28TH ANNUAL

GRADUATE RESEARCH SYMPOSIUM

Hosted by the Graduate Student Senate

Washington University in St. Louis

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WELCOME LETTER & ACKNOWLEDGEMENTS

Friends and Colleagues,

Welcome to the 28th Annual Washington University Graduate Research Symposium!

This year, the Graduate Student Senate is proud to present a fantastic program of over 80 posters that features work from a wide range of schools, research groups, and foci. Within this microcosm of Washington University, you will encounter research conducted by graduate and professional students representing all disciplines, including Biomedical Engineering and Earth and Planetary Sciences, as well as those not normally found in poster symposia, including Art History and Archaeology. Each poster presents a novel and innovative way of questioning, interpreting, and understanding the world around us, whether through a scientific exploration of the world or a study of its cultural, historical, and social dimensions. We hope that you enjoy the symposium as much as we have enjoyed putting it together, and that you join us in celebrating the hard work that graduate and professional students have put into pushing forward our collective knowledge and understanding.

Finally, we would like to thank Rachel Pepe and Jessica Cissell at the Graduate Center, the Graduate Professional Council, and the Association of Graduate Engineering Students for their support, without whom this event would have not succeeded. We also thank Steve Pijut and Rachel Smith-Peirce, who graciously volunteered their time to lead workshops that helped students prepare for the GRS.

Sincerely,
The Graduate Research Symposium Organizing Committee

Hoyon Mephokee
Maegan Ruiz
Samantha Randolph
Salvador Lopez Rivera

GSS GRADUATE STUDENT SENATE gpc Graduate Professional Council AGES

SYMPOSIUM SCHEDULE

SYMPOSIUM WELCOME

2:00 p.m., Frick Forum

Opening Remarks by Patricia Elisabeth Maurer and Gloria Zhou
Graduate Student Senate Co-Chairs

Keynote Speech by Dr. Andrew Butler
Associate Professor, Department of Education and Psychological & Brain Sciences, Chair of the Department of Education

POSTER SESSION

2:00 p.m. to 4:00 p.m., Frick Forum

CLOSING REMARKS AND AWARDS CEREMONY

4:00 p.m to 5:00 p.m., Emerson Auditorium

Closing Remarks by Hoyon Mephokee
Graduate Research Symposium Organizing Committee Chair

Closing Speech by Dr. Vijay Ramani
Vice Provost for Graduate Education and International Affairs, Roma B. & Raymond H. Wittcoff Distinguished University Professor, Department of Energy, Environmental & Chemical Engineering

Awards Ceremony

Intrinsically Flexible/Stretchable Perovskite Optoelectronic Devices

Junyi Zhao *(Electrical and Systems Engineering)*

Poster number 100

Organometal halide perovskite has already attracted extensive research attention owing to its great potential for ubiquitous optoelectronic applications. However, most hybrid perovskite-based optoelectronic devices are fabricated on rigid indium-tin-oxide (ITO) glass substrate inside the glove box with a vacuum-evaporated metal top electrode, which is a tedious and time-consuming process. In this work, we demonstrate an all-solution-processed perovskite light-emitting diodes (PeLEDs) fabricated entirely by inkjet printing in ambient condition for high-resolution flexible display applications. The PeLEDs were constructed with an extremely simple 4-layer sandwich structure, consisting of a composite transparent bottom electrode of poly(3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS) and poly(ethylene oxide) (PEO), a composite light-emissive layer of methylammonium lead tribromide (CH3NH3PbBr3) and poly(ethylene oxide) (PEO), and a silver nanowire (AgNW) top electrode, all directly printed onto an ultrathin polydimethylsiloxane (PDMS) substrate. In addition, a printed polyethyleneimine (PEI) buffer layer inserted between the emissive layer and the top electrode was found to be effective in protecting the perovskite crystals from being attacked by the solvent in AgNW ink during the top electrode printing step. The device exhibits bright green emission with a turn-on voltage of 3.18 V, a maximum luminance intensity of 10 227 cd m-2, and a peak current efficiency of 2.01 cd A-1. By optimizing the ink formulation and printing recipe and taking full advantage of direct printing, we have also achieved scalable patterning of PeLEDs with resolution down to 250 μm. The printed PeLEDs also exhibit good flexibility and can be conformably bent to a 3.5 mm radius convex curvature for over 100 bending cycles without degradation in performance. The combination of superior optical performance, simplified device structure, all-solution processibility, and low-cost printing strategy is promising to pave way for emerging flexible display and wearable electronics applications.

Nuclear export inhibition jumbles epithelial–mesenchymal states and gives rise to migratory disorder in healthy epithelia

Carly Krull *(Biomedical Engineering)*

Poster number 101

Epithelial-mesenchymal (E-M) gradients support collective cell migration to facilitate normal physiological activities, like embryogenesis, as well as malignant processes, like cancer invasion. At the leading edge of a migrating group, cells exhibiting partial E-M transition (EMT) extend protrusions and apply traction to drive migration. Meanwhile, from behind, more epithelial-like cells supply lower tractions, retaining higher cell-cell adhesions to preserve the collective. This E-M gradient transpires from tactful regulation of transcription factors (TFs) and migration-related proteins. While it is known that these proteins individually promote or inhibit EMT, it is unknown whether opposing factors compete, cooperate, or cancel to construct cell phenotypes. To explore this question, we consider that transcription changes from EMT-TFs and related proteins hinge on their nuclear localization. Therefore, we perform nuclear export inhibition (NEI), using leptomycin B (LMB) to co-localize EMT-related proteins in the nucleus. We then survey interactions between opposing EMT factors by assessing changes in E-M cellular traits and collective migration characteristics.

We found that NEI contributed to higher IκBα nucleocytoplasmic (N:C) ratios, increased p120 junctional intensity, and upregulated epithelial marker gene PTEN. However, NEI also increased vimentin expression, YAP N:C ratio, actin coherency, and mesenchymal marker genes, while giving rise to leader cells with highly polarized, protrusive morphology. Interestingly, these results indicate simultaneous elevation of epithelial and mesenchymal cellular traits following NEI. Because cells balance intercellular adhesion and mechanoactivation gradients to facilitate collective movement, we hypothesized that the observed disturbances could interfere with typical migration patterns. Indeed, results revealed time-dependent changes in migration, where velocity initially increased, while progressive disorder slowed net migration over 24 h. To understand how the changes in gene and protein expression translated to the functional migratory changes we observed, we considered that the protein α-catenin mechanically couples cells, recruiting F-actin to E-cadherin-based cell junctions. Therefore, we used α-catenin depleted MCF10A cells to characterize the role of intercellular force propagation in the observed NEI outcomes. α-catenin knockdown cells treated with LMB exhibited higher YAP N:C ratios and higher actin coherency compared to wild-type cells. Yet, remarkably, these cells lost front-back polarity, formed discrete colonies, and dissolved leader-follower relationships during NEI. Net velocities were lower than wild-type cells across timepoints, and migration arrested by 24 h. Ultimately, these findings suggest that α-catenin is required to functionally couple epithelial and mesenchymal traits.

Mechanically primed cells transfer memory to fibrous matrices for invasion across environments of distinct stiffness and dimensionality

José Almeida
(*Biomedical Engineering*)
Poster number 102

Cells sense and migrate across mechanically dissimilar environments throughout development and disease progression. However, it remains unclear whether mechanical memory of past environments empowers cells to navigate new, three-dimensional extracellular matrices. Here, we show that cells previously primed on stiff matrices, compared to soft, generate higher forces to remodel collagen fibers and promote invasion. This priming advantage persists in dense or stiffened collagen. We explain this memory-dependent cross-environment cell invasion through a lattice-based model wherein stiff-primed cellular forces remodel collagen and minimize energy required for future cell invasion. According to our model, cells transfer their mechanical memory to the matrix via collagen alignment and tension, and this remodeled matrix informs future cell invasion. Thus, memory-laden cells overcome mechanosensing of softer or challenging future environments via a cell-matrix transfer of memory. Consistent with model predictions, depletion of yes-associated protein destabilizes cellular memory required for collagen remodeling before invasion. We release tension in collagen fibers via laser ablation and disable fiber remodeling by lysyl-oxidase inhibition; both of which disrupt cell-to-matrix transfer of memory and hamper cross-environment invasion. These results have implications for cancer, fibrosis, and aging, where a potential cell-to-matrix transfer of mechanical memory of cells may generate prolonged cellular response.

The Contractile Activity of Fibroblasts Can Be Predicted and Controlled in A 3D Culture System

Ghiska Ramahdita *(Mechanical Engineering and Materials Science)*

Poster number 103

Mechanical forces are critical in activating fibroblasts into myofibroblasts during wound healing and fibrosis. Based on our previous studies, we hypothesized that not only the magnitude, but also direction of forces would be crucial to myofibroblast activation. To test this hypothesis, we used hydrogel-assisted double molding to create poly(dimethyl siloxane) (PDMS) pillars that control the geometry of engineered tissues. We engineered 3D tissues through collagen encapsulation of 3T3-fibroblasts in micro-wells containing either an anisotropic or isotropic arrangement of PDMS pillars. Recent findings suggest that myofibroblast activation in 3D is partly regulated by level of anisotropy of the tissue, whereas the effect was larger than exogenous TGF-β in this system. This result highlights the importance of geometrical design in modeling wound healing and fibrosis in vitro.

Comparison of Multivariate and Bivariate Functional Connectivity Approaches using High-Density Diffuse Optical Tomography for Human Brain Mapping

Wiete Fehner *(Imaging Science)*

Poster number 104

Traditional bivariate functional connectivity (BFC) computes correlations between two target brain regions (ROIs), which has the potential weakness of ignoring associations with other ROIs. Multivariate functional connectivity (MFC) solves for weights between one target ROI and the rest of the brain; thereby changing the question of correlation to a question of prediction, which is potentially more powerful. Methods: Human resting-state DOT data (N=6) was analyzed for homotopic contralateral functional connectivity (FC) using both approaches. In BFC time traces of ROIs are correlated using the Pearson correlation coefficient (ϱ), which can be rewritten in terms of the transpose of the data matrix: X^Ty_r = ϱ. Where X is the data set, y_r is the seed ROI, and ϱ is the correlation coefficient matrix. For MFC we simply use the (pseudo-)inverse X^†_(¬r)y_r instead of the transpose of the data matrix. The crucial difference is that using the inverse leads to a different way of asking for FC. Instead of retrieving information on correlation (i.e., how well are two ROIs correlated) we now get information on the predictive values (i.e., how well is one ROI predicted by the other ROIs). Results: Both approaches show strong connections between homotopic contralateral ROIs. The similarities between maps suggest that MFC is a measure of connectivity strength between brain regions. MFC maps, however, seem to provide higher spatial detail and focus. Conclusion: We outlined the conceptually simple mathematical difference between BFC and MFC. MFC is potentially advantageous in providing more detailed and spatially focused FC maps.

Hallucinogenic 5-HT2A receptor agonism alters cortical activity, organization, and neurovascular coupling

Jonah Padawer-Curry *(Imaging Science)*

Poster number 105

Background: Psychedelics are an appealing potential therapeutic for neuropsychiatric conditions due to their rapid, sustained, results. These effects appear to be mediated by serotonin (5-hydroxytryptamine) receptor agonism, especially at the 5-HT2A receptor (5-HT2AR). Serotonin has potent vasoactive effects and is involved with regulating neuronal plasticity and arousal. Recent human functional neuroimaging studies evaluating acute effects of psychedelics show dramatic 5-HT2AR-dependent changes in functional network organization. However, these studies have not accounted for acute neurovascular effects of hallucinogenic 5-HT2AR agonists.

Aim: Determine whether hallucinogenic 5-HT2AR activation, using 2,5-Dimethoxy-4-iodoamphetamine (DOI), affects cortical neuronal and hemodynamic activity and neurovascular coupling (NVC).

Method: Eight Thy1-jRGECO1a mice were imaged for 30-minutes before and after injection of either saline or DOI, under awake, resting-state conditions using wide-field optical imaging (Fig. 1A, B). Changes in cortical activity between 0.01Hz-5Hz were determined through power spectral density estimates (PSDE). NVC was estimated using deconvolution and resulting hemodynamic response/transfer functions (HRF, TF) were evaluated pre- and post- injection. Full-width-at-half maximum (FWHM) was calculated for HRFs and compared across conditions. Statistical differences were determined using a one-way ANOVA and post-hoc t-tests corrected for multiple comparisons.

Results/Conclusions. Canonical HRFs were observed for pre- and post- saline injection (Fig 1C). Conversely, DOI caused profound alterations to the HRF shape, with a smaller FWHM ($p=0.018$), and a secondary peak occurring prior to time zero. TFs after DOI showed significant increases in delta-band transduction compared to saline ($p=0.004$). Calcium PSDEs revealed significant increases in power from 0.32-1.28 Hz ($p=0.009$) and 1.28-5.12 Hz ($p=0.0002$). Similarly, significant changes were observed in hemodynamic activity from 0.32-1.28 Hz ($p=0.002$). Results suggest that hallucinogenic 5-HT2AR agonists differentially alter neuronal versus hemodynamic activity, potentially driven by changes in NVC. Future work will examine other models for NVC and differentiate the effects of hallucinatory and non-hallucinatory 5-HT2AR activation.

ABSTRACTS: ENGINEERING

Mapping interactions between parvalbumin inhibitory interneurons and excitatory neurons over the cortex in awake mice

Xiaodan Wang *(Biomedical Engineering)*

Poster number 106

Background: Parvalbumin interneurons(PV-INs) are the largest subpopulation of GABAergic neurons. Coherent infraslow fluctuations in blood oxygenation (reflected in resting-state functional connectivity maps) are coupled in phase and amplitude to gamma brain rhythms. These patterns emerge from the rhythmic output of reciprocally-coupled PV-INs to synchronize excitatory activity over long distances(>1mm). Recent evidence suggests PV-INs exhibit long-range, transcallosal projections in select cortical regions. Whether transcallosal PV-INs feature prominently over the cortex, and the extent to which their local influences affects global excitatory activity is unknown.

Aim: Map the interactions between PV-INs and excitatory neurons over the cortex in awake mice.

Method: We created a novel imaging system and mouse line to allow for optogenetic targeting of PV-INs and mesoscopic imaging of excitatory activity via the red-shifted calcium indicator jRGECO1a (Fig.1A). Photostimuli were delivered over a grid in the left hemisphere (Fig.1A). Regional effective connectivity (EC) was determined by correlating the time course at the photostimulated site with all other time courses in our field-of-view and mapping the resulting correlation coefficients over the cortex.

Results: Photostimulation of PV-INs resulted in local reductions of jRGECO1a fluorescence, consistent with local inhibition of excitatory activity. Photostimulating primary somatosensory cortex(S1b) reduced S1b activity and ipsilateral motor (M2) activity. Similarly, photostimulation of left M2 resulted in reciprocal, ipsilateral inhibition of left S1b, and right M2. EC mapping reveals the extent of regional PV-based inhibition. Systematically scanning photostimulti over the left hemisphere allowed for visualizing the cortical "PV connectome" and site-wise homotopic EC .

Conclusions: We used novel technology to examine the interaction between PV-INs and excitatory cells over the cortex in awake mice. PV-based inhibition extended several mm locally and into more distant, ipsilateral regions. Further, PV-INs exhibit region-specific interhemispheric inhibitory influences. Future work will examine whether these observations are mediated mono- or polysynaptically.

ABSTRACTS: ENGINEERING

Simultaneous functional and Thermal Imaging of Mouse Cortex

Shengxuan Chen *(Biomedical Engineering)*

Poster number 107

Wide-field two photon microscopy (TPM) is a promising imaging modality for mapping mouse brain function due to its capability of imaging at cellular resolution and the depth sectioning property. Various optical designs have been proposed but obtaining high signal to noise ratio (SNR) movies is still challenging. One may consider increasing the laser power, but a technique for monitoring the mouse cortex temperature is desired. Here, we propose a simultaneous thermal imaging and two-photon imaging technique to help solve this problem. Based on the large field of view TPM design previous reported, an indium-tin-oxide slide was added on top of the mouse cranial window to reflect the infrared light. The reflected infrared light was then captured by a thermal camera. We showed that the transmission of 900nm excitation light is about 85% and the functional imaging was not affected significantly. In this study, we found that the average temperature of the cortex stayed below 39°C when imaged using 400mW laser power with a 5 x 5 mm scan area, but with a 1 x 1 mm scan area, only 200mW laser power could be used so that the temperature stayed below 39°C. The peak temperature as a function of scan area and laser power will be presented along with the results of brain activities under hind paw stimulation and at rest. With the abovementioned results, we demonstrated that 400mW laser power can be used in wide-field TPM for obtaining sufficient SNR brain activities safely.

Rapid direct detection of SARS-CoV-2 aerosols in exhaled breath at the point-of-care

Dishit P. Ghumra *(Energy, Environmental and Chemical Engineering)*

Poster number 108

Airborne transmission via virus-laden aerosols is a dominant route for the transmission of respiratory diseases, including SARS-CoV-2 (CoV-2). In spite of the demonstrated significance of disease transmission via aerosols, techniques for non-invasive and direct real-time detection of respiratory virus aerosols have remained elusive. Current state of research involves exhaled breath condensate (EBC) collection followed by reverse transcription-polymerase chain reaction (RT-PCR) to detect the prevalence of SARS-CoV-2 in various communities. This methodology has limitations for mass testing applications due to long turnaround times and the need for trained personnel. Electrochemical biosensors are rapidly emerging as an alternative to conventional clinical screening techniques as they are simple, rapid and possess a low limit of detection. However, majority of studies have demonstrated the use of electrochemical biosensors to detect SARS-CoV-2 in nasal swabs, saliva or sputum samples. Here, we introduce a facile, point-of-care testing platform that directly detects CoV-2 aerosols in as little as two exhaled breaths of patients and will provide results in under 60 seconds. It integrates a hand-held breath aerosol collector and a llama-derived, CoV-2 spike-protein specific nanobody bound to an ultrasensitive micro-immunoelectrode (MIE) biosensor. The MIE biosensor detects the oxidation of tyrosine amino acids present in the Spike protein of SARS-CoV-2. It is connected to a Potentiostat and square wave voltammetry is performed to oxidize tyrosine and measure the peak oxidation current corresponding to the presence of virus aerosols in a given sample. Lab experiments using inactivated SARS-CoV-2 variants and clinical trial data indicate a device sensitivity of about 80%, and the MIE biosensor is highly specific to SARS-CoV-2. The results from RT-qPCR determined that viral RNA for samples collected using the breath aerosol analyzer ranged from 101.3 to 103.7 gene copies/sample. The device is successful in detecting all variants of concern up to omicron BA.5. Importantly, the MIE biosensor directly detects the virus itself, as opposed to a surrogate or signature of the virus and is sensitive to as little as 10 viral particles in a sample (as determined by RT-qPCR). Additionally, satisfactory results were obtained from just 20-30 seconds of sampling (2 exhaled breaths) compared to 5-30 minutes of sampling in typical EBC-based studies. Our platform holds the potential to be adapted for multiplexed detection of different respiratory viruses. It provides a rapid and non-invasive alternative to conventional viral diagnostics, and it is highly promising for applications in places/settings that require mass testing such as airports and conference centers.

ABSTRACTS: ENGINEERING

Deep Learning Driven Light-Based Motor Mapping of Multiple Limb Movements in Mice Reveals Behaviorally Relevant Movements

Nischal Khanal *(Imaging Science)*

Poster number 109

Recent developments in optogenetics have allowed for quick and minimally invasive methods of studying functional brain organization in animal models. Studies incorporating light-based mapping of forepaw motor movement representations in rodents have reported distinct cortical representations of specific forepaw movements. However, previous mapping techniques have been limited to either tracking one-dimensional motion, bulky electronics that hamper natural movement, or manual labeling of specific features, any of which preclude simultaneous mapping of multiple limbs. DeepLabCut (DLC), a deep neural network toolbox for markerless pose estimation, offers the ability to quickly track multiple user-defined features in 3-dimensions with human level accuracy. Here, we outline a pipeline to map and characterize multiple motor representations in anesthetized mice, which were subsequently validated in awake animals. Furthermore, we identify that combined, behaviorally-relevant motor movements reside in overlapping cortical limb representations independent of state. To demonstrate the utility of DLC for mapping cortical representations of limb movements, we performed light-based mapping in 7 transgenic mice expressing channelrhodopsin under a Thy1 promoter. A 473nm laser was used to stimulate 238 cortical sites separated by 300 microns positioned primarily over motor and somatosensory regions of the left hemisphere. Photostimulus induced movements in awake and anesthetized mice were captured by 3 cameras positioned around the animal. A set of representative frames were manually labeled and used to train the neural net for a specified set of iterations and the resultant models were used to automate labeling of videos. Label coordinates output by DLC were imported into MATLAB for analysis. Movement trajectories were baseline subtracted and significant movements were interpreted as displacements larger than 2 standard deviations above baseline fluctuations. Robust, repeatable motor movement representations of the left and right forepaws and hindpaws as well as the mouth were observed in each mouse across multiple mapping sessions. Stimulus evoked awake movements were approximately 4-10x larger than those under awake conditions, consistent with other studies. Across all mice, representations of left and right fore- or hind- limbs movements overlapped, with the contralateral representation being qualitatively larger compared to the ipsilateral limb. Photostimulation of overlapping motor movement representations of multiple limbs (e.g. left and right forepaw) produced combined, behaviorally relevant movements of each limb (e.g. grasping). These 3D movement trajectories were repeatable and persisted independent of state. Furthermore, dissection of forepaw movements into finer articulations showed that photostimulation elicits articulated movements that occupy distinct cortical locations. These results suggest that motor circuits for specified motor output are spatially preserved in the cortex. Future studies include characterizing recovery of finer, articulated movements of individual paws (grasping, supination, etc.) after stroke, as well as mapping brain network activity during naturalistic behavior.

Integrating neuroimaging and behavioral monitoring for applications in mouse models of stroke recovery

Evan Morris *(Biomedical engineering, Radiology)*

Poster number 110

Stroke is the leading cause of disability in the US. Among patients affected, a common (~80% of patients) long-term consequence includes motor control deficits. During recovery, these disabilities often result in behavioral compensation when executing goal-oriented motor tasks, which can be mistaken for, but are maladaptive to, true recovery. Concomitantly, during the recovery phase following stroke, functional brain networks reorganize at local and global scales through the formation of new or alternative circuits. The ability to distinguish early neuroimaging biomarkers of compensatory versus true recovery might allow for targeted therapeutic interventions designed to correct for aberrant brain reorganization after injury. Towards this goal, we combined wide-field optical imaging (WFOI) of neuronal and hemodynamic activity with motor behavior tracking in awake mice. This system is currently being developed for use in healthy mice and, once optimized, will be applied in mice subject to photothrombosis of the left motor cortex. We constructed a behavioral tracking system to provide reward-based assessment of specific motor tasks (e.g. lever pulls). This Arduino-controlled system consists of a hall-effect joystick, visual cues, and a reward delivery apparatus. In parallel, we are developing a behavioral training protocol. Prior to data acquisition, mice are mounted into the WFOI system for environmental acclimation. Over a seven-week period, water-deprived mice are trained to execute lever pulls in response to a visual cue. Successful reaches are rewarded with a sweetened-water solution, while unsuccessful trials result in a timeout period, indicated by a 12-kHz tone. WFOI occurs throughout all trials and allows for examining how patterns of cortical neuronal activity correspond to specific motor behaviors. In conclusion, we developed an integrated behavior and neuroimaging system for measuring motor performance. This technology will be the foundation for evaluating relationships between behavioral output and imaging measures of circuit repair after stroke.

ABSTRACTS: ENGINEERING

Technological advancement of biogas upgrading to renewable natural gas- an update on practice and research

Yue Rao *(Energy, Environmental, and Chemical Engineering)*

Poster number 111

Biogas generated from organic wastes by anaerobic digesters is acknowledged as one of the foremost renewable energies and can help address the current energy challenges. However, many places that operate anaerobic digesters do not actually use biogas. Converting biogas to renewable natural gas (RNG) will enhance the utilization of this bioenergy. This presentation will thoroughly summarize state-of-the-art biogas upgrading approaches including CO2 removal and CO2 conversion to methane. Practical examples of biogas upgrading will be introduced. Research progress on new technologies for biogas upgrading will be discussed. It aims to provide the audience with knowledge about biogas upgrading and identify the associated challenges that must be addressed for a broader implementation of the biogas upgrading technologies.

There are mainly five different CO2 removal technologies including water scrubbing, organic solvent scrubbing, chemical adsorption, membrane separation, and photosynthetic biogas upgrading. CO2 is removed from the raw biogas through either physical, chemical, or biological processes. On the other hand, there are two different CO2 conversion technologies including chemoautotrophic biogas upgrading and chemical hydrogenation process. CO2 will be converted into CH4 with exogenous H2 during these two technologies. The cost of each technology varies depending on the operation and required equipment. Details of all these technologies will be introduced in the presentation along with industrial implementation. Hydrogenotrophic methanogens utilize H2 and CO2 to convert into CH4 in the process of anaerobic digestion (AD). But insufficient H2 generated through AD results in a high amount of CO2 in the raw biogas. Extra H2 is needed in the reactor to convert raw biogas into biomethane in which the amount of CH4 is close to natural gas. However, the key challenge is the gas-liquid transfer efficiency of H2. To solve this problem, previous researchers investigated the effects of gas retention time, mixing rate, and the ratio of H2 and CO2. In addition, various diffusion devices were also installed to enhance the gas-liquid transfer rate. This study investigated the feasibility of a novel lab-scale in-situ biogas upgrading system and the development of the bacterial community. Synthetic wastewater was used to mimic brewery wastewater as a substrate. The reactor was designed vertically with three different function zones: anaerobic digestion (AD) zone, bioconversion zone, and gas-liquid separation zone. Inner circulation was applied to the AD zone to enhance mixing, and extra H2 was only injected into the bioconversion zone continuously for biofilm consumption. An optimal upgrading situation was achieved when methane content was increased to 90%. Batch experiments were also conducted to investigate the biofilm formed on the membrane. The bacteria community showed that methanogen was the dominant species in the AD zone and hydrogenotrophic methanogens played an essential role in the formed biofilm.

ABSTRACTS: ENGINEERING

Reticulospinal Tract Contributions to Lower Limb Movements in Able-Bodied Humans

Rachel Hawthorn *(Biomedical Engineering)*

Poster number 112

Spinal cord injuries (SCI) leads to long-lasting paralysis, and hundreds of thousands of people live with this condition in the United States. When combined with training, spinal cord stimulation (SCS) has been shown to induce significant functional improvements in patients with SCI. However, the mechanisms of neurorecovery remain poorly understood. This study aims to determine whether the reticulospinal tract is activated by SCS, which has a higher degree of plasticity than the corticospinal tract and is thought to be a critical pathway that mediates functional recovery after SCI. This work will help to inform and create personalized SCS rehabilitation strategies that take advantage of residual reticulospinal tract connections to enhance and accelerate recovery.

Materials and Methods: This study has been reviewed and approved by Washington University's Institutional Review Board, and volunteers gave informed consent to participate. To quantify the effect of SCS on the reticulospinal contributions to lower limb functions, our study utilized the StartReact response, a shortening in response time after a startling auditory cue. The involuntary release of a prepared movement is thought to be primarily mediated by the reticulospinal tract, therefore allowing for estimations of its contribution to a movement. During the StartReact experiment, unimpaired participants were asked to lay in front of a large monitor displaying their joint angles and with two speakers close to their heads. Participants were asked to move their ankle and hip joints as soon as they perceived a 'go' cue, consisting of either a visual cue (VRT), a visual + auditory cue (VSRT, @80dB), or a visual + startle cue (VSRT, 120dB). Six EMG sensors were placed on the dominant leg over the muscle belly of the rectus femoris, semitendinosus, vastus lateralis, tibialis anterior, medial gastrocnemius, and the soleus. EMG signals were recorded with wireless surface electrodes (Delsys Trigno Avanti) sampled at 2148 Hz, and the joint angle was recorded with 3-axis inertial measurement unit (IMUs) (Yost Labs 3-SpaceTM Sensors), sampled at 100 Hz. Joint angles were estimated using the IMU pitch and displayed as biofeedback in real-time. Transcutaneous spinal cord stimulation was delivered using a biphasic constant-current stimulator (Digitimer DSR8) with surface electrodes (Axelgard PALS) with 1 ms pulses at 30 Hz over the lumbosacral enlargement under the T11/T12 vertebrae. In this work, we describe differences in reaction time and reticulospinal tract contribution as participants performed the StartReact task using either precision (target range: 30-35% of maximum range) or range of motion (target range: 70-100% of maximum range) movement requirements. Precision and range of motion tasks were completed with and without stimulation for ankle flexion, ankle extension, and hip flexion movements. Our study will serve as the framework to establish the contribution of the reticulospinal tract during leg movements requiring different levels of dexterity. Moreover, this study will allow us to determine whether the use of SCS increases the contribution of reticulospinal pathways during those movements. This knowledge will enable the long-term evaluation of changes in neural plasticity mediated by the reticulospinal tract during SCS-assisted rehabilitation programs after SCI.

ABSTRACTS: ENGINEERING

Correcting for biases in filter-based aerosol light absorption measurements at the ARM Southern Great Plains site

Joshin Kumar *(Energy, Environmental, and Chemical Engineering)*

Poster number 113

Measuring aerosol light absorption is crucial to assess direct radiative forcing that impacts local and global climate. While filter-based instruments like the Particle Soot Absorption Photometer (PSAP) are low-cost and simple to operate, they suffer from unquantifiable artifacts due to the filter medium and complex interactions between filter fibers and deposited aerosols.

Various correction algorithms (Bond et al., 1999; Virkkula et al., 2005; Li et al., 2020) have been introduced to correct for the filter-based absorption coefficient measurements toward predicting the particle-phase absorption coefficient (Babs). Since previously developed correction algorithms have a fixed analytical form, fundamentally, they are unable to predict particle phase absorption coefficients with a high degree of accuracy universally: different corrections for rural and urban sites across the world.

In this study, we have analyzed three months of high-resolution ambient data collected in parallel using a PSAP and 3-wavelength photoacoustic spectrometer; both instruments were operated at the Department of Energy's Southern Great Plains user facility in Oklahoma. We implemented the following algorithms to predict particle phase Babs values from PSAP data and estimate their accuracy – (1) the Virkkula (2010) correction algorithm, (2) Revised Virkkula algorithm with updated coefficients, and (3) a Random Forest Regression (RFR) machine learning algorithm. The RFR algorithm outperformed predictions by both the Revised Virkkula and Virkkula (2010) algorithms. The wavelength averaged Root Mean Square Error (RMSE) values for predicting Babs using RFR, Revised Virkkula and Virkkula (2010) algorithms were 0.37, 0.67 and 3.18 Mm-1, respectively.

To further test the potential of the proposed machine learning model, we trained and tested the RFR algorithm on dataset of laboratory-generated combustion aerosols. The RFR model used the size distribution, uncorrected Tricolor Absorption Photometer based Babs, and Nephelometer Bscat as input variables and predicted particle-phase Babs values within 5% of the reference Babs.

Components derived from high-density diffuse optical tomography data during overt motor imitation

Sung Min Park *(Imaging Science, Radiology)*

Poster number 114

Introduction: Autism spectrum disorder (ASD) is a neurodevelopmental disorder traditionally characterized by heterogenous phenotypes. However, a central affected domain in ASD is impairment of social communication. Current literature suggests that difficulty in motor imitation may be associated with impaired development of social-communicative skills. Therefore, we aim to investigate ASD using HD-DOT, a modality that allows neural imaging during unrestricted upper limb movement. Conventionally used hypothesis driven methods such as generalized linear models involve a priori activation maps. Here, group independent component analysis (GICA), a data-driven analysis, was applied to HD-DOT data to reveal compact representation of neural activity from high-dimensional data acquired during motor observation and imitation.

Methods: Neural data were acquired from 20 healthy adults (17 F, ages 18-31) during motor observation and imitation tasks using a HD-DOT system consisting of 128 sources and 125 detectors, with over 3,500 measurement pairs. During the observation task, participants were instructed to observe stimulus videos, whereas, during the imitation task, participants were instructed to imitate a series of upper extremity movements presented through video stimuli. HD-DOT data were processed using the NeuroDOT pipeline in MATLAB which includes motion detection and censoring using global variance in the temporal derivative (GVTD). To isolate functional network components associated with the tasks, GICA was performed using GIFT toolbox. Multiple regression was computed using subject ICA time courses as the observation and event design paradigm as the model. Calculated coefficient values for imitation and observation were compared using t-test to assess the difference in activation of the components during the two experimental conditions.

Results: Twenty components and their corresponding time courses were estimated (Figure 1). Thirteen out of the twenty components contained beta weights that were significantly different during observation and imitation. Components showed high spatial correlation with YeoBuckner atlas with mean 0.3448 and standard deviation 0.091 (Table 1).

Conclusion: GICA effectively summarizes high-dimensional HD-DOT data into a compact set of components. These results suggest unique patterns of contribution by each component during motor observation and imitation tasks and show promise that group ICA derived components may be further utilized to assess motor imitation in ASD.

Phosphorus Leaching and Recovery from Anaerobic Digestion Sludge in a Three-Chamber Nutrient Recovery Cell

Zixuan (Zach) Wang *(Energy, Environmental & Chemical Engineering)*

Poster number 115

With the rising concerns about the depletion of phosphate ore in the next century, phosphorus recovery from secondary wastes is fast becoming a key step for sustainable phosphorus supply and global food security. In this work, we design a nutrient recovery cell (NRC) to recover phosphate from municipal anaerobic digestion sludge, one of the most abundant phosphorus sinks in the centralized wastewater treatment facilities. The NRC could simultaneously leach and recover phosphorus from the sludge via the water electrolysis reaction and selective ions transport. Operated at a constant current of 50 mA, the anodic reaction in the NRC leached 95% of phosphorus (in the form of phosphate) from the sludge within 90 min. Due to the formation of hydroxyapatite, only 40% of the leached phosphate was recovered in the nutrient recovery solution. With a cathode pH adjustment, the phosphate recovery efficiency could be enhanced to 70~100%. The final nutrient recovery solution contained hardness from the sludge that contributed to phosphate co-precipitation as struvite and hydroxyapatite at a basic pH. Because of the protection from ion exchange membranes, the solid product contained little sludge-derived heavy metals. In addition, the NRC process improved sludge sedimentation ability and removed 80% of dissolved chemical oxygen demand, 95% of ammonium, and 97% of phosphate in the final supernatant effluent. This work achieved sludge phosphorus leaching and recovery in one system and can be potentially applied to phosphorus-rich solid wastes generated from different sectors.

ABSTRACTS: ENGINEERING

Towards fast, low-power, and high-resolution LiDAR beam steering

Lin Lin *(Electrical & Systems Engineering)*

Poster number 116

Optical metasurfaces offer unprecedented flexibility in light wave manipulation but suffer weak resonant enhancement. Tackling this problem, we experimentally unveil a new phase gradient metasurface platform made entirely from individually addressable high quality factor (high-Q) silicon meta-atoms. Composed of pairs of nearly identical nanoblocks, these meta-atoms support dipolar-guided-mode resonances that, due to the controlled suppression of radiation loss, serve as highly sensitive phase pixels when placed above a mirror. A key novelty of this platform lies in the vanishingly small structural perturbations needed to produce universal phase fronts. Having fabricated elements with a Q-factor ~380 and spaced by λ/1.2, we achieve strong beam steering, up to 59% efficient, to angles 32.3°, 25.3°, and 20.9°, with variations in nanoantenna volume fractions across the metasurfaces of ≤2.6%, instead of >50% required by traditional versions. Aside from extreme sensitivity, the metasurfaces exhibit near-field intensity enhancement over 1000×. Taken together, these properties represent an exciting prospect for dynamic and nonlinear wave shaping.

PIEZO1 as a Target for Cartilage Regeneration and Post Traumatic Osteoarthritis Treatment

Alireza Savadipour *(Mechanical Engineering, Orthopaedic surgery)*

Poster number 117

Post-traumatic osteoarthritis (PTOA) is a debilitating condition that affects millions of people worldwide. It is a degenerative joint disease that often occurs after joint injuries. Chondrocyte death, caused by excessive deformations, is suggested to play a role in this joint degeneration. Despite its prevalence, there are currently no effective treatments for PTOA, leaving patients with few options to manage their pain and improve their mobility.

Fortunately, recent research has identified PIEZO1 and PIEZO2 ion channels in chondrocytes, which respond to supraphysiologic levels of loading. These channels have been found to play a critical role in chondrocytes death and cartilage degeneration. Inhibiting them could reduce chondrocyte death and potentially slow or even reverse the progression of PTOA. This discovery has opened up new avenues for the development of effective therapies for PTOA.

To further understand the mechanisms behind PIEZO signaling and its implications for cartilage injury, we conducted a study which shed light on the critical role that PIEZO1 plays in chondrocyte mechanotransduction and the ways in which pre-straining the cell membrane affects PIEZO1 sensitivity to loading.

We found that membrane tension and calcium signaling are dependent on loading rate and sources of calcium, suggesting that these factors play a critical role in chondrocyte mechanotransduction. These findings are significant because they provide critical insights into the activation of PIEZO1 in chondrocytes, paving the way for the development of new therapies for joint diseases such as osteoarthritis.

One of the most exciting aspects of this study is the potential for the development of targeted therapies that can selectively inhibit PIEZO1 channels in chondrocytes, reducing the risk of off-target effects. This would be a significant step forward in the treatment of joint diseases such as PTOA, as it would allow for more effective and targeted treatment options that can be tailored to individual patients' needs.

This study represents a significant breakthrough in our understanding of the role of PIEZO1 channels and membrane tension in chondrocyte mechanotransduction. The findings provide critical insights into the potential mechanisms behind the activation of PIEZO1 in chondrocytes and open doors to new ways in which we can develop targeted therapies for joint diseases such as osteoarthritis. Ultimately, this has the potential to transform the way we approach the treatment of joint diseases and improve the quality of life for millions of people around the world.

Prediction of biogas production in anaerobic digestion of a full-scale wastewater treatment plant using ensembled machine learning models

Jiasi Sun, Yanran Xu, Shaker Nairat, Jianpeng Zhou, Zhen He
(Energy, Environmental & Chemical Engineering)

Poster number 118

Anaerobic digestion (AD) of sludge is a key approach to recover useful bioenergy from wastewater treatment and its stable operation is important to a wastewater treatment plant (WWTP). Because of various biochemical processes that are not fully understood, AD operation can be affected by many parameters and thus modeling AD processes becomes a useful tool for monitoring and controlling their operation. In this case study, a robust AD model for predicting biogas production was developed using ensembled machine learning (ML) model based on the data from a full-scale WWTP. Eight ML models were examined for predicting biogas production and three of them were selected as metamodels to create a voting model. This voting model had a coefficient of determination (R2) at 0.778 and a root mean square error (RMSE) of 0.306, outperformed individual ML models. The SHAP analysis revealed that returning activated sludge and temperature of wastewater influent were important features, although they affected biogas production in different ways. The results of this study have demonstrated the feasibility of using ML models for predicting biogas production in the absence of high-quality data input and improving model prediction through assembling a voting model.

Antibiotic resistance gene-free plasmid maintenance in a probiotic strain of E. coli

Matt Amrofell *(Energy, Environmental & Chemical Engineering)*

Poster number 119

Plasmids are a cornerstone of modern molecular biology. They are easily modified, allowing researchers to progress through the design-build-test-learn cycle quickly and easily. However, plasmids are often maintained by using antibiotic resistance genes. This is not ideal for the development of microbial therapeutics and diagnostics because antibiotics could contaminate the final therapeutic product if included in the culture medium, plasmids cannot be maintained within the gut using antibiotics, and resistance markers can be horizontally transferred to native microbes, leading to spread of antibiotic resistance. Current efforts to overcome these limitations require 1) laborious genome integration of genetic constructs and subsequent re-optimization of expression levels or 2) bespoke antibiotic-independent selection systems that nevertheless rely on antibiotic resistance genes for initial plasmid construction and/or additional in vitro reactions to remove the resistance cassette. To address these issues, we have developed a fully antibiotic resistance gene-free plasmid cloning and maintenance pipeline. First, we used auxotrophic gene-based selection in engineered E. coli cloning strains to construct plasmids containing both auxotrophic and essential gene markers at comparable efficiencies to that of antibiotic resistance-based cloning. Second, we used these plasmids to transform strains of E. coli Nissle 1917 (EcN), a common chassis for microbial therapeutic development, which are missing both the auxotrophic and essential genes. Finally, we demonstrated that these plasmids can be maintained in our EcN strains at least for one month. Our plasmid backbones and strains will enable a simpler development of engineered microbes for therapeutic and diagnostic applications.

ABSTRACTS: ENGINEERING

Influenza A Virus Surface Proteins Determine the Spatial Structure of Viral Spread

Zijian Guo, Michael Vahey *(Biomedical Engineering)*

Poster number 120

Influenza A virus (IAV) is an enveloped RNA virus responsible for the seasonal flu. The IAV genome encodes two surface proteins with competing activities: hemagglutinin (HA), which binds to sialic acid (Sia) on the cell surface; and neuraminidase (NA), which cleaves Sia. To enable viral attachment to naïve cells while still permitting the release of new virions late in infection, IAV requires functional balance between HA and NA. While prior work has provided valuable insights into the genetic and biochemical basis, it remains unclear how HA-NA functional balance influences viral replication and spread. To address this gap in knowledge, we investigated the in situ activity of NA on the cell and viral surface during productive infection. Using a chemical approach to quantitively label Sia in cell monolayers, we show that NA on the surface of infected cells cleaves Sia on both the infected cell and the adjacent uninfected neighbors. The extent of this cleavage does not necessarily follow the intrinsic NA activity as determined by traditional assays (e.g., MUNANA). Using fluorescence microscopy to track the spread of individual virions from initial sites of infection, we find that the Sia depletion from neighboring uninfected cells leads to a reduction in virus binding and uptake by these cells. Performing these measurements in the H1N1 strain A/California/04/09 in the presence of NA inhibitors, exogenous sialidase, or genetic replacement with the enzymatically weaker NA from A/WSN/1933, we find that the efficiency of localized virion spread is inversely correlated with in situ NA activity, leading to differences in multiplicity of infection and efficiency of multicycle spread. Thus, the activity of cell surface NA represents a viral intrinsic mechanism that can tune cellular multiplicity of infection, with implications for virus evolution and cross-species transmission.

ABSTRACTS: ENGINEERING

Development of a Light Scattering Sensor to Measure the Size of Lunar Dust Particles

Abhay Vidwans *(Energy, Environmental, and Chemical Engineering; Physics)*

Poster number 121

We stand at the frontier of a new wave of lunar missions. Since the last Apollo mission lifted off the Moon in 1972, there have been no crewed missions and only a handful of robotic landed missions. However, recent interest in the Moon has grown due to knowledge of its valuable resources, the potential to answer critical planetary science questions, and its potential to serve as a base to study human presence beyond Earth. In 2017, NASA announced the Artemis program to establish a permanent human base on the Moon and facilitate human exploration to Mars. A significant challenge that must be overcome for these long-term missions is lunar dust.

A fine rock dust blankets the Moon to a meter or more. It formed from the breakdown of larger rocks over billions of years from hypervelocity meteorite impacts. During the Apollo missions, dust was a nuisance: coating astronauts and equipment and requiring time-intensive cleaning procedures when returning to the cabin. For the longer-term Artemis missions, dust-related issues are expected to exacerbate – coating sensitive power and thermal surfaces of mission-critical equipment, and even migrating into pressurized habitation areas where dust can be inhaled and cause health complications (Cain, 2010). The situation is further complicated by the strong evidence of dust lofting and levitation due to electrostatic forces, enabling dust to behave even less predictably. Technology development to mitigate these dust particles is limited by our poor understanding of dust characteristics – particularly their size. Analyses of lunar soil samples indicate a wide particle size range – from millimeters (Carrier, 1973) down to nanometers (1/1000th as thick as a human hair) (Greenberg et al., 2007) and provides no information on what particles are lofted above the surface. Therefore, in-situ measurements of lofted dust particles are necessary to properly inform dust mitigation technology and enable smooth long-term missions.

In this study, we first evaluated a popular Earth-based optical particulate matter sensor (Sharp GP2Y1010AU0F) for measurement of individual dust particles. We found that the sensor can detect coarse (>10μm) particles, but not fine (<2.5μm) particles. The sensor exhibited poor size resolution, with significant variance spanning nearly its entire dynamic range. High noise levels, narrow scattering angle, and the wide inlet, allowing for various entry areas into the sensor, may be significant contributors to error. With these shortcomings identified, we developed an improved sensor prototype for measurement of simulated lofted dust particles. The sensor consists of a laser (632nm, 1.2 mW), wide-angle, bilateral scattered light collection at ±90°, photon-current conversion using a Si photodiode, and current-voltage conversion using a state-of-the-art transimpedance amplifier. The sensor prototype was able to detect both coarse and fine particles when the laser intensity was controlled with focusing lenses. Size resolution was superior to the Sharp sensor, while still exhibiting variance for non-spherical particles. Future work will focus on miniaturization of the prototype for deployment on the surface of the Moon.

ABSTRACTS: ENGINEERING

Dual-color Optogenetic Tool Enables Non-invasive Heart Pacing and Restorable Heart Arrest in D. melanogaster

Jiantao Zhu *(Biomedical Engineering)*

Poster number 122

We have developed a new D. melanogaster optogenetic pacing system based on a transgenic line containing two opsins, ChR2 and NpHR2.0, and customized hardware involving optical coherence microscopy (OCM) imaging and a dual-color LED light pulse generation module. ChR2 is a member of the channelrhodopsin family, responding to blue light (~480 nm) and causing cells depolarization. NpHR2.0 is a halorhodopsin with ensitivity to orange/red light (~590 nm), which induces cells hyperpolarization. We combined ChR2 and NpHR2.0 transgenes using genetic tools and confirmed the presence of both transgenic constructs on the molecular level. The heart-specific opsins expression pattern was achieved by driving the expression with Hand-GAL4. Having an optogenetic system with a functional tissue activator (ChR2) and inhibitor (NpHR2.0) responding to discrete light wavelengths allowed us to create a sophisticated cardiovascular research platform in Drosophila. The initial experiments demonstrated the feasibility of increasing the heart rate following the designed blue light pulses and inducing the restorable heart arrest caused by prolonged red-light illumination in the same animal. Reducing the heart rate using red light with square pulses was also demonstrated. The main advantage of our system is that the heart function control was achieved noninvasively. We have optimized the OCM system parameters, such as irradiance level, pulse width and illumination schedule, to minimize the detrimental effects on live animals to ensure longitudinal studies on Drosophila models of human diseases, such as Type 2 diabetes.

ABSTRACTS: ENGINEERING

Development of a clinic ready multispectral short wave infrared imaging device for cutaneous water assessment

Quinlan McGrath *(Biomedical Engineering; Dermatology)*

Poster number 123

Inflammatory skin diseases affect an estimated 2-20% of the worldwide population. Visual inspection of disease-associated changes in skin morphology is the main clinical tool for inflammatory disease diagnosis and management. Clinician experience and interobserver variability significantly limits the accuracy of visual inspection, particularly in patients of color given the more subtle contrast of erythema against pigmented skin. There exists an urgent clinical need for a technology that can objectively and quantitatively evaluate cutaneous inflammation across diverse skin tones. Measuring local shifts of cutaneous water content may offer a more direct physiological measure of inflammatory skin disease state. The short wave near infrared (SWIR) spectrum (~900-1800 nm) is an emerging biological imaging window that is well suited for interrogating cutaneous water. Water is the dominant absorber while the spectrum remains relatively insensitive to melanin. Therefore, SWIR imaging affords the opportunity to measure intradermal water content in a manner independent of skin tone. It has been shown that SWIR multispectral imaging provides high contrast quantitative information on water content that progresses with inflammation severity. However, past SWIR imaging research has relied on benchtop devices that are limited in translation to clinical practice. Furthermore, no prior work has not explored the impact of skin pigmentation on imaging contrast. The major goals of this work were (a) build and characterize a novel multispectral clinic-ready SWIR imaging modality (b) validate the ability of the device to achieve high contrast imaging of water in the SWIR in the absence and presence of pigmentation. A mobile, filter-wheel-based imaging device was constructed that can automatically obtain high resolution, widefield images at six wavelength bands from 650-1600 nm. The imaging device is mounted on a wheelable scanner that can be used to obtain full body images. Primary components include an InGaAs camera, an aberration correcting lens, broadband halogen lamps, crossed polarizers, and a fast switching filter wheel with narrowband bandpass filters. Tissues mimicking phantoms of various scattering and absorption properties were imaged to evaluate the impact of relative chromophore content on water signal strength. A preliminary evaluation of water signal contrast of a drop of saline on a limited number of subjects across the Fitzpatrick skin tone spectrum was conducted. While pigmentation was associated with some decrease in contrast, it remained significant even in areas of high pigmentation and demonstrated a vast improvement over the visible spectrum.

Results suggest that a multispectral SWIR imaging device is a promising clinical strategy for obtaining unbiased, improved quantifiers of inflammatory skin disease. The developed device will support future imaging studies, including larger studies across the full spectrum of skin pigmentation and an evaluation of the clinical utility of quantifiers for disease diagnosis and management.

ABSTRACTS: ENGINEERING

Advances in Simulating the Global Spatial Heterogeneity of Air Quality and Sectoral Contributions: Insights into the Global South

Dandan Zhang *(Energy, Environmental, and Chemical Engineering)*

Poster number 124

High-resolution simulations are essential to resolve fine-scale air pollution patterns due to localized emissions, nonlinear chemical feedbacks, and complex meteorology. However, high-resolution global simulations of air quality remain rare, especially of the Global South. Here, we exploit recent developments to the GEOS-Chem model in its high performance implementation to conduct one-year simulations in 2015 at cubed-sphere C360 (~25 km) and C48 (~200 km) resolutions. We investigate the resolution dependence of population exposure and sectoral contributions to surface fine particulate matter (PM2.5) and nitrogen dioxide (NO2), focusing on understudied regions. Our results indicate pronounced spatial heterogeneity at high resolution (C360) with large global population-weighted normalized root mean square difference (PW-NRMSD) across resolutions for primary (62% - 126%) and secondary (26% - 35%) PM2.5 species. Developing regions are more sensitive to spatial resolution resulting from sparse pollution hotspots, with PW-NRMSD for PM2.5 in the Global South (33%), 1.3 times higher than globally. The PW-NRMSD for PM2.5 for discrete southern cities (49%) is substantially higher than for more clustered northern cities (28%). We find that the relative order of sectoral contributions to population exposure depends on simulation resolution, with implications for location-specific air pollution control strategies.

ABSTRACTS: ENGINEERING

Quantifying snow albedo reducing effects of brown carbon aerosols on the brown-black continuum using SNICAR radiative transfer model

Ganesh Chelluboyina, Benjamin Sumlin, Rajan K. Chakrabarty
(Energy, Environmental, and Chemical Engineering)
Poster number 125

As wildfire frequency and intensity have trended upward in recent years, the deposition of light-absorbing aerosols of biomass-burning origin on snow and ice has gained salience. These impurities, when dispersed in snow and ice, induce a reduction in surface albedo compared to pristine snow. Previous studies have extensively measured the concentrations of black carbon (BC) and mineral dust in snow, and attributed albedo reductions to these constituents. However, the influence of brown carbon (BrC), which is co-emitted with BC in wildfires, on albedo remains poorly constrained, and has not been examined as much on account of the wide variability in its optical properties, as well as its differing solubilities.

In this study, we use the optical classification of BrC proposed by Saleh et al., 2018, referred to as the 'brown-black continuum' of light-absorbing aerosols, to show the response of snow albedo to a broad range of BrC optical properties. Specifically, we apply the brown-black continuum parameterization to generate, through Mie theory calculations, an optical property dataset for BrC. This is used within simulated aerosol dispersal scenarios in snow to calculate spectral and broadband albedos.

Our results show that, at 1 ppm of aerosol in snow, the strongest absorbing BrC can produce a broadband albedo reduction of up to 0.12 between the wavelengths 400-1000 nm. Within the category of strongly absorbing BrC (S-BrC , k550 in the range 0.1-0.25), for the same concentration of BrC aerosol, the spread in albedo reductions can be as large as 0.11. Further, we show the results of a combined sensitivity analysis that includes snow microphysical properties such as ice grain size along with aerosol optical properties, and develop a parameterization to predict broadband albedo. Finally, we calculate the mean radiative forcing. These results could be consequential in better predicting glacier and snow melt in areas downwind of forest fires.

Catecholamine-independent neural pathways drive the rapid catabolism of metabolically inert fat

Xiao Zhang *(Biomedical Engineering)*

Poster number 126

Adipocytes classically store or release energy in response to changes in metabolic status. However, several fat depots throughout the body are resistant to these metabolic cues. Identification of novel mechanisms that drive energy release from metabolically inert adipocytes is needed to inform strategies to deplete stubborn fat and, conversely, to preserve these depots in pathologic settings of wasting and cachexia. To address this question, we focused on the constitutive bone marrow adipose tissue (cBMAT), a well-established site of metabolically inert fat that remains unchanged with fasting, exercise, and cold exposure and is depleted only in extreme conditions of cachexia or starvation. To study this unique depot, we developed a mouse model of rapid, complete depletion of all fat, including cBMAT, within 9 days using central intracerebroventricular (ICV) injection of leptin. Neither surgical denervation, chemical sympathectomy, nor genetic dopamine beta-hydroxylase (DBH) deletion could prevent the ICV leptin-induced depletion of cBMAT, revealing this process to be independent of catecholamines and the sympathetic nervous system (SNS). Vossicle implantation defined the mediators as transported through the circulation, and immunohistochemistry for phospho-hormone sensitive lipase (p-HSL) did not show any increase in cBMAT lipolysis in response to leptin treatment. However, BMAT-specific ablation of adipose triglyceride lipase (ATGL) identified dependence on basal lipolysis. Gene expression and de novo lipogenesis assay pinpointed a concurrent suppression of lipogenesis, and subcutaneous insulin supplementation prevented leptin-induced cBMAT depletion, but not other depots. Together, this defines the differential regulation of metabolism in metabolically inert fat depots such as cBMAT. Specifically, leptin-responsive circuits in the brain can deplete inert adipocytes by suppressing lipogenesis while maintaining basal lipolysis independent of the SNS.

Improving representation of the AOD to PM2.5 relationship with a convolutional neural network

Siyuan Shen *(Energy, Environmental & Chemical Engineering)*

Poster number 127

Fine particulate matter (PM_2.5) concentration are relied upon for air quality assessments, health impact assessments, and epidemiological analyses. Global PM_2.5 assessment is impeded by a paucity of monitors. We improve global PM_2.5 concentration estimation by developing and applying a convolutional neural network with information from satellite-, simulation- and monitor-based sources to a priori (geophysically based PM_2.5) from 1998-2019.
We develop an adjusted mean-square-error(MSE) loss function that incorporates the a priori value to train the model, which solves the phenomenon that the traditional MSE loss function used in regression models leads to abnormal estimation in some local regions. The resultant PM_2.5 estimation was highly consistent with spatial cross-validated PM_2.5 concentrations from monitors in the global range(R^2= 0.86), North America(R^2= 0.59), Europe(R^2= 0.70), and Asia(R^2= 0.73). The population-weighted annual average PM_2.5 varies widely across the globe, the highest exposure to PM_2.5 is in South Asia and Mid-East, followed by China and Sahel area. We withhold from 10% to 99% monitors for training to evaluate the sensitivity and robustness of model performance to the distribution density of observation monitors, and the model remains highly consistent with observations in the global range under extreme condition(99% withheld, R^2= 0.73), which indicate the high reliability of the model in areas with sparse distribution of monitors.

ABSTRACTS: ENGINEERING

Elemental characterization of ambient particulate matter for a globally distributed monitoring network: methodology and implications

Xuan Liu *(Energy, Environmental & Chemical Engineering)*

Poster number 128

Global ground measurements of elements in ambient particulate matter (PM) can provide valuable information to understand emission sources of dust and trace elements, assess their health impacts, and improve atmospheric models. We use Energy-dispersive X-ray Fluorescence (ED-XRF) to characterize the elemental composition of PM collected from 24 globally distributed sites in the Surface PARTiculate mAtter Network (SPARTAN) over 2018−2022. Consistent protocols are applied to collect all the samples and analyze them at one central laboratory which ensures the comparability of data among different sites around the world. Particular standards that mimic filter material and mass loadings of typical PM samples are applied to better calibrate the instrument. Routine quality control measures are implemented to monitor instrument stability and acceptance testing is conducted to ensure filter quality. Background levels from both lab and field are considered to conduct background subtraction and calculate method detection limits. Additive and proportional uncertainties are estimated to provide overall measurement uncertainties. With the elemental dataset, concentrations of dust and trace element oxides (TEO) are estimated for all sites. In addition to sites in arid regions, high dust concentration (6 μg/m3) in PM2.5 is also observed in Dhaka (Bangladesh) with a high TEO level (6 μg/m3). High carcinogenic risk (>1 cancer case per 100,000 adults) from airborne arsenic is observed in Dhaka, Kanpur (India), and Hanoi (Vietnam). Common emission sources including dust, traffic, and coal combustion are identified for these sites where coal combustion is likely the major As source indicated by principal component analysis.

ABSTRACTS: ENGINEERING

Global Spatial Variation in PM2.5 to AOD Ratio and the Driving Factors

Haihui Zhu *(Energy, Environmental & Chemical Engineering)*

Poster number 129

Ambient fine particulate matter (PM2.5) is a leading global environmental determinant of health. However, large gaps exist in ground-based PM2.5 monitoring. Satellite remote sensing offers information to fill these gaps worldwide, when augmented with information from a chemical transport model. More specifically, this satellite-derived PM2.5 is obtained from satellite-retrieved aerosol optical depth (AOD) by applying the modeled PM2.5 to AOD relationship. Uncertainties, however, exist in the modeled relationship between PM2.5 and AOD. This study aims at understanding the spatial pattern and driving factors of the PM2.5 to AOD ratio (eta) from observation and model. Measured PM2.5 from 7 ground-based networks and measured AOD from satellites show that the highest eta is found in desert areas, followed by regions strongly influenced by anthropogenetic aerosol sources, where aerosols are more accumulated near surface. Minimum eta is found in humid areas, where aerosol extinction coefficient is high due to high RH. A global chemical transport model, GEOS-Chem, is used to reproduce and interpret the spatial pattern of eta. The discrepancy between model and measurements highlights the importance of spatial and temporal variation of aerosol size, model resolution, and biomass burning plume injection height. Sensitivity tests showed that aerosol vertical distribution and aerosol composition are the strongest factors. Further model developments on smoke transportation and aerosol optical properties will benefit satellite-derived PM2.5 and the subsequent epidemiological studies.

Prison Violence as Punishment

William Bell *(Philosophy)*

Poster number 130

The United States carceral system is widely considered to be an immoral and inhumane system of criminal punishment. There are a number of pressing issues related to this topic, but here, I will focus upon the problem of prison violence. Inadequate supervision has resulted in unsafe prison conditions where inmates are regularly threatened by rape, assault, and other forms of physical violence. Such callous disregard and exposure to unreasonable risk constitutes a severe violation of the rights of prisoners by the state. While there have been numerous legal, political, and activist efforts to draw attention to this issue—with the goal of reforming and making prisons safer—my goal here is different. I argue that prisoners who are victims of prison violence should have their sentences automatically reduced.

Ethically Staging Sanctuary: Questioning the Representation of Refugees and Asylum Seekers in Theater and Performance

William Bonfiglio *(Performing Arts - Theater and Performance Studies)*

Poster number 131

What are the ethical concerns of presenting refugee and asylum-seeking stories on stage? How might these sanctuary stories be told without emphasizing the victimization and trauma often associated with forced migration? Through an evaluation of current and recent Western theater and performance in the twenty-first century dealing with refugee and asylum-seeking populations, I demonstrate how two techniques are essential for presenting these stories ethically while inviting social change: (1) a shared spatial environment between audience and performer and (2) characters that resist the universalized generalizations of refugees or asylum seekers as victims lacking agency and futurity. After exploring each of these conditions and gesturing towards various supporting examples, I turn my focus to two case studies in particular, one on the performances of Joe Murphy and Joe Robertson's THE JUNGLE in London and New York City between 2017 and 2023 and another examining productions of Dries Verhoeven's NO MAN'S LAND in Europe between 2008 and 2014. Through these case studies, I will demonstrate that both THE JUNGLE and NO MAN'S LAND bring these relational and dramaturgical conditions together into the performance event, and in effect, destabilize the spectator in order to encourage self-reflection, build community, and invite social change.

Rethinking Monuments in Forest Park, St. Louis

Sydney Watt, William Bonfiglio *(Performing Arts - Theater and Performance Studies)*

Poster number 132

Guided by theories around speculative design, Afrofuturism, and critical fabulation design theory, this project explores the theoretical conception of new or revised monuments. We specifically focus on three present and past monuments in Forest Park, St. Louis: (1) Memorial to the Confederate Dead, (2) Thomas Jefferson Statue, and (3) The Apotheosis of St. Louis. Considering how these monuments and memorials, as well as monuments and memorials in general, are tied to collective memory, a critical question of ours focuses on the inherent tension in changing monuments: How can monuments be changeable and resist stasis, while also resisting erasure of critique? Other foci of our project include investigating the community's potential role in reconceptualizing the site and also exploring how former sites may be repurposed into new spaces of community and collective memory. As a result of our investigation, we have identified and visually prototyped three potential approaches to rethinking monuments: video mapping projection, spatial revision, and community art projects. Through these questions and resulting approaches, we explore how we might reckon with histories of racial violence and conduct the reparative work necessary for imagining new futures.

Performances of ASMR: The Theatrical-Therapeutic Spectrum

Sydney Watt *(Performing Arts - Theater and Performance Studies)*

Poster number 133

ASMR (autonomous sensory meridian response) videos are meant to provide a pleasant scalp-tingling sensation to the viewer through auditory and visual stimuli. These videos compose a new performance genre, which ranges in function from theatrical to therapeutic. Through engagement with important performance studies scholarship, such as Richard Schechner's efficacy-entertainment braid and Erving Goffman's theory on the performance of fronts, various modes of ASMR can be analyzed and categorized in relation to theater, therapy, or combinations of the two. The poster will present four distinct modes of ASMR performance, from the non-linguistic and disembodied to the Aristotelian narrative-driven, outlandish spectacle. This research especially considers a popular sub-genre of ASMR in which the "ASMRtist" role-plays as a healthcare professional, further bridging the two ends of the spectrum. Additionally, the research considers the influences of gender and capitalist structures within the sphere of ASMR. Finally, the researcher embarks on an auto-ethnographic entry into the world of ASMR performance herself.

Sex/Gender Metaphysics

Jordan Shaw *(Philosophy, Medical Scientist Training Program)*
Poster number 134

Despite the growing acceptance and cultural prominence of gender and sexual minorities (GSM) –including trans, non-binary, intersex, and gender-nonconforming people – we remain urgently underserved and underrepresented in critical domains of contemporary human life. The discipline of philosophy is concerned with conceptualizing, clarifying, and helping to progress or improve human life; to do this, philosophers draw from a few distinct areas or modes of argumentation in order to focus an issue within one particular set of perspectives at a time. These areas include metaphysics (which aims to clarify all of reality and its contents; the nature of existence), morality and ethics (including social and political philosophies, as well as bioethics), epistemology (what is knowledge, and how do we know when we have it?) and aesthetics (the philosophy of art and appearance). One far-reaching metaphysical claim regarding human sex and/or gender, for example, is that sex/gender is, in some sense, just a performance we put on for others. Another could say it involves a deeply internal sense of who one is. Another, still, emphasizes a distinction between sex and gender.

Even in queer communities, there is no consensus on what sex/gender actually is, how it forms on an individual level, or to what extent it's a real thing. Political and physical attacks direct our and our allies' attention toward important but entirely different questions: what are the best ways to promote and protect trans rights? How can we best treat people in terms they identify with? Without being able to ground our identities in some independent reality, however, we shortchange ourselves and our allies of the conceptual prerequisites for advocacy in novel and highly individualized contexts, such as in healthcare and the provision of public services. Recent improvements in medical training emphasize acceptance and support for GSM, but it's largely up to individual providers to factor that idea into medical decision-making. Multiple large-scale studies demonstrate significant discrepancies between trans people's understandings of their own sex/gender and the dearth of public servants and providers' knowledge, with one consequence that GSM spend a good portion of their doctor-patient facetime actually educating their providers when they should be receiving care.

The first aim of my dissertation, then, is to address these discrepancies with a comprehendible sex/gender metaphysics. Drawing from my philosophical predecessors, I argue that sex/gender, itself, is constituted in the process of self-identification, which makes a difference to personal and social reality. If we can better understand how self-identification constitutes sex/gender, we will know to think of sex/gender as something both expressive – teeming with symbology and potential meaning – but impossible to know with precision, at least without first-person perspective. If sex/gender is deep to the self in this way, then any one person's sex/gender is based on their unique variations in biology, psychology, and social conditions. Later chapters spell out the immediate implications of my metaphysical view, with a focus on healthcare settings and the aesthetics of sex/gender expression in progressive arts.

The Stakes of Academic Centralization. Literary Writing Education as a Point of Entry onto the Danish Literary Field

Kristian Svane *(Germanic Languages and Literatures)*

Poster number 135

International trade, the globalization of education, and broad access to digital media create new worldwide contact zones. Knowledge and culture circulate globally through networks, as well as poetics, aesthetics, and ideas. Travelling, they adapt to local configurations and are shaped anew. This holds true for both theory (Said) and forms. Caroline Levine argues "that artfully crafted shapes and patterns are as much the stuff of the sociopolitical world as they are of art"; gaining a critical understanding of the localized adaptations of global forms thus promises to provide insights into the social constitution of contained environments.

This poster maps the Danish literary field through an analysis of previously underexplored literary institutions: regional writing schools, such as the Kopenhagen forfatterskole. It argues that these well-connected local nodes of education exert pressure on the surrounding literary network, resulting in a division of the literary field into graduated writers of critical renown and outsiders struggling for symbolic capital. Using Føtexsøen by Lone Aburas, which offers a fictionalized autobiographical approach of a literary outsider aspiring to make an appearance on and challenge the literary field (Bourdieu), the paper contributes to the ongoing conversation on the role of institutions in the sociology of literature.

A close reading contrasted with examples of public discourse reveal the potential of an institutionalized literary education in Denmark to lance young writers into the field. Lone Aburas vividly depicts the hardship of entering the field by one's own means. She repeatedly makes clear, that the institutionalized approach to writing both provide financial stability and literary recognition through admittance to the Forfatterskole. The highly selective entry conditions thus limit access to literary recognition and systematically restrict and distribute the socio-economic goods of literature.

Gauguin and the Virgin Mary: A Syncretic Icon

Elizabeth Mangone *(Art History and Archaeology)*

Poster number 136

Paul Gauguin's paintings are widely known for their depictions of exoticized landscapes, sensual women, and vivid colors. They are also rife with religious imagery from Europe, Polynesia, and Asia. Gauguin's use of Christian iconography commonly made use of figures such as Eve, Christ, and the Virgin Mary, but his images of Mary are less studied in comparison to other religious subjects. Gauguin was also deeply interested in syncretism, or a blending of two or more religions, as well as theosophy, a religious theory that held that all religions were interpretations of the same source. Gauguin's iconographic treatment of the Virgin Mary shows that she was an important figure in the artist's visualization of his personally imagined, deinstitutionalized, syncretic religion.

This research explores Gauguin's depiction of the Virgin Mary with a special focus on the paintings he made while living in Tahiti and the Marquesas Islands. This analysis contextualizes his Marian imagery through an examination of his early seminary education under Bishop Dupanloup as well as his troubled relationship with the Catholic Church both in France and the French colonies. Further, this research seeks to situate Gauguin's paintings and syncretic theology within the popularity of the Virgin Mary as a devotional figure in nineteenth-century France and its rapidly changing religious landscape.

Gauguin's depictions of Mary as a Tahitian figure and in a syncretic context were unusual within the broader field of art in his time and reflected a period of intense colonial interest by the French Empire and an increased focus on the feminine holy image. His approach to Marian imagery reveals his complicated religious background and his experiences of faith, place, and the French state in the nineteenth century. This research then explores not only Gauguin's background but also seeks to reveal the nature and extent of the Virgin Mary's importance to his visual depictions of syncretic theology.

ABSTRACTS: PROFESSIONAL

The peso vs. the dollar: Currency of debt choices among Mexicans working in the U.S.

Tatiana Vdovina *(Finance)*

Poster number 137

In this project, I intend to empirically understand the choice of Mexican households, which have at least one member working in the United States, to borrow in pesos or dollars. The two experiments will involve a select group of Amazon MTurk, SurveyMonkey, or Qualtrics users presented with a hypothetical choice to obtain small, short-to-medium-term (3 to 5 years) household loans. The users are selected based on their primary residence in certain states of Mexico and their status as an immigrant worker in the United States. For the purposes of this study, I will focus on low-wage, manual labor workers and seasonal workers from the northern region of Mexico employed in 3 metropolitan areas close to major U.S.-Mexico border crossings: San Diego, CA, Imperial County, CA, and El Paso, TX. I will attempt to derive the elasticity of the chosen fraction of total financing in dollars for households given household characteristics (risk aversion, income in dollars, other financials) following their responses to the interest rate reduction experiment when presented with an opportunity to borrow in either pesos or dollars. I also intend to identify the elasticity of the level of dollar borrowing if the agent only intends to borrow in dollars.

TM6SF2 exhibits cell type and species-specific roles in ApoB and triglyceride-rich lipoprotein secretion

Allen Liu, Elizabeth P. Newberry, Yan Xie, Elizabeth Molitor, Nicholas O. Davidson
(Department of Medicine, Division of Gastroenterology and Hepatology)
Poster number 138

Background: TM6SF2 variant rs58542926 (E167K) is a loss of function allele associated with impaired VLDL secretion. We previously demonstrated that liver-specific Tm6sf2 knockout mice (Tm6-LKO) exhibit impaired VLDL-triglyceride (TG) secretion with preserved ApoB secretion, resulting in smaller, underlipidated VLDL. However, there are unresolved questions including organ-specific functions of variant vs knockout of Tm6sf2 (liver vs intestine) and the role of TM6SF2 in human hepatic VLDL APOB and TG secretion.

Approach: We generated homozygous Tm6sf2 K167K (Tm6 K167K), APOB100-only Tm6sf2 K167K knock-in (Apobec1 –/– Tm6 K167K) and Tm6sf2 enterocyte-specific knock-out mice (Tm6-IKO). We also generated CRISPR/Cas9 TM6SF2 K167K knock-in HepG2 cells. We measured hepatic VLDL-TG and APOB production and intestinal TG absorption and chylomicron production with oral 3H triolein and measured fecal fat. We performed pulse-chase analysis measuring cell/media 35S-labeled APOB100 and 3H-labeled TG production in HepG2 cells supplemented with 200 μM oleate.

Findings: Tm6 K167K mice fed a high fat diet developed increased hepatic steatosis with impaired VLDL-TG secretion, no change in APOB and smaller VLDL particles, phenocopying serum and hepatic profiles in Tm6-LKO mice. APOB100-only mice in both Tm6 K167K and Tm6-LKO backgrounds exhibited similarly reduced VLDL-TG secretion with unchanged APOB100 secretion. These findings suggest that mouse hepatic VLDL secretion is shifted to smaller, underlipidated particles with preservation of APOB (both B100 and B48) production. By contrast, Tm6-IKO mice (exclusively B48) exhibited a subtle phenotype, with decreased initial intestinal TG secretion, increased jejunal TG accumulation but no fat absorption deficit. Those findings suggest that loss of enterocyte Tm6sf2 is tolerated with a shift in lipid absorption and decreased rate of chylomicron formation. In further contrast, TM6 K167K hepatocyte-like HepG2 cells exhibited decreased secretion of both APOB100 and TG with corresponding increased intracellular APOB100 degradation. Those findings complement other findings where inhibition of VLDL assembly in HepG2 cells results in decreased APOB secretion and also observations in humans suggesting the TM6SF2 variant is associated with decreased APOB production.

Conclusions: Tm6 K167K in mouse liver impairs VLDL lipidation with preserved APOB production and smaller VLDL particles, phenocopying Tm6-LKO mice. By contrast, Tm6-IKO mice exhibit no TG absorption impairment with a distal shift in gut TG processing. Expression of the TM6SF2 variant in HepG2 cells impairs secretion of both APOB100 and TG, in line with other observations in humans and which are different from mouse. Taken together, our findings emphasize a hitherto unrecognized tissue- and species-specific divergence in the role of Tm6sf2 in VLDL assembly and secretion.

ABSTRACTS: PROFESSIONAL

A Scoping Review of Health Equity Framework and Models Applied in Empirical Studies of Chronic Disease Prevention & Control

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Poster number 139

Chronic diseases, such as heart disease, diabetes, and cancer, present the greatest burden of morbidity and mortality globally. Marginalized populations, communities, cities, and countries are disproportionately impacted, leading to a health inequity crisis. Health equity in the past two decades has become a significant area of focus in public health, health services, and the implementation and dissemination science research. As the global conversation of health equity continues, there is a clear gap in defining health equity as a concept, measuring health equity indicators, and a lack of conceptually theorizing how health equity is the ideal outcome. Many current theories, models, and frameworks (TMFs) guide equity-focused chronic disease empirical research, but there is no clear consensus on how to apply these TMFs to empirical research. This scoping review seeks to fill this gap by identifying the application of health equity TMF in empirical studies along the chronic disease prevention and control continuum, describing how these TMF are used, and exploring potential applications to the field of implementation science.

We follow established guidelines for conducting scoping reviews, which include six stages: 1) identify the research question; 2) identify relevant studies; 3) select studies for inclusion; 4) data extraction; 5) collate, summarize, and report the results; and 6) consultation. This protocol presents the iterative, collaborative approach to conceptualizing this study and developing the search strategy. We describe the criteria for inclusion in this review, the methods to conduct two screening phases (title and abstract, full text), the data extraction procedures we will use, and quality assurance approaches taken throughout the project.

This scoping review is currently in progress at the data extraction stage. Although the review has not concluded, the title/abstract and full-text screenings have already provided valuable information on the broad application of TMFs in empirical research. The PRISMA diagram shows that a total of 90,975 studies were identified through the search strategy, and, out of 2731 of these studies in the full-text screening, 1551 used no TMF and 313 had an unclear application/ not health equity relevant were ultimately excluded in the meta-analysis.

The findings from this scoping review will inform health-equity-focused chronic disease prevention and control research. The comprehensive methodology of a scoping review gave way to the identification and application of TMFs in the research. Our methodology serves as an example for scholars seeking to conduct reviews of health equity TMFs in other health disciplines. A future direction for this research will consist on understanding how heath equity TMFs are used for measurement in the research

Spillover Effects of Online Reviews: Evidence From the Hotel Industry

Cheolho Song *(Marketing, Olin Business School)*

Poster number 140

Do online consumer reviews have spillover effects on the sales of competitors? We study this question using a natural experiment where a major hotel group introduced its own review system to all the hotels within its portfolio. Using a modified Synthetic Control Method, we analyze the monthly financial performance data of reviewed and competing hotels before and after the review system was introduced. We find that the review system has significant economic impacts on both reviewed and competing hotels, and that the effects are highly heterogeneous. Surprisingly, the correlation between the economic impact on reviewed and competing hotels is significantly positive: If the occupancy rate of a reviewed hotel increases by 1%, its competitors' occupancy rate increases by 0.39%. The positive correlation can be explained by the information spillover. Under this mechanism, consumers update their beliefs about competing hotels based on the reviews for reviewed hotels. We explore alternative explanations, but none can fully explain the positive correlation. Our results suggest that, besides monitoring their own reviews, managers should also monitor competing hotels' reviews because of information spillover from the competitors' reviews.

The use of simulation modeling for care delivery improvement in informatics: a scoping review

Mikie Rachman *(School of Medicine, Nursing Program)*

Poster number 141

As patient care evolves and becomes more complex, there is an increased interest in holistically evaluating nursing care using data. Researchers have used data from electronic health records (EHR) to assess clinicians' time spent, stress, and well-being.1 Integrating such data with psychosocial factors has potential to help leaders identify systematic solutions to reduce nurses' burnout. Previous studies have used simulation modeling to incorporate multi-dimensional data to inform care delivery and workforce planning.2,3 However, little is known regarding the complexity of data needed to portrait nurses' workload properly and the need for a more comprehensive approach. Thus, this review aims to identify different data sources, methods, and components used in simulation modeling.

A scoping review is conducted using the Preferred Reporting Items for Systematics Reviews and Meta-Analysis (PRISMA) extension for Scoping Reviews guidelines. We systematically searched four electronic databases, including PubMed, CINAHL, Scopus, and PsyInfo, from inception to January 12, 2023. The search strategy included the following MeSH term and keywords: ("Computer simulation" OR "discrete event simulation" OR "system dynamics" OR "agent-based simulation") AND "Nurse." We specifically included studies that use dynamic simulation modeling approaches and have nurses as a component in the model. Dynamic simulation modeling uses mathematical and theoretical approaches to examine complex system processes, interventions, and behavior over time. We excluded reviews, clinical simulation lab/education studies, and studies that were not healthcare-related.

Among the 685 articles retrieved, a total of 34 studies met the inclusion criteria and were included; 17 use the discrete-event model, eight use the system dynamics model, and nine use the agent-based model. Seven simulation studies use a mixed method approach for data collection and analysis, of which discrete-event (n = 3) and system dynamics (n = 4) models were applied. About half of the outcomes reported in these studies are related to care delivery process which evaluate time and efficiency of medical tasks/treatments, followed by 35.3% on staffing and workforce prediction, and a few studies are related to infection control and workplace stress. The majority of these simulation studies use a combination of observation data with stakeholders interview, existing literature, hospital administrative data, EHR data (audit logs and process timestamps), real-time location systems (RTLS) data, or self-reported stress survey data to investigate resource planning and care inefficiencies. These results suggest that the need of evaluating the upstream and downstream consequences of stress/burnout interventions in a complex system.4 However, there are minimal studies that have intergrated EHR data sources into the dynamic simulation model to assess and evaluate the role of socio-technical indicators on nurses' stress/burnout.

Case Report of a Refractory Mogamulizumab-Associated Rash Responding to a Janus Kinase Inhibitor

Carine Lama, Miguel Hernandez Rovira *(School of Medicine)*

Poster number 142

Sezary Syndrome (SS) is the second most common form of Cutaneous T-cell Lymphoma (CTCL), occurring in 0.1 people per million annually in the United States. Mogamulizumab is an anti-CCR4 antibody that is FDA-approved for the treatment of CTCL, and it has been shown to improve progression-free survival in these patients. Response rates have been shown to be as high as 37% overall and 95% in the blood compartment. Mogamulizumab-associated rash (MAR) is one of the most common adverse events associated with mogamulizumab use, occurring in up to 25% of patients in a phase 3 study. Herein, we detail a SS patient treated with mogamulizumab who developed a treatment-refractory rash that eventually cleared using a Janus Kinase inhibitor (JAKi).

ABSTRACTS: PROFESSIONAL

Rates and Causes of Food Insecurity among International and Domestic Graduate Students at Washington University in St. Louis: A Cross-Sectional Study

Victoria Anders; Rachel Zimmerman RD, CNP *(George Warren Brown School)*

Poster number 143

College and university students in the U.S. face a heightened risk of food insecurity than the overall population, with prevalence as high as 43.5% as compared to 13% of the total U.S. population. The COVID-19 pandemic highlighted issues in food access and affordability nationwide, and also for this sub population. Food insecurity among graduate students, those seeking Masters and Doctoral degrees, has not been as widely studied as students seeking their undergraduate degrees.

The authors completed a cross-sectional study investigating food security among Washington University in St. Louis (WashU) graduate students who are domestic (U.S. citizens and permanent residents) versus international (carrying a student visa) status, seeking to answer the following questions: what are the rates of food insecurity among WashU graduate students using USDA metrics, and how do the rates and main causes of food insecurity differ between international and domestic graduate students at WashU? The authors hypothesized that the rates of food insecurity would be different among international and domestic students, and higher among international students.

The authors developed a mixed methods online survey using Qualtrics software made up of four parts: demographic data (including student status), academic program information, the USDA 6-item Food Security Survey to determine food security status (out of four possible levels, from food secure to very low food security), and perceptions and attitudes about food security and university resources. The survey received 129 complete responses from current WashU graduate students used for data analysis and bivariate correlation testing using R software.

Based on the USDA Survey, 16.3% of study participants had very low food security and 83.7% of study participants had full or marginal food security. By comparison, only 3.8% of U.S. households experienced this level of F.I. in 2021.1 Food insecurity was more prevalent among international students (20%) than domestic (15.4%). No statistically significant relationships were found between food security status and possible predictors within this sample. The overarching finding from this study is that food insecurity rates are higher than expected among WashU graduate students, but there is no statistical difference in the F.I. rate between international and domestic students. Previous studies have found that college students experience F.I. at a higher rate than the general public, and this study contributed to that research by also adding data regarding graduate students.

The authors present three key action steps for WashU graduate school administrators, as well as administrators at similar institutions with high food insecurity levels, to consider. Based on participant perceptions about existing support for student food security, these steps are: establishing an on-campus food pantry, improving the financial aid disbursement process, and institutionalizing practicum and stipend equity among professional and graduate students.

Disparities in healthcare-associated infections at the intersection of race and rurality

Hannah Kinzer, Katelin B. Nickel, Jason P. Burnham, Jennie H. Kwon
(Brown School at Washington University in St. Louis, Public Health Sciences; Washington University in St. Louis School of Medicine, Division of Infectious Diseases)

Poster number 144

Background: Preventing healthcare-associated infections (HAIs) is critical due to the associated increase in patient morbidity, mortality, and healthcare expenditures. Understanding risk factors for HAIs are necessary to create interventions to prevent them. The objective of this project is to examine HAI disparities by both race and geographic residence (rural vs urban residence).

Methods: This retrospective cohort study examined HAIs by race and urban/rural residence among patients admitted for ≥48 hours to one of three hospitals in the St. Louis, MO region between 1/1/2017 and 8/31/2020. The outcomes of interest were bloodstream, respiratory, and urine HAIs confirmed by laboratory culture along with intensive care unit (ICU) admission and mortality among patients with HAIs. Bivariate analyses were conducted using Chi-square tests.

Results: Among 214,955 admissions, the overall incidence of HAIs was 3.12%. Race/urban group was significantly associated with acquiring an HAI ($\chi 2$ $p<0.01$). As compared to all other groups, Black patients living in rural areas had the highest proportion of admissions with an HAI (4.09%), and Black patients living in urban areas (2.74%,) had the lowest proportion of HAIs. Among 6,699 HAI admissions, death and ICU admission were significantly associated with racial/urban group ($\chi 2$ $p<0.01$ and $p<0.01$ respectively). Among patients with an HAI, Black patients living in rural areas had the highest proportion of admissions resulting in mortality (37.78%, n=45) and ICU admission (77.78%).

Conclusion: The results of this study indicate that Black patients living in rural areas had a higher proportion of admission with an HAI and poor outcomes during their HAI admission compared to Black urban and White rural/urban patients. Further studies are necessary to investigate the intersection of race and rurality.

CD30-positive Lymphoproliferative Disorder Masquerading as an Atypical Melanocytic Proliferation

Miguel A. Hernandez-Rovira, Carine M. Lama, Barbara B. Hernandez-Rovira, Amy C.M. Musiek, Aaron J. Russell
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Poster number 145

CD30-positive lymphoproliferative disorders account for a large proportion of primary cutaneous lymphomas. Herein, we discuss the case of a 52-year old female with epidermotropic CD30-positive lymphoproliferative disorder that clinically and histopathologically resembled an atypical melanocytic proliferation. The patient presented to clinic with hyperpigmented patches on the extremities that vaguely resembled a speckled lentiginous nevus. Biopsy demonstrated a broad proliferation of large atypical cells forming nests within a heavily-pigmented epidermis. Given the growth pattern and cytology of these cells, as well as the clinical concern for an atypical melanocytic proliferation, the lesion was initially misdiagnosed as melanoma in situ, despite equivocal staining for melanocytic markers. Subsequent biopsies revealed that the large atypical cells within the epidermis were diffusely positive for CD3 and CD30 but negative for MART-1 and SOX-10. This case demonstrates a rare and unusual presentation of a pigmented epidermotropic CD30-positive lymphoproliferative disorder. It highlights the importance of rigorous clinicopathologic assessment as well as the importance of repeat biopsies when the diagnosis is unclear.

CD30-positive Lymphoproliferative Disorder Masquerading as an Atypical Melanocytic Proliferation

Samah Gassass (WUSM), Karen Steger-May (WUSM), Taewon Kim (WUSM), Susan E Mackinnon (WUSM), Jana Dengler (Sunnybrook Hospital, University of Toronto), Benjamin A Philip (WUSM)
(Washington University School of Medicine, Sunnybrook Hospital, University of Toronto)
Poster number 146

CD30-positive lymphoproliferative disorders account for a large proportion of primary cutaneous lymphomas. Herein, we discuss the case of a 52-year old female with epidermotropic CD30-positive lymphoproliferative disorder that clinically and histopathologically resembled an atypical melanocytic proliferation. The patient presented to clinic with hyperpigmented patches on the extremities that vaguely resembled a speckled lentiginous nevus. Biopsy demonstrated a broad proliferation of large atypical cells forming nests within a heavily-pigmented epidermis. Given the growth pattern and cytology of these cells, as well as the clinical concern for an atypical melanocytic proliferation, the lesion was initially misdiagnosed as melanoma in situ, despite equivocal staining for melanocytic markers. Subsequent biopsies revealed that the large atypical cells within the epidermis were diffusely positive for CD3 and CD30 but negative for MART-1 and SOX-10. This case demonstrates a rare and unusual presentation of a pigmented epidermotropic CD30-positive lymphoproliferative disorder. It highlights the importance of rigorous clinicopathologic assessment as well as the importance of repeat biopsies when the diagnosis is unclear.

"Nip it in the Bud!" Managing the Opioid Crisis: Supply Chain Response to Anomalous Buyer Behavior

Annie Shi *(Olin Business School - Marketing)*

Poster number 147

Over the past three decades, the opioid epidemic has wreaked havoc upon thousands of communities across the US. In this study, we provide a supply-chain perspective to manage the ongoing opioid crisis. Using the ARCOS database -- which tracks opioid drug shipments across the entire supply chain in the US, spanning the period 2006 to 2012 -- we employ a novel anomaly detection algorithm to detect suspicious buyer activity. Our algorithm is non-intrusive on patient privacy, in that it does not rely on prescription-level data (from drug retailers or physicians). Using a random sample of 48,464 drug retailers, and tagging a subset of 188 among them, using observed convictions from the Drug Enforcement Administration (DEA) website, as "suspicious", we train our anomaly detection algorithm to detect suspicious buyers based on their historical opioid buying patterns. Our anomaly detection algorithm, which is built on a training set of 24,232 drug retailers, selected the hyperparameters on a validation set of 12,210 drug retailers (which includes the 94 convicted buyers), yields a precision of 100 % and a sensitivity of 46 % (thus yielding an F-1 score of 64 %) in terms of correctly detecting suspicious buyers in a test set of 12,210 drug retailers (which includes the remaining 94 convicted buyers). While we employ a total of 40 input variables to train the anomaly detection algorithm, it ultimately relies upon only 5 input variables to achieve its impressive predictive accuracy. By applying our algorithm on real-time opioid shipments data as and when orders are placed by drug retailers around the country, the DEA can flag those that are tagged as suspicious for further investigation. By halting large shipments of opioids through early identification of suspicious orders placed by either (willfully or otherwise) negligent, or outright criminal, drug retailers, dangerous drugs can be prevented from reaching vulnerable communities, thus saving lives.

What characteristics are related to having a healthy food environment at home? Cross-sectional associations between financial resources and sociodemographic characteristics with home food environments

Olivia Weng *(Brown School)*

Poster number 148

Introduction: Access to healthy and unhealthy food at home can affect health status, but additional research is needed to understand the relationship between financial resources and home food environments. This study identifies predictors (financial status and sociodemographic characteristics) of healthy or unhealthy home food environments, and determines the strength and direction of relationships (positive or negative) of predictors.

Methods: This secondary analysis used baseline survey data from 177 participants from an ongoing study. Outcomes were the continuous indices of healthy (preparation of and accessibility to healthy food) or unhealthy (accessibility of soda and snacks) home food environments. Predictors were: reported likelihood basic needs (e.g., utilities, essential purchases) would be met, whether participants were SNAP or WIC recipients, and sociodemographic characteristics (age, education, and ethnicity). Only results from fully adjusted linear regression models were reported.

Results: Participants were English- or Spanish-speaking mothers (age 18-45 years) of young children with body mass index 25-45 kg/m2. Participants reporting a higher likelihood of unmet basic needs (beta=-0.18, p=0.03), or self-identifying as Hispanic (beta=-0.37, p=0.01), were less likely to have an unhealthy home food environment. Further, SNAP recipients were more likely to report an unhealthy home food environment (beta=0.30, p=0.04). Participants identifying as Hispanic were less likely to report a healthy home food environment (beta=-0.27, p<0.01). WIC status, age, and education were not significantly associated with the home food environment.

Conclusion: Participants identifying as Hispanic families may experience food insecurity limiting (healthy or unhealthy) food purchases. Participants with unmet basic needs may be less likely to purchase unhealthy food, while SNAP recipients may allow additional food purchasing including unhealthy food.

How Incentives Help Us Do Hard Things First

Matt Healey *(Marketing, Olin Business School)*

Poster number 149

When facing two tasks of differing difficulty, which do you choose to do first? We find that people's preference for doing the hard task before the easy task increases when task completion is incentivized: People who stand to earn a bonus for task completion are more likely to choose to begin with the harder (vs. easier) task than are people who do not stand to earn a bonus. This increase in preference results from an increase in motivation from the incentive, which shifts the person's focus from enjoying the process of completing the tasks to focusing on the importance of success. We further find that people perceive the difficult-first order to be more likely to lead to success than the easy-first order. Thus, when an incentive is present, an increase in motivation happens, success becomes more important, and the preference for the supposed more successful order (the difficult-first order) increases. This effect is attenuated when the difficult-first order no longer appears to be the order most likely to lead to success.

ABSTRACTS: PROFESSIONAL

Development of microbiota directed complementary foods for treating childhood malnutrition

Hannah Lynn *(Pathology, School of Medicine, Medical Scientist Training Program)*

Poster number 150

We hypothesize that healthy growth of infants and children depends, in part, on "normal" postnatal development of their gut microbiota. We previously showed in a randomized controlled clinical trial that a microbiota directed complementary food prototype (MDCF-2) we developed repaired gut microbiota immaturity in 12–18-month-old Bangladeshi children with moderate acute malnutrition (MAM) and produced superior ponderal growth compared to a standard intervention (RUSF), despite MDCF-2's lower caloric density. To identify another 'biosimilar' MDCF for testing in Bangladesh and other sites with prevalent undernutrition, we screened 50 food staples with favorable global production and consumption properties in gnotobiotic mice colonized with microbiota from trial participants. Eight foods were advanced to a secondary screen where prototype MDCFs were generated by swapping one of the four MDCF-2 ingredients for one of the eight. Because we hypothesize that MDCF carbohydrates drive changes in the gut microbiota, swaps were informed by similarities in monosaccharide composition. MDCF-7 (sweet potato swapped for banana) was most like MDCF-2 based on the cecal microbiota configurations, monosaccharides, and short chain fatty acids. Using a gnotobiotic mouse model of dam-pup microbiota transmission, we wanted to further evaluate the 'biosimilarity' of MDCF-7 to MDCF-2. MDCF-7 was more like MDCF-2 than RUSF based on cecal microbiota configurations. PCA of cecal glycosidic linkages showed separation of the germ-free and colonized mice along PC1, and separation of the MDCFs in the colonized group along PC2. SVD shows glycosidic linkages projecting most positively along PC2 can be traced back to the original MDCFs. Together these results provide evidence of microbiota-dependent transformation of MDCF carbohydrates. Next, we employed age/growth discriminatory bacteria cultured from Bangladeshi children and diets containing one or all four of the MDCF ingredients to study MDCF ingredient-specific effects on the microbiota and host. We demonstrate 'biosimilarity' of banana and sweet potato based on cecal microbe absolute abundances, cecal glycan linkages, and microbial gene expression with PCA. To identify which carbohydrates key growth-associated microbes are utilizing from banana and sweet potato, P. copri, an important growth-associated bacteria that degrades a variety of carbohydrates, was used as a 'biosensor'. Gene expression analysis reveals strain- and diet-dependent differences in polysaccharide utilization loci expression patterns. Diet-dependent differences in gene expression reflect known variations in carbohydrates between banana and sweet potato, demonstrating how carbohydrates of the ingredients directly influence the gene expression of the microbes. We are also performing single nucleus RNA-seq of gut epithelial lineages, and spatial transcriptomics of intestinal segments to understand how ingredient biotransformation affects the host. A pre-proof-of-concept clinical study testing MDCF-7, MDCF-2, and RUSF in 8-12-month-old Bangladeshi children with MAM has concluded and is being analyzed to evaluate if MDCF-7 is non-inferior to MDCF-2 in a clinical setting in Bangladesh. Overall, this project demonstrates preclinical 'biosimilarity' of MDCF-7 to MDCF-2, shows the importance of MDCF carbohydrates in affecting the microbiota, and is currently evaluating the clinical 'biosimilarity' of the two prototypes in undernourished children. It also highlights a translational pipeline that will be useful for identifying additional foods that promote healthy childhood development.

Improving Diabetes Diagnosis: Making An Argument Of Efficiency for Glycated Hemoglobin Estimation

Emmanuel Afful, Daniel Appiah, Baffour Boaten Boahen-Boaten *(Brown School)*

Poster number 151

Background: Diabetes is a leading contributor to morbidity and mortality due to the chronicity of the symptoms and associated complications with prolonged exposure of body tissues to high blood sugar levels. In the US, approximately 11% of the population lives with diabetes. Most diabetes cases in the US are categorized as Type 2 Diabetes Mellitus which is related to insulin resistance (CDC, 2023). Fasting blood glucose [FBG] has been the gold standard for diagnosis and for monitoring sugar levels while on treatment (Das et al, 2014). Beyond the FBG, the Oral Glucose Tolerance Test [OGTT] which involves administering oral glucose after which blood samples are drawn after 2 hours for tests is also used. Both tests have some limitations. In using FBG and OGTT, participants are mandated to fast for at least 8 hours before their blood is drawn. They are not always conclusive, and confer physical stress occasioned by regular blood draw and possible financial stress. It is in light of the foregoing that glycated hemoglobin is evidenced to be more sensitive in picking up prediabetes and detecting diabetes due to its high specificity (Mayega et al, 2014). Glycated hemoglobin is the product formed from the binding of hemoglobin and sugar and its percentage range over a 3-month period gives an indication of one's glycemic control. This means glycated hemoglobin can be used as a measure to diagnose diabetes. In pursuit of boosting efficiency, an inquiry is initiated to determine the glycated hemoglobin range that may predict diabetes from the following indices: FBG, Hemoglobin [HB] (low or normal), and Body Mass Index (underweight, normal overweight, and obese)

Methods: Data from the US National Health and Nutrition Examination Survey [NHANES] was obtained. The 2017-2018 cohort data was used. The demographics, complete blood count, fasting blood glucose, and body measures were merged. The data was then analyzed to obtain answers to this inquiry. The analysis included 2,887 participants that satisfied all the needed data requirements.

Results: There was a strong positive linear correlation between glycated hemoglobin and FBG, (Pearson's $r = 0.844$). There was a statistically significant linear model to predict glycated hemoglobin from FBG. $F(1, 2885) = 7154.27$, $p < .05$. The Pearson's .844 with $R2 = .713$. The regression coefficient ($B = .025$, 95% CI [.025-.026]), y-intercept = 2.97. The model predicted 71.3% of the variance in HBA1c with a tight confidence interval. Further, HB and BMI were added to the model which gave a statistically significant linear model, $F(2,2835) = 3584.187$, $p<.05$. The F change, 34.089 was statistically significant.

Discussion: A significant strong positive correlation exists between fasting blood glucose and glycated hemoglobin. Given that the statistical model is significant, it means glycated hemoglobin can be predicted by Fasting Blood glucose. With FBG, BMI, and HB, one's glycated hemoglobin level can be predicted.

Implication: Accurately predicting glycated hemoglobin with FBG, HB, and BMI means patients are spared the strains of fasting and periodic needle pricks for samples. This confers efficiency in the monitoring and management and monitoring of diabetes.

Rat Cortical Potential, Complexity and Connectivity Analyses during Isoflurane-induced General Anesthesia with Nociceptive Stimuli

Fengrui Zhang *(Anesthesiology)*

Poster number 152

General anesthesia is a crucial component of modern medicine that is widely used to prevent surgery-induced pain. However, the underlying mechanisms of anesthetic-induced induction, anesthesia, and emergence states have been little studied at the mesoscopic or cortical level. To explore the mesoscopic mechanism of general anesthesia, we anesthetized rats with isoflurane and applied nociceptive laser stimuli during general anesthesia, simulating the clinical surgery process. We recorded dynamic cortical responses using electrocorticography (ECoG) during the experiment and analyzed the ECoG power spectra, symbolic dynamic-based entropy (permutation entropy (PE)), complexity (permutation Lempel-Ziv complexity (PLZC)), information integration (permutation cross mutual information (PCMI)), and PCMI-based cortical brain networks to characterize the complexity and connectivity changes of the whole anesthesia process. Our results demonstrate that all these features are capable of discriminating anesthesia and emergence states, while only PLZC and PCMI are able to further distinguish burst suppression phase from moderate anesthesia phase. We also analyzed laser stimuli-evoked potentials by combining them with the tail-flick behavior during the induction and emergence phases. We found that event-related synchronization in the gamma-band (gamma-ERS) reflects the dynamic change of nociceptive sensations. Furthermore, we discovered that gamma-ERS is more sensitive to nociceptive sensations than behavior. Overall, this study utilized multiple indexes to characterize state switches and cortical features of nociceptive sensations, providing a systematic approach for translational research.

Transcription factor fluctuations underlie cell-to-cell variability in a signaling pathway response

Avinash Ramu *(Genetics)*

Poster number 153

Stochastic differences among clonal cells can initiate cell fate decisions in development or cause cell-to-cell differences in the responses to drugs or extracellular ligands. We hypothesize that some of this phenotypic variability is caused by stochastic fluctuations in the activities of transcription factors. We tested this hypothesis in NIH3T3-CG cells using the response to Hedgehog signaling as a model cellular response. Here we present evidence for the existence of distinct fast and slow responding substates of NIH3T3-CG cells. These two substates have distinct expression profiles, and fluctuations in the activity of the Prrx1 transcription factor (TF) underlie some of the differences in expression and responsiveness between fast and slow cells. We speculate that similar variability in other TFs may underlie other phenotypic differences among genetically identical cells.

Targeting Tissue-resident Macrophage Secreted MCP-1 for Attenuating Inflammation After Myocardial Infarction

Jiaxing Wen *(The Institute of Materials Science & Engineering)*

Poster number 154

Following myocardial infarction (MI, heart attack), the death of cardiac cells triggers inflammation in the infarcted hearts. Control of the inflammation will decrease tissue remodeling, leading to improved cardiac function. After MI, tissue-resident macrophages are activated to release MCP-1. The monocytes then migrate along the MCP-1 gradient to the infarct followed by differentiating into macrophages. Thus, targeting MCP-1 secreted from resident CCR2+ macrophages represents a viable approach to attenuate inflammation. In this work, we developed nanoparticles that specifically bind to CCR2+ macrophages, and gradually release MCP-1 binding peptide to neutralize the secreted MCP-1. The efficacy of the nanoparticles in reducing tissue inflammation and increasing cardiac function was studied.

Resolving the Nanoscale Organization of Self-assembled Peptides using Single-Molecule Orientation-Localization Microscopy

Weiyan Zhou, Conor L. O'Neill, Tianben Ding, Jai S. Rudra, Matthew D. Lew
(Electrical & Systems Engineering)

Poster number 155

Self-assembling peptides have remarkable exciting applications in biomaterials and therapeutics. Amphipathic peptides with alternating polar and nonpolar residues tend to self-assemble into amyloid-like fibrils, which are usually signatures of various protein-misfolding pathologies. Key to understanding the mechanisms of self-assembly these assembly processes is the ability to quantify and visualize and quantify the complex, heterogeneous organization of these peptides with single-aggregate sensitivity. Here, we utilize single-molecule orientation-localization microscopy (SMOLM), a variant of super-resolution microscopy capable of measuring the positions and orientations of single dye molecules, to probe the nanoscale structural organizations of visualize measure amyloid-beta (Aβ42) fibrils and amphipathic KFE8 (Ac-FKFEFKFE-NH2) assemblies. Using the transient binding of Nile red (NR) as a blinking mechanism, we find that NR binds to Aβ42 along the long axis of each fibril , the polar angles are nearly in-plane (polar angle $\theta \sim 90°$). The azimuthal angles are aligned with the long axis of fibrils. By In contrast, NR binds to KFE8 assemblies with orientations that are not aligned with the long axis of each assembly; interestingly, we find that the orientation distribution of NR is consistent with thea helical arrangement of binding sites. A detailed analysis of NR binding angles verifies finds that they are consistent with a helical ribbon model of the underlying peptide assembly. Finally, we show that NR SMOLM can resolve a variety of nanoscale structures formed by model self-assembling peptides. These results provide the first experimental demonstration of utilizing fluorophore orientation "spectra", i.e., the positions and orientations of NRdye molecules, to resolve the complex nanoscale organization of self-assembled peptides.

Quasi-Floquet engineering of a dipolar many-body spin system in diamond

Guanghui He *(Physics)*

Poster number 156

Floquet (periodic) driving has recently emerged as a powerful technique for engineering quantum systems and realizing non-equilibrium phases of matter. Even richer phenomena can arise in "quasi-Floquet" settings, where a single time-translation symmetry is replaced by multiple time-translation symmetries. Here, we present our recent results on the observation of quasi-Floquet prethermalization in a strongly-interacting nitrogen-vacancy (NV) spin ensemble in diamond. In contrast to a single-frequency (Floquet) drive, we find that the existence of prethermalization is extremely sensitive to the smoothness of the applied field. Moreover, using quasi-Floquet engineering, we realize time quasi-crystalline order which is fundamentally distinct from those realizable in periodically driven (Floquet) systems. Our results open the door to stabilizing and characterizing many-body phenomena in quasi-periodically driven systems.

Enhancing lysosomal lipid metabolism prevents the loss of Kupffer cells in non-alcoholic steatohepatitis and attenuates liver pathology

Mandy M. Chan *(Pathology and Immunology)*

Poster number 157

During the development of non-alcoholic steatohepatitis (NASH), liver resident Kupffer cells (KCs) are progressively lost and replaced by monocyte-derived macrophages (MdMs). The impact of KC loss on NASH pathology is not currently known. Given the important role of KCs in maintaining tissue homeostasis and clearing blood-borne antigens, we hypothesized that KC depletion contributes to NASH pathogenesis. Thus, we aimed to elucidate the mechanism(s) of KC loss and to devise a strategy to enhance KC survival during NASH.

We had previously shown that lipids can cause lysosomal cell death in macrophages. Using a mouse model of NASH, we discovered that KCs also develop phagolysosomal pathology. Transcription factor EB (TFEB) is a master regulator of lysosomal biogenesis and lipid metabolism that has been shown to rescue lysosomal dysfunction in other metabolic diseases. To test whether TFEB activation could protect against KC death in NASH, we generated a mouse model in which a KC-specific Cre induces expression of a TFEB overexpression construct (KC-TFEB). Despite having similar body and liver weight as WT mice fed a NASH-inducing diet, KCTFEB mice had a striking preservation of KC number. Moreover, KC-TFEB mice had reduced recruitment of pro-inflammatory MdMs and this was associated with lower liver triglyceride and injury. RNA sequencing of KCs from transgenic and WT mice revealed that TFEB induced the expression of several lysosomal and lipid metabolic genes. Together these findings provide important proof-of-concept evidence that KC loss contributes to disease pathology in NASH and suggest that targeting macrophage lysosomal/lipid metabolic function could be a useful strategy to enhance resident macrophage survival.

Precision High-Density Diffuse Optical Tomography (pHD-DOT) for single-subject functional cortical mapping

Aahana Bajracharya *(Department of Radiology)*

Poster number 158

Introduction: The need for reliable and reproducible data in neuroimaging research is a longstanding concern that has mostly been approached through the lens of large-N studies. In recent years, the focus has shifted to obtaining high-fidelity maps by scanning a few subjects for longer durations [Laumann et al., 2015]. Precision functional mapping, as introduced by Gordon et.al 2017 in fMRI, takes a subject-specific approach to localize spatial and organizational variability in brain networks by increasing the signal-to-noise within individuals. However, fMRI has physical limitations due to exclusion of individuals with implanted medical devices, body mass index above a certain level, noisy claustrophobic setup, and a general lack of naturalistic environment. High-Density Diffuse Optical Tomography (HD-DOT) is a functional near-infrared imaging technique that uses dense, regularly spaced arrays sources and detectors to obtain overlapping measurements of the underlying hemodynamic activity [Eggebrecht et al., 2014]. HD-DOT has the advantage of a noise-free experimental setup that is suitable for carrying out long durations of scans in a wide demographic of individuals, including children and individuals contraindicated by MRI. In this study, we demonstrate the effectiveness of precision HD-DOT (pHD-DOT) to generate high-fidelity single-subject cortical maps.

Methods: We collected over 5 hours of data on three subjects each over multiple sessions using previously validated tasks (visual, auditory, motor, and language) and resting-state paradigms. Data pre-processing was done using the NeuroDOT toolbox based on the principles of modeling light emission, diffusion, and detection through the head [Eggebrecht and Culver, 2019]. Global variance of temporal derivative (GVTD), a motion detection index that identifies parts of the data contaminated by movement or physiological artifacts, was used to censor noisy time points in the data [Sherafati et al., 2020]. A voxel-wise general linear model framework to estimate the task-related responses and generate statistical maps of cortical activations.

Results: The overarching premise of precision mapping is that the standard error in the measured responses will shrink with a 1/sqrt(N) function, following the central limit theorem. As a result, the maps should become more stable, and as the window lengths grow, show better similarity and less difference to full session maps. Our preliminary result from the visual task (retinotopic mapping by Zeff et.al., 2007) confirms this for HD-DOT within a single subject for both tasks and seed-based visual functional connectivity. The centers of mass from the activations show that location error between the sessions is less than 3 mm(std).

Conclusion: Accurate single-subject mapping can inform changes in functional brain activity over time. This valuable resource helps to understand individual brain organization while also improving group-level analyses. The next step for this project is to expand this approach to other tasks (auditory, motor, language), and resting-state networks from this dataset.

Estimating the Total Number of Volcanoes on Venus

Rebecca Hahn *(Earth and Planetary Sciences)*

Poster number 159

Radar imagery collected by NASA's Magellan spacecraft enabled the recognition and classification of volcanic features and structures across Venus far beyond the scope of earlier missions. These Magellan data revealed a planetary surface covered in volcanic edifices of a range of sizes, but the relatively low resolution (75 m/px) of the Magellan SAR (synthetic-aperture radar) FMAP (full-resolution radar map) left- and right-look global mosaics prevents the accurate and consistent delineation of edifices <5 km in diameter. Here, we utilize our previously developed global catalog of volcanic edifices on Venus (available through the WUSTL data repository) that contains ~85,000 features, but in which only that population of volcanoes down to 5 km in diameter is complete, to estimate the total number of volcanoes 1–5 km in diameter on Venus—and thus estimate the total number of all volcanoes ≥1 km in diameter across the planet. Volcanoes <5 km in diameter represent the most common volcanic feature on the surface of Venus, and the quantification of their number will shed light on the global rates of resurfacing and magma production, leading to a better understanding of volcanic processes on Venus generally.

To estimate the total number of volcanoes across Venus, we developed an exponential size-frequency distribution for volcanoes >5 km in diameter within our global dataset. From there we calculated the integral of the distribution to estimate the number of volcanoes that are 1 to 5 km in diameter using the MATLAB integral function. Lastly, we scaled the resulting integral to our entire global dataset. In total, we estimate that there are ~566,000 volcanoes 1–5 km in diameter on Venus, and a total of ~567,000 volcanoes ≥1 km in diameter globally.

Our estimated value of about a half-million volcanoes ≥1 km in diameter is comparable to the approximate total population of seamounts on Earth, a number that is proposed to range from 104 to 106. Previous workers noted the similarities in the size and shape of small volcanoes on Venus (those <20 km in diameter) and seamounts on Earth, as well as the high-pressure ambient conditions under which such volcanoes manifest on each planet. These similarities suggest the formation of small edifices on Venus and seamounts on Earth may have common controls. The origins of Terran seamounts are well understood, and are found in several tectonic settings on Earth such as mid-ocean spreading ridges, near transform faults and regions of extension, over upwelling mantle plumes, and in island-arc convergent settings.

This trait of seamounts on Earth raises an interesting prospect: that there are systematic expressions of volcano morphology, size–frequency distribution, or other characteristic on Venus that correlate with some other property such as lithospheric thickness, geoid, or even stratigraphic age. Moreover, the spatial distributions of seamounts on Earth reflect tectonic control; it remains unknown as to what extent tectonic structures control the distributions of volcanic fields and individual, small (D <20 km) volcanoes on Venus.

Impact of Macromolecular Crowding on the SARS-CoV-2 Nucleocapsid Protein

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Poster number 160

The cellular milieu is a solution crowded with a significant concentration of different components (proteins, nucleic acids, metabolites, etc.). Such a crowded environment affects protein conformations and interactions. Here, we investigate the effect of macromolecular crowding on the N-terminal domain (NTD) and RNA Binding Domain (RBD) of the SARS-CoV-2 Nucleocapsid protein and quantify its impact on protein conformations and interactions with RNA using single-molecule fluorescence spectroscopy.

Previously, we have shown that the NTD is flexible and dynamic and facilitates RBD-recruitment of RNA. We mimic the crowded environment of the cell by titrating increasing concentrations of polyethylene glycol (PEG). Single-molecule Förster Resonance Energy Transfer provides a direct measure of the associated conformational changes. We found that large molecular weight PEG induces a collapse of the disordered NTD, whereas small molecular weight PEG molecules lead to an expansion. Under both conditions, nanosecond Fluorescence Correlation Spectroscopy confirms that the chain maintains a dynamic behavior. Data can be explained by accounting for two opposing effects: i) favorable interactions between the protein and crowders that locally increase the effective excluded volume of the protein and ii) screening of excluded volume interactions by crowders.

We also characterized the protein-RNA interaction in the presence of crowding agents. While for all PEG molecules tested we observed an increase in the binding affinity of the protein, the trend is not monotonic as a function of the degree of polymerization, suggesting additional impact of non-specific protein-PEG interactions on binding. To separate the enthalpic and entropic contributions introduced by the crowders, we investigated the temperature dependence of binding in absence and presence of crowders.

Overall, our data provide new insights into understanding and modeling the contribution of crowding effects on disordered proteins, including the impact of interactions between proteins and crowders.

Two alternative paths towards reliable infant network studies

Jiaxin (Cindy) Tu *(Department of Radiology)*

Poster number 161

Infant functional brain networks show major differences from adult networks (Fransson et al. 2007; Gao et al. 2015; Rajasilta et al. 2020; Sylvester et al. 2022; Neil and Smyser 2018). Accordingly, several recent studies have used data-driven methods to derive networks in neonates (Sylvester et al. 2022; Eyre et al. 2021) and older infants (Kardan et al. 2022; Eggebrecht et al. 2017). However, there have been no systematic evaluations of infant data-derived networks and what factors could affect the quality of infant data-derived networks and many studies still employ adult networks to study infant functional connectivity (FC; Rudolph et al. 2018a; Nielsen et al. 2022). Moreover, sometimes a common network definition across age is often desirable when comparing across age groups. Here, we quantify the quality of adult and infant network assignments and propose two alternative strategies for infant functional network studies.

We calculated the infant and adult FC with Gordon 333 area parcellation from the Baby Connectome Project (BCP; Kardan et al. 2022)) and WashU120 (Gordon et al. 2016) resting-state fMRI data, respectively. The qualities of network assignment for adult networks (Gordon et al. 2016) and infant networks (Kardan et al. 2022) were quantified on infant and adult FC using the average silhouette coefficient (SC) across parcels, which measures how well the network assignments fit the parcellated FC. We found that the average SC in infant FC was lower than that in adult FC for adult network assignment and the opposite trend was seen for infant network assignment. Further, we identified the parcels with low homogeneity by calculating the homogeneity Z-score compared to null rotation models. Removing the lower homogeneity (Z-score <0) parcels improves the clustering quality of the infant networks, suggesting that a more accurate infant-specific parcel definition may further enhance network detection when data-driven community detection techniques were applied to identify infant-specific networks. In summary, our results suggest that using infant-specific networks provides a more accurate model for infant functional organization, which ma¬¬y improve clinical outcome predictions, and provide information about how network segregation evolves across development.

Further, we identified 157 parcels with positive SC in infant FC with regards to the adult networks (a.k.a. parcels in agreement with adult network assignments). We found that these parcels happen to be near the 153 high probability areas with consistent network assignment across adult individuals. Using this subset of areas to define new network definitions, both the mean and the range of within-network connectivity became higher. Our results suggested that the regions that form early adult-like network connections are the same regions that form highly consistent network connections across individuals. In across age-group comparisons, researchers can select those ROIs to increase robustness of results.

In conclusion, researchers can either use a data-driven community detection to find age-cohort specific networks in infant neuroimaging studies or use a subset of parcels to define the stable networks for across-age group comparisons.

Investigating the unexpected effect of phosphorylation on isocitrate dehydrogenase 2 activity

Hannah Pletcher *(Biochemistry & Molecular Biophysics)*

Poster number 162

Best known as "the powerhouses of the cell," mitochondria are central hubs for metabolic processes. While numerous reactions catalyzing nutrient catabolism occur within mitochondria, the mechanisms underlying their regulation are not fully known. Phosphorylation, as a rapid and reversible modification, is well positioned to regulate these metabolic reactions, yet our understanding of phosphorylation-mediated regulation on mitochondrial proteins is lacking. Our lab found that knockout of mitochondrial protein phosphatase Pptc7 in mice leads to the hyperphosphorylation of specific mitochondrial proteins, resulting in metabolic defects such as hypoketotic hypoglycemia. When Pptc7 is knocked out across multiple models (i.e., mice and cells), isocitrate dehydrogenase 2 (Idh2; human homolog IDH2) is reproducibly hyperphosphorylated at serine residue 423. IDH2 contributes to tricarboxylic acid (TCA) cycle flux, oxidative stress protection, and biosynthetic processes. Notably, IDH2 is mutated in multiple cancers, but the post-translational regulation of IDH2 is not yet well understood. To decipher the functional consequences of IDH2 phosphorylation, we have generated IDH2 mutants that mimic constitutive phosphorylation (i.e., phosphomimetic mutations) and conducted lysate-based enzyme assays. These assays demonstrate that phosphomimetic mutation of serine 423 significantly elevates IDH2 enzyme activity, unexpectedly contradicting the role of phosphorylation on Escherichia coli homolog IDH. These results suggest that phosphorylation regulates IDH2 activity, potentially contributing to the regulation of multiple critical metabolic processes.

Diagnosing magnetism using nanoscale quantum snesors

Zhongyuan Liu *(Physics)*

Poster number 163

Diagnosing magnetic properties is an importance theme of modern material science. However, classical methods are commonly used for ensemble behaviour with little spatial information. Fortunately, thanks to the recent advancement of quantum technologies based on spin defects in diamond, it has become feasible to directly probe local magnetism with combination of high sensitivity and spatial resolution. Here, I will briefly introduce the widely potential sensing applications using Nitrogen-Vacancy (NV) centers in diamond including magnetic spectroscopy and strain imaging.

Hints of Natural Supersymmetry in Flavor Anomalies?

Fang Xu *(Physics)*

Poster number 164

The recent results from the Fermilab muon g−2 experiment, as well as the persisting hints of lepton flavor universality violation in B-meson decays, present a very strong case for flavor-nonuniversal new physics beyond the Standard Model. We assert that a minimal R-parity violating supersymmetric scenario with relatively light third-generation sfermions provides a natural, well-motivated framework for the simultaneous explanation of all flavor anomalies, while being consistent with a multitude of low-energy flavor constraints, as well as with limits from high-energy collider searches. We further propose complementary tests and distinct signatures of this scenario at current and future colliders. Specifically, we find that an sbottom in the mass range of 2-12 TeV accounts for RD(∗) and RK(∗) flavor anomalies and it only plays a minor role in the (g−2)μ anomaly, whereas a sneutrino with mass between 0.7-1 TeV is the dominant player for (g−2)μ.

Spontaneous Seed Formation During Electrodeposition Drives Epitaxial Growth of Metastable Bismuth Selenide Microcrystals

Jiang Luo, Guodong Ren, Brandon M. Campbell, Dongyan Zhang, Tengfei Cao, Rohan Mishra, Bryce Sadtler
(Chemistry)

Poster number 165

Materials with metastable phases can exhibit vastly different properties from their thermodynamically favored counterparts. Methods to synthesize metastable phases without the need for high-temperature or high-pressure conditions would facilitate their widespread use. We report on the electrochemical growth of microcrystals of bismuth selenide, Bi2Se3, in the metastable orthorhombic phase at room temperature in aqueous solution. Rather than direct epitaxy with the growth substrate, the spontaneous formation of a seed layer containing nanocrystals of cubic BiSe enforces the metastable phase. We first used single-crystal silicon substrates with a range of resistivities and different orientations to identify the conditions needed to produce the metastable phase. When the applied potential during electrochemical growth is positive of the reduction potential of Bi3+, an initial, Bi-rich seed layer forms. Electron microscopy imaging and diffraction reveal that the seed layer consists of nanocrystals of cubic BiSe embedded within an amorphous matrix of Bi and Se. Using density-functional theory calculations, we show that epitaxial matching between cubic BiSe and orthorhombic Bi2Se3 can help stabilize the metastable orthorhombic phase over the thermodynamically stable rhombohedral phase. The spontaneous formation of the seed layer enables us to grow orthorhombic Bi2Se3 on a variety of substrates including single-crystal silicon with different orientations, polycrystalline fluorine-doped tin oxide, and polycrystalline gold. The ability to stabilize the metastable phase through room-temperature electrodeposition in aqueous solution without requiring a single-crystal substrate, broadens the range of applications for this semiconductor in optoelectronic and electrochemical devices.

Using long-read CAGE sequencing to profile cryptic-promoter derived transcripts and their contribution to the immunopeptidome

Ju Heon Maeng *(Genetics)*

Poster number 166

Recent studies have demonstrated that the non-coding genome can produce unannotated proteins as antigens that induce immune response. One major source of this activity is the aberrant epigenetic reactivation of transposable elements (TEs). In tumors, TEs often provide cryptic or alternate promoters, which can generate transcripts that encode tumor-specific unannotated proteins. Thus, TE-derived transcripts have the potential to produce tumor-specific, but recurrent, antigens shared among many tumors. Identification of TE-derived tumor antigens holds the promise to improve cancer immunotherapy approaches; however, current genomics and computational tools are not optimized for their detection. Here we combined CAGE technology with full-length long-read transcriptome sequencing (Long-Read CAGE, or LRCAGE) and developed a suite of computational tools to significantly improve immunopeptidome detection by incorporating TE-derived and other tumor transcripts into the proteome database. By applying our methods to human lung cancer cell line H1299 data, we demonstrated that long-read technology significantly improves mapping of promoters with low mappability scores and LRCAGE guarantees accurate construction of uncharacterized 5' transcript structure. Augmenting a reference proteome database with newly characterized transcripts enabled us to detect non-canonical antigens from HLA-pulldown LC-MS/MS data. At last, we showed that epigenetic treatment increased the number of non-canonical antigens, particularly those encoded by TE-derived transcripts, which might expand the pool of targetable antigens for cancers with low mutational burden.

Cell profiling defines metabolic dysregulation in kidney fibrosis

Haikuo Li *(Biology & Biomedical Sciences)*

Poster number 167

Chronic kidney disease (CKD) affects ~10% of the population worldwide and ultimately can lead to kidney failure. The underlying cellular events driving kidney fibrogenesis and metabolic dysfunction are incompletely understood. Here, we employed single-cell combinatorial indexing RNA sequencing to analyze 24 mouse kidneys from two fibrosis models. We profiled 309,666 cells in one experiment, representing 50 cell types/states encompassing epithelial, endothelial, immune, and stromal populations. Single-cell analysis identified diverse injury states of the proximal tubule, including two distinct early-phase populations with dysregulated lipid and amino acid metabolism, respectively. Lipid metabolism was defective in the chronic phase but was transiently activated in the very early stages of ischemia-induced injury, where we discovered increased lipid deposition and increased fatty acid β-oxidation. Perilipin 2 was identified as a surface marker of intracellular lipid droplets, and its knockdown in vitro disrupted cell energy state maintenance during lipid accumulation. Surveying epithelial cells across nephron segments identified shared and unique injury responses. Stromal cells exhibited high heterogeneity and contributed to fibrogenesis by epithelial-stromal crosstalk.

New method to control selectivity in electrochemical reactions by modifying electrode surface

Enqi Feng *(Chemistry)*

Poster number 168

We have been trying to introduce new selectivity into electrochemical reactions by modifying the surface of an electrode and then confining chemical reactions to the region of the reaction close to that surface. The goal is to translate the extremely high levels of site-selectivity seen in chemical reactions on a microelectrode array into a tool for preparative synthetic reactions. Previously, in series of competition studies between electron-rich and electron-poor benzyl alcohol substrates, we found the oxidation always favor the electron-rich benzyl alcohol to aldehyde, with the help of diblock copolymer coated electrode and confining agent. By applying larger amount of confining agent or more reactive mediator, we learned how to optimize the selectivity to higher level. It is clear that a molecular recognition event on the surface of the electrode could be used to control the selectivity of the reaction.

Knowing the diblock copolymer's ability to select electron rich aryl rings, the origin of this selectivity and how it induces selectivity have been studied. Based on experimental evidence, hydrophobic pocket interactions between polymer and substrates might be the explanation for selectivity. In order to better utilize these hydrophobic interactions, we targeted on the remote selectivity inducement. By separating the recognition center and reaction center, we used polymer to recognize one side of molecule and let mediator react on the other side. From new series of aromatic substituted cyclohexanol competition studies, we observed remote effect of an electron-rich aromatic group contributed to the alcohol oxidation. After optimizing reaction conditions, we achieved a chemoselectivity in electrochemical reaction which nonelectrochemical mediators cannot obtain.

Stroop fMRI activity in cognitively normal adults predicts future dementia

Sabrina G. Clemens *(Neuroscience)*

Poster number 169

Background: Alzheimer's disease (AD) is an age-related neurodegenerative disorder responsible for 60-70% of dementia cases worldwide. Emerging evidence suggests that the prodromal phase of AD features deficits in attentional control, which when compounded manifest in memory problems.

Methods: In this retrospective study, we examine the performance of 109 cognitively normal individuals (clinical dementia rating [CDR]=0) on the Stroop color-naming test using functional magnetic resonance imaging. The incongruent Stroop trials (e.g. blue written in red) require the most attentional control and have previously been shown to be sensitive to AD pathology. We sought to determine whether behavioral performance and/or change in the BOLD signal on incongruent trials predicts future cognitive impairment (CDR>0). Since the original study (6.8 ± 1.88 years), 15 individuals have become demented (converters). Average reaction time during incongruent trials was compared with neutral trials and this cost was correlated with brain activity controlling for age, using FSL FEAT. We also contrasted general brain activation in incongruent trials with congruent trials and examined if activity discriminated between converters and stable individuals.

Results: Brain activity in dorsal attention and lateral prefrontal regions correlated with increasing inhibition costs. Though there is no significant difference in accuracy between groups (t=0.392, p=0.696), a post-hoc test indicated the increased brain activity predicts future dementia status (t=2.669, p=0.0088) (Figure 1). When comparing on incongruent relative to congruent trials, we found that that pre-dementia individuals exhibit heightened activation (t=4.405, p = 2.52e-05) in a subset of attentional areas compared to those who remain stable (Figure 2). These activated voxels overlap with the areas shown to be correlated with inhibitory reaction time cost (Figure 3).

Conclusions: These data suggest changes in attentional control precede the development of clinically relevant diagnostic criteria and may serve as a valuable tool for assessing aging in cognitively normal individuals.

Keywords: aging, dementia, Alzheimer, attention, Stroop

An ILC2-chitinase circuit restores lung homeostasis after epithelial injury

Haerin Jung *(Immunology)*

Poster number 170

Cytopathic respiratory viruses such as influenza virus and SARS-CoV-2 cause lung inflammation, tissue damage, and epithelial cell loss. Restoration of barrier function after viral injury is critical for re-establishing lung tissue homeostasis but the underlying mechanisms are unclear. In the steady-state, lung epithelial cells express acidic mammalian chitinase (AMCase), a secreted enzyme that degrades chitin, an insoluble polysaccharide constituent of environmental fungi and arthropods. We find that chitin spontaneously accumulates in the airways of mice after respiratory viral injury, consistent with a transient loss of AMCase-producing epithelial cells that normally degrade the polysaccharide. During the repair phase, AMCase expression is re-established coincident with robust type 2 immune activation, chitin degradation, and epithelial cell recovery. AMCase-deficient mice fail to clear airway chitin after influenza virus infection, and exhibit increased mortality, prolonged lung inflammation, and delayed epithelial repair as compared to wildtype mice (WT mice), demonstrating a non-redundant role for this enzyme in promoting chitin clearance and barrier restoration after viral injury. RNA-seq analysis of AMCase-deficient epithelial cells revealed impairment of differentiation and proliferation gene pathways during the recovery phase, suggesting that inefficient clearing of chitin particles after viral infection results in dysfunctional epithelial repair. These results implicate AMCase as a critical mediator of post-viral chitin clearance and lung repair after epithelial injury.

Gait and Balance Dysfunction in Individuals with Huntington Disease

Lauren Tueth *(Physical Therapy)*

Poster number 171

Huntington disease (HD) is a genetic neurodegenerative disease that causes motor, cognitive, and psychiatric dysfunction. HD is a rare disease, impacting approximately 30,000 individuals in the United States. Because of this, there is limited research on HD, particularly in the rehabilitation realm. Although HD is rare, the genetic component of the disease allows for earlier diagnosis than other neurodegenerative diseases. Earlier diagnosis may allow for earlier intervention, but more needs to be known about the progression of motor symptoms so that appropriate rehabilitation programs can be created. Currently, it is known that individuals with HD have impaired balance, but little is known about what aspects of balance are impaired. In this study, we performed comprehensive balance assessment on 11 individuals with HD using the Balance Evaluation Systems Test (BESTest). The BESTest assesses six domains of balance: I. Biomechanical Constraints, II. Stability Limits / Verticality, III. Anticipatory Postural Adjustments, IV. Postural Responses, V. Sensory Orientation, and VI. Stability in Gait. Lowest average scores were seen in subsections IV (47.5 +/- 27.9%) and VI (48.1 +/1 28.3%), Postural Responses and Stability in Gait respectively. Participants also had low overall BESTest scores, with an average of 61.7% (SD = 17.6%). To put this score in perspective, individuals with Parkinson disease, another neurodegenerative disorder, who experience falls tend to score less than 69% on the BESTest. Overall, these preliminary results indicate that individuals with HD experience impaired balance, particularly in the domains of postural responses and gait dysfunction. Better understanding of these deficits will allow for development of rehabilitation interventions to improve motor function.

Real-time detection of biological binding events between YM/FR analogs and G proteins on the microelectrode array

Siyue Liu *(Chemistry)*

Poster number 172

YM-254890 and FR900359 are potent and selective inhibitors of the Gq/11-signaling pathway. As such, they have been attractive targets for both synthesis and biological studies. Yet in spite of this effort, a versatile and scalable synthetic approach to the molecules that allows for rapid analog construction of analogs remains elusive. A convergent building block approach to the molecules that can solve this challenge is discussed. Microelectrode arrays are powerful tools for monitoring binding interactions between small molecules and biological targets. Study of signaling calibration on the microelectrode array is also discussed.

Detection of microbial metabolite using structure-switching signaling aptamers

Yu-Chia Chang *(Chemistry)*

Poster number 173

Bacteria can produce different kinds of metabolites, which are associated with human health and disease. Mass spectrometry is used to identify metabolites produced by bacteria, but it is time-consuming and costly, making a barrier for its clinical use. For this purpose, a microelectrode array-based platform is intriguing because it is cheap and allows for the rapid monitoring of multiple binding events in real-time. Accordingly, we are developing an electrochemical method that allows for the reliable, quantitative analysis of metabolites using a microelectrode array. Two known aptamer/ligand pairs are being used to demonstrate how the signal from aptamer-ligand binding events can be detected. In this session, the synthetic strategy used to functionalize any electrode or set of electrodes in a microelectrode array with a DNA aptamer will be presented along with analytical experiments that show how a microelectrode array once functionalized in this manner can be used to detect and quantify metabolites in solution. The results set the stage for the development of an array-based microbial metabolite detection platform.

cAMP-Mediated Acid Signaling Regulates Tumor-Myeloid-Bone Cell Crosstalk in the Bone-Tumor Microenvironment

Kaylee O'Donnell *(Molecular Cell Biology)*

Poster number 174

The physiological pH of bone marrow has been reported as low as 6.7, which may contribute to metastatic breast cancer severity and resistance to therapies, especially since rapid tumor metabolism makes the pH of the solid tumor microenvironment (TME) as low as 6.4. Tumor cells sense extracellular pH through GPCRs which signal through GαS (Gnas) to activate adenylyl cyclase to produce cyclic AMP (cAMP). Breast tumors have high levels of arginase 1 (Arg1) positive tumor infiltrating macrophages (TIMs) and we previously described that GM-CSF signaling through p38/MAPK and STAT3 and extracellular proton signaling through cAMP/CREB are both necessary for Arg1 expression. In the current study, we further explore the role of extracellular acid sensing in tumor and bone cells in the bone TME. We have developed an in vitro culture system to modulate pH without the use of CO2 using 2-(N-morpholino) ethanesulfonic acid (MES). 4T1 and bone colonizing PyMT-BO1 BC cell lines were cultured at pH 6.4, 6.8 and 7.2 and GM-CSF production was elevated with increasing culture acidity. We used CRISPR/Cas9 to knock out Gnas in these cell lines and found that tumor cells grown in acidic conditions no longer had increased GM-CSF. Likewise, Gnas -/- bone marrow macrophages (BMMs) derived from Gnasfl/fl LysM-Cre +/- mice had decreased Arg1 expression when exposed to acid and GM-CSF. We hypothesize that breast tumors utilize self-generated protons in a feed-forward manner to produce more GM-CSF and maintain immune suppression by sustaining Arg1+ myeloid cells. These data suggest that tumor cells and TIMs can sense acid through GαS with functional consequences on immune suppression. We will compare tumor growth in bone, characterize immune infiltrates and evaluate resistance to checkpoint inhibitor therapy in wild type and Gnas -/- cells inoculated in Arg1-YFP mice. Further, we will use lactate dehydrogenase (Ldha) -/- cells that do not acidify the TME as controls. Since the bone TME is acidic and a common site of BC metastasis, we will next evaluate the role of GαS/cAMP in osteoclasts. Wild type and Gnasfl/fl LysM-Cre +/- BMMs will be used for osteoclast differentiation and function testing in MES-buffered medium. Gnasfl/fl LysM-Cre +/- mice will be implanted with bone colonizing tumors and osteoclast and bone parameters will be analyzed by IHC and μCT. Understanding GαS/cAMP mediated acid-sensing pathways in bone metastases may allow for improved efficacy of immune therapy.

Mechanisms of immunopathology during genital HSV-2 infections

Ying Shiang Lim (*Immunology)*

Poster number 175

Genital Herpes Simplex Virus-2 (HSV-2) infections is a highly prevalent and incurable sexually transmitted disease. Symptomatic recurrences occur episodically to promote viral transmissions, trigger genital lesions and triple the risk of secondary HIV-1 acquisition. There are currently no cures or FDA-approved vaccines for this chronic infection. Understanding how the immune system interacts with HSV-2 would thus enable us to develop better therapeutics and design new immunization strategies. We used a female mouse infection model to define immunopathogenic pathways and revealed that sustained type I interferon (IFN) signaling is a driver of pathogenic neutrophil responses, identifying IL-18 as a novel component of disease during genital HSV-2 infection. We further show that IL-18 drives natural killer (NK) cells to produce the serine protease granzyme B. Accumulation of extracellular granzyme B in the vagina coincided with epithelial ulceration. Remarkably, genetic loss of granzyme B or therapeutic inhibition by a specific protease inhibitor was sufficient to reduce disease and restore epithelial integrity without altering viral control. Both IL-18 and granzyme B were markedly elevated in human herpetic ulcers compared to non-herpetic ulcers, suggesting these host mechanisms may be engaged in HSV-infected patients. Collectively, our study reveals that IL-18 induced by sustained type-I IFN signaling in neutrophils drive NK cells to promote granzyme B accumulation in the vagina, which in turn drives the destruction of vaginal epithelium during HSV-2 infection. Granzyme B is identified as a novel therapeutic target that can augment the treatment of genital herpes.

Chromatin remodeler BPTF is essential for B cell response to vaccination

Alexandria Sturtz *(Pathology & Immunology)*

Poster number 176

B cells are a type of immune cell that mediate host protection primarily through the production of antibodies. Antibodies are proteins that can bind and neutralize specific pathogens, making their production an important part of immune responses to both vaccination and infection. Following vaccination or infection, B cells that recognize their antigen become activated and differentiate along two primary pathways. Some B cells begin quickly secreting large amounts of antibodies in an attempt to suppress the perceived infection. Another subset of the activated B cells enters specialized microstructures located in secondary lymphoid organs, such as lymph nodes or the spleen, where they undergo proliferation and a maturation process that fine-tunes the antibodies of participating B cells. A primary goal of these microstructures, called germinal centers (GCs), is to optimize and select germinal center B cells (GC B cells) to seed B cell memory compartments, which consist of memory B cells and long-lived plasma cells. These cells work together to provide a barrier against reinfection and an ability to rapidly respond in case of reinfection, meaning a proper GC is paramount to developing good immune memory.

However, the molecular determinants that regulate the size and duration of the GC remain poorly understood and this incomplete understanding makes it challenging to improve the magnitude, breadth, and duration of B cell responses to many vaccines. Here, we show that the chromatin remodeler BPTF is essential for robust GC B cell responses to immunization. Mice with BPTF conditionally deleted in GC B cells had significantly fewer vaccine-specific GC B cells and lower titers of antibodies in their serum compared to littermate controls. Additionally, these mice had fewer vaccine-induced memory B cells and long-lived plasma cells months later. BPTF-deficient B cells expressed lower levels of proliferation markers, suggesting that BPTF may be regulating proliferation networks integral to GC formation. Broadly, these data identify a previously unrecognized factor that plays a significant role in driving the B cell response following vaccination.

ABSTRACTS: SOCIAL SCIENCE

Bilingual Education Reduces Ethnic Outgroup Discrimination Through Perspective-Taking

Jeremy Siow *(Political Science)*

Poster number 177

How to reduce intergroup prejudice is one of the most difficult challenges many societies face. Research on prejudice reduction usually focuses on short-term interventions that yield relatively inconclusive results. Instead, I focus on people's formative years and argue that bilingual instruction in schools durably reduces political discrimination against ethnic outgroups. By promoting the acquisition of a second language, bilingual instruction facilitates the cognitive development of perspective-taking ability, which in turn fosters more inclusive political attitudes. I find support for this argument by studying the effects of an education reform in Malaysia, which resulted in those students who were born after the cutoff receiving bilingual instruction, while those born before the cutoff were only taught in their mother tongue. I also provide suggestive evidence that the observed patterns stemmed from improvements in perspective-taking ability. The findings imply that education plays a pivotal role in reducing intergroup prejudice from an early age.

ABSTRACTS: SOCIAL SCIENCE

What is Trauma?: The Mingling of Science and Social justice

Judith Carlisle *(Philosophy, Neuroscience, Psychology)*

Poster number 178

Recently the term "trauma" has become increasingly controversial. Many of these controversies revolve around the definition of trauma, and the way that this definition varies across contexts. What kinds of experience can plausibly be considered "traumatic"? In some contexts, the standards are incredibly permissive. Notoriously, TikTok-ers have been criticized for finding traumatic experiences – and their aftereffects – lurking everywhere. A recent Slate article, for example, points out that a wide variety of (normal-seeming) behaviors – including struggling to make small decisions, overpreparing, overanalyzing, excessive scrolling on social media, defensiveness, and perfectionism – have all been described as "Trauma Responses" (Palus 2021).

This broader notion of trauma, however, is not particular to TikTok. There has been a recent increase in calls for "trauma informed" systems in both business and healthcare sectors (e.g., Elliott et al. 2005; Lanphier 2021; Oral et al. 2016; Pawlo et al. 2019; Scheer and Poteat 2021). One of the motivating goals of "trauma informed" practices is to display care and concern for all people – whether they are employees, customers, etc. – in light of the possibility that they are traumatized.

Relatedly, many have raised concerns about the significant impact of racial trauma – experienced broadly by people of color – on the mental and physical wellbeing of a huge portion of our population (Biden 2022; Comas-Díaz 2019, Parker 2022). Despite their variations, these different ways of talking about trauma – from trauma informed care, from social concerns about racial injustice – all presuppose that traumatic experiences (and their aftereffects) really are everywhere, and that there is something to be gained by recognizing this and responding appropriately.

In other contexts, however, the criteria for traumatic experiences are more restrictive. Recently, for example, in the trial of Derek Chauvin, Hennepin County Judge Peter Cahill argued that evidence did not support the claim that the children present during the murder of George Floyd were traumatized by their experience, as the prosecution claimed (Griffith 2021a; 2021b). This kind of skepticism about trauma has arisen within the legal context over the years as lawyers and political theorists began discussing the various legal benefits that come along with claiming "trauma" (especially in litigation cases).

These different ways of understanding "trauma" prompt a number of questions: Who has the authority to define trauma? In other words, who decides which conception of trauma is the most "legitimate" – who decides when an experience is or is not traumatic? My project attempts to answer these questions by considering each of the different conceptions of trauma that arise in a variety of distinct contexts. In particular, I will recognize three major areas making use of the concept: I will attempt to outline the theories of trauma that arise from (1) clinical practice as defined in the Diagnostic and Statistical Manual of Mental Disorders DSM, from (2) animal researchers in neuroscience and similar laboratory settings, from (3) Van der Kolk's somatic theory of trauma. I will conclude by attempting to unify these disparate perspectives with what I am calling the Schematic Account of Trauma.

ABSTRACTS: SOCIAL SCIENCE

The President as a Polarizing Symbol in Congressional Speeches, 1973-2016

Benjamin Noble *(Political Science)*

Poster number 179

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Does Knowledge about Historical U.S. Intervention Shape Attitudes about Refugee Deservingness? Evidence from a Survey Experiment

Garrett Pekarek *(Sociology)*

Poster number 180

The United States has a long history of destabilizing intervention abroad which often leads to the displacement of people. This paper explores whether information about U.S. intervention can increase support for refugees, and whether/how processes of racialization impact the effect of information treatments. Using an original survey experiment, I find that information about historical U.S. involvement abroad can improve attitudes under certain conditions. Still, sending country, refugee racial appearance, and respondent ethnoracial identity remain crucial factors in the way Americans perceive refugees. For white respondents, information about U.S. intervention significantly increases a sense of refugee deservingness in the context of one sending country but not another. For Black respondents, refugee racial appearance and country of origin, but not exposure to information, shapes attitudes. This study contributes to scholarship on how information can change attitudes toward immigration and refugees and on the importance of considering multiple dimensions of race in immigration attitudes research.

Opening Dual Enrollment: How Removing Barriers to Entry Influences the Participation of Historically Excluded Students

Rachel Martin *(Education)*

Poster number 181

A majority of high school students in the United States aspire to earn a postsecondary degree, yet far fewer of these students enroll in and complete college. Further, matriculation and degree attainment is not equitable across race and class, despite the high aspirations that students across identity markers hold. These inequities are artifacts of an educational system that has separated students by race, class, and perceived academic ability for over 100 years. In the U.S., white and wealthy students are traditionally tracked into "high-level" classes that prepare them for college, staffed with highly trained teachers and gold standard resources. On the other hand, students of color and students from lower income backgrounds are tracked into "low-level" classes that lack educational resources and prepare them to immediately enter the workforce. Access to challenging, advanced academic coursework in high school is a critical component for preparing students for college, but these opportunities are not equitably distributed.

Dual enrollment (DE) is an increasingly popular college preparation program implemented by school districts in partnership with postsecondary institutions. The literature provides substantial evidence for the efficacy of DE – students who participate are more likely to enroll in college, persist to a second year, and complete a degree. Yet, restrictive academic eligibility requirements (e.g., minimum grade point average, standardized test score) keep many students out of DE programs. As a result, the participation patterns of students across race, gender, and class demonstrate the perpetuation of historical inequities in the distribution of educational resources.

The current study investigates one DE program that has attempted to increase access to enrollment and success by removing eligibility requirement at the postsecondary, programmatic level and implementing unique course structures. Using descriptive analysis tools and inferential statistics (e.g., linear regression, hierarchical linear models), I examined the participation patterns of students across districts and campuses to understand how students from historically excluded backgrounds accessed a DE program with an open-enrollment policy. Findings suggest that there is better representation of some groups of historically excluded students, but others remain underrepresented. Further, while districts are relatively uniform in their representation of historically excluded students, there is considerable variation among campuses. District- and campus-level factors such as socioeconomic status and average prior academic performance of students are significant predictors of the representation of historically excluded students. Situating these results within relevant theoretical frameworks about structures and justice, I conclude that a single policy solution such as an open-enrollment policy is unlikely to disrupt an educational structure that has been in place for over a century. Additional work is necessary to evolve the schemas of educational leaders at all levels and promote the equitable redistribution of educational resources.

The Impact of Multitasking on Attention and Retention During Online Lectures

Zubeiru Mahama *(Education)*

Poster number 182

Research has shown that students more frequently multitask online than in face-to-face courses, yet the extent to which multitasking affects learning during online lectures remains to be examined. This study seeks to examine the impact of multitasking on attention and retention during video-recorded lectures, given that video-recorded lectures constitute an important component of online learning platforms, particularly in asynchronous online courses where students are more likely to multitask. The study will assess the impact of lecture-relevant and/or lecture-irrelevant activities during a video-recorded lecture on attention to and retention of the lecture material. Four conditions will be compared on performance measures: (1) a lecture-only control condition in which participants will be asked to view the lecture without engaging in a secondary task, (2) a lecture-relevant multitasking condition in which participants will be asked to take notes in addition to viewing the lecture, (3) a lecture-irrelevant multitasking condition in which participants will be asked to view the lecture and also complete a survey not related to the lecture, and (4) a combined lecture-relevant and lecture-irrelevant multitasking condition in which participants will be asked to view the lecture and also engage in both note-taking and survey completion. The theoretical and practical implications of the findings for learning during lectures in asynchronous online courses will be discussed.

Predictive looking and Predictive looking errors in daily activities

Sophie Su *(Psychological and Brain Sciences)*

Poster number 183

People automatically segment continuous streams of stimuli into distinct episodes while watching everyday activities. Prediction errors, the difference between prediction and reality is theorized to drive segmentation. An implicit and continuous measurement of people's prediction errors while watching movies is needed to test theory and validate computational models. Previous studies have shown people look predictively for static pictures and at critical periods in movies. However, it's unclear if predictive looking is present throughout movies. We present a model of predictive looking in which people's previous gaze patterns are predictors of the current frame's saliency density. We tested this model using participants' group gaze density maps and movie actors' hand locations. We showed that people's past gaze up to 3 seconds is predictive of actors' current hand locations. Prediction error generated based on gaze density is correlated with segmentation density, making it a potential candidate to serve as an implicit measure of people's prediction error and a benchmark of computational models.

Age-related changes in representing and remembering complex events

Angelique I. Delarazan *(Psychological and Brain Sciences)*

Poster number 184

Aging has long been associated with memory decline. In particular, older adults show marked deficits in remembering episodic details, whereas more gist-like representations are generally preserved. However, much of our current understanding of age-related memory decline arise from paradigms of isolated studied items. Our real-world experiences, on the other hand, are dynamic and continuous. An emerging literature has implicated a set of cortico-hippocampal networks in representing and remembering continuous events. Yet, an important question remains: how do complex event representations change as we age? A behavioral study testing recognition and recall of a 26-minute television episode found age-related deficits in discrimination of similar lures for detailed perceptual, but not narrative information. This is consistent with a loss of episodic detail. A second experiment tested encoding and verbal recall of this same episode during fMRI scanning. We conducted representational similarity analyses of the fMRI data to investigate age-related differences in activity patterns between encoding and retrieval. Preliminary analyses, which are still ongoing, show that older and younger adults engage different cortico-hippocampal networks when reinstating event patterns. Together, emerging results suggest an age-related shift in the way complex events are processed and remembered.

Making sense of nonsense: How U.S. preschoolers' spellings reflect their early understandings of letters and sounds

Jayde Homer *(Psychological & Brain Sciences)*

Poster number 185

Purpose: Young children informally learn about the sounds and letters of their language before entering school. Children reveal this early knowledge in their spelling attempts, which are often dismissed as poor or incorrect by adults. For example, consider two 3-year-olds, Sammie and Zeke who were asked to spell "cat." Sammie wrote "K" indicating that she knows that that letter can represent the first sound in "cat." Zeke wrote "Z," perhaps because his name starts with Z. Neither is correct, but judging preschoolers' seemingly poor spellings on a variety of factors besides simple correctness elucidates the mental processes involved in spelling. In this study, I investigated how properties of (1) the word being spelled, of (2) the alphabet, and of (3) the child's own name influence their ability to represent the first sound of a word with a plausible letter —a letter that can spell that sound in English. For example, "cat" can be plausibly spelled with K because "cat" has the same first sound as "king."

Method: I scored U.S. 3¬–5-year-old preschoolers' (N = 857) spellings of words (e.g., "bat," "man") and nonwords (e.g., "nen," "brid"). Six factors have previously been found to influence children's spelling, but most studies have tested one factor at a time on small datasets. Using a binomial generalized mixed model to test these factors altogether on a large data set of 19,346 spellings, I determined which factors make an independent contribution to explaining the plausibility of children's spellings.

Results: Overall, children spelled 31% of items with a plausible first letter (SD = 35%). (1) Word frequency and length were not influential, but consonant clusters significantly predicted the likelihood of plausible spellings ($b = -0.94$, $p < .001$). That is, children spelled items with consonant clusters, such as "brat," plausibly 21% of the time, as opposed to 33% for items without consonant clusters, such as "bat." (2) Children were significantly more likely to spell an item plausibly if there is a letter whose name starts with that item's first sound ($b = 1.92$, $p < .001$); compare "bat" at 50% and "hat" at 31%. (3) The number of letters in children's names was not influential, but the first letter of their name had a significant effect on plausible spelling ($b = 1.84$, $p < .001$). That is, items that started with the same sound as the child's name were spelled plausibly 48% of the time, as opposed to 30% for items that started with a sound later in or absent from the child's name.

Conclusion: Of the six factors previously highlighted, I found that three factors are sufficient to explain children's spelling skills: consonant clusters, letter names, and the first letter of a child's name. When evaluating preschoolers' spelling development, seemingly random and nonsensical spellings should be appreciated as reflecting the effect of these factors on spellers who may not yet know conventional spelling rules.