribute that perspective to orchestra members. Etude allows musicians to effectively practice with conductor feedback by integrating technology into the ensemble rehearsal process. Instead of solely utilizing rehearsal time for verbal communication, Etude allows conductors to leave written comments concerning the rehearsal. The recorded audio and conductor comments can conveniently be sent to selected ensemble members via email through taps on a touch-screen, ensuring that feedback is accessible beyond the immediate rehearsal. Etude uses a Raspberry Pi connected to a touchscreen, and two microphones for recording. The user interface is coded in Python, and distributes audio by accessing the Gmail API. In order to test the Etude and ensure the microphones stay in sync, we recorded a consistent beeping tone on both microphones and then plotted the audio signals on MATLAB. Additionally, since the Etude needed to stay in sync for long periods of time, we ran an additional test where we had the Etude sound a tone at the start of recording then a tone after a long period of time. Since this product is designed to aid the rehearsal process, it will be an ideal tool for orchestras at the educational level, and will help conductors communicate methods to help students improve. The Etude: Smart Rehearsal System allows conductors to easily distribute recordings and meaningful feedback to orchestra members.

Project Mentor: Dr. David Kazdan, Department of Electrical Engineering

Swim Prediction System: Smart New Swim Meet Predictions using Available Data

Michael Schmidt, Department of Electrical Engineering and Computer Science; Soumya Ray, Department of Electrical Engineering and Computer Science

Competitive swimming is a smaller than such sports as football, basketball, and soccer, and as such there are fewer resources for people interested in the sport. The goal of Swim Prediction System (SPS) is to offer a convenient solution to predicting the outcome of a meet between two teams. SPS intelligently uses data available from an online database of swim teams, swimmers, events, and times to create a meet prediction useful to its user. The meet prediction automatically adjusts the times available to account for randomness that is typically present in swimming competitions. SPS is a Java application that relies on native Java packages for User Interface elements and implements publicly available API features to aid in data obtainment and parsing. Data parsing is a crucial. Swim Prediction System is a standalone application that simply requires a reliable internet connection and a Java-compatible device. The expected primary user for this application is anyone on a college level swim team curious about the outcome of a potential future meet, but users may be anyone interested in swimming that just want to estimate the outcome of a hypothetical swim meet. A Swim Prediction System user simply inputs two college level swim team names, selects a swim meet format, and runs an algorithm that returns a score breakdown of the simulated swim meet.

Project Mentor: Professor Soumya Ray, Department of Electrical Engineering and Computer Science
Mixed-methods secondary analysis of a social media-based weight loss intervention study.

Ellen Sears, Department of Nutrition; Dr. David Cavallo, Department of Nutrition

A 12-week weight loss intervention was delivered in a closed Facebook group to 39 low-income, overweight adults in the Cleveland area. A mixed methods secondary analysis was conducted using data from the intervention. For the qualitative component, 181 posts were randomly selected from the Facebook group and qualitatively coded for type of functional social support, including companionship, esteem, informational, and encouragement social support; shared experiences; and social competition. Coded data were analyzed descriptively and to identify themes in the participant’s posts. For the quantitative component, a linear regression was performed to examine the association between participant engagement level and perceived social support. Additionally, dependent sample t-tests were used to analyze the change in weight measured objectively (kg), Sallis perceived social support scale (1-5), HEI overall score (out of 100), and HEI sub scores of whole fruits (out of 5), total vegetables (out of 5), whole grains (out of 10), refined grains (out of 10), sodium (out of 10), added sugars (out of 10), and saturated fats (out of 10) measured by the NCI ASA24 online dietary recall system.

Project Mentor: Dr. David Cavallo, Department of Nutrition

Assessing Personality Type from Gesture

Adrienne Simmons, Department of Cognitive Science; Angelina Lopez, Fairview High School; Fey Parrill, Department of Cognitive Science

Everyone gestures. From small movements to sweeping motions paired with speech, gesture is a natural part of communication. It serves to convey meaning, add emphasis, and show information. Gesture varies from person to person and differences have even been observed between gestures of extraverts and those of introverts. This research questioned if observers can detect the personality type of a speaker based on their gestures. By having participants watch videos of speakers and rate the extraversion of the speaker, the average prediction was compared to the speakers’ personality assessment answer. Experiments are underway to investigate the accuracy of prediction and to determine if humans can judge the personality types of their peers.

Project Mentor: Professor Fey Parrill, Department of Cognitive Science
Witnessing Diplomacy Through an Internship at the U.S. Embassy in Bern, Switzerland

Ann Marie Smetona, Department of Political Science, Department of Modern Languages and Literatures

As an intern in U.S. Embassy Bern, Switzerland’s consular section, I wrote reports analyzing visa application trends that were disseminated throughout the U.S. Department of State and a blog post with recommendations for Americans traveling to Switzerland, which was posted on Embassy Bern’s website. The consular section processes visas and passports and provides general services for American citizens. Since it is a connecting point for all of the embassy’s branches, I coordinated with other departments to design a social media outreach strategy. At Embassy Bern, it was clear that the U.S. Ambassador’s key focus was on increasing Swiss investment in and economic ties with the U.S., and much of my work entailed raising awareness of business opportunities for Swiss companies in the U.S. through social media posts and presentations. The economic relationship between Switzerland and the U.S. is extremely important for both countries and responsible for a large quantity of jobs and investment. On an academic level, the ties between Switzerland and the U.S. are also significant with the U.S. being the most important partner for Swiss scientists and serving as a popular destination for Swiss students and researchers. Diplomatically, Switzerland plays a major role in U.S. foreign policy, serving as the U.S.’s protecting power in Iran. Throughout the internship, I learned about the many unique characteristics of Switzerland and how much international political and financial significance it has despite its small size. For example, Geneva is home to the European headquarters of the United Nations and a host of other international organizations. By working next to Foreign Service officers, I saw what life as a diplomat is like, realizing that it is both rewarding and challenging.

Project Mentor: Professor Kelly McMann, Department of Political Science

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The Extraction, Isolation, and Identification of Δ9-THC from Cannabis

Adam Steel, Department of Chemistry

As efforts to legalize medical and recreational marijuana use spread across the country, research into the cannabis plant and its chemical constituents is spreading as well. Multiple institutes and the United Nations have spent considerable time and money looking into how to isolate and identify the various components of cannabis. The primary compound being researched is Δ9-Tetrahydrocannabinol (Δ9-THC), the primary psychoactive chemical in cannabis. Δ9-THC is extracted from the plant via two methods, supercritical fluid extraction and focused ultrasound extraction, each method has advantages and disadvantages. The Δ9-THC is then analyzed using a combination of gas and liquid chromatography and mass spectroscopy to confirm its identity.

Project Mentor: Rekha Srinivasan, Department of Chemistry
The Impact of Active-Learning Videos on Student Understanding in Organic Chemistry

Joyce Su – Department of Biochemistry; Dr. Rekha Srinivasan – Department of Chemistry

A challenge that many students face when learning organic chemistry involves balancing concept learning and concept application in problem-solving. Too often, students lean towards rote memorization and binge learning to learn organic chemistry without understanding the concepts behind them. This leads to lower retention of information and limited ability of the students to efficiently progress further in their organic chemistry education. In this project, we offer supplemental video resources as a tool for students to learn and apply organic chemistry one concept at a time. The videos differ from simple concept-review in that they integrate active learning exercises. Video length generally ranges from three to ten minutes and follow a basic template of concept introduction, connection to previously learned topics, followed by a concept check where students are asked to pause the video and solve the displayed problem based off of previous and newly acquired knowledge. The videos continue the pattern of concept coverage followed by application exercises, allowing students to interact with and use the concepts instead of passively absorbing material. After each problem, a short explanation is given where concept utilization is emphasized. The goal is to increase student knowledge retention and learning by supplying additional online resources that allow the student to actively engage in the material. Student participation in the study was selected on a voluntary basis from the Organic Chemistry II course. Participation involved watching a set number of videos per week as per course schedule, followed by an online survey. Short assignments addressed students’ conceptual and practical understanding from the videos. Weekly questionnaires were sent out to monitor progress and the effects of video utilization during the semester-long course, along with inquiry into the video’s role in student learning.

Project Mentor: Dr. Rekha Srinivasan, Department of Chemistry
The Impact of Prenatal Substance Abuse on Infant Mortality

Margo Swann, Department of Psychological Sciences.

Infant mortality is a current and widespread societal problem today. The national rate of infant deaths before their first birthdays was approximately 5.9 deaths for every 1,000 live births, while the rate in Cuyahoga County was almost double that (Centers for Disease Control and Prevention 2018, Ohio Department of Health, n.d.). While infant mortality remains a problem, the rates have been decreasing over the past several years, and initiatives are being put into place in order to help solve the problem. However, a large part of what causes infant mortality is substance abuse during pregnancy. This substance abuse can lead to miscarriage, preterm birth, and birth defects, among other maladies on the developing fetus, all of which can result in infant mortality. Prenatal substance abuse is common, and identifying the factors that are associated with women’s drug use is crucial. This review will discuss psychological factors pertaining to prenatal substance abuse, including mental illness, dependency, and the woman’s social environment. All of these factors are somewhat unavoidable, and treatment options must be put into place to provide women with substantial care, in order to decrease the risks and consequences of prenatal substance abuse. Collective evidence demonstrates that pregnant women refuse to seek out mental health services due to the stigma of mental health. Unfortunately, a number of women are already extremely dependent on substances and continue to use them during pregnancy, due to environmental and genetic factors, and due to past behavior. Social determinants including family, friends, finances, and household environment all contribute to a woman’s substance use during pregnancy. Healthcare bias against these women have harmful effects, as providers will often refuse to treat women with substance abuse problems. Medical sources indicate that professionals are unaware of the severity of using during pregnancy, as well. Questions have been raised in the literature as to whether these women should be prosecuted and incarcerated, as many have been in the past for charges of involuntary manslaughter, child abuse, and for the distribution of illegal substances to a minor. It is important to understand reasons for why a woman uses, as infant mortality is still a very large cause of death among children.

Project Mentor: Anastasia Dimitropoulos, Department of Psychological Sciences

References:

Radiomic Characterization of Pathologic Tumor Regression and Disease Metastasis via Colorectal Cancer MRIs

Nitya Talasila, Department of Biomedical Engineering; Jacob Antunes, Department of Biomedical Engineering

Rectal cancer has a 56% mortality rate, to minimize likelihood of which patients undergo chemoradiation. This research focuses on medical imaging informatics to aid in evaluating response to chemoradiation via routine MR imaging. To accomplish this, sub-visual advanced image features called radiomics are extracted and the most relevant features are identified. These are used to train a machine learning algorithm to predict pathologic tumor regression (considered the “ground truth” outcome). Feature and model performance was evaluated via classifier receiver-operator characteristic (ROC) analysis. The most relevant features associated with tumor regression were primarily gradient and... texture responses within the rectal wall on post-chemoradiation MRIs. Our model achieved 78% accuracy in assessing pathologic tumor regression in a cohort of 27 cases, and resulted in a 78% in hold-out testing on nodal, metastatic, and complete response patients. We hope to extend our findings to utilize additional disease markers and a larger cohort to validate our findings.

Project Mentor: Satish Viswanath, Biomedical Engineering
Gene therapy of Alzheimer’s disease by rAAV or plasmid vectors expressing PrP-N1

Wanyun Tao, Department of Biochemistry

N1 peptide is the N-terminal product of cellular prion protein (PrP<sup>C</sup>) through α-cleavage. N1 has neuroprotective properties and prevents cytotoxicity induced by amyloid-β (Aβ) oligomers. Since the accumulation of toxic Aβ oligomers is a main cause of Alzheimer’s disease (AD), the N1 peptide has great potential in AD treatment and prevention. Our lab aims to develop a N1-based gene therapy against AD. My project focuses on developing effective delivery and expression of N1 using recombinant adeno-associated virus (rAAV) or plasmid vector encoding N1. We constructed N1-encoding plasmid and rAAV vectors that were designed to secret N1. I transfected/transduced the N1-encoding plasmid or rAAV viral preparation into C2C12 murine myoblast cell line and we injected these vectors intramuscularly into C57BL6 mice in vivo. Then I examined the cell culture medium or peripheral blood from the injected mice for secreted N1 with enzyme-linked immunosorbent assay (ELISA) and Western blot. To avoid complications from endogenous PrP in wild type C2C12 cells, I compared N1 secretion from wild type C2C12 cells and PrP-knockout C2C12 cells. No significant N1 was detected in transfected/transduced C2C12 culture medium or in blood from injected mice with either N1 plasmid or N1 rAAV. These results suggest that the N1 peptide may not be able to be expressed from a N1-encoding vector. We have designed a revised N1 plasmid construct. This new vector will express a safe PrP fragment that can generate N1 via α-cleavage, which will be tested similarly in C2C12 cells and in mice. After the new vector is confirmed to express and secrete N1, it will be intramuscularly injected into AD mouse models to test its effectiveness in vivo.

Project Mentor: Dr. Qingzhong Kong, Department of Pathology

Social Interactions in Rio Sao Francisco Piranhas at Cleveland Metroparks Zoo

Josie E. Thal, Department of Biology; Jason D. Wark, Brookfield Zoo; Nick J. Zarlinga, Cleveland Metroparks Zoo; Kristen E. Lukas, Cleveland Metroparks Zoo; Ronald G. Oldfield, Department of Biology

The Rio Sao Francisco piranha (Pygocentrus piraya) is the largest species of piranha. It is rare in captivity, and its social behavior has never been studied. My preliminary observations of P. piraya at Cleveland Metroparks Zoo revealed frequent aggressive interactions. Aggressive behavior may negatively affect the welfare of low-ranking individuals and may be associated with the death of some individuals. In the current study, I tested the hypothesis that the individuals at the Zoo are organized into a dominance hierarchy. I analyzed 24 video recordings made when no food was present. Continuous recording and scan sampling methods were used to quantify aggressive interactions between individuals. In addition, each individual’s behavior was recorded every 60 seconds to determine time budgets. Dyadic relationships indicated that individuals were organized in a linear dominance hierarchy. In general, higher-ranked individuals performed greater numbers of aggressive bouts and fewer numbers of escapes than lower-ranked individuals. Similarly, time budget data indicated that higher-ranked individuals spent more time behaving aggressively and less time escaping than lower-ranked individuals. The high rates of aggression observed may be the result of the limited amount of available space, as predicted by resource defense theory. This study provides the first known report of the social interactions of P. piraya. In addition, it takes an important step in addressing the welfare of aquarium fishes, an underrepresented area of research in zoos and aquariums. My data suggest that the welfare of Rio Sao Francisco piranhas, and possibly other species of piranhas, kept in aquariums might be improved by using larger enclosures.

Project Mentor: Dr. Ronald G. Oldfield, Department of Biology
Trauma and Related Experiences in LGBTQ, Cisgender, and Heterosexual Individuals

Margarid Turnamian, Department of Psychological Sciences; and Dr. Amy Przeworski, Department of Psychological Sciences

Lesbian, gay, bisexual, transgender, and queer (LGBTQ) individuals are more likely to be victims of violent crimes than cisgender heterosexual individuals. Additionally, they have higher rates of mental health symptomology than cisgender heterosexual individuals. Previous studies have demonstrated that LGBTQ persons who suffered some type of injustice were more likely to suffer from mental illness. This study examined LGBTQ and cisgender heterosexual individuals’ exposure to traumatic events and their ability to cope. We hypothesize that LGBTQ individuals will be exposed to more trauma. Additionally, we hypothesize that coping ability will be impacted by personal and life experiences, such as discrimination, support, and others. A worldwide sample of LGBTQ adults were recruited for the study. Participants completed an online self-report questionnaire that assessed gender identity, sexual orientation, experiences of victimization, coping methods, perceived social support, and emotions, as well as anxiety, depression, and PTSD. Results and the conclusions that may be drawn from the data presented will be discussed.

Project Mentor: Dr. Amy Przeworski, Department of Psychological Sciences
Faculty Sponsor: Dr. Amy Przeworski, Department of Psychological Sciences

Extradomain-B Fibronectin as a Biomarker for Invasive Prostate Cancer

Helen C. Wang, Department of Biology; Dr. Amita M. Vaidya, Department of Biomedical Engineering

Prostate cancer (PCa) is the second most commonly diagnosed cancer in men. Current diagnostic markers, such as prostate-specific antigen (PSA), are unable to differentiate between indolent and aggressive prostate cancers, resulting in unnecessary, intensive treatments that lead to long-term side-effects. Because of this, characterization of biomarkers associated with the invasiveness of this heterogeneous disease is imperative.

This project aims to demonstrate that increased invasion and aggressiveness in prostate cancer cells is associated with overexpression of Extradomain-B Fibronectin (EDB-FN), an oncofetal isoform of the extracellular matrix protein fibronectin. EDB-FN aids in the process of cell migration and adhesion during fetal development but shows negligible expression in normal tissues. Abundant EDB-FN expression has been correlated with biological processes related to cancer and metastasis such as angiogenesis, tumorigenesis, and epithelial-to-mesenchymal transition (EMT). Overexpression of EDB-FN has also been correlated with lower patient survival rates in colorectal and ovarian cancers.

In this study, we evaluated the EDB-FN expression in two PCa cell lines, DU-145 and DU-Pro, in 2D and 3D cultures. Compared to DU-145, DU-Pro cells demonstrate increased proliferation, invasion, and migration. Results from 3D immunofluorescence microscopy using an EDB-FN-specific peptide, ZD2-Cy5.5, qualitatively show an increase in EDB-FN expression in DU-Pro cells. In addition, polymerase chain reaction (qRT-PCR) results show that DU-Pro cells have a statistically significant overexpression of EDB-FN mRNA when compared to DU-145. This study suggests that EDB-FN is possibly associated with increased aggressiveness and is a promising candidate as a biomarker for high-risk prostate cancer.

Project Mentor: Dr. Zheng-Rong Lu, Department of Biomedical Engineering
Faculty Sponsor: Dr. Susan Burden-Gulley, Department of Biology
High mobility 2D electron gas at InSe-GaSe heterostructures

Mingyuan Wang, B.S Physics and Mathematics, Department of Physics; Arvind Shankar, Department of Physics; Kasun Premasiri, Department of Physics

GaAs and AlGaAs are two semiconductor materials that have been well studied. People can create high mobility 2D electron gas in GaAs and AlGaAs using Molecular Beam Epitaxy. Like GaAs and AlGaAs, both InSe and GaSe have similar crystal structures, which will reduce lattice mismatch at the interface. In this project, we aim to create a high mobility 2D electron gas at the interface of InSe-GaSe heterostructures. We use silicon oxide as substrates to fabricate multilayer InSe-GaSe heterostructures. The field-effect mobility and intrinsic Hall mobility were measured at various temperatures by using bottom gating and Hall measurement in the four-probe configuration. By studying InSe-GaSe heterostructures, we find that conduction is mainly through InSe. Placing GaSe on top of InSe is expected to improve electron mobility in GaSe by suppressing surface scattering, and we found that gating of GaSe playing an essential role in understanding the behavior of this type of heterostructure.

Project Mentor: Dr. Xuan Gao, Department of Physics

Characterizing Induced Genomic Alterations and Inheritance Patterns in Flax

Nicole Wilkinson, Department of Biology; Dr. Christopher Cullis, Department of Biology

Most strains of flax have a stable genome; however there are some, such as Stormont cirrus (Pl), that when grown under stressful conditions are found to undergo changes to their genome in subsequent generations. When Pl is grown under inducible conditions (exhausted soil, nutrient stress), specific regions of the DNA are altered in reproducible ways. Bethune flax, whose genome has been fully sequenced remains stable even when grown under these conditions so it is of interest to examine the inheritance of these variable regions in the Pl genome. We predict that these alterations are happening during the period in which they are growing under stressful conditions, but they could also potentially be occurring during meiosis in the parental generation. In this study, we are investigating the original Stormont cirrus line grown under different conditions to look at the reproducibility of the genomic changes and whether they are coordinated or have a programmed order of appearance.

Project Mentor: Dr. Christopher Cullis, Department of Biology
Extra and Intra-Ovarian Factors in the Development of Polycystic Ovarian Syndrome and Associated Risks

Marilena Wolf, Department of Cognitive Science

Polycystic Ovarian Syndrome (PCOS) is a common endocrine condition characterized by any two of the following symptoms: hyperandrogenism, menstrual irregularity, and/or polycystic ovaries. Most affected women with PCOS also present with infertility. This is thought to be a result of atypical secretion of gonadotropic hormones from the brain including Luteinizing Hormone (LH) and Follicle Stimulating Hormone (FSH). LH, the hormone that stimulates ovulation, increases in amplitude and frequency. In contrast, FSH, which is responsible for the development of the dominant follicle, decreases. The altered ratio of LH and FSH are thought to lead to underdeveloped eggs that fail to ovulate, thus it is the primary source of infertility in women with PCOS. In addition, women with PCOS often express additional extra-ovarian factors that aggravate the condition, such as obesity and insulin resistance. Women with PCOS have also been shown to have altered intra-ovarian environments that may further contribute to the development of excess large, anovulatory follicles, high levels of circulating free testosterone, or altered hormone concentrations. Collectively, these factors appear to complicate conception and pregnancy. This can manifest in diminished oocyte quality, predisposition towards miscarriage, or the development of conditions such as preeclampsia or gestational diabetes. Some of these risks have been attributed to PCOS alone, while others are co-dependent on obesity or insulin-resistance. Because PCOS is a multifactorial condition, attempts to treat it should acknowledge the variety of potential influencing factors. This literature review looks to analyze the sources of infertility in women with PCOS and the potential risks during pregnancy.

Project Mentor: Dr. Rebecca Benard, Department of Biology

Flow Separation Control of an Overexpanded Rocket Nozzle Using Microjets

John Wylie, Department of Mechanical and Aerospace Engineering, CWRU; Dr. Rajan Kumar, Department of Mechanical Engineering, Florida State University; Dr. Jonas Gustavsson, Dept. of ME, FSU; Nikhil Khobragade, Dept. of ME, FSU

Recent advances in commercial space transportation emphasize rocket engine reusability and its operation over a wide range of operating conditions. Rocket nozzles are designed for optimal performance at a certain design point in the rocket trajectory, which happens to be typically in the vacuous, upper atmosphere. Therefore, these rocket nozzles underperform at sea level conditions where they operate at highly overexpanded pressure conditions. Operation at highly overexpanded pressures leads to flow separation and flow entrainment from the ambient conditions that lower nozzle efficiency and causes shock boundary layer interactions. The flow separation inside the nozzle is inherently asymmetric and associated with high-frequency fluctuations, resulting in side loading and nozzle fatigue. In the previous studies, active flow control using high-momentum microjets has been shown to reduce flow separation on both internal and external flow surfaces. The main objectives of the present study are to characterize the performance of a scaled convergent-divergent supersonic rocket nozzle by identifying separation locations along the diverging section at various nozzle operating conditions and introduce microjet based flow control. Measurements include pressure distributions inside the nozzle with and without microjet control over a range of nozzle pressure ratios. Results show that the flow separation location is a function of the nozzle pressure ratio for the baseline configuration. An increase in nozzle pressure ratio results in a downstream movement of separation location. Microjet control appears to be very effective in delaying the flow separation and in turn improving the rocket nozzle performance.

Project Mentor: Dr. Jonas Gustavsson, Department of Mechanical Engineering, Florida State University
Mosquito Inspired Insertion Strategy to Improve Microelectrode Implantation

Marina Yu, Department of Biomedical Engineering; Rachel Welscott, Department of Biomedical Engineering; Seth Meade, Department of Biomedical Engineering; Carmen Toth, Department of Biomedical Engineering; Andrew Shoffstall, Department of Biomedical Engineering

Mosquitoes are very efficient at successfully biting humans and animals. To successfully bite, they use numerous strategies to insert their thin needle-like mouth, called a proboscis, through layers of skin. The mosquito was an inspiration for new insertion techniques for microelectrodes in the brain. Improving insertion techniques can create opportunities for thinner, more flexible microelectrodes. This is important because smaller electrodes could mean less trauma and inflammation in the brain. The mosquito’s strategies were used as inspiration because of the mosquito’s ability to insert long, flexible needles successfully. Specifically, when the proboscis penetrates the skin, the sheath around it, called the labrum, remains as a guide at the surface. The labrum, used as a guide, effectively increases the critical buckling load of the proboscis. This allows the proboscis to be successfully inserted without bending or breaking. The Capadona lab had previously developed a mosquito labrum-inspired guide as an insertion strategy for microelectrodes that significantly improved insertion success. Currently, the lab is exploring an oscillation inspired strategy. Mosquitoes oscillate the proboscis at different frequencies as it penetrates through layers of skin. A piezo motor was created and a vibrating disk motor was used to apply a desired frequency of oscillation to the microelectrode as it was inserted. Testing was completed with dummy electrodes and agar gels to mimic in vivo use. Small oscillations with the piezo motor did not produce a significant difference in the amount of successful implantations but larger oscillations with the vibrating disc motor did produce a significant difference. Additional studies are ongoing to explore additional variables within the parameter space: insertion guide dimensions, frequency, and probe dimensions. As the field is driving toward smaller and smaller electrodes, these strategies could be used to successfully implant smaller, more flexible electrodes.

Project Mentor: Dr. Andrew Shoffstall, Department of Biomedical Engineering
Faculty Sponsor: Dr. Jeffrey Capadona, Department of Biomedical Engineering

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Gene therapy for Usher syndrome type 1C in mice model

Zihao Yu, Department of Biology

Usher syndrome type 1C (USH1C) is a genetic disease causing hearing loss and blind in humans. For mice, usher syndrome can result in hearing and balance dysfunction. Our research hope to come up with a reliable genetic treatment of the disease by studying mouse model. USH1C mice are not able to produce harmonin because of a mutation in USH1C gene, and cannot produce a protein called harmonin, so we hope to treat the disease by using microinjection technique to introduce AAV2 virus containing harmonin cDNA to mice ear. We also hope to determine whether round window or semicircular canal is a more efficient region for microinjection. The effect of surgery on auditory ability recovery is going to be tested by auditory brain response (ABR) test and balance recovery is going to be tested by swimming test.

Project Mentor: Dr. Qing Yin Zheng, Department of Otolaryngology
Faculty Sponsor: Dr. Emmitt Jolly, Department of Biology
The Use of CY-PSMA-1 as a Probe to Target PSMA for Prostate Cancer Radiotherapy

Sophia Zeng, Department of Biochemistry; Dong Luo, Department of Radiology; Xinning Wang, Departments of Biomedical Engineering and Radiology; Gopalakrishnan Ramamurthy, Department of Radiology; Clemens Burda, Department of Chemistry; and James P. Basilion, Departments of Biomedical Engineering and Radiology

Much interest has developed in gold nanoparticles as a promising anti-cancer therapy. Gold nanoparticles have been studied because of their biocompatibility, facile platform for modification, and strong interaction with incident radiation that generates secondary radiation and electrons, which damages the cells around the gold nanoparticles. However, gold nanoparticles by themselves would not be an effective treatment for cancer. While high energy radiation kills cancer cells, it also damages many healthy cells. Therefore, it is important to have a strategy that will allow specific targeting to cancer cells to minimize side effects. In previous research, prostate specific membrane antigen (PSMA) has been commonly used to target gold nanoparticles to tumors. In this paper, cysteine and tyrosine are added on to the C-terminus of PSMA-1 (CY-PSMA-1), which is then conjugated to gold nanoclusters (AuNC) and glutathione to construct a probe with a higher affinity to prostate tumor cells. These conjugates are shown to have a high clearance renal clearance rate. The PSMA-targeted AuNCs are observed to gather around PSMA expressing tumor cells, making them more effective radiosensitizers and an attractive potential treatment for cancer.

Project Mentor: Dr. Clemens Burda, Department of Chemistry

Use of Electrochemical Techniques to Explore Mechanisms Causing Tissue Damage during Neural Stimulation

Alfred (Jinyi) Zhang, Department of Chemical and Biomolecular Engineering

Electrical stimulation of neurons is a clinical technique for improving quality of life for people with a variety of neurological issues, like providing pain relief. However, neuron stimulation, in some cases, has been reported to cause tissue damage. One possible pathway of tissue damage is correlated to peroxynitrate generation from a two-step reaction sequence: nitric oxide reacting with superoxide that is first generated electrochemically during stimulation by oxygen reduction. A better understanding is needed of the possible factors that might minimize oxygen reduction. In this work, these factors will be explored using cyclic voltammetry and pulsing methods. Cyclic voltammetry is being used to measure oxygen reduction at common stimulating electrode materials such as platinum. Constant rate voltage sweeps are applied with dissolved gas mixtures that have oxygen concentration resembling that of the extracellular fluids, and the level of oxygen reduction can be determined from the voltammogram shape. The level of oxygen reduction will be compared for metal and diamond electrodes; diamond is an attractive alternative for neuron stimulation because of its resistance to oxygen reduction. Kinetic data for oxygen reduction will be compared between these materials and data for different diamond surface chemistries summarized. In the future, to make simulation more realistic, measurements will be extended from the linear voltage sweeps to a pulsing technique, of which the voltage profile compared to linear sweep, would vary more rapidly with time and thus better simulate the clinical stimulation conditions.

Project Mentor: Professor Heidi Martin, Department of Chemical and Biomolecular Engineering
Pictures make statements more believable

Lifeng Zhang, Department of Psychology

When people evaluate claims presented with pictures or without pictures, they usually make a judgment based on whether the claims feel true. Forty-two students participated in an experiment where they saw 152 general-knowledge statements (half true and half false) one at a time. Half of the statements were accompanied by non-probative pictures, that is, pictures relevant to the topic but providing no evidence as to whether the statement is true or not (e.g., the statement “NAIROBI IS THE CAPITAL OF KENYA” shown with a picture of the flag of Kenya). The other statements were shown with no pictures. We divided people into 2 groups: if group A got a particular statement with a picture, then group B got that statement without a picture. Participants were asked to judge whether each statement was true. Using a 2 tailed T-test, we found a statistically significant difference between the mean number of times people judged statements with pictures true (44.10) and the mean number of times statements without pictures were judged true (41.14). Non-probative information can make statements feel more believable.

Project Mentor: Dr. Robert Greene, Department of Psychology
Faculty Sponsor: Dr. Robert Greene, Department of Psychology

The Influence of Stigma and Body Insecurity on Self-esteem in Obese Children

Muzhen Zhang, Department of Psychological Science

Childhood obesity is the focus of many public health efforts in the United States because of the negative impact it has on individuals, communities, and societies. After an upsurge in childhood obesity rate in the late 1970s, the obesity rate in American children presents a stable pattern. 17% of American children and young adults aged 2–19 years were obese in 2007-2008 regardless of new health-related policies (as cited in Ogden, Carroll, Kit & Flegal, 2014). Besides the tremendous cost of medical treatment and health maintenance, obesity leads to lower self-esteem in children, which increases the potential for mental health illnesses, and decline in their engagement with social activities. This comprehensive literature review investigates how stigma and body insecurity impede the development of self-esteem in children with obesity based on the data collected from empirical studies, self-reported surveys, and qualitative interviews. However, this correlation does not apply to all obese children. Collective research has found that children with higher socioeconomic backgrounds and more social supports are less likely to have lower self-esteem, regardless of obesity. Gender and age are also factors that could influence self-esteem in obese children. For example, older obese children have lower self-esteem compared to younger obese children. The research indicates an urgent need for social support, funding for childhood obesity programs, and strategies to effectively establish higher self-esteem in obese children.

Project Mentor: Anastasia Dimitropoulos; Department of Psychological Science
Dietary Supplement Use Among Undergraduate Nutrition Majors

Eric Zhou, Department of Nutrition; Dana Goldberg, Department of Nutrition; Dr. Stephanie Harris, Department of Nutrition

Dietary supplement (DS) use among adults has drastically increased over the past three decades in the United States, with over half of U.S. adults reporting using one or more DS, according to NHANES data. Research on DS use in the college population has largely focused on athletes and medical students, but is lacking in the pre-health undergraduate college population. In addition, there is limited research examining the influence of education, training, and experiences of undergraduate pre-health students on their DS perceptions, attitudes, practices, and use. This information is important, as it will allow for a better understanding of pre-health students’ use and perceived knowledge of DS, which has been shown to impact future patient recommendations. In a sample of 27 undergraduate nutrition majors, an online survey was administered through REDCap to (i) determine what types of DS students are taking and their motivations for use, (ii) identify where students are learning about DS and where they most often obtain information on DS, and (iii) learn about their perceptions, attitudes, and practices surrounding DS. A majority of the undergraduate students reported using DS (89%), with an average of two DS used (2.37 ± 1.5). Multivitamins/multiminerals (56%) and protein supplements (48%) were the most commonly reported DS used, with the major motivation for use including to improve or maintain overall health (92%) and to build muscle mass (64%), respectively. Students reported that they most frequently obtained information about DS from nutrition courses (63%), which was also where they most often learned about DS (78%). Moving forward, this data could be a cross-sectional first step in a longitudinal study that continues to examine the influence of education on DS use, with the potential of allowing educators to rethink current academic curriculum on DS to better prepare our future health care professionals.

*Project Mentor: Dr. Stephanie Harris, Department of Nutrition*
December 7, 2018

The Celebration of Student Writing and Research showcases undergraduate student writing scholarship from across the university by encouraging students to present and display their research and writing in formats other than conventional word-processed documents. Some students create video projects; others produce poster presentations or read aloud portions of their writing; still others design models or digital illustrations that present their writing projects in new media. The event receives assistance from the following academic centers:

The Writing Resource Center (WRC) at Case Western Reserve University provides writing consultation to students across the university in Bellflower Hall, in four other campus locations, and online. More than 40 full-time Writing Program faculty, graduate students, and undergraduate students staff the WRC. Each year, WRC consultants hold more than 5,000 individual sessions with approximately 1,500 individual students ranging from first-year writers to graduate students and faculty. The WRC also conducts a campus-wide workshop series and sponsors other writing-focused events.

The Center for the Study of Writing was established in 2008 to facilitate research and scholarship on writing at the University and in the world. It serves three distinct but interrelated roles at the University: to support writing and research by resident and visiting students and scholars; to facilitate exciting new courses and curricula on writing; and to provide an array of practical writing and publishing support services to the University and University Circle communities. For more information, see http://www.case.edu/writing/csw.

Since 2009, the Center for the Study of Writing has been sustained by generous gifts from Marilyn McCulloch (FSM ’50); from Edward S. Sadar, M.D. (ADL ’64, SOM ’68) and Melinda Melton Sadar (FSM ’66); from Sharon Schnall (MBA ’87) and Dr. R. Drew Sellers (EMBA ’08); from Eric Winter, M.D. (CWR ’98, GRS ’91, MD ’98); from Jackson McHenry (ADL ’52); Dixon Long, Ph.D. (Dean Emeritus, Western Reserve College; Professor Emeritus, Political Science, CWRU); and from an anonymous donor.

The Celebration of Student Writing and Research is additionally supported by the SAGES Program and the Department of English.
Courses and Organizations Presenting:

CWRU Writing Programs & The Writing Resource Center

Director of the Writing Program: Kim Emmons
Assistant Director: Martha Shaffer

Writing – defined broadly to include oral, visual, digital, and inscriptive modes of communication – is essential to all academic and civic endeavors. Writing enables scholarly exchange of ideas; it facilitates civic and professional participation; it inspires creativity and innovation; it transforms students into leaders, activists, inventors, artists, teachers, and citizens of the world. The CWRU Writing Program’s mission is to ensure that all students develop sophisticated communicative strategies through understanding their own writing processes; assessing the contexts and audiences for their ideas; and articulating their messages clearly, passionately, and persuasively.

Student Group: Discussions

Group Adviser: Sheila Pedigo

Students: Saloni Lad

Discussions is the undergraduate research journal of CWRU. We publish two to three issues each year and feature research in all disciplines in order to promote undergraduate exploration in the sciences and humanities. For one of our recent issues, we received over twenty submissions from various undergraduate institutions across the nation. If you are interested in assisting us in the publication process or if you wish to submit an article to Discussions, please stop by our table or visit our website at www.case.edu/publications.

Student Group: Writers Writing Words

Group Adviser: Barbara Burgess-Van Aken

Students: Hernan Rincon, Todd Cheng, and Jonathan Schaeffer.

We will be sharing short stories we have written as well as information about our writing club.
Universities across the U.S. are welcoming international students at increasing rates each year. However, these students face struggles that may go unnoticed by administrators, faculty, staff, and peers. Specifically, first-year international students deal with personal challenges that arise within the six dimensions of wellness: emotional, social, physical, intellectual, occupational, and spiritual. These dimensions overlap and affect one another. Therefore, a student struggling emotionally may also see negative intellectual, social, and physical consequences. Although wellness issues persist among all university students (both domestic and international), international students’ wellness can be further complicated by cultural acclimation, homesickness, displacement from support systems, and language barriers. Due to correlations between a student’s state of wellness and his or her academic performance, the topic of international students’ wellness warrants attention by individual students as well as the broader university community.

As a college student, reading might seem like a commonplace ability. But since the development of cuneiform in the third millennium BC, reading has been a special skill, one that has sometimes conferred social status on those who possessed it and sometimes provoked suspicion or fear among those who did not. In this seminar, we have explored how print technology has affected the act of reading over time by considering two broad questions: 1) How have developments in reproducing the written word changed the reading experience from ancient times through the digital age? 2) What societal ramifications have these changes had on the act of reading? Today’s presentation is a digital anthology of time travel stories that we have written to represent our explorations in this class.
Course: FSSY 185R: Oh the Place You Will Go: Representations of Space in Children’s Picture Books

Course Instructor: Cara Byrne


Students in this SAGES course have studied how children’s picture books communicate social norms and ethics through the depiction of imagined and real spaces. Students will be present to discuss the picture book they chose to analyze as their final project. The display features additional picture books from the course, as well as pages from the students’ own adapted children's picture books.

Course: USSO 286L: Exploring Nonprofit Organizations

Course Instructor: Barbara Clemenson

Nominees for Best Individual Research Prize: Sarah Hamilton, Yuliang (Bill) Ding

Students in this class select different Cleveland area nonprofit organizations and spend the semester studying them in depth, applying general knowledge about nonprofits to their chosen organizations. As a result, students come to understand their nonprofits' structure and governance, purpose and history, mission and effectiveness, and finances. They are therefore able to make informed decisions about their organizations' sustainability and effectiveness in meeting their missions.

Course: USSY 286X: The Future of News

Course Instructor: Bill Doll


This century has seen an explosion of new digital news sources, from Vice, to Vox, to Buzzfeed to ProPublica and Infowars. Some are fun. Some are mean, and some are expanding the hard work of strengthening democracy. Our exhibit explores how the media has changed and how it has not.
**Course:** FSCC 110: Foundations of College Writing

**Course Instructor:** Susan Dominguez

**Students:**
Section 101: Jack Crouch, Bob Faller, Leah Fireman, Dante Grecco, Rachel Hopey, Brinda Kapur, Prithik Karthikeyan, Justin Rehklau, Carter Theis, Ellils Wright, Arland Lojo Zatania

Section 102: Tristan Acosta-Pecina, Brandon Callow, Josiah Cann, Wonyoung Choi, Michael Derrimiggio, Yassine El Mouniri, Alejandro Jimenez-Cortez, Maya Montemayor, Tristan Phemister, Henry Vorosmarti, Keri Wood, Tyler Young

Students will present their research for a critical essay on "Big Food."

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**Course:** USSO 176: Savor: The Ethics and Politics of Eating

**Course Instructor:** Narcisz Fejes

**Students:** Emily Bence, Ryan Briscoe, Robert Ciupinski, Thomas Hankey, Abigail Haste, Sarah Hoffman, Sandy Huynh, Morgan Hyun, Tamara Jeffries, Jaya Jolly, Claire Keanna, Thomas Koss, Alex Neyman, Karl Scherf, Matthew Thornton, Aaron Umen, Hannah Xu

Students will be discussing their final projects/research papers on "food production's impact on global quality of life" focusing on 1. the impact of climate change on grape and wine production 2. the sustainability of tuna farming 3. the economic well-being of corn farmers 3. cattle production's impact on our health and the environment.
**Course:** FSSY 183: E-Lit: New Media Narrative  
**Course Instructor:** Kristine Kelly  
**Students:** Blake Aschenbrener, Ashwin Datta, John Dominicos, Samantha Dunbar, Marc Franquesa-Guivernau, William Huang, Eytan Kaplan, Sarah Krueger, Abbey Lawrence, Gabrielle McBroom, Sriram Satyavolu, Katherine Schade, Macin Sheeder, Brianna Van Zanten, Savannah Walters

In this class, we read and write about electronic literature, including works of hypertext, digital games, e-narratives about social issues, digital documentaries, and social media as social narrative. The work we display at the CSWR shows examples of our class's unconventional approaches to writing about these media-rich, often non-linear modes of storytelling. Our presentation highlights the idea of "creative analysis," a term coined by Mark Sample, for writing practices that incorporate processes of assemblage and design.

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**Course:** FSNA 136: Saving the World from Poverty, Injustice, Disease, and Environmental Exploitation  
**Instructor:** Andrew Rollins  
**Students:** Amy An, Ben Browngardt, Sebastien Cayo, Beatriz Feijo, Annie Franklin, Ben George, Hope Hardman, David Hernandez, Hein Htet Aung, Rachel Jung, Kelly Moton, Ryan Newton, Lewis Orr, Sanjana Pandit, Sarah Pequeno, Alexandra Weinhofer

Half of the world's population lives in poverty. The causes of poverty and injustice are complex and the ramifications are numerous and serious and include grave risk to human health and to the environment. Through reading, analysis, writing, and discussion the class has investigated issues surrounding poverty and disparities in health and opportunity. We have also explored how innovation and engineering design can help address causes of poverty and disparity and meet needs of people at risk. We have worked in teams throughout the semester to identify an unmet need and to design, prototype, and test a solution to benefit an under-served or under-resourced population (previous projects include electricity generation, water filtration, and safe disposal of medical waste). Today we present these prototypes to you.
**Course:** FSSY 185U-100: On Being Human

**Instructor:** Bharat Ranganathan

**Students:** Alvin Cao, Jacob Chang, Eileen Petros, Jake Prusky, Wynne Zheng

This seminar explores religious and philosophical views about what it means to be human. We will address questions such as: to what extent are we free? Does freedom conflict with traditional authority, our own pasts, our irrational impulses, or our physical natures? What is the relationship between reason and emotion? How well do we know our own motives? And to what extent are we hidden to ourselves? To investigate these questions, we will read, discuss, and write about a range of classical and contemporary religious and philosophical thinkers. Each offers a different perspective about the nature of the human being, human excellence, and what it means to live a life of integrity. They are also enduringly relevant to our lives, inside and outside of the classroom. Together, the texts and thinkers constitute a conversation filled with sometimes competing and sometimes complementary views about who we are, why we do the things we do, and what sorts of lives we ought to lead.

**Course:** FSCC 110: Foundations of College Writing

**Instructor:** Martha Schaffer

**Students:**

- **Section 104:** Nicole Baier, Harrison Chough, Peter Dernelle, Michael Gabe, Josh Gao, Nadra Haji-Suleyman, JJ Henson, Alexandra Jaccard, Rahul Mikkilineni, Justin Porter, Christian Querrey, Molly Whelan, Joa Xie

- **Section 105:** Nomar Arocho, Louis Charles, Angela Cho, Alex Glatz, Kathryn Golden, Brittany Hoopingarner, Alyssa Hyland, Austin Keil, Kayla Kirton, Brianna Smith, Bryanna Tran, Spencer Weigand, Max Winebrake,

Foundations of College Writing is a SAGES First Seminar that explores how we get things done together through language and how writing affects who we are in the world. Students will present on their individual research projects about a social issue that negatively impacts a community that they care about, using writing and speaking to create meaningful change.
Course: FSNA 144: Is the Mind What the Brain Does?

Instructor: Lee Thompson

Students: Jett Adler, Derick Casiano, Evan Davies, Kathryn Devadoss, Tara Dickinson, David Gueye Katie Hart, Anthony Jahng, Marie Kallay, Ammar Kazi, Michelle King, Kristen Lay, Hannah Lee, David Li, Thomas Lipke, Josie Shiff, Christiana Wang

After reading An Anthropologist on Mars by Oliver Sacks, students created a graphic visual design project using Comic Life. The goal of the project is to have images work hand in hand with textual information to effectively convey information to the reader. Sacks states that he “is sometimes moved to wonder whether it may not be necessary to redefine the very concepts of “health” and “disease”, to see these in terms of the ability of the organism to create a new organization and order, one that fits its special, altered disposition and needs rather than in terms of a rigidly defined “norm.” Each student’s project will focus on a chapter of Sacks’ book and examine a specific individual’s condition and how it both limits and enables them to pursue a meaningful life.