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Dear Researchers,

We are thrilled to address you, the driving force of innovation and intellectual curiosity. Your dedication to advancing knowledge and pushing the boundaries of research is truly commendable.

As young researchers, you are not just scholars; you are pioneers. You have the unique opportunity to challenge conventional wisdom, to take risks, and to uncover new paths. Embrace this opportunity with enthusiasm, for it is through your courage and creativity that the boundaries of human knowledge are expanded.

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With admiration for your commitment to knowledge and discovery,

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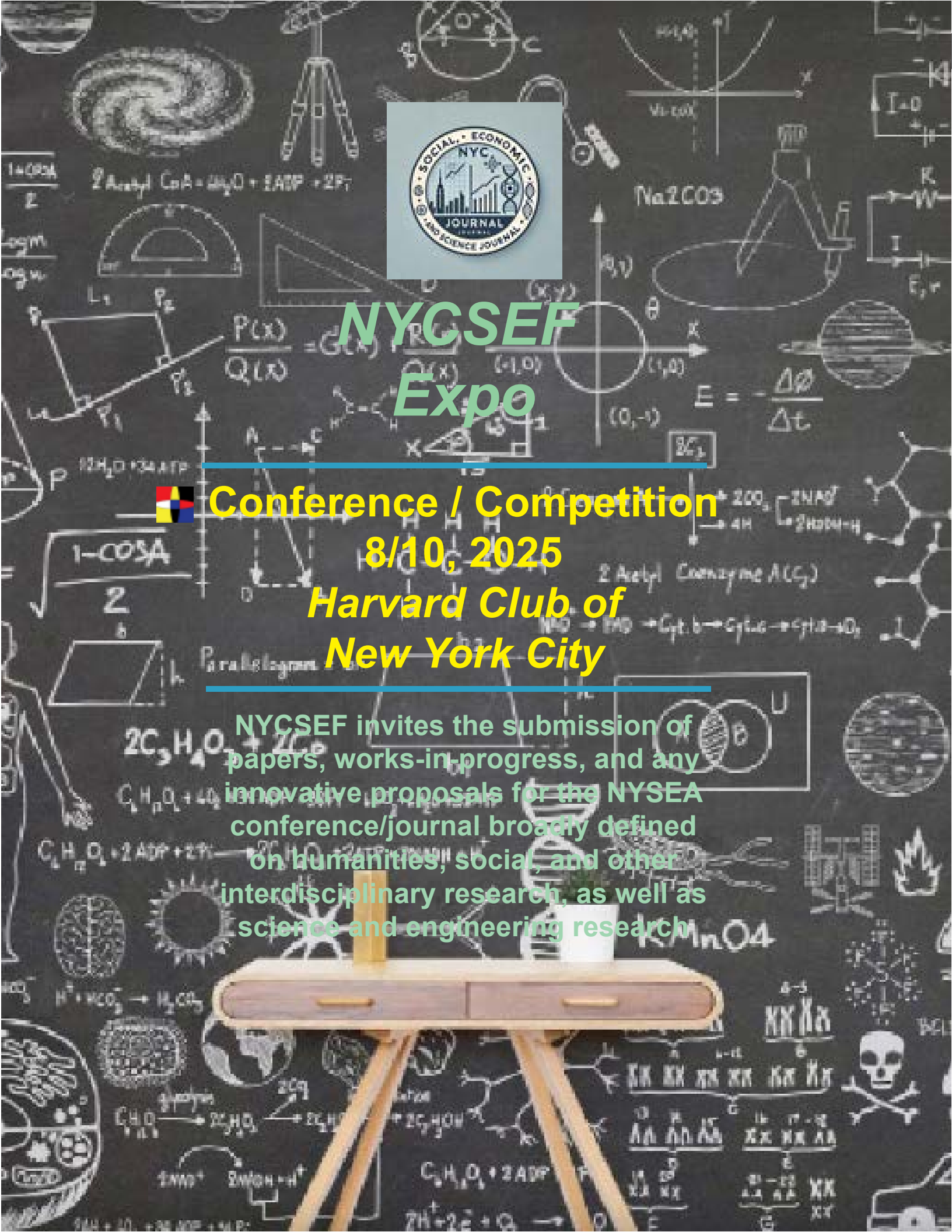
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Seeing Through the Scan: The Impact of fMRI Evidence on Juror Satisfaction and Verdicts

Isabella Souza

Columbia Unversity

Abstract - The areas of the brain that become active when formulating a lie, or "deceit patterns", are denoted on fMRI scans, yielding results that are more accurate than the polygraph. Using publicly available court records and fMRI results obtained from previous literature, the extent to which fMRI scan evidence influences juror confidence, perceived strength of argument, and verdict counts between participants serving as mock jurors in a mock trial exposed to fMRI scan evidence and those not exposed to it were compared. Analysis of these metrics revealed that a mock juror's exposure to fMRI evidence increases their perceived strength of the argument for the side consistent with their verdict and drastically changes the distribution of guilty versus not guilty verdicts. The difference in confidence levels between mock jurors in the control and experimental groups was not found to be statistically significant, however future research using a larger sample size may verify the current trend that viewing fMRI evidence increases juror confidence in their verdict. Although fMRI evidence possesses the potential to revolutionize the way juries lend weight to pieces of evidence, because it was found to cause such significant shifts in juror decision making, court judges should caution its admission into evidence or further scrutinize its credibility during evidentiary suppression hearings until it is deemed generally acceptable by the scientific community.

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Evaluation of Brain Structure and Function in Currently Depressed Adults with a History of Early Life Stress

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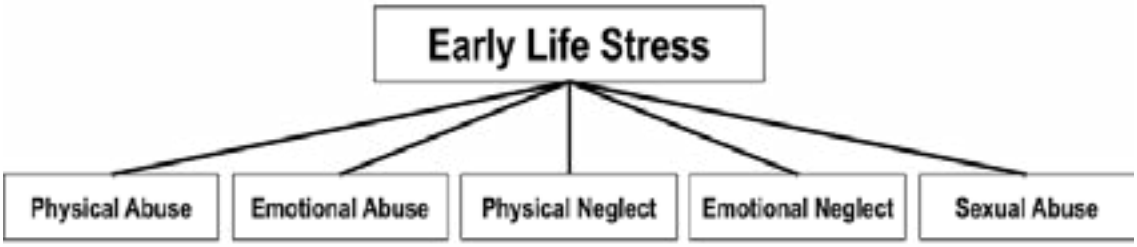
Abstract - Even though Major Depressive Disorder (MDD) is the leading cause of disability worldwide impacting over 300 million individuals, early detection and intervention is hindered by the limited knowledge of its underlying mechanisms [1]. One association found to be significant within MDD is the presence of early life stress (ELS), such as sexual abuse [2], emotional abuse [3] and family conflict [4]. However, the biological mechanism linking ELS and MDD are unknown.

Figure 1: Five Main Categories of Early Life Stress



The Childhood Trauma Questionnaire divides ELS into five groups: Physical Abuse, Emotional Abuse, Physical Neglect, Emotional Neglect, and Sexual Abuse

Source: Student Generated

The relationship between ELS and depression may be through the detrimental effects of ELS on the developing brain, including in emotional regulation and network architecture [5]. ELS can lead to impairments in the regulation of stress which may occur through improper neurodevelopment of the hypothalamic pituitary adrenal (HPA) axis

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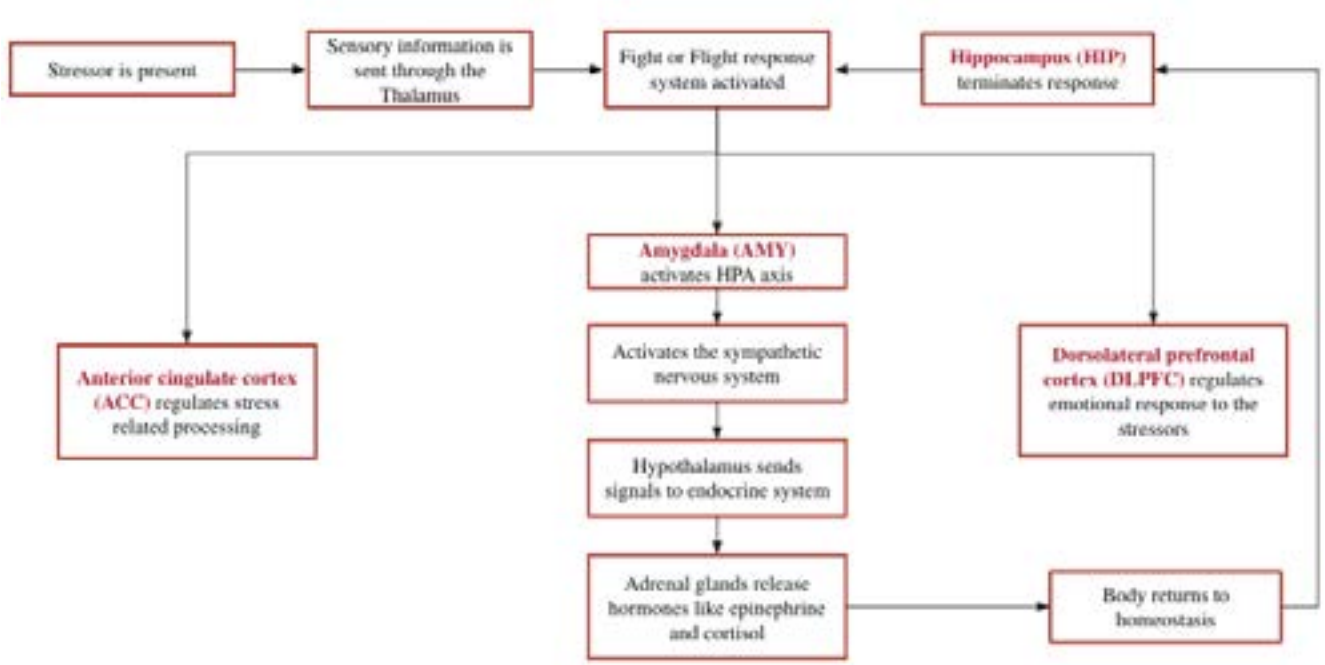
and corticolimbic circuits [6, 7]. Critical regions in this circuitry are the dorsolateral prefrontal cortex (DLPFC), anterior cingulate cortex (ACC), hippocampus (HIP), and amygdala (AMY), which are known to play an important role in memory as well as emotions [8, 9], and for coordinating responses to stimuli [6].

The AMY, implicated in emotional response, activates the HPA and autonomic nervous system when a stressor is present. The stress is then regulated by the prefrontal cortex [10] which not only maintains homeostasis, but also assists in the detection of threats [11]. In addition to being involved numerous aspects of cognition, the ACC also contributes to the regulation of such autonomic responses [12, 13]. The HIP, a critical area which aids in memory and cognition [14], is also regarded to play an important inhibitory role in terminating the HPA stress response [15, 16] and this region appears to be highly vulnerable to change following emotional distress [16, 17].

Figure 2: Flow of the Normal Stress Response System



Demonstrates the roles of the ACC, AMY, DLPFC, and HIP in the natural stress response system. ELS can disrupt this flow and hinder the roles of these areas. **Source**: Student Generated

Chronic stress, such as ELS, can cause long-term effects in these regions [16]. Some of these effects are exhibited in Figure 3. For example, people and animals exposed to ELS exhibit smaller HIP [6, 17-19] and AMY [16, 20] volumes with a correspondingly lower dendritic spine den-

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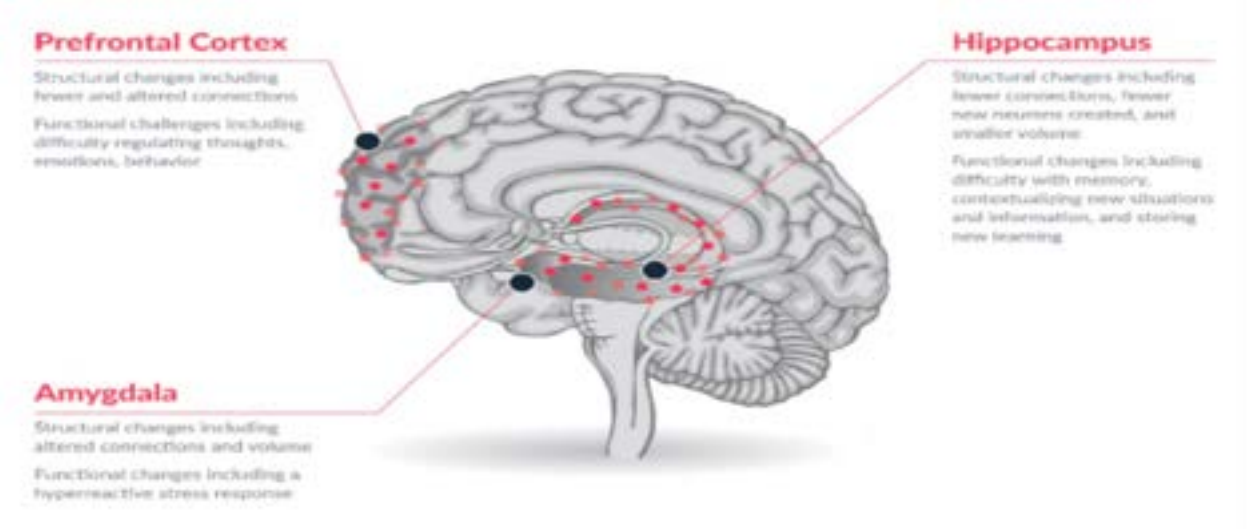
sity in these regions [15, 16, 21]. In fact, one study noted that the size of HIP and AMY volumes correlated with the severity of the ELS in people [20]. Reduced volumes were also observed in the DLPFC and ACC regions in response to ELS [5, 18, 22-27] which were also related to impaired working of short-term and long-term memories [22] and, in the case of the ACC affected self-regulatory response mechanisms [28, 29].

Figure 3: Impact of Stress on Different Areas of the Brain



Demonstrates the changes in the Prefrontal Cortex, HIP, and AMY when under stress.

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Investigating uveal melanoma using a Seurat scRNA-seq analysis of SEAM organoid gene clusters

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Abstract **-** Uveal Melanoma (UM) is the most common eye cancer with a mortality rate of 80%. However, only 1% of patients have detectable UM at metastasis and UM exhibits punctuated early growth. The origin and proliferation of UM was investigated using single-cell RNA sequencing analysis as it is currently the best method to define cell states and phenotypes. The Seurat R toolkit was used to separate the cells of a self-formed ectodermal autonomous multi-zone (SEAM) organoid and UM cells into gene clusters. These gene clusters were then identified using canonical gene markers and compared in samples with and without UM. In this way, the origin of UM was attributed to certain genetic clusters and targeted for future treatments. Distinct cell clusters with unique gene expression patterns were found in the UM datasets, which provided insight into the mechanisms underlying UM progression and facilitated comparisons between the control SEAM organoid and the experimental UM gene datasets. Moreover, the potential of the SEAM organoid model in modeling UM metastasis was verified. In the future, both in vitro and in vivo experiments will be performed to confirm the results of the scRNA-seq analysis. Additionally, RNA interference with lentivirus therapy will be tested using the SEAM organoid model to determine whether it effectively minimizes the UM phenotype.

Introduction - Uveal melanoma (UM) is the most common cancer of the eye and the second most common form of melanoma. The four-year mortality rate of patients with metastatic UM is approximately 80% (Rietschel, 2005), with a median survival period of fewer than six months (Singh, 2005). Only 1-3% of patients have detectable metastases at diagnosis (Rietschel, 2005), and UM exhibits punctuated early growth (Field, 2018), so rapid and early treatment is critical to long-term survival. Unfortunately, within 2.4 years after primary tumor treatment, 50% of UM patients develop metastasis, often to the liver (Nabil, 2015), so the minority of patients who have successfully

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treated their initial occurrence of UM are still at long-term risk (Kolandjian, 2013). Given the poor prognosis of those diagnosed with metastatic UM and the lack of a documented cure, a deeper understanding of the origin and mechanism behind UM cell proliferation is essential to the development of future treatments. In fact, BAP1, SF3B1, or EIF1AX mutations are critical to UM proliferation (Field, 2018), and BAP1 loss leads to tumor cells devolving to have the stem cell-like properties associated with the neural crest (Kuznetsov, 2019).

Currently, researchers use animal and human cell lines to test UM treatments. Unfortunately, animals have different genetic makeups than humans, leading to potential inaccuracies. However, human tissue samples cannot be controlled for and are not only highly individual, but also prone to contamination and mutation, preventing universal reproducible results. Created by Dr. Blenkinsop of the Icahn School of Medicine, the SEAM organoid model is a cluster of selectively differentiated stem cells produced in vitro to overcome the limitations of animal and human cell lines. By analyzing if the SEAM model accurately reflects the human eye, the possibility of effectively testing UM treatments on the model can be determined.

Single-cell transcriptional analysis (scRNA-seq) shows the gene expression profiles of individual cells within a gene population and is currently the best method to define cell states and phenotypes (Tanay, 2017). Currently, Seurat is the most accurate and efficient scRNA-seq analysis toolkit (Zhao, 2019). Since gene expression patterns can be identified using gene clustering analysis, rare cell types and developmental processes can be mapped, facilitating the location of diagnostic and therapeutic targets for various eye-related diseases. The plot created by the scRNA-sequencing analysis visually represents the data that will be compared to an online database of genes like Enrichr and GeneCards, and it can be used to identify whether the SEAM organoid model is truly effective in replicating every region of the human eye for future UM treatment purposes. Moreover, the data can then be compared to UM scRNA-seq datasets to identify the mutated genes that need to be targeted for potential therapies.

The gene expression and number of cells will be evaluated to determine whether the SEAM organoid model accurately represents each eye region. Additionally, the gene clusters containing genes specific to UM were identified by creating a map of SEAM organoid scRNA-seq gene clusters and comparing it to UM's gene clusters, which will indicate genes involved in uncontrolled cell proliferation and allow for targeted therapies to be developed.

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The Effect of Cetirizine and Loratadine on the Photosynthetic

Lucas Papamitsakis
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Abstract: The study of well-being has become increasingly important in society during the past few decades, especially after the COVID-19 Pandemic. While exploration of the different features of individual well-being has grown substantially, research has lagged in comprehending trends of global-scale well-being. This paper aims to delve deeper into the properties that make up global well-being and to track the indicators that yield the greatest influence on a nation's quality of life. Such findings could help guide government policies for the improvement of public life and provide a more abstract understanding of measuring general well-being. To conduct this analysis of 183 countries, I compiled seven socioeconomic indicators from the United Nations Human Development Programme and The World Bank, and I chose the Human Development Index (HDI) to represent the well-being of each country. I utilized the Python language to deploy multivariable Linear Regression models to analyze the extent to which each indicator influences the HDI of a country, and I validated the observed relationships using regression slope t-tests, Mean Test Error, and R-squared. This study found that the College Enrollment and Control of Corruption indicators demonstrated a universal positive correlation to HDI, regardless of developmental or regional differences in countries, while the other chosen indicators varied in influence from region to region. Governments of developing countries could use the detailed impacts of each indicator to properly allocate funds to improve the necessary socioeconomic aspects of their societies.

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Efficacy of Mask Use in Reducing Sars-Cov2 Infection Rates

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Abstract: SARS-CoV-2, a novel coronavirus also known as COVID-19, has caused a global pandemic, claiming the lives of over 3 million people, and counting. Governments and local polities have implemented public health mandates to reduce the spread, including mask-wearing, a policy that remains controversial. The aim of this study was to examine how effective strict enforcement of mask-wearing policies is in reducing COVID-19 infection rates. A total of 30 countries and subnational political jurisdictions were selected using Text Finder's random choice generator, then sorted into three categories of mask enforcement: strict, moderate, and lax, characterized by punishments, non-enforcement, or lack of precautions. The percent changes in cases were recorded over a 3-month period prior to and after the declaration of mask mandates for each locality, then analyzed using the Kruskal-Wallis test to rank the three categories. The mean rankings from greatest to least were: lax (24.90), moderate (12.90), and strict (8.70). The Kruskal-Wallis test result was H(2)= 18.240, P=.000. Locations with stricter mask policies had lower infection rates. Therefore, it was concluded that strictly enforced mask policies were most effective in limiting COVID-19 transmission. Confounding variables include political agendas, the sway of public opinions, and a transient lack of data on COVID. Future research could analyze the effectiveness of mask enforcement in locations with different COVID-19 variants.

Keywords: SARS-CoV-2, masks, infection rates, mask enforcement, Kruskal-Wallis test

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Neurobiology of Suicide: Claudin-5 Is a Biomarker Process of Chlorophyta

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Abstract: Every forty seconds, suicide steals a life, yet no biomarkers exist for suicide. Suicide has largely been investigated from a psychological lens, and therefore the pathogenesis remains unclear. This study investigated blood-brain barrier (BBB) claudin-5 breakdown, the most enriched BBB tight junction, as a biomarker for suicide. Human de-identified postmortem brain tissue (n=20) was stratified based on suicide as a cause of death. ELISAs assessed cytokine and claudin-5 levels, St. Paul-Ramsey Scale (SPRS) evaluated stressful life events, and an immunolabeling solvent-cleared organs protocol determined claudin-5 anatomical localization. RNA-sequencing data from publicly available repositories was aligned to perform pathway enrichment and differential expression analyses. Molecular docking software PyRx determined whether current medications to treat suicide and anti-inflammatory compounds dock with claudin-5. IL-6 and IL-8 were higher in suicide cases ($p < 0.05$) indicating neuroinflammation and claudin-5 was increased in the brain of suicide cases ($p < 0.05$). Photomicrographs indicated mislocalization of claudin-5 in neurons and brain microvessels of suicides. Inflammatory and neurodegenerative pathways modulating claudin-5 degradation were found. BBB destabilizing matrix metalloproteinase-1 (MMP-1) was upregulated ($log2F2 = 4.10$, $p < 0.001$), and aquaporin-1 (AQP1) was downregulated ($log2F2 = -1.58$; $p < 0.001$) in suicide. Molecular docking indicated a weak affinity of antidepressant medications for claudin-5, but a strong affinity for medications targeting MMP-1 and AQP1. High claudin-5 levels and SPRS scores could serve as pre-markers for suicide. Future in vitro assessments should evaluate the novel therapeutics promoting claudin-5 for suicide risk prevention.

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Physiological Effects of Biotite-EMF Exposure: Immune, Metabolic, and Hemodynamic Outcomes

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Abstract: This study examines the physiological effects of chronic exposure to a low-intensity (0.5 Gauss) electromagnetic field (EMF) emitted by biotite (iron-rich black mica) embedded in a sleeping mattress. Ten healthy participants slept on the biotite mattress for 60 consecutive nights, with biomarkers measured at baseline (D0) and post-exposure (D61). Key outcomes included:

Immune Enhancement: Natural Killer (NK) cell activity increased by +78.8 LU30 (14.5%, p = 0.001), suggesting EMF-induced immunomodulation, potentially via Ca2+ signaling pathways documented in prior in vitro studies (Karolinska Institute, 2018).

Metabolic Shift: Urine pH rose from 5.97 to 6.74 (Δ+0.77, p < 0.0001), indicating systemic alkalization. This aligns with EMF's proposed role in reducing oxidative stress, as biotite's iron lattice may act as a redox buffer (KAIST, 2020).

Hemodynamic Improvement: Transcranial Doppler (TCD) revealed +7.9 cm/s (p < 0.001) in cerebral blood flow velocity, consistent with EMF-mediated vasodilation, possibly through nitric oxide (NO) upregulation (Journal of Circulation Research, 2021).

These results demonstrate that prolonged 0.5 Gauss EMF exposure from biotite significantly enhances circulatory efficiency, immune surveillance, and acid-base homeostasis. The findings support the hypothesis that weak EMFs can act as a non-invasive biophysical stimulus, with implications for integrative therapies targeting chronic inflammation, fatigue, and metabolic acidosis.

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Human Hepatic Liver Stellate Cells and Hepatocytes

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Abstract: Vitamin A, not naturally produced by the body, undergoes a series of metabolic steps to become retinyl esters, which are then stored and activated in the liver. Before being stored as retinyl ester in HSCs (hepatic stellate cells), though, the liver receives retinol bound to chylomicrons from the intestine and transported through the blood. It is known that retinol is first released in hepatocytes, but there is not a consensus on what reactions occur in hepatocytes and in HSCs. Mechanistically, the final product of retinol is retinoic acid (RA), the natural ligand for the retinoic acid receptors (RARα, β, and γ) that drive the transcription of target genes. In order to test what processes happen in HSCs and hepatocytes, gene expression of the RARs was tested in response to RA, and AC261066 (AC), a RARb2 agonist, using gel electrophoresis. It was reported that RARβ is essential to maintain lipid homeostasis, so this was tested in both stellate cells and hepatocytes using oleic and palmitic acids with dye-fold change, then quantified. In addition, fibrosis-related genes were tested in stellate cells, because it is known that they produce scar tissue in the liver. Overall, RA did not affect the expression of the RARs in the HSCs and hepatocytes. For the lipid accumulation experiments, RA and AC were both extremely effective in reducing fat levels, especially in the hepatocytes. In conclusion, hepatocytes are more affected by RA and AC, especially in regards to lipid accumulation, though further testing at different concentrations and time points needs to be done.

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