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About *The Arsenal*

The Arsenal: The Undergraduate Research Journal of Augusta University is a peer-reviewed, open access, interdisciplinary journal for undergraduate research conducted at Augusta University. This journal is managed in collaboration with the Center for Undergraduate Research and Scholarship (CURS) and University Libraries.

The Arsenal was initiated by On the Shoulder of Giants in Fall 2016. The journal represents and highlights undergraduate research of academic and scholarly value from various disciplines at Augusta University. Each article undergoes a peer-review process facilitated by the journal's Editorial Review Board and must be approved by an appointed faculty reviewer in the article's respective discipline.

About The Summer Scholars Program 2024 Special Issue

This special issue of *The Arsenal* presents the abstracts of the Center for Undergraduate Research and Scholarship 2024 Summer Scholars Program, with permission given from the authors and faculty advisors.

The Summer Scholars Program is an intensive hands-on research experience that allows students to collaborate with a faculty mentor in the process of discovery. The goals of the program include providing undergraduate students with experiential learning through engagement in research and creative scholarship, to support high impact scholarly activity that yields significant student development and academic achievements while furthering research productivity of Augusta University, and to increase opportunities for underrepresented students to become actively engaged in research and creative scholarship.

More information regarding the Summer Scholars Program can be found on their website: https://www.augusta.edu/curs/summer-scholars.php

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Special Issue

Predicting Epileptic Seizures Using Spiking Neural Network

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ABSTRACT

Epilepsy is a neurological disorder characterized by sudden electrical discharges (seizures) that manifest in uncontrollable body functions. Their unpredictable nature has led to many applications of machine learning algorithms to predict seizure events. However, those methods present limitations in energy efficiency, computational costs, and hardware realization. This makes the feasibility of a seizure predicting wearable improbable. To mitigate those limitations, we propose predicting seizures using a spiking neural network (SNN). SNNs are brain-inspired networks that are trained in an event-driven manner which reduces both computations and power consumption. In this study, the main SNN components (the spike encoding algorithm, neuron model, and learning algorithm) were investigated. Spike encoding aims to encode the EEG data into spikes. A comprehensive review of encoding schemas revealed a combination of adaptive threshold and inter-spike-interval (ISI) algorithm to be a viable encoding schema. The capability of adaptive threshold to capture intricate information paired with ISI recognition of irregular firing patterns promises significant results. A neuron model has to accurately represent the biological neurons and synapses. The proposed neuron model is the Izhikevich model, known for its biological accuracy and computational efficiency. To train the network, we propose a surrogate gradient learning algorithm that utilizes backpropagation. The network is trained on an EEG dataset from CHB MIT. The ability of the model to discern between pre-ictal (before seizure) and inter-ictal (between seizures) phases would indicate success in training. A new batch of data would be tested on the model to calculate its accuracy in predicting seizures.

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Can Objective Measures of Gait, Posture, and Balance More Accurately Discriminate Between Older Fallers Versus Non-Fallers than Clinical Measures of Gait and Posture?

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ABSTRACT

Poor physical function predicts falls among older adults. The Short Physical Performance Battery (SPPB) is a subjective clinical assessment of physical function that may lack sensitivity. Wearable inertial sensors provide objective measures of posture, balance, and gait and may be more sensitive than clinical assessments, but further research is needed. This study aimed to determine if objective or clinical assessments of gait and posture can distinguish older fallers from non-fallers. n =17 community-dwelling and residential care older adults (≥ 65 years) were grouped into fallers (n= 10; Age:81.8 years, Montreal Cognitive Assessment (MOCA)=23.1 points, 50% Female) and non-fallers (n=7; Age:78.9 years, MOCA=22.9, 14.3% Female) based on their fall history in the past year. During the 2-hour baseline visit, participants underwent clinical assessments with the SPPB and objective assessments using inertial sensors for postural assessments, usual-paced walking, and timed-up-and-go (TUG), which involved standing up, walking 3 meters, turning, and sitting down. Separate repeated measures analyses of variance were conducted for all clinical measures, posture, gait, and TUG. There was no significant interaction effect of group for clinical measures ($F_{(1.25,16.27)}$=0.191, p=0.723, η_p^2=0.015), posture ($F_{(1.03,14.39)}$=0.058, p=0.82, η_p^2=0.04), gait ($F_{(1.2,17.95)}$=0.23, p=0.68, η_p^2=0.015), and TUG ($F_{(1.30,18.24)}$=0.10, p=0.817, η_p^2=0.07).There was no significant main effect of group for clinical measures ($F_{(3,11)}$=0.725, p=0.56, η_p^2=0.165); posture ($F_{(7,8)}$=3.77, p=0.4, η_p^2=0.768), gait ($F_{(4,12)}$=0.22, p=0.63, η_p^2=0.18), and TUG ($F_{(4,11)}$=0.429, p=0.79, η_p^2=0.135). Our findings suggest clinical and objective measures of posture, gait, and balance did not differentiate between fallers and non-fallers. Caution is advised due to small sample size and ongoing data collection.

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Architecture and the Progression of Education

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ABSTRACT

This research project explores the correlation between architecture and the spread of information, specifically in the medical field. Focusing on early twentieth century China, we are able to explore a period of immense change in the architectural output of a society that had remained relatively stagnant for thousands of years. The fall of the imperial system with the Qing dynasty and subsequent shift in political, social, cultural, and economic conditions created an environment that favored modernization and the adoption of new architectural styles and technologies. In analyzing *Jianzhu Yuekan* (The Builder), an architectural magazine showing the structures planned and built between 1932 and 1937 in Shanghai, there are clear unified efforts to modernize their architectural practices which proceed a standardization of the medical education system. This magazine's blueprints, concepts, and photographs reveal a deliberate shift from their traditional style to a modern western blend. Prior to these new techniques and materials used in architecture, medical education was widely based on Traditional Chinese Medicine (TCM). However, as larger and more sophisticated institutions were made possible in this modernization period, medical practices within China began to standardize, create uniform teachings, and introduce pharmacology. Modern medical universities provided the necessary infrastructure to support this shift in medical education and research, and ultimately, architectural modernization paved the way for medical advancement and demonstrated the crucial role of architecture in the progression of science and education.

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Priming in Word Processing

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ABSTRACT

The recognition of upcoming words is influenced by prior short-term listener experience. We are interested in the influence of a specific type of listener experience on word recognition, namely the effect of phonological overlap, and position of overlap of a preceding word. We will investigate this question using a prime-target paradigm with a lexical decision task (LDT) where participants must decide whether the target is a word or a nonword. Studies have shown that when the overlap is at the beginning (onset) of a prime-target pair, it slows word recognition, whereas when overlap at the end (offset), it facilitates word recognition. Models of spoken word recognition have provided different accounts to explain these effects through interactions between different levels of processing (phonological, lexical, etc.). Typically, the inhibitory effect of overlap is attributed to lexical competition – when two words share the onset, they are both activated and compete with one another, making it more difficult to recognize the target. The models that incorporate feedback from the lexical to the phonological level can better explain the facilitation effect of the offset due to top-down activation. The goal of the work presented in this poster is to replicate prior findings with a larger set of stimuli and two control conditions. In the full study, participants will make either a lexical decision or phonological decision (other poster), which will weigh in on different accounts. This study will serve as a foundation for a future experiment that will address additional questions related to phonological-lexical interactions.

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Enzyme Engineering: Showing the Flexibility of the Homologation Enzyme HphA

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ABSTRACT

Natural products from microorganisms and plants are vital drug sources. However, antibiotic-resistant pathogens necessitate new drug candidates. While modifying known molecules is promising, traditional organic chemistry struggles with complex NP structures. Enzymes provide a solution for precise modifications. Homologation of amino acids, involving the addition or removal of a methylene group in their side chains, is not common yet impactful transformation catalyzed by enzymes in peptide natural product (NP) structures. This modification can enhance the stability and bioactivity of NPs within biological systems, but the biosynthetic pathways remain poorly understood. This study focused on HphA, the first enzyme in the homologation pathway of L-phenylalanine and L-tyrosine, with the aim of engineering HphA to function similarly to LeuA, an enzyme in the L-valine homologation pathway, to demonstrate the enzyme's flexibility for further modifications to accept other amino acids. To achieve this, site-directed mutagenesis introduced specific mutations into HphA, followed by expression and purification of the mutant enzymes. Enzyme kinetics, structural analysis, and colorimetric assays assessed the catalytic activity and substrate specificity of these mutants. Optimizing HphA's functionality aims to engineer the homologation pathway to produce non-readily available homologated amino acids, making them more accessible for drug development. By enabling efficient and cost-effective biosynthesis of homologated amino acids, this study contributes to the discovery and development of novel antibiotics, offering a potential solution to the growing challenge of antibiotic-resistant pathogens. This work lays the groundwork for future combinatorial biosynthesis, contributing to the creation of novel NPs with enhanced medicinal properties.

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Developing a System to Introduce Multiple Transgenes Simultaneously into *Drosophila*

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ABSTRACT

The development of genetic tools to manipulate and study gene function in *Drosophila* melanogaster has greatly enhanced our understanding of genetics and developmental biology. This work describes a novel technique for injecting numerous plasmids into *Drosophila* fly stocks at the same time. The goal is to co-produce and deliver numerous genetic constructs in one generation by fine-tuning injection procedures and plasmid combinations. Using a combination of plasmids carrying various genetic markers and selectable genes, the procedure entails precision microinjection techniques. With this proposed method, producing multi-gene transgenic fly lines takes a fraction of the time and effort, making it an effective tool for advanced genetic research on *Drosophila*. This approach has effects in the fields of synthetic biology, genetic interaction mapping, and functional genomics, among others, opening up new avenues for in-depth studies of the regulation and function of genes.

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The Role of JMJD1C in Oligodendrogenesis following Neonatal Brain Injury

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ABSTRACT

Over ten percent of babies are born preterm. Often, the lungs of preterm infants are not fully developed, leading to brain hypoxia. This causes white matter injury (WMI) in the brain characterized by aberrant axonal myelination. Prior research using a hypoxic mouse model of developmental WMI demonstrated that oligodendrocytes (OLs), the myelinating cells in the brain, generate in higher numbers, myelinate more axons, and locomotor recovery improves, when mice recover in an enriched environment. To explore mechanisms of this enrichment-induced recovery, oligodendrocyte-specific RNA sequencing was performed. One particularly interesting differently expressed gene is Jumanji Domain Containing 1C (JMJD1C), a histone demethylase that promotes lipogenesis, a critical process for myelination. JMJD1C is downregulated after hypoxic injury but upregulated during enrichment-induced recovery. We hypothesize that JMJD1C directs enrichment-induced effects on oligodendrocytes following hypoxia. To determine the role of JMJD1C in oligodendrocytes after hypoxic injury, JMJD1C was conditionally knocked-out of oligodendrocyte precursors. Transgenic mice were housed in hypoxia (10.5% O2) from postnatal day (P) 3 through P11. Mice recovered in either a standard cage or an enriched environment, until P45. Oligodendrocyte dynamics were assessed in the subcortical white matter using immunohistochemistry. Our data suggests that oligodendrocyte-specific knockout of JMJD1C diminishes the oligodendrogenic response present during enrichment-induced recovery from hypoxia. Future work will elucidate the role of JMJD1C in myelination and functional recovery following hypoxia. This work has the potential to identify a therapeutic target for preterm infants with white matter injury.

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Oligodendrocyte Specific Knockdown of Histone Demethylase-JMJD1C

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ABSTRACT

Premature birth leads to white matter injury (WMI) within the brain and results in several neurodevelopmental disabilities. Injuries arise due to an underdeveloped respiratory system during a vital period of neurodevelopment. At the cellular level, oligodendrocytes, the myelinating cells of the central nervous system, are damaged. Because low oxygen environments lead to WMI, gene expression changes associated with injury pathogenesis and repair are likely regulated by epigenetic mechanisms. Our prior work using a preclinical mouse model showed that oligodendrocyte gene expression changes post WMI had many affected histone modifying enzymes. Research shows that histone modifying enzymes are common epigenetic regulators of gene expression by altering the structure of chromatin, thereby influencing the accessibility of gene transcription. Out of the group of affected enzymes, expression of jumonji domain containing 1C (JMJD1C) was reversed after environment enrichment, an intervention shown to promote recovery. To study the role of JMJD1C in oligodendrocytes, we generated an oligodendrocyte-specific *jmjd1c* knockout mouse. The aim of this project is to verify that *jmjd1c* was successfully reduced in this transgenic mouse model. We hypothesize that *jmjd1c* mRNA expression will be reduced within oligodendrocytes in the knockout mice. To detect *jmjd1c* expression, target-specific RNAscope probes were combined with immunohistochemistry for oligodendrocyte markers. Our data indicates that JMJD1C expression is significantly reduced within oligodendrocyte progenitor cells and oligodendrocytes in knockout mice. Furthermore, this project supports the work towards understanding whether neonatal brain injury and repair is mediated by oligodendrocyte histone modifications.

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Missing Persons: Predicting Incident Frequency with Vector Auto Regression

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ABSTRACT

Missing Persons incidents are underreported in the media, despite causing emotional stress to their communities and often ending in arrests. As a result, many missing persons remain at large for decades. In an effort to enhance resource allocation and police preparedness, this study aims to predict incident frequencies using a Vector Auto Regression (VAR) model. This study utilizes a publicly available dataset of police incidents from the San Francisco Police Department, spanning from 2018 to the present. San Francisco is divided into four regions, each forming its own time series vector to predict future incident frequencies. The accuracy of the VAR model is compared to other machine learning models, including Exponential Smoothing, Long Short Term Memory (LSTM), Facebook Prophet, Auto Regressive Integrated Moving Average (ARIMA), and K-Nearest Neighbors (KNN). VAR was found to be inferior to models like LSTM, Exponential Smoothing, and ARIMA; however, region four was found to Granger-cause regions two and three, suggesting room for improvement with the VAR model.

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Taking the Next Step: Turning Undergraduate Research into A Manuscript

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ABSTRACT

Students in the science classroom need additional pedagogical support (Akinoglu 2008; Firman et al. 2019). Inquiry-based learning (IBL) is a form of support which can deepen students' conceptual understanding more than traditional learning (Aktamis et al., 2016). The purpose of the current study is to investigate how K-12 students and undergraduate mentors view questioning in scientific inquiry through participation in the iBEARS (Inclusive Biologist Exploring Active Research with Students) program. iBEARS is a novel program that allows undergraduate students to mentor K-12 students through a semester-long IBL experience, intended to promote the development of 21st century skills in undergraduate students, and content knowledge in K-12 students (St. Louis et al., 2021). The participants of this study are undergraduate mentors and K-12 students. Using a qualitative methods design, we used the *Views About Scientific Inquiry* (Lederman et al., 2014) instrument to investigate how participants consider questioning in the scientific inquiry process. Preliminary results of this study show that undergraduate mentors' views about questioning decreased, becoming more naïve (rather than informed) after serving as mentors, while K-12 students' views about questioning were mostly stagnant. Additional research is needed to understand further why views about questioning changed after serving as a mentor, and how participation in this classroom intervention affected K-12 student views. Preliminary results of this study give insight into how students and mentors view questioning in science, and how IBL interventions may affect these views. Future directions and the process of disseminating the current study into an undergraduate manuscript is discussed.

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One-Pot Synthesis of Diarylpiperidinone Conjugates as Potential Therapeutics for Cancer

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ABSTRACT

For many years, scientists have researched the potential anticancer properties of natural products, aiming to develop treatments with reduced chemotherapy risk and fewer toxic side effects. Turmeric, specifically its active component curcumin, has shown promise in this area. However, due to its complex nature and limited abundance, curcumin has struggled to effectively target cancer cells. To address this issue, diarylpiperidone compounds have been designed to mimic curcumin and overcome its limitations. This research aimed to synthesize hybrid molecules by utilizing diarylpiperidone scaffolds, secondary amines, and bromoacetic acid through a one-pot synthesis approach. Optimized reaction conditions and various purification techniques were employed during the synthesis process. The synthesized molecules will undergo investigation to assess their potential anticancer properties.

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Behavior-Analytic Assessment of Variables Associated with Music Preference

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ABSTRACT

Research shows that music provides beneficial uses beyond recreational enjoyment, particularly in the fields of medicine and therapy. The potential of music-based interventions is such that the NIH is supporting funding opportunities to study the application of music in health settings. Prior studies on musical components, such as tonality and meter, indicate the presence of hierarchies that define the relative importance of notes and beats in a piece of music. These tonal and metrical hierarchies interact to affect an individual's perception of music. Therefore, understanding the perception of these hierarchies may help in refining the application of music as a non-pharmacological means of improving healthcare and well-being. The current CURS Summer Scholars project was aimed at developing an empirical approach to study how tonality and meter interact to influence music preference from a behavior-analytic perspective. By building on the experimental analysis of operant choice behavior, we aim to test the hypothesis that the degree of alignment between tonal and metric hierarchies influences the value of a piece of music as a reinforcer in a free-operant choice procedure. The project also provides a context for the evaluation of the Python-based software "PsychoPy" as a viable medium to design and run behavioral experiments with human subjects. As of the end of our 5-week project, we have established a proof of concept, but additional work is needed to refine the experimental design.

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Design, Synthesis, and Biological Evaluation of Novel Biotinylated Diarylpiperidinone Derivatives as Potential Antitumor Agents

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ABSTRACT

Cancer is a medical condition characterized by uncontrolled cell division resulting from genetic or epigenetic changes. In 2023, there were 1,958,310 new cases of cancer reported, with 297,790 new cases of breast cancer, leading to 43,170 deaths related to breast cancer. This highlights the pressing need for more effective cancer treatments. However, the intricate and rapid development of tumor heterogeneity makes breast cancer resistant to current therapies, often causing high levels of cardiotoxicity and undesirable side effects. Natural products may offer a promising alternative for cancer treatment as they have been a dependable and safe source for drug synthesis over the past forty years. Curcumin, a compound found in the turmeric plant, has exhibited diverse applications in treating various diseases, including cancer. Despite its potential, its low bioavailability, solubility, and hyperactive sites hinder curcumin's effectiveness as a therapeutic agent. Our lab has explored the diarylpiperidinone scaffold and identified it as a potential candidate for anticancer drugs. However, pinpointing the pharmacological target remains one of the challenging tasks in the drug development process. Biotin, a water-soluble B-complex vitamin, plays a crucial role in various biochemical processes in the body, such as energy production, fatty acid synthesis, and amino acid synthesis. Additionally, biotin can be a tracer for compounds that are difficult to track in vitro. By attaching biotin to indole-piperidone hybrids, the signal amplification of the hybrid compounds can reveal their pathways and associated target molecules. Further biological screening will be conducted on the synthesized compounds.

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Generation of BCAT2 Knockout Proximal Tubule Cell Lines for Studying Ferroptosis in Chronic Kidney Disease

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ABSTRACT

Cisplatin-based chemotherapy can cause kidney injury, leading to the development of chronic kidney disease (CKD) in cancer patients. We have recently reported that endogenous microRNA-messenger RNA (miRNA-mRNA) interactions mediate attenuation of branched-chain amino acid (BCAA) catabolism in mouse kidneys exposed to repeated low doses of cisplatin. The attenuation of BCAA catabolism results in a specific type of iron-dependent cell death known as ferroptosis in proximal tubules. However, the mechanism by which impaired BCAA catabolism leads to ferroptotic cell death in CKD remains unknown. Leucine, isoleucine, and valine, collectively known as BCAA, are catabolized by two key enzymes: BCAA aminotransferase 2 (BCAT2) and branched-chain α-keto acid dehydrogenase (BCKDH). To study the role of BCAA catabolism in ferroptotic renal cell death, we generated a loss-of-function allele of Bcat2, using CRISPR/Cas9 technology. Genomic DNA sequencing and Western blot analysis confirmed the deletion of four base pairs in the Bcat2 gene locus. This frameshift mutation led to the knockout BCAT2 expression. This engineered cell line could provide crucial insights into the biochemical processes connecting BCAA catabolism to ferroptosis, potentially unveiling a new therapeutic target for preventing CKD in cancer patients undergoing cisplatin treatment.

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The Influence of Language and Cultural Barriers as a Means of Preserving Perspectives of Architects and Architectural Styles in Early Twentieth Century Shanghai

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ABSTRACT

Early twentieth century Shanghai, formerly known as Nanjing, was a coastal port city and a Chinese sphere of influence that was teeming with western cultural importation. Consequently, these events had resulted in the exploration of new ideas through mergers in both culture and resource, thus leading to a revolution in the once stagnant architecture of Shanghai. In our research, we are analyzing the architectural magazine, *Jianzhue Yuekan* (The Builder) published periodically in the 1930s in order to derive new findings and perspectives on the urban and city development of Shanghai. Throughout our work, the presence of distinctly Chinese architecture amidst foreign influences can be seen through architects understanding of Chinese culture. One such aspect of culture is language, and throughout this project, language has been a significant influence on the perspectives of architects and the intent of their craft. The aforementioned statement regarding the importance of language and its influences on architecture can be most often seen through the translation barriers as well as complex nuances of Mandarin. Our study has shown that there are instances in which architects have utilized a greater understanding of Mandarin in order to effectively create architecture that demonstrates modernity while still retaining a traditionally Chinese cultural style in their work.

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How Cognitive Assessment Results of Older Adults Relates to Their Fall Risk

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ABSTRACT

One third of older adults ≥65 fall annually, resulting in injury and impaired quality of life. Older adults who fall repeatedly are at risk for cognitive decline and reduced balance and strength, which further increases their risk of falling. Determining fall risks in older adults has come to limited conclusions due to the uncertainty of what assessments to use. We therefore aimed to evaluate the efficacy of a battery of cognitive assessments in discriminating between fallers and non-fallers to refine the fall-risk screening protocol for physicians. n= 18 community-dwelling and assisted-living older adults ≥65 with self-reported decline in physical stability were grouped into fallers (n= 11; age: 79.64 years, Montreal Cognitive Assessment (MOCA)=23.18 points, 45.45% Female, 36.4% Community-dwelling) and non-fallers (n=7, age: 78.86 years, MOCA=22.86 points, 14.29% Female, 42.9% Community-dwelling), where fallers were participants who had recorded a fall in the past 12 months. The cognitive assessment scores were gathered during a one-time in-person testing session. The assessment tools used include: the MOCA, the Rey Auditory Verbal Learning Test (RVLT), timed trail-making tasks (TMT), and the Digit Symbol Substitution Test (DSST). Repeated measures analysis of variance was conducted using SPSS. There was no interaction of group and cognition ($F_{(1.01,15.16)}$=0.269, p=0.614 η_p^2=0.018) and there was also no significant main effect of group for cognition ($F_{(5,11)}$=1.039, p=0.442, η_p^2=0.321). Our results showed that the cognitive assessments could not differentiate between fallers and non-fallers, however the results should be interpreted with caution due to the small sample size as testing is currently ongoing.

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Determining the Factors Influencing Summer Day Camp Capacity to Promote Accessibility and Children's Health

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ABSTRACT

Research indicates children engaged in summer day camp programming have better cardiovascular fitness and healthier weight trajectories than those who do not participate. Currently, demand for summer day camps surpasses the available capacity, limiting camp access for numerous potential children. The factors influencing summer day camp capacity are unknown. Understanding the social and logistical systems within camp organizations and identifying potential intervention points may offer guidance for capacity expansion. The data in this study is gathered from semi-structured interviews via phone and video conferencing. Transcribed interviews were coded using template analysis in NVivo. Qualitative analysis was guided by the Consolidated Framework for Implementation Research (CFIR). Preliminary analysis indicated factors influencing camp capacity are an interconnected, complex framework. For example, camp directors commonly mentioned camper-to-staff ratio as a factor they considered when determining the number of campers a program can accommodate. However, the differing reasons mentioned for determining the camper-to-staff ratio include considerations of the implementation process such as camp quality, internal context like program budget, and outer context such as the ability to provide competitive hourly wages to staff and state policy. Expanding summer camp capacity may be challenging due to the intricacies of various factors. A singular solution may be improbable for increasing capacity as future interventions will need to target a diverse range of issues regarding camp expansion.

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Exploring the Capacity of Summer Day Camps: A Qualitative Study in South Carolina and Georgia

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ABSTRACT

Attending summer day camp supports preventing summer learning loss, promoting social-emotional growth, and maintaining cardiovascular fitness for children. Studies suggest that increasing access to summer programs can improve many children's physical, mental, and educational outcomes by reducing costs or expanding camp capacity. Because the factors influencing the capacity of summer day camps remain unclear, this research intends to investigate what those factors are. Calling via phone or Teams, we conducted semi-structured interviews with senior summer program staff in Georgia and South Carolina. We then produced preliminary qualitative system maps using the Consolidated Framework for Implementation Research as a theoretical guide.

Results: Several directors from non-profit summer programs were interviewed in June-July of 2024, and mentioned an immediate association between the resources available such as grant funding, sponsor support, and USDA Summer Food Service Program (an in-kind support) and the camp's duration or the number of kids they could accommodate for. Among the camps interviewed, none offered a form of transportation to get to and from camp, but interviewees mentioned other ways in which they maintained a way for the child to attend the camp location, such as having longer program hours and more flexible drop-off and pick-up times. Few camps offered scholarships, but many had low tuition between $0-$175. Summer programs used various strategies to meet participants' needs, including backup plans. Expanding camp capacity will require tailoring efforts to local needs and factors.

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AGPAT3 Potentially Regulates Kidney Function in Male Mice

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ABSTRACT

Acylglycerophosphate acyltransferases (including AGPAT1, 2, 3, 4, 5) convert lysophosphatidic acid (LPA) into phosphatidic acid (PA) crucial for production of phospholipids and triglycerides. AGPAT3 is highly expressed in the kidney. A specific genetic variant in AGPAT3 is linked to a higher risk of kidney disease in non-Hispanic Whites and African Americans. However, we do not know whether AGPAT3 plays a role in regulating kidney lipid metabolism and function. In this study, we compared the kidney histology and functions in wild-type (WT) mice and mice with a whole-body knockout of AGPAT3 (KO). We found that the KO mice are smaller in size when compared to the WT across sexes. They maintained a similar food intake. While the absolute kidney weights were similar, male, but not female, KO mice had proportionally larger kidney weights when normalized to their body weights. Interestingly, male KO mice displayed a higher water intake without showing a significant difference in urine output. In contrast, female mice demonstrated no differences in water intake and urine output. Histological analyses of kidneys showed no obvious anatomical differences between the WT and KO mice. In addition, we did not observe significant differences in the urine urea nitrogen levels between WT and KO mice. However, male KO mice had a significant increase in plasma creatinine concentrations over the WT, indicating potentially impaired kidney function. In summary, our findings suggest that AGPAT3 may contribute to kidney function in a sex-dependent manner. The underlying mechanisms remain to be further examined.

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Curiosity Unleashed: Mastering Inquiry Skills Through Science and Engineering Practices

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ABSTRACT

This qualitative study explores the relationship between students' views about scientific inquiry and their ability to engage with the science and engineering practices (SEPs). Further, it examines how participation in the iBEARS (Inclusive Biologist Exploring Active Research with Students) Program supports students' scientific inquiry skill development. The Next Generation Science Standards (NGSS) emphasize scientific inquiry as essential practices for investigating the natural world, and in the iBEARS Program, K-12 students engage in inquiry-based learning, culminating in creating a research poster. The qualitative study employed the *Views About Scientific Inquiry* (VASI) (Lederman et al., 2014) instrument and analyzed students' completed research posters to assess their understanding and implementation of two inquiry aspects: 1) scientific investigations can follow different methods, and 2) questions drive the [scientific] process and two science and engineering practices: 1) asking questions and defining problems and 2) analyzing and interpreting data. Preliminary data analysis investigating the inquiry aspects suggests student knowledge gains in the SEPs. Findings suggest that inquiry-based programs like iBEARS significantly enhance students' understanding about scientific inquiry. Future research should investigate how students' views about scientific inquiry and their development of SEPs evolve over time. This can provide deeper insights into how inquiry-based learning curricula can support student development in science content and practice skills, refining pedagogical approaches.

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Isolating Deuterium Isotopes Via Quantum Filtering

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ABSTRACT

Heavy water (D2O) and hydrogen isotopes such as deuterium provide a vast array of applications in modern technology. This includes implementations like optimizing nuclear reactions or calibrating magnetic resonances (MR) instruments. Given its shared chemical properties with protium, deuterium isotopes can only be separated from its lighter counterpart by leveraging differences in its nuclear properties. Current separation techniques for separating hydrogen isotopes require appreciable amounts of energy. This research considers the alternative technique of sieving such particles using the quantum mechanical nature of graphene monolayers presented by its two-dimensional, honeycomb lattice structure. The motivation of this research is to employ a separation system that is more energy-effective than current methods. We investigate the effectiveness of graphene as a quantum filter by computationally simulating the dynamic behaviors of interacting isotopes. First, we numerically solve Newton's laws to determine the classical trajectories and equilibrium positions of isotopes above the monolayer surface. Then we use two quantum mechanical approaches to find the quantum transmission probabilities and flow rates of isotopes across the graphene monolayer.

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Modeling Cell Behaviors with Deep Reinforcement Learning

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ABSTRACT

Cell behaviors are determined by interactions within and around the cell, which can be modeled within computer-simulated environments. Research efforts are currently underway to understand how cells are influenced by intercellular mechanical interactions, an example of which is cell movement. The movement of a cell from one location to another is important for proper immune response and tissue development, while aberrant cell migration is relevant during the progression of various diseases, such as cancer. Hence, investing time and effort to uncover patterns behind tumor cell migration could lead to better strategies for cancer treatment. Our research employs AI-based modeling to recreate cell migration, incorporating reward systems in Python and MATLAB to identify an optimal path from a starting point to an end goal. Utilizing a reinforcement learning approach, we created a grid environment where an agent would navigate to a set destination within a certain step count to receive a reward. The agent iterates through the environment multiple times, learning from each iteration, eventually generating the path within a certain number of steps. We monitored the changes in behavior when variables such as learning rate, chance to behave randomly, prioritization, and rewarded actions were adjusted, each distinctly altering how agents seek out paths. These early findings suggest that controlling modeled cells within more complex simulated environments could lead to better understanding the patterns governing cell migration in real world environments.

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Priming Effects on the Phonological Level

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ABSTRACT

This study examines the effects of phonological priming on sound recognition in spoken words. Phonological priming occurs when a preceding word, or "prime," influences the perception of a similar-sounding word. The position of sound overlaps — whether at the beginning or end of a word— affects how quickly listeners recognize a word. There is some debate among different theoretical models of word recognition and how they explain the position-dependent effects on word recognition; they will depend on the position of overlap, whereas others do not. What is even less clear is whether the ability to recognize specific sounds in a target word also depends on position of overlap between two words, and whether the effect will be the same or different from the effect on word recognition. This study investigates this question. To this end, we will recruit 70 participants aged 18-40, with no hearing loss or speech disorders, who are native American- English, monolingual speakers from a young age. Participants will hear pairs of words and make quick decisions about the sounds they heard. This study will serve as a foundation for follow-up studies in the lab, including a follow-up experiment on the effect of noise on priming effects. Together, the results will speak to models of spoken language processing, which could potentially impact research on how to improve speech recognition technology. My interest is in marketing and communication, and so I am interested, in whether there would be any implications for marketing strategies or public speaking practices.

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The Relationship Between Sleep and Cognition Among Older Adults with Impaired Mobility

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ABSTRACT

Poor sleep patterns can lead to cognitive decline, increasing fall risk among older adults. Despite the known impact of sleep quality and cognitive function on fall risk, the specific relationship between these factors among fallers and non-fallers is not well understood. This study examines the relationship between sleep and cognition in older adults with impaired mobility, comparing fallers and non-fallers. The study recruited n=12 older adults with impaired mobility, aged 65 and older, with self-reported balance/walking impairment. Participants were categorized into fallers (n=8; Age: 83.1 years, MOCA=23.5, 37.5% Female) and non-fallers (n=3; Age: 86.3 years, MOCA=21.3, 0.0% Female) based on their fall history in the past year. Each participant underwent cognitive assessments including the MOCA, Rey Auditory Verbal Learning Test (RAVL), Digit Symbol Substitution Test (DSST), and Trail Making Tests (TMT). They wore an activity monitor on their non-dominant ankle for 7 days to track sleep parameters. Pearson correlation analyses were conducted to explore the relationships between sleep and cognition measures within each group. The analysis revealed no significant correlations between sleep and cognition measures in both fallers and non-fallers. For instance, the correlation between TMT and sleep efficiency was r=-0.078 (p=0.854) in fallers and r=0.912 (p=0.269) in non-fallers. These findings suggest that sleep and cognition measures do not have a strong linear relationship that differentiates fallers from non-fallers. However, the results should be interpreted with caution, as only 12 participants have been tested so far, and data collection is ongoing.

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Modeling Tumor and Cancer Stem Cells in the Presence of TGF-β Treatment, Cancer Immunotherapy in Form of CAR-T, and Effector Cells

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ABSTRACT

In this work, we study a model for capturing cancer stem cells and tumor cells population in the presence of Transforming Growth Factor-Beta (TGF-β) treatment, cancer immunotherapy treatments in form of Chimeric Antigen Receptor (CAR-T) cells, and effector cells. The purpose of the combination therapy is so that the cancer cells do not become resistant to treatment due to their treatment adaptability. The cancer stem cells are a subpopulation of cancer cells that cause the proliferation of the tumor cells. The tumor cells on the other hand, are assumed to be the normal cancer cells. The CAR-T therapy uses immune cells called T cells that are genetically altered in a lab for locating and destroying cancer cells more effectively. The TGF-β cells, which are either tumor promoter or suppressor, are multifunctional cytokine that acts in a cell. The Regulatory T-cells regulate the immune system and stop it from going into overdrive. The model discussed here is made up of a system of differential equations capturing the populations: tumor stem cells (T), cancer stem cells (S), CAR-T cells (E) and (C) targeting the tumor and cancer stem cells, respectively, the TGF-β cells (B), and the T-cells (R). The tumor and cancer stem cells are assumed to have a logistic-like model, a model well known for capturing population counts. The parameters in the model are estimated using the Least-Square estimation scheme. The model is verified by applying it to capture lung cancer stem cells in mice.

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Quantifying Behavioral Patterns in a Mouse Model of Movement Disorder

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ABSTRACT

Movement disorders (MD) refer to a collection of neurological disorders that lead to abnormal motor control, which is a considerable public health concern. One barrier in the development of therapeutic options for patients is a scarcity of approaches to identify motor anomalies in pre-clinical models (e.g. rodents). Traditional motor behavior testing in laboratory animals typically requires specialized equipment, which are unable to capture natural movements that reflect pathological motor epochs in patients. Here, we implemented recently developed software packages to analyze complex mouse behavior patterns. Our protocol enables mice to freely explore their environment while also using simple materials available to every researcher. We identified discrete behavioral syllables using generative machine learning and developed methods for analyzing additional behavioral metrics. We applied this approach to a novel mouse model of MD and explored the value of adrenergic pharmacology to adjust behavior patterns. Altogether, this framework is anticipated to better evaluate therapeutic options in pre-clinical MD models.

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Reversing Abstract Machines in Lambda Calculus

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ABSTRACT

Lambda calculus is a low-level Turing-complete functional programming language used to help design and implement functional languages. Understanding how to compute reducible terms in lambda expressions can better help languages to evaluate code, this in turn opens the door to several applications like optimizations in runtime and reversibility. Our focus is on reversibility, or the ability to return to any previous state without loss of information. Being able to run code in the backward direction eliminates the need for more code to undo an action, also reversible computation may use less energy due to small requirements to dispose of information. However, to fully use reversibility, we must show that it is viable on the lowest level of programming (lambda calculus). Prior research by Malgorzata Biernacka et al (2022) produced a non-reversible machine capable of executing lambda expressions. Our study aims to show that our simpler and more condensed machine has an equivalent structure, which in turn would be more amendable to execute forward and backward terms. Currently, we are proving that our machine has an equivalent structure to Biernacka's machine; we are doing this by applying induction on the size of a given lambda expression, and then showing that no matter what step the machine takes to evaluate it, the result will be the same as if Biernacka's machine evaluated it. In the future, we plan to finish our proof and add reversibility to our machine.

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Impact of Castration on Blood Pressure and Arterial Stiffening in XX and XY Male Mice

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ABSTRACT

Androgen deprivation therapy increases the risk for cardiovascular disease (CVD). Recently, we have shown that young castrated, compared to testicular intact XX and XY male (M) mice, have increased pulse wave velocity (PWV) and aortic collagen deposition. Therefore, we tested the hypothesis that castrated middle-aged XXM, compared to XYM mice, will have increased blood pressure, PWV, and body composition. We used castrated middle-aged XXM and XYM mice (n=7-9/group). Blood pressure was assessed using tail-cuff plethysmography, PWV by the Doppler flow velocity system, and body composition by Minispec analyzer. All data was analyzed using an unpaired t-test using GraphPad Prism 10. There were no significant differences in blood pressures, including mean arterial blood pressure (MAP; P=0.5) of XYM (82±1 mmHg) and XXM (84±2 mmHg) mice. PWV was greater in XXM (3.0±0.2 m/s) than in XYM (2.7±0.1 m/s) but not statistically significant. XYM versus XXM body composition showed no significant difference in body mass (29±1 g vs. 30±2 g), lean mass (17±0.5 g vs. 17±0.9 g), and fat mass (5±2 g vs. 5±3 g). Pearson correlation indicated a significant correlation between body mass and lean mass (P=0.006) but not with PWV (P=0.09) and MAP (P=0.2). Our data suggests that castrated middle-aged mice with XX or XY sex chromosome complement have no statistically significant differences in arterial stiffening, blood pressure, or body weight composition under a standard chow diet. Ongoing studies include left carotid artery ligation and a high-fat, high-cholesterol diet coupled with adenovirus to deliver PCSK9 for atherosclerotic development.

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Boron Nitride Quantum Dots as Nanocarriers and Imaging Agents for Cancer

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ABSTRACT

Introduction: Nanotechnology refers to the manipulation and utilization of materials and structures at the nanoscale, typically ranging from 1 to 100 nm. Nanomedicine utilizes these structures for targeted drug delivery, imaging, sensing, and therapy at the molecular level. Among numerous nanomaterials, hexagonal boron nitrides (hBNs) stand out with their low toxicity, therapeutic, carrier, and optical properties. They also show photoluminescence (PL) properties due to single photon emissions which have potential to be used for high-resolution medical imaging. The source of PL is considered to originate from structural defects during synthesis. In this study, we aimed to manipulate the defects formed during their synthesis or during exfoliation with sonication.

Methods: A VWR Sonicator with 35 kHz frequency and 144 W power was used for sonication. With the aim of influencing hBNs' PL property, five amino acids, glycine, phenylalanine, lysine, glutamic acid, and serine, possessing -H, -phenyl, -NH_2, -COOH, and -OH, -R groups, respectively, were used. Thus, hBNs were dispersed in diH_2O, or amino acid solutions and sonicated at increasing times. Absorption and PL emission were monitored using a UV/Vis spectrometer and Fluorometer.

Results: The sonochemical effect during exfoliation of hBNs in the presence of amino acids influenced the defects present in the hBNs structure.

Conclusion: The study concludes that sonochemistry has a great potential to modulate the PL emission of hBNs for their variety of applications. Although more work should be done, using amino acids as modifiers gives the opportunity to prepare hBNs for carrying cancer drugs and high-resolution biomedical imaging.

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National Area Health Education Centers Organization (NAO) Preceptors' Survey: Assessing Workplace Mental Health and Well-Being

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ABSTRACT

Introduction: In response to rising concerns over the health of U.S. healthcare workers, the U.S. Office of the Surgeon General has emphasized the importance of addressing burnout, loneliness, and poor workplace conditions.

Methods: This study presents the findings of the National Area Health Education Centers Organization (NAO) Preceptors' Survey 2024, aimed at assessing the workplace mental health, well-being, burnout, loneliness, and fulfillment of health professional preceptors across the United States. The survey, conducted between November 2023 and February 2024, involved 123 respondents from 49 states who serve as preceptors in the Area Health Education Centers (AHEC) program.

Results: A notable 58.2% reported that precepting contributes to burnout, while 41.8% experienced burnout, and 45.3% felt loneliness. Despite these challenges, 92.5% of respondents reported a high quality of life, and the overall workplace mental health and well-being were rated positively on the Augusta Scale. Advanced Practice Nurses (APNs) reported the highest rates of burnout and loneliness, while Physician Assistants (PAs) reported the lowest.

Discussion: These findings highlight the need for targeted interventions, such as training programs to address burnout and promote work-life harmony, and workshops on career and life planning to enhance preceptors' well-being and fulfillment. This survey underscores the critical role of preceptors in the healthcare system and the importance of supporting their mental health and well-being.

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