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"Featured Article of the Current Volume"

Computational Biology & Bioinformatics/ Evaluation of Brain Structure and Function in Currently Depressed Adults with a History of Early Life Stress

Joshua Jones
University of Rochester

ABSTRACT

Early life stress (ELS) is often a precedent of major depressive disorder (MDD). Critical regions in this connection include the dorsolateral prefrontal cortex (DLPFC), anterior cingulate cortex (ACC), hippocampus (HIP), and amygdala (AMY). Previous studies demonstrate structural differences exist in these regions exposed to ELS. These regions are also implicated in MDD pathophysiology, however, most biological findings in MDD do not account for ELS. Structural findings demonstrate that ELS can reduce volumes in certain regions when MDD is present, however, the functional aspect has yet to be considered. To address this question, in this study, 86 currently depressed participants were subjected to a Childhood Trauma Questionnaire (CTQ) and completed a multimodal neuroimaging study. From these images, structure (volume or cortical thickness) and function (metabolism) were calculated. I hypothesized that MDD patients with history of ELS, compared to those without ELS, will exhibit a reduced volume/thickness and metabolism in the DPLFC, ACC, HIP, and AMY. The results demonstrate that metabolism and cortical thickness of the DLPFC were significantly different across childhood trauma levels, as was metabolism of the ACC. Volume of HIP and AMY were significantly inversely correlated with total CTQ score. Additionally, a significant correlation between DLPFC thickness and metabolism (p=.006) was found. This study successfully provided a comprehensive examination of the relationship between neurobiology and ELS within MDD.

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The Effect of Contracting COVID on Speech Perception in High-School Students: Evidence from the Brain

Shaun Karani

ABSTRACT

Increasing evidence suggests that Coronavirus Disease 2019 (COVID-19) caused by SARS-CoV-2 has affected the global population, but a group often overlooked is the adolescent population. Facing milder symptoms of COVID-19 as compared to their older counterparts, adolescents are not the prime focus of COVID research. This study measured the impacts of COVID on teenage neural processing and speech perception.The current study compared the neural response to speech sounds in high-schoolers with and without a history of contracting COVID. event-related potential paradigm was used, and the electro-encephalogram (EEG) waves were time-locked to each speech stimulus. The mismatch negativity responses (the difference between the standard and deviant sounds) were compared between the two participant groups. The two English vowels /ɪ/ and /ɛ/ were used in a nine-equal-step continuum as stimuli.Overall, adolescents without a history of COVID showed larger standard and deviant responses at all three brain regions and across both standard and deviant conditions, except deviant conditions at the dominant hemisphere. Taken together, these findings suggest that contracting COVID may have long-term effects on the brains of adolescents. Future studies may examine the longer-term effect of COVID on the developing brain, given that participants of this study who had COVID were tested within 6 months of recovery.

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The Effects Of Chemical And Physical Sunscreens On Aquatic Invertebrates

Jacqueline Quinn

ABSTRACT

Two types of sunscreen are produced: chemical sunscreens containing oxybenzone and physical sunscreens containing nanoparticles (titanium dioxide and zinc oxide). Oxybenzone and nanoparticles have previously been tested on saltwater organisms and had various negative effects, so I tested both sunscreens on the freshwater invertebrate, Streptocephalus (redtail fairy shrimp). I predicted: 1.) More fairy shrimp in the control sample would survive the entire six-week trial, and 2.) Chemical and physical sunscreens presence, respectively, would curb growth among the surviving organisms. I placed twenty fairy shrimp in each tank, keeping food and light consistent among the three tanks; the only variables being chemical sunscreen (Experimental Tank 1) and physical sunscreen (Experimental Tank 2). Tank 2 (physical sunscreen) had a mortality rate of 20%, Tank 1 (chemical sunscreen) had a mortality rate of 15%, and no mortality in the control tank (Tank 3), meaning the sunscreens had a significant impact on the mortality of the fairy shrimp; however, there was no correlation between the weight of fairy shrimp and the effects of chemical or physical sunscreen ($p > 0.05$). I also observed the behavior, finding that, after three weeks the experimental fairy shrimp (Tanks 1 and 2) moved at a much slower rate than the fairy shrimp in the control tank.

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Study on DNA Intercalation and Gene Mutation by Photoproducts

Mu Ping(Kenny) Yu

ABSTRACT

UV-induced DNA damage is crucial in the onset of melanoma and other photobiological effects. If affected cells do not undergo apoptosis, the resulting DNA lesions can become mutagenic, potentially activating proto-oncogenes. The wavelength of UV radiation strongly influences the type and severity of DNA damage. Specifically, UVB radiation causes the formation of DNA photoproducts through cycloaddition reactions between adjacent pyrimidine bases.This study investigated a common type of photoproduct, the cyclobutane pyrimidine dimer (CPD), which forms through the cycloaddition of the C5-C6 double bonds of two adjacent pyrimidine bases. Another type, the pyrimidine (6-4) pyrimidone photoproduct (64PP), was studied since when exposed to large doses of UVB or UVA radiation, 64PP can undergo photoconversion, further altering its structure and increasing the risk of DNA damage. Also, this paper studied how BaP (benzo[a]pyrene) becomes carcinogenic only after being metabolized by enzymes into BaP diol epoxide. This metabolite was modeled using the molecular editor program when it intercalates into the DNA structure and forms covalent bonds with guanine bases, forming guanine-benzopyrene adducts.

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Comprehensive Comparison of Disease Registries for Coronary Artery Disease-Associated Genes

Stacey Krivitsky

ABSTRACT

Coronary artery disease (CAD) is the prevalent cardiovascular condition in the United States, caused by plaque buildup in coronary arteries, impeding blood flow to vital organs. This project utilizes Reactome, a comprehensive database of biological pathways and reactions in human biology, along with computational analyses, to explore large sets of biological data. Reactome defines reactions as pathway 'steps' and encompasses any event that alters the state of a biological molecule. By overlaying experimental datasets onto Reactome's annotations, researchers can perform pathway overrepresentation analyses to visualize changes in affected pathways. Multiple gene-disease databases, encompassing both manual curation and machine-driven curation, were integrated to explore the connection between biological pathways and CAD. Data was extracted from six databases, aggregated, and overlap analyses were conducted using Python. Reactome was then used to perform multiple pathway overrepresentation analyses. Comparisons were made between machine and manually curated databases, as well as among the individual databases. By combining the Reactome results and the overlap analyses results, the study identified enriched biological pathways and evaluated the suitability of each database for CAD research. Notably, DisGenNet, PHAROS, and Kegg exhibited enriched pathways that are more likely to be associated with CAD compared to pathways of MalaCards, DISEASES, and ClinVar. Furthermore, manually curated data exhibited enriched biological pathways with stronger associations with CAD than pathways of machine curated data.

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Mathematical Transformations for Fractal Designs and Enhancement of the Pixel Quality in Artworks

Louis Kyungnoh Park

ABSTRACT

In this paper, designing new fractals using Hilbert transformation and enhancing the pixel quality of artwork using the Gamma method were performed using numerical and computational processes. Scripts for linear and quadratic transformation are written for the user to enter input of various factors to change pixels and the quality of pixel values of artworks. The developed program can modify the RGB values in the codes for linear, quadratic, gamma, and log transformation. Specifically, the Gamma factor determined the type of transformation. This study aims to find a technique to restore hidden or damaged pixels in artworks. Also an alternative starter geometries that can be efficiently used in a transformation method in creating fractals was suggested. The new model can reduce operational counts and the cost of calculating complex artistic and geometrical patterns. We reviewed typical and contemporary fractal designs to develop a procedure that can be applied to various fields, such as image processing, 3D design, and pattern design. We assume modified Hilbert transformation methods exist to construct fractal designs using simpler and more efficient algorithms. That means we hypothesize that alternative starters can be efficiently used in SFC, which are used as the basic units in constructing complex artistic and geometric patterns. To test the possibility, we developed HFC analogs to determine if they would produce SFC or how fast they could fill out the

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Assessing Health-Risk Behaviors and their Associations with Suicidal Ideation in Adolescents within the U.S

Ethan Wu

ABSTRACT

Suicide is a widely increasing issue across the United States, particularly in adolescents due to the hormonal change that occur at their age. However, most research centered around suicide have focused on the adult population. This brings in an important issue of how suicide interacts with adolescents. The YRBS data set was used to gather data on adolescent suicidal behavior and their health risk behaviors. There were three questions in the survey that had suicidal information, and the user input for these questions, each participant was categorized into 1 of 6 increasing categories of suicidal ideation. Chi-square tests of independence were used to select risk factors from the data set to add into the final regression model. A separate model was created for location, and odds ratios from the model showed that every borough sampled in New York City were 18 times less likely to have higher levels of suicidal ideation compared to other locations sampled. For the health-risk behaviors, once again odds ratios were calculated from the coefficients of the ordinal regression model. The risk factors with strong positive associations with suicidal ideation were forced sexual intercourse, followed by bullying and cyber bullying. On the other hand, risk factors with strong negative associations were getting 8 hours of sleep, eating breakfast everyday, and staying physically active everyday. The implications of the findings give future researchers clear questions to investigate to battle suicide in a largely neglected population.

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Water Retention of Small-Scale Green Roofs with Edible Vegetation

Annika Spaet

ABSTRACT

Green roofs (GRs) are typically used to retain stormwater and are increasingly being used to produce food by growing edible vegetation, such as Mad Hatter Peppers (Capsicum baccatum). However, there have been conflicting studies on whether GRs can feasibly produce Capsicum baccatum in GRs compared to in-ground production. To test this, water retention was compared among small-scale models of three different vegetation types: two Sedum setups, two Capsicum baccatum setups, and one bare setup. The models used water storage compartments and moisture retention fabric to increase water retention and to reduce the need for irrigation. There was not a statistically significant difference in water retention between the different vegetation types, and the Capsicum baccatum wilted by the end of the study, so it did not produce food. These results indicate that Sedum should be used in future GRs because they can provide many benefits other than water retention, whereas Capsicum baccatum may not be healthy enough to provide other benefits.

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The Effect of Astragalus membranaceus Root Extract on Parkinson Inflicted Caenorhabditis elegans

Jun Lin, Donato Massimo Brogna, Omar Chaudhry

ABSTRACT

The effect of Astragalus membranaceus on Caenorhabditis elegans was assessed in this experiment. Parkinson's Disease directly causes dopamine depletion and other related symptoms. Astragalus contains complex carbohydrates linked to dopamine neuron protection, which could be used to treat Parkinson's. In this experiment, C.elegans inflicted with Parkinson's were treated with different concentrations of Astragalus. C.elegans are free-living nematodes that can be genetically engineered to model or stimulate various diseases caused by genetics, Parkinson's being one of them. The concentrations of astragalus solution were 2 mg/mL, 4 mg/mL, and 8 mg/mL, which were added to the agar that the C.elegans inhabited. Mechanosensory tests included tap reflex and gentle and harsh touch assessment. M9 Buffer was used to inhibit the egg-laying behaviors of C.elegans, and the thrashing rate was assessed for each group. The results indicate that 4 mg/mL is the optimal concentration to treat disease-inflicted C.elegans and had the best results out of the 3 trials. The 4 mg/mL group constantly had the highest tap reflex, gentle, and harsh touch scores that were similar or greater than the wild-type control group. Additionally, the 2 mg/mL also had high scores in trials 2 and 3 in both the gentle and harsh touch assessments. No definite conclusions can be determined from thrashing rate data. The results imply that lower and intermediate concentrations of Astragalus may treat the symptoms of Parkinson's Disease.

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Enhanced Presence of Inflammatory Mediators MAG Lipase and COX-2 in Severe Osteoarthritis

Mariam Hassan

ABSTRACT

Osteoarthritis (OA) is the degradation of joint cartilage and bone, resulting from joint overuse and injury. The endocannabinoid system (ECS) is a molecular system that regulates bodily functions, including pain, inflammatory responses, and immune responses. Within the ECS, cyclooxygenase-1 (COX-1), cyclooxygenase-2 (COX-2), and monoacylglycerol lipase (MAGL) function within a pathway that produces prostaglandins to signal pain. This study observed the differences in the amount of pain signaling proteins of interest (CGRP, MAGL, COX-1, and COX-2) present in knee samples of differing OA severity. It was hypothesized that OA samples that were assigned a higher grade of arthritic severity based on the Kellgren-Lawrence scale would have greater levels of these proteins, indicative of more pain being relayed in more severe cases of arthritis. Knee OA samples were collected and analyzed from patients receiving knee replacements (n=10) from June to August 2022. Immunohistochemistry techniques were used to identify and score proteins of interest (COX-1, COX-2, MAGL, and CGRP) within fixed tissue samples. When the presence of pain-signaling proteins were compared between samples of moderate to severe OA degradation, significantly more COX-2 and MAGL were found in more severe arthritic samples, leading to the hypothesis being supported. It was observed that drastic differences in protein levels based on arthritic severity were seen in the superficial cartilage of the sample.

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The Effects of Architecture on the Human Psyche and Behavior

Catherine Shin

ABSTRACT

Architecture can significantly impact human thoughts, moods, and behaviors by shaping the environments in which people live, work, and interact. For example, a bright, well-ventilated space with a balanced layout can provide calmness and well-being. In contrast, a dark, congested space can negatively affect our mental health, causing stress and anxiety. The choice of natural materials can convey a sense of warmth and comfort, while cold and sterilized spaces can instill a feeling of distance and coldness. Architectural psychology, consisting of studies of the interrelationship between humans and their surroundings, reveals that design elements such as space, light, color, and materials can profoundly affect individuals' mental states and social behavior. Therefore, a more well-developed understanding of the psychological aspect of architecture and how the human brain reacts to its environment can help extend our desire to create structures and man-made environments with purpose and impact.

This paper explores how architectural design influences psychological states and actions, drawing on insights from B.F. Skinner's Science and Human Behavior, David Graeber's The Utopia of Rules, and contemporary perspectives. As a result, our study concludes that understanding psychological influences is essential for architects and designers to create spaces that improve the quality of life for people by promoting their well-being, productivity, and social cohesion both at home and within the workplaces we frequent.

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Developing a Hydroponics System with the Incorporation of an Arduino Uno-Powered pH Sensor

Sofia Maciel-Seidman

ABSTRACT

From 2005 to 2050, crop demands will increase by 100% to 110% and 50% of land will not be suitable for agriculture (Monsees, 2019). To address this issue, we developed a cost-efficient hydroponic system. In phase 1 of our project, we compared the growth of plants in a long, shallow system and a deep, short system. All p-values were over 0.05, indicating that there is no difference in plant growth between the two different tub sizes.. During phase 1 we faced problems with consistently measuring the pH which led to the wilting and deaths of some plants due to over absorption of nutrients. We decided to focus on pH in our phase 2 project with two main goals: to design a cost-efficient hydroponic system that is sustainable to grow fresh basil and to develop a pH sensor with the use of Arduino Uno that provides accurate, instant readings. The sensor monitors and records the system's pH, notifying users when the pH is not in its optimal range of 5.500-6.500. The sensor was connected to a spreadsheet and LED lights outside of the hydroponic system that lit up when the pH was too high or too low, allowing for modifications to be made. This system offers an alternative method of monitoring of pH, while still being financially accessible.

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