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THIRTY-THIRD ANNUAL SYMPOSIUM OF TRINITY COLLEGE UNDERGRADUATE RESEARCH

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BIOLOGY

1.

SPECIALIZATION FOR YOLK PROCESSING IN ALLIGATOR SPECIES *ALLIGATOR MISSISSIPPIENSIS*

Madeline Barnes ‘20, Charlie Reimers ‘20
Faculty Sponsors: Daniel G. Blackburn, Yumming Hu

Scanning electron microscopy (SEM) has allowed us to visualize and better understand the methods of how the developing alligator embryo processes yolk in the species *Alligator mississippiensis*. Using SEM, we examined yolk tissue at various developmental stages and were able to notice a pattern in yolk cellularization and the vascularization by blood vessels. In early stages, the yolk consists of free yolk spheres with few nutrient-rich, endodermal cells; these cells assist in yolk digestion. As development continues in the mid-stages, the endodermal cells proliferate, taking up large yolk spheres through phagocytosis and digesting them into smaller droplets within the cell. In late-stage eggs, the yolk-filled endodermal cells proliferate around a network of blood vessels, forming “spaghetti strands”. These strands provide an efficient means to transport nutrients from the yolk to the growing alligator embryo. This unique pattern of yolk transport and uptake was previously found in our lab in three snake species, the lizard species *Sceloporus undulatus*, and the turtle species *Chelydra serpentina* and *Trachemys sripta*. The distribution of this pattern indicates that this yolk processing mechanism is universal among reptiles. Given that reptiles are photogenically basal to birds, the yolk processing mechanism in avian species is a derived trait and likely arose after avian ancestors split from reptiles.

2.

CREATING A CAUDAL INTRON 2 POTENTIAL ENHANCER TO STUDY THE ROLE OF THE CAUDAL GENE IN THE EMBRYONIC SEGMENTATION CLOCK OF THE RED FLOUR BEETLE *TRIBOLIUM CASTANEUM*

Suzanne N. Carpe ‘22
Faculty Sponsors: Alice Vossbrinck, Terri Williams, Dr. Lisa Nagy, PhD, University of Arizona

The embryo of the red flour beetle *Tribolium castaneum* is known to develop sequentially by adding segments in an anterior-to-posterior progression using a “clock”-like mechanism similar to that of vertebrates. The segmentation clock in *Tribolium* is regulated by a molecular oscillator: three pair-rule genes *even-skipped (eve), odd-skipped (odd),* and *runt* produce waves of expression during elongation. Previous studies indicate that these oscillations are driven by a gradient of the transcription factor *caudal* (*cad*), which can both activate and regulate the frequency of the clock oscillations. Since it is known that the frequency of the clock changes during development, we are looking for factors that regulate embryonic *cad* expression and therefore drive these changes in the segmentation clock of *Tribolium*. To analyze the regulation of *cad*, we cloned both upstream and intronic fragments predicted to have *cad* binding sites in order to construct potential enhancer sequences. For this project, we were specifically interested in studying a 4 kb base pair sequence in the *cad* intron 2. We used an available reporter construct (piggyGUM) that allows the insertion of potential enhancers upstream of a fluorescent protein (mCherry). This construct uses Gateway cloning to allow the insertion of enhancer fragments, so we added Gateway specific sequences (attB) to the *cad* intron 2 fragment, then performed BP and LR Gateway cloning reactions to insert the sequence into the piggyGUM construct. This process was also completed for three other

upstream and intronic fragments. Ultimately, we plan to use these fragments in a yeast one-hybrid assay to identify proteins that bind to the *cad* enhancer and to use the reporter constructs to create transgenic lines in order to determine the role of each fragment in the regulation of *cad*.

3.

DASYA SYLVIAE (DELESSERIACEAE, RHODOPHYTA), A PUTATIVE NEW SPECIES FROM THE MESOPHOTIC ZONE OFF BERMUDA.

Maggie Cassidy '21
Faculty Sponsors: Craig W. Schneider, Gary W. Saunders, University of New Brunswick

Advances in deep-water diving technology and collections from submersibles have allowed for the exploration of the mesophotic zone (deeper than 50 m), where exceptionally low light conditions challenge the photosynthetic organisms that survive there. One such organism is *Dasya sylviae* put. sp. nov. collected at 60–90 m by technical rebreather divers off the coast of Bermuda. Preliminary genetic sequencing of cytochrome oxidase 1 segment of mitochondrial DNA (COI-5P) shows at this time that it is distinct from all other known species. The genus *Dasya* presently hosts 90 known species from throughout the world's temperate and tropical oceans. Only 10 species of these including three from Bermuda, *D. collinsiana, D. cryptica* and *D. mollis*, appear to share the overall pattern of pseudodichotomous branching of their axes, however key morphological characteristics easily distinguish them from *D. sylviae*. It appears that the species most similar to *D. sylviae* is *D. crouaniana* but it bears shorter pseudolaterals overall (1–2 µm vs. 1.7–5.5 µm) and has longer (to 2 mm vs. 269–305 µm) and broader tetrasporangial stichidia (80–120 µm vs. 73–80 µm). The new species will be named for Sylvia A. Earle, pioneering phycologist, scientist and open-water diver, 50 years after she led the first all-female team of aquanauts in Tectite II at the bottom of the Gulf of Mexico.

4.

THE EFFECT OF HYPOXIA ON BRAIN CELL PROLIFERATION IN WEAKLY ELECTRIC FISH, *PETROCEPHALUS DEGENI*

Kaitlin Klovdahl '20, Evelyn Luciani '21
Faculty Sponsor: Kent Dunlap

Oxygen levels tend to remain at a steady state concentration in the Earth's atmosphere, yet in some bodies of water, they can fluctuate and decrease drastically. Many organisms that inhabit the swamps, lakes, streams, and parts of the ocean where this occurs have evolved adaptations to manage this environmental uncertainty and continue normal oxygen consumption. The Lwamunda swamp in Uganda is chronically hypoxic, yet it is home to many species, including the electric fish *Petrocephalus degeni*. *P. degeni* are unusual by nature of their immense brain, and the Lwamunda swamp appears ill-suited for maintaining this large, metabolically active organ. To determine the possible mechanisms *P. degeni* employ for survival and brain maintenance in this hypoxic swamp, 33 individuals were collected aiming to analyze their brain cell proliferation. One-third were immediately sacrificed, and two-thirds were transported to a laboratory and divided into hypoxic and normoxic environments for two weeks. All brains were collected, and new brain cell proliferation was quantified using PCNA immunohistochemistry. *P. degeni* from the hypoxic lab condition showed significantly fewer PCNA+ cells than their conspecifics in normoxic water, and individuals harvested directly from the field showed the overall highest density of PCNA+ brain cells. Our results suggest that hypoxia and captivity negatively impacted brain cell growth in *P.*

degeni. The activation of hypoxia-inducible factors (HIFs) likely mediated this reduction in brain cell proliferation and the corresponding oxygen demand. Despite showing a reduction in new brain cell growth, *P. degeni* remains capable of surviving and maintaining their large brain in extremely hypoxic conditions.

5.
THE EFFECT OF CDT1 AND ALS1 ON ALUMINUM STRESS TOLERANCE IN *ARABIDOPSIS THALIANA*

Izzy Maggioni ‘23
Faculty Sponsor: Susan M. Bush

Many fertilizers that are used for crops in agriculture lower the pH of the soil, causing toxic aluminum in the soil to be more easily taken up by the crops. Aluminum has been proven to have a dangerous effect on plants, as it can alter and inhibit the processes of many of the plant’s functions, but some genes have been found to help plants with aluminum stress tolerance. Thus, the goal of this experiment was to pinpoint two genes and determine their role in the aluminum tolerance of *Arabidopsis thaliana*. Two versions of the CDT1 gene, one linked with the reporter GUS and one with GFP, were sequenced and transformed into Agrobacterium, then transformed into plants using a micropipette. Additionally, the ALS1 genes from *Solanum lycopersicum* (tomato) and *Solanum pennellii* were sequenced and transformed. However, after the sequencing of the ALS1 plasmids came back, it was revealed that the ALS1 genes were not successfully transformed. Therefore, to recreate the ALS1 plasmids, they were put through a restriction digest and run through a gel. The DNA fragments from the gel were removed and ligated together, and will ultimately be put onto the Arabidopsis plants. The resulting plants will produce seeds that will be tested for higher aluminum tolerance. The genes with GUS and GFP proteins will display exactly where the gene is active, demonstrating the gene’s specific role in stress tolerance. These genes provide the potential for higher aluminum tolerance, allowing plants to be healthier and more resistant to less ideal soils, making the job of growing crops easier and more efficient.

6.
DESIGNING A REPORTER CONSTRUCT AND CRISPR CONSTRUCT TO IDENTIFY THE ROLE OF *AtCDT1* IN ALUMINUM AND CADMIUM TOLERANCE IN *ARABIDOPSIS THALIANA*

Hannah McCurry ‘20
Faculty Sponsor: Susan M. Bush

The gene *CDT1* was first discovered in the crabgrass *Digitaria cilaris* to confer cadmium tolerance. Five homologs of this gene exist in rice (*Oryza sativa*), one of which, *OsCDT3*, was found to confer aluminum tolerance, instead of cadmium tolerance. The homolog of this gene in *Arabidopsis thaliana* (*AtCDT1*), is currently under study. Arabidopsis plants carrying a mutation in this gene were found to overexpress *AtCDT1* in response to cadmium, but not to aluminum, suggesting that *AtCDT1* is cadmium responsive, not aluminum responsive. This research study aims to learn more about the *AtCDT1* gene and its potential involvement in tolerance to aluminum toxicity. The current study proposes a reporter construct to show where in the plant and when during development the *AtCDT1* gene is expressed in Arabidopsis, with predictions that it is expressed in the cell membrane of cells in the roots, and throughout development of the Arabidopsis plant. Preliminary CRISPR constructs were designed to be used in further research to design a knockout line of Arabidopsis for the *AtCDT1* gene, to determine its potential function in tolerance to aluminum, or to cadmium alone.

7.

DETERMINING THE ROLE OF CDT1 UNDER METAL STRESS IN ARABIDOPSIS

Chloe Michalopoulos ‘22
Faculty Sponsor: Susan M. Bush

Cadmium is naturally available in the surface level of soil around the world and is also increased by human activity. Cadmium is toxic, so plants have mechanisms to deal with this stressor. *Cadmium tolerance 1* (*CDT1)* is a gene that is found in many plants including the model plant Arabidopsis. Does this gene help in cadmium tolerance in Arabidopsis? A homolog of *CDT1* in rice has been found to bind Al in the cell wall; mutant plants lacking *CDT1* are hypersensitive to aluminum presence (Xia et al., 2013). However, the function of *CDT1* in Arabidopsis has not yet been studied. Two insertional mutants in the *CDT1* promoter were isolated; to find the function of this gene, wildtype and mutant Arabidopsis seedlings were placed under abiotic stress to study their response. DNA was extracted from these seedlings and quantitative PCR was then used to analyze gene expression of *CDT1*. Gene expression analysis of cdt1-2 revealed over-expression of *CDT1* under cadmium stress. Aluminum stress was also tested. Wild-type (col-0) plants showed response to aluminum stress through increased PIN7 expression. Future gene analysis will help scientists better understand the role of the *CDT1* gene in environmental response.

8.

TOLL RECEPTORS’ INVOLVEMENT IN CELLULAR MOVEMENTS DURING EARLY AND LATE SEGMENTATION OF *TRIBOLIUM CASTANEUM*

Kathryn Russell ‘22
Faculty Sponsors: Alice Vossbrinck, Terri Williams, Benjamin Goldman, PhD (UArizona), Lisa Nagy, PhD (UArizona)

Cell movements are known to play a significant role in embryo elongation in the red flour beetle *Tribolium castaneum*. In another model organism, *Drosophila*, Toll receptors have a demonstrated role in convergent extension, elongation of the germband by which rows of cells intercalate together. In *Drosophila*, Toll receptors are a link between pair-rule genes expressed in discrete stripes and effector molecules causing cell movements. A recent study indicated the involvement of Toll receptors 10 and 7 in *T. castaneum* elongation. However, the intercalary behavior of cells in *T. castaneum* is less orderly than in *Drosophila*, which may reflect a difference in underlying cellular mechanisms. It is known that there are differential degrees of cell movement in early *versus* late *T. castaneum* segmentation, but it is unclear how cell movements are affected by the differential expression of Toll receptors during these times. To better understand these Toll receptor’s effects on elongation of *Tribolium* germbands, sections of each Toll gene were made into double-stranded RNA in order to knock down their function. These embryos will be viewed under a fluorescent microscope and compared with wild type embryos to observe the effect of knocking down the genes on cell movements and rearrangements.

9.

THE EFFECT OF CDT-1 ON THE ALUMINUM RESISTANCE AND ROOT GROWTH OF ARABIDOPSIS

Evan Wyman ‘23
Faculty Sponsor: Susan M. Bush

Naturally occurring aluminum found in soil poses a problem for plants as it inhibits the growth of their roots, thus causing a decrease in their overall size and yield. In order to deal with this environmental stress, some plants contain specific genes which, through various techniques, help to increase aluminum tolerance. One such gene is CDT-1, a gene proven to increase aluminum tolerance in rice plants. What we wish to discover is whether other plants can be transformed with CDT-1 can see an increase in aluminum tolerance as well. To do this, Arabidopsis plants were grown to maturity as were E. coli that contained the CDT-1 gene. The E. coli DNA was then extracted and inserted into Agrobacterium which would be the mode of plant transformation. Single drops of the suspended Agrobacterium were then placed onto the flowering buds of the Arabidopsis resulting in the transfer of their CDT-1 DNA into the plant and allowing transformed plants with the CDT-1 gene to be grown. In the future, these new Arabidopsis plants will be grown in aluminum present environments to determine their root growth. The determined root growth will then be compared to that of an Arabidopsis plant without the CDT-1 gene to determine if the presence of the gene was beneficial. In determining the effectiveness of this gene in Arabidopsis, it could potentially help to make other crops genetically resistant to aluminum in their environment. This would be extremely beneficial for the farming industry as a whole as more resistant plants would grow much larger and thus produce a much greater yield.

CHEMISTRY

10.

SYNTHESIS AND CHARACTERIZATION OF A NANOPARTICLE-HYDROGEL COMPOSITE AS AN OPTICAL STIFFNESS SENSOR

HuaYue Ai ‘21
Faculty Sponsor: Lindsey A. Hanson

Metal nanoparticles have unique optical properties due to their interaction with visible light, and these optical properties are tunable by changing their size, shape or refractive index of its surroundings. These properties, along with the small size, make nanoparticles good candidates for sensors that can detect a change in the stiffness of their surroundings and report it as an optical signal. In this work, we investigated gold nanorods (AuNRs) as candidates for optical stiffness sensors. AuNRs were synthesized using CTAB and NaOL as capping ligands and were then surrounded by a shell of soft, thermoresponsive pNIPAm (poly (N-isopropylacrylamide)) based hydrogel. A small change in temperature would trigger the hydrogel to collapse or swell and thus would cause the change in refractive index. Different cross-linking ratios (5:1, 10:1, and 20:1) were used during polymerization of the hydrogel. Upon heating the beads, a shift of the AuNR plasmon peak was observed due to the increase in refractive index of the collapsed hydrogel. Matrices were fabricated by embedding beats in a larger polyacrylamide (PA) gel. Concentration of bisacrylamide was varied in order to change the stiffness of the outer PA gel. The data was collected and analyzed using MATLAB. Future research will focus on synthesis of matrix substrates with different beats and the ultimate goal is to develop a mathematical model, which will infer the stiffness of surroundings from the amount of shift in the spectrum.

11.

OPTIMIZATION OF A DART-TOFMS METHOD FOR THE RAPID DETECTION OF VOLATILE BIOMARKERS OF PARKINSON'S DISEASE

Hannah J. Crary '23, Marjorie A. Rednor '20
Faculty Sponsor: Janet F. Morrison

Parkinson's disease (PD) is a neurodegenerative disease that increases the rate of dopamine neuron degeneration in older adults. In 2018 it was discovered that a nurse in the U.K., Joy Milne, had the ability to "smell" whether her patients had Parkinson's disease. Postulating that there are volatile molecular biomarkers characteristic of Parkinson's disease, scientists subsequently identified four major molecular candidates: hippuric acid, octadecanol, eicosane, and perillic aldehyde. The goal of the present work is the development of an analytical method based on direct analysis in real time/time-of-flight mass spectrometry (DART-TOFMS) for the rapid detection and quantitative analysis of volatile PD biomarkers in human sebaceous secretions (sebum). The method for sample collection was evaluated for efficiency of sebum recovery and matrix (substrate) interference by comparing nylon swabs, cotton swabs, and commercially available sweat patches which were provided to student volunteers. The body location of swabbing was also explored by comparing recoveries from the nose, forehead, and lower back. Spike-recovery experiments for the target analytes were performed to evaluate figures of merit, including limits of detection and linear dynamic range. Future experiments will focus on the application of the optimized methodology to actual patient samples collected by a clinical collaborator, with the ultimate goal of developing a method for early detection of PD, which could potentially prevent or slow disease progression.

12.

INVESTIGATING THE BINDING SITE OF OSTEOCALCIN ON BOVINE TYPE 1 COLLAGEN

Audrey Ettinger '20
Faculty Sponsor: Richard Prigodich

Osteocalcin is a protein found in bone that binds to collagen fibers and is anchored tightly in gap regions by crystalline hydroxyapatite. In the crystal structure of osteocalcin, there is a structurally undefined N-terminus that binds to collagen, which was previously discovered in the Prigodich Lab. However, the binding site on collagen is still unknown. Three analytical methods were used to study the structure of osteocalcin and its binding properties to bovine type 1 collagen. The N-terminus of osteocalcin was structurally analyzed using Circular Dichroism, which indicated less disorder with the increase in residues along the N-terminus. UV-Vis was used to determine the dissociation constant of telocollagen and atelocollagen with the first 16 residues of the N-terminus ($K_{d,telo} = 5.52*10^{-5}$, $K_{d,atelo} = 1.25*10^{-4}$). An Saturation Transfer Difference (STD) experiment was prepared for the NMR in order to determine structural sites involved in binding on the N-terminus of osteocalcin to collagen and atelocollagen. Proton NMR, COSY, and NOESY experiments were used to assign proton spectra peaks for osteocalcin as reference in a future STD-NMR experiment.

13.

ATTACHMENT OF AMINO ACID MOLECULES TO FERROCENE

Evan Neu ‘22
Faculty Sponsor: Timothy P. Curran

Synthetic beta sheet molecules have been studied and analyzed to determine their three-dimensional structure to learn more about the folding of beta sheet “plaques” which contribute to Alzheimer’s Disease (AD). However, many of these models are insoluble and therefore difficult to study or inaccurate since they assume a two-dimensional planar configuration, a shape that allows the molecules to aggregate. The objective of our laboratory was to synthesize organometallic beta sheet structures containing ferrocene and a ring formed from a tungsten bis-alkyne complex where amino acids are attached using a methylene and carboxyl group “spacer” joined to the two alkynes bonded to the tungsten. These organometallic models might be superior to existing beta sheet models because imaging has demonstrated that a non-planar three-dimensional conformation is assumed, which would prevent aggregation, and the molecules are soluble.

The specific goal of my research project was to create an asymmetric complex, with glycine ethyl ester on one alkyne and alanine tert-butyl ester on the other alkyne. Interactions between different amino acids have not been studied for the organometallic complexes in our laboratory.

The first part of synthesis, the creation of diazopeptides from the amino acid esters, has three parts. Bromoacetyl bromide is first attached to the amino acid esters, the other end of bromoacetyl group is then converted into an azide, and the azide is finally converted into a diazo group. The ferrocene dialkyne molecule with two attachment points is then prepared. Next, the diazopeptides are attached one at a time, and the tungsten carbonyl complex is attached to create the bisalkyne complex.

The synthesis of both diazopeptides and the ferrocene dialkyne “holder” were successfully carried out. The glycine diazopeptide was reacted with the ferrocene dialkyne, but analysis of the products formed demonstrated that the expected product was found in a smaller quantity than expected. Further work will involve isolating the product with one glycine diazopeptide attached and discovering why the reaction yielded unexpected products.

14.

EFFECTS OF PRESSURE TO OPTICAL PROPERTIES OF NANOPARTICLES

Ihsan Uyan ‘23
Faculty Sponsor: Lindsey A. Hanson

Nanoparticle research is in high demand during the last twenty years due to their unprecedented mechanical and optical properties contrary to their bulk counterparts. It has been known that nanoparticles are demonstrating distinct spectrums depending on their shape, color, and distribution. Recently, the studies also showed that nanoparticles especially noble metals demonstrating color change and pseudoelasticity when they are pressurized. In order to comprehend all the factors and mechanisms contributing on this novel phenomenon, monodisperse spherical gold and silver nanoparticles, between 10-30 nm, is going to be synthesized. Transmission electron microscopy and UV-Vis absorption spectra analysis is going to be done to do the characterization of nanoparticles. Later, the nanoparticles are going to be pressurized with a diamond anvil cell up to 20 gigapascal and their absorption spectra is going to be taken during

to process. All data is going to be compared to investigate the effects of silver and gold nanoparticles contributing to the color change. The results are going to enable us to formulate an equation that is going to predict the absorption spectrum of a nanoparticle in particular conditions. Further research on different materials is going to help to specify the best substance, in terms of being more pseudoelastic and having wider absorption spectra, that can be used with polymers as stress sensor in space industry.

15.
INVESTIGATION INTO THE EFFECT OF PHOTOSTIMULATION OF A PHOTOREPONSIVE POLYMER MATRIX EMBEDDED WITH Au NANOROD-HYDROGEL BEADS ON THE PLASMON OF THE NANORODS
Kamila Zygadlo ‘23
Faculty Sponsor: Lindsey A. Hanson

Nanoparticles have shown behavior that significantly differs from their respective bulk material. Of particular interest are noble metal nanoparticles, including Au and Ag, that absorb light within the visible spectrum region, with the wavelength of the light depending on the shape and size of the particles. It has been discovered that nanosized noble metals exhibit pseudoelasticity when small pressures are applied. In an effort to further study the behavior of nanoparticles in different conditions, Au nanorods were produced and their size and shape were checked using Transmission Electron Microscopy. Next steps will include encapsulating these nanorods into hydrogel beads that will then be embedded in a photoresponsive polymer matrix. The rods embedded in the matrix will be tested for a shift in the plasmon as a result of contraction of the matrix and the corresponding swelling of the hydrogel bead. The effect of photostimulation of the matrix will be measured by taking the UV-Vis spectra of Au NR-hydrogel beads outside and inside of the matrix, and the results will be compared with previous experiments with a thermoresponsive matrix. Possible future applications of this study include further measurement of forces in biological matrices, as well as development of stiffness sensors for early diagnosis of tumors.

COMPUTER SCIENCE

16.
SC2 MEETUP
Mason Allen ‘20
Faculty Sponsor: Chris Armen

In the real time strategy game StarCraft II, players control one of three alien races- Zerg, Protoss, or Terran. Each race has its own unique abilities and playstyle, and so players must devote considerable time to mastering each matchup. In its current state, StarCraft II does not allow player to specify the race of their opponent. This is good for creating a balanced and fair match making system, but it is bad for practice efficiency. In particular, players would benefit from the ability to match with an opponent of a specific race, as this would allow them to create more focused and efficient practice sessions that are sensitive to their personal weaknesses. SC2 Meetup does just that- users navigate to a website where they fill out a form, and they are contacted by email when a viable practice pair is found. Players receive their practice partner’s BattleTag only- no email address- which allows them to manage contact with their partner via the StarCraft II friend system. Once in contact, it is straightforward for them to set up a custom game and begin practicing. SC2 Meetup is powered by Django and styled with Bootstrap.
17.

WEB APP FOR COMPARABLE COMPANIES ANALYSIS
Prabhat Bhootra ‘20
Faculty Sponsor: Professor Peter Yoon

Comparable Companies Analysis is a method to value a company that relies on the assumption that companies from similar industries and of a relatively similar size should have a similar valuation. There are many students who could be economics majors or curious about finance who may want to use this methodology, but current methods such as Bloomberg terminals or Excel spreadsheets require a knowledge of their functionalities and have a steep learning curve. This senior project aims to allow users to carry out a customized analysis by allowing them to choose peer companies and relevant multiples that they wish to use. They can also edit data values as they deem fit. Users will be able to save analyses they have conducted for future reference. The web app will be intuitive and easy to use as users will only have to use their mouse for point and click actions.

18.
JOB HUNTER: A GAME ABOUT GETTING A JOB
Seb Kryspin ‘20
Faculty Sponsor: Peter Yoon

Many college students worry about getting a job after graduation. A video game about "getting a job" could help students see the humor in an often competitive and stressful process. Therefore, the author created *Job Hunter*, a 3D action platformer that was built in Unity and written in C#. Players can jump and move freely around the 3D world, to explore and fight enemies. They must seek out the scattered pieces of their resume across wacky, surreal mindscapes. Many challenges await players as they strive to put their resume in front of the right eyes, get an interview, and defeat the Interviewer in verbal sparring. Job Hunter tackles the daunting task of gaining employment in a stress-free and fun way, so it will be especially enjoyed by college students that are anxious about finding a job after graduation.

19.
DIGITAL TRUCK TICKETS: MODERNIZING CONTAINER SHIPPING
Brendan Lynch ‘20
Faculty Sponsor: Takunari Miyazaki

Ocean container shipping moves more than five times as much international freight as all other modes (rail, road, and air) combined. But once a ship arrives at a port, trucks are needed to move the containers to their final destinations. Since ports can have tens of thousands of containers at a time, ports need a way to let drivers know where their containers are. Currently, ports print out individual paper tickets to direct truckers to their containers and provide other instructions as needed. This wastes significant quantities of paper and money, while requiring the use of hardware that is vulnerable to failure. To address environmental and fiscal concerns, a system is designed to provide ticket information to truckers digitally, working. To demonstrate proof of the concept, a model system is implemented consisting of an iOS mobile client and a Unix-based web server.

20.

VOTE SMART
Lucy Matz ‘20
Faculty Sponsors: Chris Armen, Mark E. Stater

Many American college students face the decision of whether to register to vote on their college campus or become an absentee voter from their home address; however, there is not yet a way to effectively evaluate which mode of voting carries the most weight in any given election. Voter engagement for Americans aged 18 to 29 years old is lacking, and as Millennial and Gen Z voters surpass the Baby Boomers as the largest electorate group in 2020, it is imperative to the functioning state of democracy that they engage in elections. This is why it is important to show voters, specifically young and possibly disenfranchised ones, that their vote matters and that they can make an impact by turning out to the polls. Vote Smart provides a solution in weighing which address to vote from to make the most impact, based on their Partisan Voter Index (i.e. the likelihood that the district will vote for one party or the other). This tool is a web application that compares two addresses and the Partisan Voter Indices of their corresponding voting districts, and returns a suggestion of where to vote to the user along with electorate demographic information for each state.

21.
THE BANTU WARRIOR
Mehluko Myanga ‘20
Faculty Sponsor: Madalene Spezialetti

This game aims to educate its players about African culture and the strength of the African Woman through a fun and playful environment. The game will be an educational treasure hunt. Each scene of the game will introduce its players to different countries of Africa with different cultures. In a quest to hunt for artifacts, players will be taught about the history of that country through pop-up texts. Each level will be divided into three modes: the main scene with character moving around the game environment, the tile match mode where the player will have to solve a shuffled picture of an artifact, and the word search mode filled with the appropriate African words. All characters of the game will be women dressed in traditional attire and will gain character powers over the levels. Through the attire, character powers, and the pop-up texts during the game, this game will educate about the history of Africa and will portray the strength of African women.

22.
INVESTMENT CLUB INTEGRATED PLATFORM
Alejandra Pardos ‘20
Faculty Sponsors: Takunari Miyazaki, Christopher Hoag

The Investment Club at Trinity College is a student-run organization that manages over five hundred thousand dollars of the school’s endowment and invests this money in the stock market. Given the large membership of the club and the need to make quick investment decisions due to the rapid movements of the market, there can be an occasional lack of communication among the students in the organization. In addition, it is hard to balance the task of making investment profits while fulfilling the mission of the club, which is to educate and start conversations on market conditions and possible investments.

Through a personalized integrated platform with various features for the organization, the members are able to track equity trends and experiment using the Modern Portfolio Theory. This theory calculates position recommendations with the goal of creating an efficient portfolio, yielding the highest investment return for a given level of risk. The platform also makes all the resources available to the members during and after club meetings creating an even more cohesive, transparent and productive experience.

23.
PERSONALIZED HOTEL APPLICATION FOR HOTEL MULBERRY
Kalsang Wangmo Sherpa'20
Faculty Sponsor: Peter Yoon

My family business, Mulberry is a private hotel which effortlessly combines contemporary international standard with time-honored, personalized service that reflect Nepal's traditional family values and high-quality hospitality. In most hotels, a common way for guests to use hotel facilities is either through going to the reception or making a phone call. However, this application provides the hotel guests with seemless experience by providing convenient, flexible and easy access to the amenities of the hotel. It provides specific features for each of the services the hotel provides such as access to restaurant menu and making food and booking appointments for the spa. This application encourages guests to make best use of the hotel's facilities providing quality hospitality.

24.
CREATING RANDOMNESS
Fumihiro Tamada '20
Faculty Sponsor: Takunari Miyazaki

Random number generators (RNG) are used everywhere such as monte-carlo simulation and computer science algorithm. However, the correctness of the random number generator is yet to be proven. Creating random phenomena out of deterministic computer is not easy. My research is about producing better RNG from a deterministic object called expander graph.

25.
THE TRUST GAME 2.0
Jillian Winer '20
Faculty Sponsors: Madalene Spezialetti, Arthur M. Schneider

A number of ground-breaking and innovative findings have been made in the field of experimental and behavioral economics during just the last few decades, particularly in the interest of trust and bargaining. The *Trust Game* is a classic game theory experiment in which players send money back and forth over the course of multiple rounds with the goal of earning the highest payoff. It is used by experimenters to examine the presence of trust and bargaining in economic transactions. However, current platforms for the game lack adjustability and creativity which limits the extent to which research can be conducted. *The Trust Game 2.0* is a complex and flexible renovation which provides the means of discovering new theories surrounding trust in economics.

Utilizing the *The Trust Game 2.0* research platform built with oTree, economists have the power to produce more than 1 billion unique experiments through the manipulation of thirty different variables. Settings range from changing numerical amounts, allowing randomized opponents and roles, displaying round or partner information, enabling chat rooms specific to player type, and presenting results, to even grouping based on a gender or class year algorithm. At the end of any experiment, researchers immediately receive customized and sorted data reports along with the names of winners and eliminated players. By providing economists with the tools to manipulate game theory situations and generate trust dilemmas, the answers to a plethora of trust hypotheses can finally be discovered.

ENGINEERING

26.
FEEDWATER SUPPLY ASSEMBLY DESIGN
Maria Boucher ‘20, Katherine Bullock ‘20
Faculty Sponsor: Clayton Byers, Collins Aerospace Sponsor: Gregory Quinn

A call for improvements in space exploration technology is being made in light of the U.S. government pushing NASA to return to the Moon in 2024. As part of this effort, various elements of the existing space suit are being improved, including the relocation and redesign of the feedwater supply assembly (FSA). The function of the FSA in the portable life support system (PLSS) is to supply additional water to the thermal control subsystem as the water is gradually being expelled into vacuum by the suit water membrane evaporator (SWME). The primary focuses of this study include: prototype analysis and selection, compatible material literature review, and bubble detachment literature review. Three prototypes were analyzed in a proof-of-concept test to identify which FSA design would produce the most repeatable volume measurements. It was determined that the implementation of flex sensors to relate the curvature of the FSA bladder to volume remaining in the bladder was the best option based on the repeatability of volume measurements in each test iteration. It was found that perfluoroelastomer (FFKM), fluoroelastomer (FKM), polytetrafluoroethylene (PTFE), and fluorinated ethylene propylene (FEP) were all potential materials to make the FSA from because they are compatible with water and iodine and they would leach minimal contaminants into the water.

27.
CLASSIFICATION OF HEART MURMURS USING MACHINE LEARNING
Fabiana Guajardo ‘20, Erin Evangelista ‘20
Faculty Sponsor: Taikang Ning

Heart disease is the leading cause of death worldwide. Due to the critical role of the heart in the human body, cardiac diseases and disorders must be diagnosed at an early stage. Heart murmurs, sounds produced by turbulent or abnormal blood flow through the heart valves, are typical symptoms of heart disease. Cardiac auscultation, the main diagnostic method for detecting heart disease, provides a qualitative diagnosis for heart murmurs. Due to the subjective nature of cardiac auscultation, heart murmurs are not always correctly classified or even detected. This project aims to provide an objective assessment of heart sound murmurs using machine learning to provide a patient with an accurate diagnosis. The project is divided into three tasks: I) to distinguish between

abnormal and normal heart sounds, II) to classify heart sounds without murmurs, with systolic murmurs, and with diastolic murmurs, and III) to classify heart sounds without murmurs and six different types of heart sounds with murmurs, including early systolic, mid systolic, late systolic, holo systolic, early diastolic, and mid diastolic. The overall solution strategy and methodology for this project and each of its tasks consists in two approaches: 1) the use of signal processing to extract relevant heart sound and murmur features which are then used in the second approach, 2) the implementation of machine learning techniques–such as k-means, decision tree, and support vector machine–to assist classification. The machine learning program developed in this project successfully classifies heart murmurs and is able to complete the first task at a 99 % accuracy rate, the second task at a 93 % accuracy rate, and the third task at an 84 % accuracy rate.

28.
ROBOTIC SMART CHESSBOARD
Shahnila Malik ‘20, Chloe Gillian ’20, Olga Koszykowska ‘20, Meizi Wu ‘20
Faculty Sponsors: Deborah A. Fixel, Lin Cheng

The abstract game of chess is a fascinating yet quite complicated leisure to master. The ability for a student to learn the rules all while enjoying a game is imperative to the teaching process. The autonomous robotic chess board was created with the sole intent of helping students learn the game of chess, and inherently the logic of fair game play. A smart chess board prototype was fabricated using reed switches for piece position detection, LED lights for legal move confirmation, multiplexer chips along with electrical circuits for the board wiring, and a microprocessor for a chess engine logic implementation. In initial testing, the fault of the electrical circuits and reed switches was evident. The decision was made to research hall sensors and a PCB board for a more accurate and organized circuitry. A gantry robotic tree was decided to become the functionality of the autonomous robot. The construction of this gantry robot was impractical due to drastic changes and resources, thus the autonomous aspect of our robot, the mechanical arm, was foregone. The focus was returned to academically applying the ability for the chess board to teach students legal moves and generating an opponent's move. Alternative robotic systems were then researched in an attempt to improve the theoretical application of this system. An intrusive smart chess board teaching system has become the ultimate goal of this capstone project.

29.
APPEARANCE BASED TRACKING USING SUPERVISED ML
Daniel Melesse ‘20, Mahmoud Khalil ‘20 and Elias Kagabo ‘21
Faculty Sponsors: Kevin Huang, Taikang Ning

Applications that use gaze have become increasingly popular in the domain of human-computer interfaces. Advances in eye gaze tracking technology over the past few decades have led to the development of promising gaze estimation techniques. However, gaze detection was previously constrained to indoor conditions, so techniques required in most cases additional hardware. Recently, Gaze detection techniques try to eliminate the use of any additional hardware that can be expensive and intrusive, while maintaining the accuracy of detection. In this paper, an in-house video camera-based tracking system has been analyzed. This process involves image acquisition using a USB web camera mounted on the user’s PC or laptop at a fixed position.

In order to determine the point of gaze, Viola Jones is used to detect the face of the user from the image frame. The gaze is then calculated using image processing techniques to extract the coordinates of the pupil. Using the calculated center, a database is created which forms the training and testing data set. This database is used to train a classifier using a multi-class supervised learning method-Support Vector Machine (SVM) to distinguish point of gaze from input face image. K-fold cross validation is used to train our model. Also, confusion matrices are used to evaluate the performance of the classification model. Precision, recall and accuracy are determined to assess performance. Evaluation of the proposed appearance-based technique using various kernel function is assessed in detail.

30.

THE THERMODYNAMIC STUDY OF A VAPOR-COMPRESSION REFRIGERATION CYCLE

Maalik McPherson ‘23, Thoboki Mohohlo ‘20
Faculty Sponsor: John D. Mertens

The vapor-compression refrigeration cycle is integral to our everyday lives as the system employed in similar designs for an extensive range of common refrigerators. The refrigeration cycle is responsible for maintaining the desired temperature in the refrigerated space, and from a thermodynamic perspective, it is categorized as a means that removes heat. A refrigeration cycle essentially consists of a refrigerant fluid passing through a continuous loop that has four major components. The evaporator component is where Q_L, the heat from the refrigerated space, is taken up by the refrigerant fluid. The compressor is a critical component as it is the only one onto which work, W_c, is applied. The condenser is where Q_H, the heat taken up by the refrigerant fluid, escapes into the environment. The expansion valve is where pressure decreases significantly, and the pressure drop should be equivalent to the increase in pressure the compressor experiences. At different points along the refrigeration line, the refrigerant fluid is in different states, whether primarily a vapor or liquid at different temperatures. β, the coefficient of performance, calculated by dividing Q_L by W_c, measures the efficiency of the cycle in removing heat from the refrigerated space, and ideally the coefficient equals one. We intend to obtain data regarding the four refrigerant fluid states and the coefficient of performance as a control group, as well as when we apply at least three insults or experimental groups, affecting the function of the evaporator, affecting the function of the condenser, and the removing of refrigerant fluid. All three insults simulate the most common issues refrigeration cycles experience over time, and our goal is to determine if the data can give evidence of what specific issue a refrigeration cycle is experiencing at a given time.

31.

POWER GENERATION THROUGH SIMULATED OCEAN WAVES

Valentino Nicoletta ‘20, DeShawn Adams ‘20, Ahmed Eldmerdash ‘20
Faculty Sponsor: Clayton Byers

This quantitative research study explores the practicality of converting ocean wave energy into electrical energy. An experimental analysis of a buoy’s motion was conducted to determine the dependence of the buoy’s motion on wavelength, wave speed, amplitude and period. An acrylic tank measuring 12 x 13 x 48 inches was used to simulate specific ocean wave parameters analogous to those of the Connecticut shoreline waves. A motor was used to oscillate a flat plate through the tank’s water to produce waves. To accomplish this, a motor’s rotational motion was

converted into a linear motion. A 0.26 kg spherical buoy of radius 1.80 inches was placed in the tank to determine its buoyant force under different experimental conditions. After observing the oscillatory motion of the buoy, data was gathered on the buoyant force. In addition, a sine function was extrapolated to accurately fit the data, resulting in regressions (R^2) of 0.93. The sine functions follow similar sinusoidal paths as curves previously predicted for the buoy. However, they exhibit shorter amplitudes and phase shifts translating to a smaller range of motion than predicted. Furthermore, these findings were used to explore designs for generating electricity by utilizing the buoyant force to drive magnets through a copper coil, capitalizing on Faraday's law. This research opens the door for a better understanding of generating renewable and environmentally friendly energy.

32.
SMART REACTOR DESIGN FOR CONTINUOUS FLOW SYNTHESIS
Esme Ostrowitz-Levine '23
Faculty Sponsors: Clayton Byers, Jo-Ann Jee

To limit the quantity of situations in which having access to proper pharmaceuticals is limited, such as astronauts in space or army medics in the field, the use of a microreactor capable of synthesizing active pharmaceutical ingredients (APIs) on hand in a timely manner has been thought of to rectify these limitations. Microreactors are compact devices that have a low capital cost, low energy, low maintenance, and an inherent safety. In an effort to 3D print a microreactor and flow channel with the capacity to synthesize APIs at a high yield and high purity in a timely manner, drafting was done to asses the optimal channel parameters for mixing. Experimentation must be done with scaling down such a reactor, ensuring it has the same mixing efficiency and produces a similarly pure product at a high yield. As the microreactors we are intending to print are measured in millimeters and micrometers, we must ensure the proper scaling of both the fluid pathway itself and the obstructions within the pathway to allow for substantial mixing quality. Based on previous experimentation, we plan on beginning with the split-and-join approach & chaotic method which may involve a Y-mixer, smooth-diamond and stepped-diamond shape obstructions, testing at a Reynolds number of 200, and the embedding of herringbone structures on the floor of the channels. Further work will be directed towards testing various syntheses and assessing the mixing efficiency of each depending on reactants, solvents, and catalysts used. This research may create a more efficient method for people in remote locations to gain immediate access to APIs without the concerns of expiration dates or storage environments.

33.
THE AUTONOMOUS ROBO-ASSISTANT
Donovan Palmer '20, Hannah Neufeld '20
Faculty Sponsors: John Mertens, NASA CTSGC Student Project Grant (#P-1423)

The Compact Autonomous Robo-Assistant (CARA) is a land-based robot that aims to localize within an indoor environment using a combination of perception and odometry. In order to achieve perception, a two-dimensional RP LiDAR captures a 360-degree laser scan of the environment and a camera which captures landmark frames for image processing. Odometry is achieved through quadrature encoders and fused BNO055 IMU data which helps localize with a continuously updated pose estimate within its environment. This robot follows a differential drive kinematic model and uses a motor controller with an Arduino MEGA 2560 to power and control

two planetary gear DC motors via pulse-width-modulation (PWM). A NVIDIA Jetson Nano was used as a Linux machine capable of running the Robot Operating System (ROS) – a middleware that facilitates robotics software development through hardware abstraction and published packages. A ROS software package was developed for the robot control and visualization. In the robot's current state, the package allows for tuning velocity output using PID control and faithfully publishing odometry messages given input motor commands.

34.
HIGH FIDELITY STEREO
Farhan Rozaidi '20, Fiona McElroy '20
Faculty Sponsor: Joseph L. Palladino

The primary purpose of a stereo system is to reproduce sound. However, most stereo systems do not reproduce sound that is faithful to its input signal. A high fidelity stereo is capable of reproducing sound for the entire range of human hearing, from 20 Hz to 20,000 Hz. It should also reproduce sound that is identical to its driven signal. This project consisted of designing, constructing, and testing a high fidelity stereo system. Reproducing a faithful signal is highly dependent upon the drivers utilized, the type of enclosure, and the crossover network. The system itself is composed of two ported, two-way speakers. A Second-Order Linkwitz-Riley crossover network was utilized with a crossover frequency of 3,000 Hz. The system was then tested with a calibrated microphone to validate the frequency range, as well as its faithful reproduction of the input signal. The stereo was able to reproduce sound from a range of 45 Hz to 20,000 Hz. A Fast Fourier Transform (FFT) was then performed on the recorded signal for spectral analysis of the stereo. This system was able to reproduce sound with less than 0.1% Total Harmonic Distortion (THD).

35.
SYSTEM DESIGN AND ANALYSIS OF TURBULENCE TO DETERMINE EFFECT OF VALVE STENOSIS ON BLOOD FLOW FOR HEART MURMUR APPLICATION
Alex Sinson '20, Colette Scheffers '20
Faculty Sponsors: Clayton Byers, Taikang Ning

Heart murmurs are abnormal sounds due to turbulent flow in the blood arising from abnormalities in one or more of the four heart valves in a human's heart. There are many potential causes of heart murmurs in humans, but the focus of this project was on stenosis: the narrowing of a heart valve which prevents it from fully opening and closing. Many studies have empirically analyzed murmurs using qualitative assessments; however, few studies have attempted to use experimental data to provide quantifiable measures of the severity of a heart murmur. We constructed a physical system analogous to pulsatile blood flow through a heart with valve stenosis, using water pumped at a rate of 1Hz through a tube with a narrowed component that partially restricted the flow. Contact microphones were placed on the tubing near the restriction to collect vibration data from the flow. The power spectrum of the vibration data from different severities of narrowness were compared to the power spectrum of the baseline measurement with no restriction. When the tube was restricted to about 16% of its initial cross-sectional area, energy was found to have been injected in the flow in the range of 40-60 Hz and 80-90 Hz. For a restriction in the tube of about 28% of its initial cross-sectional area, energy was found to have been injected in the flow in the range of 30-40 Hz, 70-80 Hz, and 90-110 Hz. This provides quantifiable evidence that an increase

in the energy of the flow at certain frequencies indicates narrowing in the flow and can provide insights on the severity of the narrowing. More research is needed to determine why these peaks occur at these frequencies and to compare these results to a system that more closely resembles a heart with a murmur.

36.
TELELOCOMOTION WITH HAPTIC DEVICES
Ananya Swamy ‘23
Faculty Sponsor: Kevin Huang

The study was designed to explore the relationship between haptic controls and performance in telelocomotion applications. Telelocomotion, which is the human control of robots, helps combine the innate muscle memory of humans with the durability and precision of robots. The study of telelocomotion performance is important because it can be used in hazardous environments such as disaster response. Haptic devices make use of tactile sensory output that makes the robot easier for humans to operate. The experiments compared haptic controllers with non-haptic devices such as joystick controllers and keyboards. The haptic devices consisted of two handheld controllers, that generated an impulse when the user traveled off track. The participants of the study, who were 21 randomly selected college students, were required to navigate a hexapod simulation through a maze using their designated controller. The success of the controller was measured based on the speed and accuracy with which the participant was able to navigate the robot. Participants using haptic controllers took 78.0 seconds to travel on stairs compared with an average of 160.8 seconds for non-haptic devices. Further development of this study will include a similar comparison of haptic and non-haptic devices using a real hexapod robot in place of a simulation. The results of the study will provide more data on the relationship between haptic devices and human control, which can be used to develop well-designed interfaces for telelocomotion.

ENVIRONMENTAL SCIENCE

37.
RISK OF MERCURY LEVELS WITHIN FRESHWATER TURTLE COMMUNITIES
Eleanor Tate ‘21, Jared Buchman ‘21
Faculty Sponsors: Amber Pitt, Joseph Tavano

Mercury contamination of freshwater ecosystems and the subsequent accumulation of mercury by aquatic organisms is a global issue. Few data are available regarding mercury levels in river turtles, which are an increasingly imperiled taxonomic group. In an effort to identify the mercury accumulation in river turtle communities, we analyzed river turtle scutes collected from turtles in a 4.6 km section of the North Fork of the White River, Ozark County, Missouri. We analyzed the data in comparison to each individual and species, including the Northern Map Turtle (Graptemys geographica), Red Eared Slider (Trachemys scripta elegans), and River Cooter (Pseudemys concinna). We used a DMA-80 to determine mercury levels within our samples. Mean mercury for all species combined ranged between 0.112 – 0.385 ppm. The threshold mercury concentration in fish deemed acceptable for human consumption is set to 1 ppm for federal guidelines, but varies from 0.1 – 0.3 ppm for state guidelines, depending on the stringency of state. Results of the study are below

federal safety guidelines, but above state guidelines for some states, suggesting river turtles in our study area contain harmful levels of mercury. When comparing data between turtle species, there was no significant difference between the mercury concentrations ($F = 1.461$, $df = 2,4$, $P = 0.334$). High mercury levels found within the turtles acts as another threat to the highly sensitive turtle community.

38.
DRINKING WATER ON CAMPUS
Isabelle W. Wallace '20
Faculty Sponsor: Arianne A. Bazilio

Metals such as lead (Pb) and copper (Cu) which may be found in varying concentrations in drinking water can cause serious health issues. The objective of this study was to test the Pb and Cu concentrations in drinking water fountains across the Trinity College Hartford campus to determine if the levels were within EPA safety guidelines. This study also hopes to encourage people on campus to decrease the quantity of non-reusable bottles used currently and promote sustainability.

The water was tested by taking two samples from representative collection of water fountains on campus. The first sample was taken initially to look at the levels of the metals found in water stagnant in the pipes. A second sample was taken after a five-minute flush of the fountain to see if there was a change in the levels found, and better mimic the EPA water testing regulations. Pb and Cu concentrations were measured for both filtered and unfiltered samples using an inductively coupled plasma mass spectrometer (ICP-MS).

None of the samples exceeded the action levels (requiring intervention) set by the EPA. However, the first flush on average showed higher levels of lead and copper. More filtered, bottle refilling stations should be placed around the campus to improve buildings that presented with higher levels of lead.

HEALTH FELLOWS

39.
A NOVEL METHOD OF COMPUATATIONAL MODELING PROMOTING RECYCLABILITY AND INTEROPERABILITY
John S. Albanese '21
Faculty Sponsors: Alison J. Draper, Amy Hunter MPH PhD, Michael L. Blinov, Ann E. Cowan,
University of Connecticut Health Center, Farmington, CT

A useful way to study complex biological systems is by using a systems biology approach that incorporates computational modeling; however, most models are built from scratch for single use. Moreover, modelers build very complex systems, assigning rate laws and reaction rules to species and reactions within their models, yet once the authors publish their work, these models are no longer used. To understand why these models work as they do, precise mathematical descriptions of molecular circuitry are needed. In order to improve recyclability and interoperability of computational models, we propose ModelBricks. In this project, we sought to initiate a database of ModelBricks for public use among modelers. A computable ModelBrick is a small, thoroughly

annotated model derived from a much larger, more complex model that is minted a DOI for permanent reference. Element annotations include stable identifiers such as PubMed IDs and references from Gene Ontology, Systems Biology Ontology, and Reactome as well as from other public databases such as UniProt and CheBi. ModelBricks are interoperable with the Systems Biology Markup Language (SBML) model composition standard. Currently, the ModelBricks database consists of sixteen ModelBricks that are available to the public, yet the database continues to expand and serves as an open source for these small, comprehensive biological models. Using ModelBricks to construct complex models saves significant time on the model builders behalf, and modelers are able to contribute their own ModelBricks back to the database. Since ModelBricks are citable, modelers who contribute their own ModelBricks will have their work referenced if their ModelBricks are used by others, thereby spreading their research to a vast number of modelers. The project is a part of the Virtual Cell modeling and simulation framework, originating at the University of Connecticut Health Center.

40.

QUALITY ASSESSMENT OF CONTINUOUS EEG MONITORING IN HARTFORD HOSPITAL

Brendan Conroy ‘20
Faculty Sponsors: Faculty Sponsors: Alison J. Draper, Amy Hunter MPH PhD, Gabriel Martz M.D., Ayer Neuroscience Institute at Hartford Hospital

Seizures often occur in the setting of brain injury, regardless of etiology, and are associated with worsened morbidity and mortality. Continuous EEG (cEEG) is the is the gold standard for seizure detection, but in the absence of formal guidelines or expert consensus describing clinical indications for cEEG, gaps in care may be present. The objective of this study was to evaluate the utilization of cEEG in intracranial hemorrhage (ICH) patients with an elevated risk for seizure.

We retrospectively identified 12,236 hospital patients over a 1.5-year period with diagnoses placing them at increased risk for seizure. Patients designated for comfort measures only were excluded. cEEG utilization was assessed by comparing two groups of ICH patients from this population: those clinically indicated for cEEG who received it and those clinically indicated for cEEG who did not. The indication used for cEEG in ICH patients was definite altered mental status and was defined as 3 consecutive positive confusion assessment method (CAM) tests. Patient and clinical characteristics were collected and Pearson’s correlation were performed to identify factors that contributed significantly to cEEG use.

Data acquisition is still pending. We anticipate these data will demonstrate underutilization of cEEG in patients for whom it is indicated. Specific patient and hospital factors may help highlight approaches to improving patient care.

41.

GLYCOGEN STORAGE DISEASE TYPE IX: NATURAL HISTORY, CLINICAL, AND LABORATORY PROFILE

Uyen (Vivien) Doan ‘21
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Objectives: To characterize the clinical, laboratory, and anthropometric profile of a cohort of patients with glycogen storage disease type IX managed at an inpatient visit at Connecticut Children’s Glycogen Storage Disease Program.

Methods: This was a descriptive study with cross-sectional analysis of GSD IX patients based on a convenience sampling strategy. Retrospective chart review was performed for 10 patients with GSD IX. Data on diagnosis, management, anthropometric parameters, and follow-up were assessed. Analysis of serum triglyceride concentration, body mass index (BMI) standard deviation score (SDS), height SDS, weight SDS between cases at time of diagnosis and at time of study inclusion were evaluated.

Results: Twenty patients were included (median age 13.7 years, range from 4 to 25 years), all using uncooked cornstarch therapy. Median age at diagnosis was 24.1 months (range from 2 to 62 months), and eight patients underwent liver biopsy for diagnostic confirmation. Overweight, short stature, hepatomegaly, and liver nodules were present in 8 of 10, two of 10, four of 7, two of 7, respectively. A correlation was found between height-for-age and BMI-for-age z-scores ($r = 0.561$; $p = 0.008$).

Conclusions: Diagnosis of glycogen storage disease type IX is delayed, and the achievement of optimal biochemical control of glycogen storage disease type IX continues to be a challenge. Most patients undergo liver biopsy for diagnostic confirmation, even though the combination of a characteristic clinical presentation and molecular methods can provide a definitive diagnosis in a less invasive manner. Obesity is a side effect of cornstarch therapy and appears to be associated with growth in these patients. Minimizing the metabolic abnormalities of the disease may decrease the risk of long-term complications.

42.

BASED BEHAVIORAL HEALTH SCREENING IN THE PEDIATRIC EMERGENCY DEPARTMENT

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BACKGROUND: Adverse behavioral health is a major problem among every age population in the United States, especially children and adolescents. Psychiatric complaints are the fastest growing complaint in the pediatric emergency department (ED) among adolescents and children and require the attention of physicians and ED clinicians.

OBJECTIVE: The Pediatric Symptom Checklist (PSC) has been proven to effectively and accurately address patients that show any signs or symptoms of behavioral health problems but this survey has not been translated to be used on e/Tablet technology. We screened children and adolescents 4-18 years old, with a chief complaint in the pediatric ED, using a validated tablet-based screening tool to investigate whether the tool can identify any behavioral health concern.

METHODS: This single-center prospective cross-sectional pilot study collected patient recorded outcomes (PROs) on the PSC on an e/Tablet. The data was then translated to an excel sheet to keep track of patient demographics, positive and negative screenings, patient refusal to enroll in the study, and follow up from the Center for Care Coordination. The data will be analyzed to find the effectiveness of screening tool using number of positive screenings compared to negative screenings and the feasibility and acceptability based on number of patients who decline enrollment compared to those subjects who want to participate.

ANTICIPATED RESULTS & IMPACT: Adverse behavioral health in children and adolescent populations should be recognized and diagnosed early on in a child's life. The PSC is a tool that has effectively and accurately tested pediatric patients for any behavioral health concern they have not been diagnosed with previously. Our results hope to show that the conversion of the PSC tool onto an e/Tablet will prove to be feasible, efficient, and acceptable by ED health professionals and patients alike. We hope to fill the gap in literature analyzing the feasibility and acceptability of conducting behavioral health screenings with the PSC on e/Tablet technology, in a pediatric ED setting. We further hope this tool can be applied to all pediatric EDs to call attention to behavioral health of younger populations in the United States.

43.

UTILIZING THE CRITICAL AIRWAY RESPONSE TEAM EXPEDITES ESOPHAGEAL BUTTON BATTERY EXTRACTION

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Esophageal button battery ingestion is a potentially dangerous event that can be challenging to manage efficiently because these cases typically present without warning. Importantly, the expeditious removal of button batteries is critical to lessen the severity of tissue damage and to lower the risk of potentially catastrophic associated complications. The purpose of this study was to determine if the activation of our institution's Critical Airway Response Team (CART) at the time when the diagnosis of esophageal button batteries is established shortens the time interval to button battery extraction. We collected process measure data for all cases of esophageal button battery ingestion from January 2015 through December 2019. These data included time of ED arrival to chest x-ray, time of chest x-ray to operating room arrival, and time of ED arrival to operating room arrival. We compared process measure times from baseline to after a clinical management algorithm was put in place where esophageal button battery cases triggered activation of the CART team. During the study period 8 cases of esophageal button battery ingestion were managed at our institution. Six cases presented before a clinical management algorithm for esophageal button battery ingestion were implemented, and 2 cases occurred after algorithm implementation. The time from diagnosis to endoscopic removal of esophageal button batteries decreased from a mean of 167±110 minutes to a mean of 55±21 minutes after algorithm

implementation. Activating our institution's Critical Airway Response Team for button battery ingestion decreased the time from patient arrival to esophageal button battery extraction.

44.

MINDFULNESS AND TRANSDIAGNOSTIC RISK FACTORS FOR ANXIETY DISORDERS

Misha Mehra '21
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Anxiety disorders are found to be the most widespread psychiatric condition that affects 1 in 5 Americans annually. About 29% of the adults in the US will experience some level of anxiety disorder in their lifetime, which reiterates the importance of research on anxiety disorders. The primary aim of this case study is to determine whether mindfulness intervention can directly target transdiagnostic risk factors for anxiety disorders. For this study we proposed that mindfulness is one way we can target intolerance of uncertainty (the fear of the unknown) and anxiety sensitivity (fear of anxiety). We hypothesized that the participant randomized to receive brief mindfulness intervention as compared to the control (Humor) will demonstrate higher tolerance towards uncertainty, endorse lower levels of fear and depict longer task persistence towards decision-making tasks as a result of the hyperventilation exercise. The data obtained from this case study will be used as an informative platform for any future research on this project. The experimental design consisted of one in-person study visit estimated to take up to 2 hours to complete, followed by one online follow-up (15 minutes). Data was collected in the form of well-validated self-report measures (surveys) mapping on to the constructs of interest in the proposed study at both the in-person visit and the online one-week follow-up. The results obtained from the two patients (one for each condition) demonstrated mindfulness to be an effective intervention for anxiety related symptoms. The patient in the mindfulness condition hyperventilated for a longer duration as predicted (anxiety sensitivity), however didn't demonstrate a longer wiliness to wait (intolerance of uncertainty) for a better monetary reward. It's difficult to conclude on a trend from a case study but if this pattern were to persist, it would suggest that humor might be better at improving intolerance of uncertainty.

45.

A QUALITATIVE STUDY OF BARRIERS TO AND FACILITATORS OF MANAGEMENT IN CHILDREN WITH EPILEPSY

Martha Peregoy '21
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About half a million US children have epilepsy. Approximately 27%-42% of children with epilepsy don't adhere to their medications, but it is unclear which factors are associated with adherence. Children with epilepsy are more likely to have learning disorders, underperform in school, and be burdened with social stigmas. Interventions, such as smart-phone apps and peer mentors, could help reduce barriers to and facilitate epilepsy management. No prior published studies have used qualitative interviews to identify barriers to and facilitators of epilepsy

management, and potential interventions for facilitating epilepsy management. The study aim, therefore, is use qualitative research methods to identify 1) barriers to and facilitators of epilepsy management in children; and 2) potential interventions for facilitating epilepsy management. Qualitative interviews will be conducted with children with epilepsy who are 10-17 years old and their caregivers. A baseline sociodemographic survey will be orally administered. Two moderator's guides (one for patients and the other for caregivers) consisting of five questions, 41 patient probes, and 38 caregiver probes, will be used to conduct qualitative interviews. Interviews will be digitally recorded and transcribed, and transcripts analyzed to identify themes. Transcript-based analyses will be performed, with highlighting and margin coding of themes. To validate thematic coding, each reviewer will analyze transcripts independently, and resolve any differences by consensus. Thematic analyses will be performed using grounded theory, in which new theory is generated from the data and appropriate existing theory is modified or refined through comparison with incoming information. Finally, a taxonomy of themes will be created regarding barriers to and facilitators of epilepsy management, and potential interventions for facilitating epilepsy management. The study findings have the potential to reveal barriers to and facilitators of epilepsy management, help improve school life for children with epilepsy, and identify interventions that could improve the management of pediatric epilepsy.

46.

A REVIEW OF POTENTIAL PEDIATRIC PATIENTS EVALUATED FOR AUTOIMMUNE ENCEPHALITIS AT CONNECTICUT CHILDREN'S MEDICAL CENTER

Emily Perotti '20
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Autoimmune encephalitis (AE) is an inflammatory brain disease with an abnormal immune response directed against the central nervous system (CNS), identified by the presence of anti-neuronal antibodies, targeting neuronal cell surface antigens or intracellular antigens. Antineuronal antibodies have also been linked to neuropsychiatric symptoms. AE can be distinguished by symptom persistence, but many pediatric AE patients do not present with well-defined syndromes or paraclinical findings. A positive CSF test with or without a positive serum test is needed to diagnose definite AE. Clinical determinant between definite and probable AE remains insubstantial, focusing on abnormalities in children's electroencephalogram (EEG) and magnetic resonance imaging (MRI). Consequence of missed diagnosis can result in acquired brain injury, although individuals will be impacted differently. The mean incidence rate has been approximated to 1.54 children per million, but the diagnosis is new with literature only beginning to appear in the last decade.

As a result, the aim of this review was to determine the patient population aged birth to 21 admitted to Connecticut Children's Medical Center between January 1, 2017 and December 31, 2019 that present with altered mental status as a result of autoimmune encephalitis, utilizing the diagnostic criteria algorithm to review presentation, evaluation, and outcomes. Screening identified seven patients had a panel of antibodies tested. Zero patients were identified who were diagnosed with definite autoimmune encephalitis. Two patients tested positive for serum antibodies suggesting antibody negative autoimmune encephalitis or possible autoimmune encephalitis, however, were diagnosed and treated for either acute disseminated encephalomyelitis (ADEM) or post-infectious encephalitis. Review of subjects over a longer time frame of five to 10 years, could provide more

conclusive understanding toward effective diagnosis of autoimmune encephalitis. Understanding the path toward diagnosis of definite AE in children will encourage a more effective algorithm to minimize treatment time.

47.

EPIDEMIOLOGY OF UNINTENTIONAL INJURY AND VIOLENCE AMONG HARTFORD HOSPITAL PATIENTS

Emily Peters ‘20
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From 2010-2018, unintentional injury was the leading cause of death for individuals from age one to age forty-four, and the fourth leading cause of death overall. Injuries are one of the most common causes of hospitalizations as well as the leading cause of years of potential life lost, also resulting in significant financial costs. These factors all contribute to the large burden of injury on society, highlighting the importance and relevance of injury prevention research, which focuses on detailing epidemiology, designing injury reduction interventions, and translating findings into public policy.

Much of the recent work of the Connecticut Injury Prevention Center (CIPC), an integral component of Connecticut Children’s and affiliate of Hartford Hospital, has focused on pediatric populations. As a result, the CIPC lacks descriptive data among adult populations. The aim of this study was to address this gap in updated epidemiological study of unintentional injury and violence among the adult population of north central Connecticut.

This study used secondary analysis of discharge records of patients treated in an inpatient unit or the emergency department at Hartford Hospital from 2015-2018 with at least one ICD-10-CM code for injury (S00-T88) and/or external causes of morbidity (V00-Y99). Univariate and bivariate analyses were used to calculate descriptive demographic and injury characteristics.
The implications of this study include the possibility for the creation of new interventions and programs based specifically on and developed specifically for the identified high risk adult populations and the injury types with the highest rates in Connecticut.

48.

IMPLEMENTATION OF A CARDIOLOGY-ONCOLOGY ALGORITHM FOR RISK STRATIFICATION TO PREVENT CANCER TREATMENT RELATED CARDIAC DYSFUNCTION (CTRCD)

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With the development of new pediatric cancer treatments, survivorship has increased and enabled pediatric survivors to live into adulthood. However, cancer therapies effect pediatric oncology patients’ quality of life, such as an increased risk of cardiotoxicity and other cardiovascular complications. Cumulative doses of anthracyclines, alkylating agents, vinca alkaloids, and history of bone marrow transplants are among the known risk factors that worsen cardiotoxicity. Researchers are not only focused on ways to improve cancer cure rates, but now look into

minimizing the adverse effects of the cancer treatments given. In this quality improvement study, we use both a prospective and retrospective comprehensive chart review at Connecticut Children's Cardiology-Oncology clinic. All subjects underwent echocardiographic evaluation and risk stratification based on the known clinical and metabolic risk factors of Cancer Treatment Related Cardiac Dysfunction (CTRCD). Subjects were assigned risk scores and categorized into low, moderate, or high CTRCD risk groups. Appropriate heart failure medication and surveillance was applied to the subject depending on their risk group. Assessing the role of cancer treatments in the long-term and cardiac mortality after childhood cancer is important to maximize childhood cancer survivorship. New ways to accurately predict a patient's risk of developing CTRCD will improve the standard of care in hospitals for cancer patients and ultimately reduce long-term post-treatment mortality rates.

49.

PREVALENCE OF MALNUTRITION AND WEIGHT LOSS IN PARKINSON'S DISEASE AND THE ASSOCIATIONS WITH GASTROINTESTINAL SYMPTOMS, MEDICATIONS, AND NUTRITIONAL SERUM LEVELS

Kirsten Thiim '20
Faculty Sponsors: Alison J. Draper, Amy Hunter MPH, PhD, Duarte G. Machado, MD, Hartford HealthCare Movement Disorders Center, Gregory Panza, PhD, Hartford HealthCare

Parkinson's Disease (PD) is associated with weight loss and malnutrition, which are frequently overlooked and untreated. Patients with PD often experience gastrointestinal (GI) symptoms such as dysphagia, sialorrhea, and constipation. Medications commonly used to treat PD (e.g., Levodopa) have side effects associated with weight loss. Risk factors for malnutrition include GI dysfunction (dysphagia, constipation, slowed gastric emptying), disease severity, medication duration, and low body weight. The study objective is to observe the prevalence of malnutrition and weight loss in PD. We will examine the differences in GI symptoms, medications associated with weight loss, and serum levels between those at risk or malnourished, compared to those who are well-nourished. The goal is to observe weight loss in PD patients and identify those with nutritional deficiencies to improve intervention and treatment.

We will obtain clinical data from the subject's medical record and nutritional assessment questionnaires and scales, assessing bowel function, swallowing, and salivation. Subject data will be collected through REDCap via iPad and exported into an SPSS program for analysis. Descriptive statistics will be calculated to examine sample characteristics. We will perform univariate comparisons of the differences between the malnutrition and weight loss groups. Bivariate correlations will be run on all scales.

We anticipate a malnutrition prevalence of 25%. We predict higher rates of GI symptoms among the malnourished. Those at risk or the malnourished are expected to be taking medications associated with a high incidence of GI side effects. We expect to find lower nutritional serum levels displayed in at risk or malnourished subjects.

Providers must regularly evaluate body weight and nutritional status in PD patients to ensure early detection and better intervention. Studying the prevalence of malnutrition and weight loss in PD may encourage providers to establish a consensus standard for nutritional assessments in PD.

50.

EXAMINATION OF PNEUMOCOCCAL VACCINATION STATUS AMONG ADULTS AGED 65 YEARS AND OLDER IN A PREDOMINANTLY URBAN, LOW-INCOME, AND HISPANIC POPULATION

Lia Urban Spillane ‘21
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Pneumococcal disease is a prominent illness caused by *Streptococcus pneumoniae* bacteria resulting in approximately 150,000 hospitalizations each year in the United States. Pneumococcal conjugate vaccine (PCV13) and pneumococcal polysaccharide vaccine (PPSV23) have been created to help prevent pneumococcal disease and are recommended for adults aged 65 years and older. Studies have shown that health disparities regarding pneumococcal vaccination status exist among different populations. This study focused on pneumococcal vaccination status in adults aged 65 years and older in a predominantly urban, low-income, and Hispanic population.
This study compared pneumococcal vaccination rates at Hartford Hospital’s Community Heath with rates among the general population. Data was collected via Epic, the online medical record system, quarried from 2016-2019 for patients aged 65 years or older with at least one visit at Hartford Hospital’s Community Heath. Information including age, gender, race/ethnicity, insurance status, smoking status, and pneumococcal vaccination dates were manually entered into an excel spreadsheet.

Data was analyzed using descriptive statistics and multiple logistic regressions. The results indicated a rate of vaccination among individuals aged 65 years and older of 74.1%. Females were statistically more likely than males to receive a pneumococcal vaccination (OR= 1.46, 95% CI= 1.09, 1.97). Hispanics were also statistically more likely than non-Hispanic whites to receive a pneumococcal vaccination (OR= 1.99, 95% CI= 1.20, 3.31). Former smokers were statistically more likely than non-smokers to receive a pneumococcal vaccination (OR=1.41, 95% CI= 1.00, 2.01) while an unknown smoking status also indicated a statistically greater likelihood of receiving a pneumococcal vaccination (OR= 0.08, 95% CI= 0.04, 0.15). There were no statistically significant differences in marital or insurance status and pneumococcal vaccination status.
Assessing health disparities within pneumococcal vaccination coverage will allow physicians at Hartford Hospital to target specific populations with lower pneumococcal vaccination rates and improve its overall pneumococcal vaccination coverage.

MATHEMATICS

51.

COLLECTIVE BEHAVIOR ON NETWORKS

Pranick Raj Chamlagai ‘23
Faculty Sponsor: Per Sebastian Skardal

Synchronization has been an inevitable part of the functioning of nature and many different approaches have been taken to understand the occurrence of synchronization. The Kuramoto model has been particularly useful, answering a number of important questions about synchronization research. It is of utmost importance to properly understand the behavior of ‘t’ degree of synchronization in the Kuramoto model, captured by an order parameter ‘r’ as a function of different variables in the governing equation of Kuramoto model, particularly the coupling

strength (K) and natural frequency (w). Here we use MATLAB to run many simulations and investigate the behavior of the Kuramoto model. While increasing the coupling strength tends to promote synchronization, it has not been completely understood yet how coupling strength affects strength of synchronization. A better understanding of this mechanism could help optimize synchronization in larger networks like that in electric power grid system and cardiac pacemaker cells. Further work will be directed towards applications of mathematical understanding of synchronization in regulating collective behavior on networks, majorly in the network of electric power grid system.

NEUROSCIENCE

52.

EFFECTS OF A KETOGENIC DIET ON TACTILE SENSITIVITY AND NOCICEPTION ACROSS THE ESTROUS CYCLE IN FEMALE RATS

Kimber Boekell ‘20
Faculty Sponsors: David Ruskin, Susan Masino

A ketogenic diet is a high fat, sufficient protein, extremely low carbohydrate diet that minimizes glycolysis and induces ketone-based cellular metabolism. Maintenance on a ketogenic diet has proven clinically effective in treating pediatric and refractory epilepsy and is hypothesized to decrease neuronal excitability through cellular changes such as increased activity of adenosine and GABA. Evidence suggests that the antiepileptic mechanisms of a ketogenic diet may be effective in decreasing pain sensitivity in male rats, but effects on sensitivity in females has not been investigated. This study evaluated the effects of a ketogenic diet on tactile and pain sensitivity across stages of the estrous cycle in female rats using tactile von Frey and hot plate sensitivity tests. Adult female rats were maintained on a standard control diet during the first round of testing, then switched to and maintained on a strict 6.6:1 ketogenic diet during repeated testing. Ketogenic diet treatment decreased tactile sensitivity, with effects present during proestrus and metestrus/diestrus, but increased pain sensitivity, with effects present only during metestrus/diestrus. These results suggest that the mechanisms of a ketogenic diet are influenced by female sex hormone levels and may have different effects on sensitivity to nociceptive versus non-nociceptive stimuli in females.

53.

EFFECT OF ACCULTURATION ON PROSPECTIVE MEMORY AND EPISODIC FUTURE THOUGHT

Alicia Camuy ‘22, Laura Cadavid ‘19
Faculty Sponsor: Sarah A. Raskin

Minorities are more likely to be misdiagnosed as neuropsychologically impaired than non-Hispanic whites due to artificially depressed neuropsychological test scores. One reason is level of acculturation. Previous studies have found acculturation into U.S (dominant) culture is correlated with better neuropsychological performance on a variety of neuropsychological measures, such as information processing and working memory. In the current study a standardized measure of prospective memory (the Memory for Intentions Test; MIST), a measure of episodic future thought (EFT), and a measure of autobiographical memory (TALE) were compared to a measure of acculturation. All tasks were given in Spanish by native Spanish

speaking examiners. Forty-six individuals from 18-80 years of age (mean 30.15, sd 17.24) with 0-33 years of education, and varying degrees of years speaking Spanish (3-79 years) and English (0-68 years). On the MIST degree of US acculturation significantly predicted performance on 15 minute delay, event-based cues, and action response items. Years of speaking English correlated with 15 minute delay, time-based cues, and action response items. Both US acculturation and years of speaking English also predicted performance on the test of EFT. Neither US acculturation or years of speaking English were related to performance on the TALE. Interestingly, both the MIST and the EFT were created in the US while the TALE was created in Trinidad.

54.

SEX DIFFERENCES IN RESTRICTED AND REPETITIVE BEHAVIORS AND INTERESTS IN CHILDREN WITH ASD

Madison Guay ‘20
Faculty Sponsor: Molly Helt

Restricted and repetitive behaviors and interests (RRBIs) are characterized by high frequency, repetition, and desire for sameness in environments, as well as inflexibility and perseverance in interests and activities. The presence of RRBIs are required for a diagnosis of Autism Spectrum Disorder (ASD), but their typology and extent varies amongst individuals with ASD. This study examines the relation between RRBIs and sex of individuals in 90 females and 90 males matched by age and IQ from an ongoing genetic study of children and adolescents with ASD at the Connecticut Children’s Medical Center. We propose to investigate sex differences in both RRBI severity (total scores) and type (symptom profiles). Previous research suggests that girls are more likely to camouflage their symptoms as they get older and may have distinct symptom profiles, although the existing research is sparse and often limited by small samples and lack of rigorous matching. Previous research either involves clinical observation or caregiver report, and has shown low agreement between these two measures in the RRB domain. The proposed study will provide more information about the female autism phenotype in terms of RRBIs through a profile analysis of both clinician and caregiver report measures in a well-matched sample.

55.

TRINITY RETURN-TO-LEARN POST-CONCUSSION PROTOCOL ASSESSMENT

Anna Hackett ‘20
Faculty Sponsors: Sarah A. Raskin, Molly Helt

Return-to-learn protocols after concussion have received less attention than return-to-play protocols. Return-to-learn protocols are step by step guidelines for students and teachers to help ease concussed students back into their academic work. At Trinity College, faculty are given information on common effects of concussion and suggested academic accommodations. This study aimed to assess the entire return-to-learn protocol currently in place at Trinity College, with a specific focus on how well known the program is to students and how helpful they have found it, in an attempt to ascertain what aspects of the protocol work well and what could be improved. Faculty were surveyed to gain their input on how the protocol has worked and how cumbersome it was for them; and coaches were surveyed to assess if they had any role in helping their athletes return to the classroom as well as the playing field. Students who have been concussed were also given a series of cognitive measures to determine if particular cognitive profiles led to greater difficulty returning to the classroom. A majority of surveyed students and approximately half of

the faculty and coaches were unfamiliar with the protocol. A deficit in executive function was found to correlate with current concussive symptoms. Severity of current concussive symptoms was found to correlate with severity of depressive symptoms. The results of this study suggest that the Trinity College community needs to be better educated on the return-to-learn protocol, extra care should be taken to account for potential rises in depressive conditions of concussed students, and accommodations for executive functions should be regularly provided.

56.

REHABILITATION OF INDIVIDUALS WITH TRAUMATIC BRAIN INJURY

Aspen Hawkins ‘23
Faculty Sponsor: Sarah A. Raskin

Individuals with traumatic brain injury experience difficulties following their injury, including memory and cognitive function difficulties. What these individuals consistently cite as the problem interfering with their daily functioning most, however, is prospective memory. Prospective memory constitutes the ability to recall a future intention, such as taking medication, or remembering to go to a scheduled doctor appointment. In this study, individuals with traumatic brain injury underwent rehabilitation strategies in order to improve their prospective memory. These individuals took a number of different cognitive function tests, including the Memory for Intentions Screening Test (MIST) as well as getting a fMRI scan both before and after treatment to analyze improvement. The treatment utilized restorative strategies aimed at re-establishing memory, primarily focused on visual and repetitive techniques. While no results have been concluded yet, other studies and research suggest that these strategies are effective techniques to restore prospective memory in the long run. These results are incredibly important because prospective memory problems can interfere greatly with a person’s life, and could potentially put them at risk. Other approaches to rehabilitation are temporary fixes that don’t have lasting effects, but restorative strategies have the potential to evoke real change in the brains of individuals with traumatic brain injury.

57.

A KETOGENIC DIET IMPAIRS CONDITIONED PLACE PREFERENCE FOR COCAINE IN SPRAGUE-DAWLEY RATS

Meg Huston ‘20
Faculty Sponsor: Luis Martinez

Abuse of illicit drugs such as cocaine is a major health issue, with very limited treatment options. A growing body of evidence suggests that ketogenic diets (KDs) have therapeutic potential for a range of neuropsychiatric disorders. KDs increase brain adenosine levels; interestingly, adenosine modulates the activity of the brain dopamine system, which is pathologically altered by drug abuse. Previously, our lab found that KD administration blocks stereotyped locomotor responses to cocaine. Here, we hypothesized that KDs positively impact brain processes that are negatively impacted by cocaine abuse, thereby reducing motivation to seek this drug. Sprague-Dawley rats maintained on a standard diet (SD) or KD were tested for the formation of a conditioned place preference (CPP) for cocaine. Following the establishment of innate chamber preference, rats received i.p. injections of cocaine (10 mg/kg) or saline in their initially non-preferred chamber on conditioning days 1, 3, and 5. All rats received saline injections in their initially preferred chamber on remaining conditioning days. While SD animals injected with cocaine exhibited a strong CPP,

KD animals failed to form a CPP for cocaine. Further investigation into how KDs impact motivation to seek natural rewards is underway.

58.

EMOTIONAL REGULATION IN THOSE WITH AUTISM SPECTRUM DISORDER

Nicole Massa ‘23, Cesira Barrett ‘23
Faculty Sponsor: Michal Assaf MD, Olin Neuropsychiatry Research Center, Institute of Living, Hartford Hospital

Autism spectrum disorder (ASD) is a developmental disorder affecting how an individual responds to social situations. The severity of symptoms lies on a spectrum ranging from nonverbal to high-functioning and is diagnosed by social deficits. Though this diagnostic process works well for those with severe ASD, many with high-functioning ASD are left undiagnosed since there is no biological marker known for the disorder. In Dr. Assaf’s lab, two groups are evaluated, an ASD group and a non-ASD control group, through a series of assessments such as the SCID (provides mental health history), the ADOS (verifies placement in ASD group), and an IQ test. In their first visit, participants go into an fMRI and rate their emotions after watching six videos of a person telling a story; two characterized as happy, two sad, and two neutral. In their second visit, participants are trained in the emotional regulation strategy of thinking more positively. If they pass training, they go back into the fMRI to view two happy and two neutral videos. They rate their valence from negative to positive and their arousal before and after implementing the emotional regulation strategy. The fMRI records the differences in functional connectivity between ASD, non-ASD, and changes caused by emotional regulation training. A study done by Assaf in 2010 showed that differences in strength and location of functional connectivity (FC) relate to severity of symptoms in ASD. Her study in 2013 found specifically that less FC in the default mode network of those with ASD likely contributes to difficulty understanding others’ emotions. The fMRI data collected from this current study will contribute to the knowledge on how the neural mechanisms in an ASD brain cause the neuropathological symptoms and will create a foundation for future behavioral interventions and new treatments regarding ASD and psychiatric disorders.

59.

THE PREVALENCE OF TRAUMATIC BRAIN INJURY IN ADULT FEMALE SURVIVORS OF DOMESTIC VIOLENCE

Michelle Mordasiewicz ‘22, Dorothy Anika ‘22, Blessing Njoku ‘23
Faculty Sponsor: Sarah A. Raskin

Domestic violence/intimate partner violence (DV/IPV) is often physical and most women who suffer from DV will obtain a traumatic brain injury (TBI). TBI can cause cognitive deficits because of frontal lobe damage, resulting in impairments in planning, concentration, speech and problem solving. Using cognitive measures, mood/personality tests, and PTSD measures, the effect of TBI on victims will be investigated. Using both DV survivors and non DV victims, this study will determine whether DV survivors have obtained a TBI and if TBI in survivors has any correlation to post-traumatic stress disorder (PTSD). This will be done through three types of tests: cognitive measures, mood personality tests, and PTSD measures. DV results in TBI and those with TBI experience cognitive difficulties as a result in their daily lives. Previous testing indicated that the most commonly reported problems were headaches (72%), fatigue (50%), difficulty concentrating

(46%) and dizziness (46%). The study indicated that DV results in TBI and those with TBI exhibit cognitive difficulties. The study contained a lack of non-TBI DV victims, so it was unable to be determined whether DV in TBI victims was directly associated with PTSD. It was also impossible to tell whether the anxiety, depression and symptoms of PTSD were separate from or related to the TBI. There remains much work to be done to understand how severe PTSD is in TBI victims as opposed to non-TBI victims. More studies could also be done to specify the exact area in the frontal lobe that the victim is affected and whether their deficits correspond to that.

60.

IMPROVING THE DIAGNOSIS AND TREATMENT OF PSYCHOGENIC NON-EPILEPTIC SEIZURES

Gillian Murdock ‘23, Nicholas Zacharewski ‘23
Faculty Sponsor: Gabriel Martz, M.D, Hartford Hospital, Ayer Neuroscience Institute

Psychogenic Non-Epileptic Seizure disorder (PNES) is a seizure condition that is believed to be caused by a disturbance in the cognitive-emotional system in the brain while showing no abnormal electrical function. This disturbance is likely a result of emotional and physical trauma such as: abuse, anxiety, depression, or PTSD. There is no definitive diagnostic test for PNES and suffering patients exhibit many symptomatic similarities to epilepsy. As a result of this, patients often go several years without a proper diagnosis. A prolonged diagnosis can cause additional stress, unnecessary hospital visits, excessive costs for the patients and healthcare system, as well as harm to the patient through a misprescription of seizure medication inducing further neurological disorders and in some cases, death. To boost the efficiency of diagnosis, approved mental-emotional surveys were translated into a virtual test via the RedCap program. Surveys would be given to patients in the seizure observation unit in Hartford Hospital. Based on the patient’s scores on the surveys, it would be determined if PNES should be considered as a diagnostic possibility on a patient-by-patient basis. Upon proper diagnosis of PNES, specific survey scores would be used to determine an underlying psychological cause of the seizures. The proper psychobehavioral therapy would then follow in an attempt to alleviate the disorder related to the causation of the seizures.

61.

THE EFFECT OF ACUTE STRESS ON TIME BASED PROSPECTIVE MEMORY

Ross Sawka ‘20
Faculty Sponsors: Sarah A. Raskin, Charles Swart

Time-based prospective memory (TBPM) is the ability to remember to perform an action at a specific point in time. During a stressful day, one usually encounters many instances where TBPM is required. The objective of this project was to see if acute stress (situational) has an effect upon TBPM. Trinity College Undergraduates from ages 18-22 were used in this study. The Socially Evaluated Cold Pressor Test (SECPT) was performed to induce acute stress and raise cortisol levels in participants. Each participant had an EEG recording collected during a computer-generated TBPM Paradigm. The resulting data was analyzed within group as well as compared to nonstressed students. Comparing the groups, there was a significant increase in response time on TBPM tasks. Additionally, comparisons of simple ERPs recorded from 0-900 milliseconds post ongoing task response between control and stress groups indicated significant differences in frontal

electrodes (FP1, F1). To our knowledge, this is the first study to investigate the electrophysiological correlates of TBPM in response to acute stress.

62.

THE EFFECTS OF A KETOGENIC DIET ON ACUTE INFLAMMATORY PAIN IN MICE

Isabella Sturdevant ‘20
Faculty Sponsors: Susan Masino, David Ruskin

Pain is one of the most common illnesses. Many types of pain disorders are due to chronic inflammation which can be difficult to treat and manage. The ketogenic diet (KD) is a high fat, low carbohydrate, moderate protein diet that is suggested to reduce neuronal excitation, increase adenosine, and have possible analgesic and anti-inflammatory effects. Adenosine activation is suggested to reduce excitability and inflammation through adenosine A_1 receptors (A_1Rs). This study analyzed the effects of the KD on inflammatory pain in male mice. A_1R knockout (KO) and wildtype (WT) mice were put on either a control or ketogenic diet regime for three weeks prior to experimentation. Tactile sensitivity was measured using an electronic plantar von Frey probe, before and after the right hind paw was injected with Complete Freund’s Adjuvant (CFA), a heat-killed tuberculosis bacteria that causes persistent inflammation. After four days there was a significant effect of the KD to reverse the sensitivity caused by the CFA injection compared to the CD WT mice. Results suggest that the KD may alleviate and reverse inflammatory pain, however a larger sample size is needed. Future research will incorporate additional methods to determine the effects of the KD on pain and inflammation.

63.

THE EFFECT OF THE KETOGENIC DIET ON SEX BEHAVIOR IN YOUNG MALE SPRAGUE DAWLEY RATS

Nina Tzianabos ‘20
Faculty Sponsor: Luis Martinez

The ketogenic diet (KD) is a high fat low carb diet that has shown therapeutic potential for neuropsychiatric disorders including drug addiction. Our lab has recently found that the KD reduces cocaine-induced locomotor activity and drug seeking behavior. What we don’t know is how the KD impacts the expression of behaviors associated with natural rewards such as sex. Given the reductions in drug-induced behaviors that we previously observed, we hypothesized that the KD more broadly disrupts how the brain processes rewarding stimuli, resulting in disrupted expression of behaviors associated with natural rewards such as sex. To test this hypothesis, we did a series of sexual experience testing on both KD and standard diet males. The males were paired with ovariectomized and hormone primed females and scored via a researcher for amount of mounts, intromissions and whether the male achieved ejaculation or not. We found that KD rats showed overall more mounts, intromit more on the third and fourth tests and were less likely to ejaculate on the 2^{nd} test. This data partially supports our hypothesis. Further studies could observe how the ketogenic diet impacts female sex behaviors in rodents.

PHYSICS

64.
A NUMERICAL SOLUTION FOR A QUANTUM MANY-BODY PROBLEM USING MATHEMATICA
Dhiraj Ganji ‘23
Professor Kalum Palandage

Studying the ‘hopping’ behaviors of electrons in electron sites can lead to a better understanding of electric conductivity and how it can be improved. To study the behaviors of electron hopping and energy transfer, The Hubbard model is used with the Hubbard Hamiltonian operator, to calculate the energy values or eigenvalues of electrons in electron sites. The operator is used to calculate the potential and kinetic energy values of the electron. Two electron sites in the Hubbard model have been used in the Hamiltonian to find out the potential and kinetic energy values that they have. Wolfram Mathematica is then used to calculate the energy values of the electron sites, and to find the probabilities of electrons in the sites by diagonalizing the matrix. This research will help us to learn more about conductivity and how different materials conduct electricity, as it talks about the energy values of electrons which cause current in different materials. In the future, this research can be continued by expanding into more than 2-site Hubbard models, and calculating the hopping electron energy values for more electron sites in the Hubbard model.

PSYCHOLOGY

65.
A COMPARISON OF ONLINE AND OFFLINE MEASURES OF METACOGNITION: FEATURING *THE SILK ROAD* COMPUTER GAME
Madison Kane ‘20
Faculty Sponsor: David Reuman

The central research question underlying this project is how well offline and online measures of metacognition agree with each other, and how well these measures of metacognition predict specific task performance and general academic performance in courses. Metacognition includes skills that enable learners to understand and monitor their cognitive processes related to learning. Offline methods of assessing metacognition are collected either before or after task performance, whereas online methods assess metacognition during task performance. The present study compared an offline measure of metacognition, The Metacognition Five (MC5), to an online measure that used a “reflect when prompted” methodology. The online measure was based on *The Silk Road*, a computer game developed by Trinity College students. The participants were 14 Trinity College students who were asked to play *The Silk Road* once as a “novice” and then again as an “expert” (after having played three additional times on their own). The results showed no significant correlations between the offline measure and the online measure, whether assessed for novice or for expert players. Furthermore, there was no evidence to support hypotheses that the offline measure would predict course grades better than the online measure or that the online measure would predict game performance better than the offline measure. Lastly, there were no significant differences between novice and expert players for game performance outcomes.

66.

THE INTERFERENCE AND INTELLIGIBILITY OF SPEECH ARTICULATION

Nadine Lee ‘20
Faculty Sponsor: Elizabeth Casserly

Researchers have looked at distracted speech intelligibility with acoustics but not with articulation. Previous research suggests that distraction causes a decrease in speech intelligibility. In this study, an Electromagnetic Midsagittal Articulographer (EMA) was used to investigate how articulation changes between the “No Distraction” and “Digit Memory Task” conditions. The vowels /i/, /ɛ/, /æ/, /u/, /ʌ/, /ɑ/ were analyzed to investigate articulation. Each participant was compared to themselves. The “No Distraction” condition had participants read phrases with the EMA sensors on the areas of the mouth. The “Digit Memory Task” had participants memorize a span of digits, read phrases, and recall the span of digits (while the sensors were on the areas of the mouth). We predicted that the “Digit Memory Task” condition will show a decrease in articulatory effort compared to the “No Distraction” condition. Four undergraduate female students participated in the study. However, due to technical difficulties regarding senor application to the tongue, the data from one participant was not used. Participant A’s results were aligned with our hypothesis. Participant C’s results showed differences between the two conditions in lateral movement. Finally, Participant D’s results did not show any differences between the two conditions. The findings suggest that different people use different strategies when speaking while doing a memory task.

67.

SOCIAL INFLUENCES ON EMERGING ADULTS’ VAPING

Carolyn Najarian ‘20
Faculty Sponsor: Laura Holt

Vaping involves heating a liquid, often with nicotine (or THC) and other compounds and inhaling the resulting aerosol. It has become increasingly popular, from seven million vapers in 2011 to 41 million in 2018. And, the number of adults expected to vape by 2021 is almost 55 million. In spite of its popularity, there is a lack of knowledge about the long-term effects of vaping and the factors that are most influential in people’s decisions to vape. Research with emerging adults has shown that vaping is prevalent; however, few studies have focused on the social or interpersonal dynamics that influence vaping in this demographic. The purpose of my study was to examine the relative influence of social motivations for vaping compared to other motivations (e.g., to focus on academic work, to quit combustible cigarettes, etc.). Using data from two sources, I examined how peers’, family members’, and significant others’ attitudes about vaping influenced an individual’s decision to vape or not. First, we collected quantitative data on participants’ reasons for vaping from an online survey distributed to approximately 1,300 students at 7 different colleges and universities in the United States. Second, we collected qualitative data on how students’ vaping behavior is affected by people in their social circle in five focus groups conducted on one college campus. Results from the survey showed that peers’ use was a primary reason students began ENDS use. Results from the focus groups suggested that family, peer, and partner attitudes toward vaping influenced their ENDS use; however, others’ attitudes were not the deciding factor in quitting ENDS use completely.

68.

ARE ADHD SYMPTOMS AND IMPULSIVITY ASSOCIATED WITH EMERGING ADULTS' PERCEIVED RISKS AND BENEFITS OF E-CIGARETTES?

Clara Pingeon '20
Faculty Sponsor: Molly Helt

The use of electronic nicotine delivery systems (ENDS) is one of the most common substance use behaviors among emerging adults. With 68 confirmed vaping-related deaths as of February 2018 and countless other cases of vaping-related lung disease and dysfunction, there is an urgent need to better understand emerging adults' perceptions of ENDS products, and which emerging adults are more/less likely to perceive ENDS products as harmful. In the present study, I examined data from an online survey of seven colleges and universities across the US and from five focus groups conducted with college students. Specifically, I explored the perceived risks and benefits of vaping, including the effects of media coverage on students' behavior, and whether ADHD symptoms and impulsivity were associated with different perceptions of e-cigarette risks and benefits. As hypothesized, students reported that media reports have affected their behaviors and perceptions on vaping and e-cigarette use, although students expressed confusion about chemical makeup and long-term effects of e-cigarettes. Also as hypothesized, there was an indirect effect of impulsivity on frequency of ENDS use and dependence through perceived benefits. ADHD symptoms, however, did not predict using ENDS to concentrate as hypothesized. Implications on these reports for finding effective intervention strategies will be discussed.

69.

AN INVESTIGATION BETWEEN THE ACTUAL AND THE PERCIEVED SELF-REPORTED SUBSTANCE USE OF COLLEGE STUDENTS

Jordan Ragland '20
Faculty Sponsor: Randolph Lee

Alcohol and illicit substance use has been recognized as a widespread public health concern across college campuses in the United States (Shepard et al. 2017). Perceived norms are among the strongest predictors of college student alcohol use and related problems (Ecker et al. 2017). Prior research has shown that normative perceptions relate to one's own drinking behavior (Lewis et al. 2011). This data has shown that college students typically over estimate the amount other students or peers drink. Based on previous literature this can be applied to drug, marijuana, and nicotine use. The purpose of this study is to examine the relationship between self-report and perceived peer alcohol, drug, marijuana, and nicotine use and to determine if a relationship exists. Specifically, this research aims to investigate if college students overestimate peer drinking and drug use by several contexts (i.e. fraternity/sorority and sports teams) and to examine normative perceptions for drinking and drug use by contexts that relate to one's own drinking behavior. The participants in this experiment are college students who will complete a 32 item forced choice questionnaire. Which measures the reported personal alcohol, drug, nicotine, and marijuana consumption compared to participants' perceived norms of their peers' substance use behavior. It is hypothesized that those who overestimate peer drinking and substance use will have a higher frequency of self-reported substance use. As well as those who underestimate their peers drinking and substance use will have a lower self-reported substance use. It is also hypothesized that those who are in a group, such as a fraternity or sports team, will overestimate peer substance use as well have more frequent substance use. Possible reasons for this overestimation will be discussed.

70.
MANTRA IN MEDITATION: THE EFFECT OF SOUND ON RELAXATION
Philisha Abrahim ‘20
Faculty Sponsor: Randolph Lee

The use of mantra as a tool for meditation is an ancient practice. It is a spiritually rooted discipline, thought to release various types of energy when producing sounds. The study expanded upon previous research, which analyzed the physiological effects of sound in meditation, to examine the “OM” sound and its effect on brainwaves and skin temperature. Participants were asked to complete four meditations: a baseline, silent, guided, and “OM” meditation. Study 1 included a sample population of 30 participants with no restriction on meditation experience. Study 2, with a sample population of 15, included participants with at minimum one month of meditation experience. Participants completed a questionnaire gauging their previous experience with meditation. Raw brainwaves peaks and skin temperature for each of the conditions were assessed. Findings showed a significantly lower number of baseline peaks compared to all other conditions of silent, guided and “OM”. There was a significantly higher number of calm brainwave peaks across the silent, guided, and OM conditions. There was a significant difference in first and final temperature for the all of the meditations. Future research may examine effects of relaxation with a sample population of OM experienced meditators.
Keywords: meditation, sound, relaxation effects, brainwave pattern, skin temperature, OM, silent, guided

URBAN STUDIES

71.
ISRAELI OCCUPATION OF PALESTINE: THE EFFECTS OF SPACE MONOPOLIZATION
Philisha Abrahim ‘20
Faculty Sponsor: Garth Myers

The Israeli occupation of Palestine is a century long feat resulting in the totalitarian control of Palestine’s development, natural resources, and spatial representation. The heavily contested land between the Jordan River and Mediterranean Sea has resulted in the dispossession, destruction, and degradation of Palestine’s infrastructure, political power, and national identity. The British established Israel Zionist State has closely worked with foreign allies to construct and maintain its power.
Keywords: Palestine, Israel, space, colonization, water, natural resources, walls, geographical representation, building, development regulations