CAN-ACN Satellite

New Frontiers in Integrative Neuroscience

May 21, 2025

CIAN

Centre for Integrative and Applied Neuroscience

Centre pour l'Intégration et l'Application des Neurosciences

YORK UNIVERSITÉ UNIVERSITY

VISTA VISION: SCIENCE TO APPLICATIONS

CAN-ACN

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Program Overview

Satellite Theme: Although reductionist approaches have provided many scientific advances, a more wholistic, integrative approach is required to understand how a structure as complex as the brain provides cognition and behaviour. A challenge for researchers is that often such work does not fit neatly within traditional neuroscience disciplines. For this one-day symposium, we encourage abstracts and presentations from trainees whose research cuts across traditional neuroscience systems, levels and approaches, bridging both theoretical and experimental work.

Location: Convention Centre, Second Student Centre, York University, Keele Campus, Toronto.

Program

9:00 AM-9:25 AM - Reception and Poster Set-Up

9:25 AM-9:30 AM - Welcome and Introduction – **Dr. Doug Crawford**, Director, Centre for Integrative and Applied Neuroscience (CIAN).

9:30 AM-10:15 AM - Keynote Lecture

- **Dr. Lara Pierce**, Dept. Psychology, York University.
    - "Experience-Driven Effects of Early Life Stress on Language and the Brain."

10:15 AM-11:15 AM - Coffee Break and Posters

11:15 AM-12:30 PM – Presentations – Chaired by **Dr. Jeffrey Schall**

- **Ana Badal** (York University)
    - "Associations Between Socioeconomic Stress, Engagement in Joint Attention, and Infant Neurodevelopment in 24- to 36-Month-Old Infants."
- **Anthony Machula** (York University)
    - "Thinking and moving towards better health: can a multidomain intervention for Persisting Post Concussion Symptoms reduce burden and improve quality of life? A case series."
- **Benjamin Corrigan** (York University)

    - "Response conflict neurons: Re-evaluation in medial frontal cortex of non-human primates."

- **Braxton Hartman** (York University)
    - "Atypical relations of default, dorsal attention and frontoparietal control networks in autism spectrum disorder."
- **Gaelle Luabeya** (York University)
    - "Integration of Functional Connectivity for Multimodal Cues during a Reach-to Grasp Task."

12:30 PM-1:30 PM - Lunch Break

1:30 PM-2:45 PM – Presentations – Chaired by **Dr. Dale Stevens**

- **Hannah Wynen** (York University)
    - "Maternal Exposure to Acetaminophen Affects Neuronal Morphology Within the Cerebellum and Associated Behaviours."
- **Michael Feyerabend** (University of Western Ontario)
    - "Decoding Neuronal Diversity from Extracellular Recordings: A Novel Approach Integrating Neuropixels, Optogenetics and Intracellular Recordings."
- **Patrick Hewan** (York University)
    - "Lower microstructural integrity in cortical brain regions implicated in decision-making is associated with an exploitative decision-making bias in older adults."
- **Riya Trikha** (York University)
    - "Investigating children's temporal memory accuracy for autobiographical events: Implications for forensic settings and future directions in developmental cognitive neuroscience."
- **Zeeshan Haqqee** (McGill Univerity)
    - "Learning reflects the reconstructive capacity of the hippocampus."

2:45 PM-3:45 PM - Coffee Break and Posters

3:45 PM – Announcement of Prizes, Wrap-Up and Departures

Oral Presentations

Associations Between Socioeconomic Stress, Engagement in Joint Attention, and Infant Neurodevelopment in 24- to 36-Month-Old Infants

Presented by Ana Badal, York University

Understanding how socioeconomic disparities influence infants' neural processes for social cognition and language through caregiver interactions is crucial for optimizing long-term development, yet this relationship remains less explored. This study explored the relationships between maternal socioeconomic stress (SE-Stress), joint attention (JA) behaviors, and infant brain activity, focusing on a sample of 116 mother-infant dyads from predominantly low-income families. We examined whether SE-Stress at 6 months was linked to the quality and quantity of JA at 24 months, and how these interactions related to relative alpha and theta power at rest in infants aged 24 to 36 months. Multiple hierarchical regressions revealed significant associations between SE-Stress and infant EEG activity, as well as between SE-Stress and the quality of JA engagement. Additionally, higher-quality JA was linked to more typical neural outcomes at 24 months. Several models tested whether JA quantity or quality mediated or moderated the relationship between SE-Stress and EEG measures. A significant moderation effect indicated that lower JA engagement amplified the association between higher maternal stress and increased theta power at 36 months. These findings suggest that maternal SE-Stress not only affects infant brain activity but also impacts the quality of caregiver-infant interactions, with JA quantity acting as a key moderator. This highlights the potential buffering role of JA, underscoring its importance in mitigating the negative effects of SE-Stress on neurodevelopment. The results emphasize the need for early interventions targeting JA to support healthy brain development in infants from socioeconomically disadvantaged families.

Thinking and moving towards better health: can a multidomain intervention for Persisting Post Concussion Symptoms reduce burden and improve quality of life? A case series.

Presented by Anthony Machula, York University

Background

Daily activities demand cognitive-motor integration (CMI), connecting perception and action through frontal, parietal, and subcortical brain networks, which are often impaired after sport-related concussion. Previous work at York University showed a once-weekly CMI

tablet intervention improved quality of life (QOL) and CMI performance in a neurologically compromised population.

Objective
To assess if a neurorehabilitation program integrating cognitive, motor, and sensory tasks reduces persistent post-concussion symptoms (PPCS) and enhances QOL.
Methods
In a case-control study, 4 participants completed a twice-weekly, 20-minute intervention over 8 weeks. They completed Symptoms and Quality of Life Questionnaires (SQLQ)—including STAI, PSS, SF-36, DHI, Rivermead, PSQ, and BRIEF-A, 3+ days before starting, at session 1, midway (session 8), and post-intervention (session 16), while maintaining a daily PPCS log. The intervention used an augmented reality task requiring simultaneous balance, reaching, and memory, rewarding higher scores for better recall and accuracy.
Results
Preliminary data (3 participants; ongoing) show improvements in symptoms and QOL. Cognitive scores rose 5–22 points (10 clinically significant), DHI scores improved 6–24 points (18 clinically significant), and QOL increased for all.
Conclusion
This gamified, whole-body intervention integrating multiple domains appears promising as a non-invasive neurorehabilitation tool for chronic concussion effects.

Response conflict neurons: Re-evaluation in medial frontal cortex of non-human primates

Presented by Benjamin Corrigan, York University

A major theory of cognitive control is based on the quantity “conflict”, which is the co-activation of incompatible response processes. In humans performing tasks that create response competition, neural evidence supporting the theory was identified with activation in medial frontal cortex, particularly ACC, observed with fMRI and single unit recordings in humans and inferred from event-related EEG. In non-human primates performing a saccade countermanding task, neurons identified with response conflict have been described in SEF but not in ACC. We re-examined the incidence of neurons signaling response conflict in supplementary eye field (SEF) and the dorsal and ventral banks of cingulate cortex (d/vCC) with more reliable sampling offered by 32-channel linear electrode arrays spanning cortical layers in two male Macaca mulatta performing saccade countermanding. We analyzed single neuron modulation of 2410 isolated units (813 DMFC, 976 dMCC, 621 vMCC) sampled in 164 penetrations at 32 grid locations spanning 26-34

mm anterior to the interaural line. Neurons modulating specifically when response conflict was maximal were found in cingulate cortex—more commonly in dCC than in vCC. Such neurons were more common in SEF. These findings confirm the presence of a response conflict signal in medial frontal cortex of monkeys although in a small fraction of neurons. Further research is investigating other measurement criteria and population-level descriptions to determine whether the weak response conflict signal in cingulate cortex is sufficient or negligible.

Atypical relations of default, dorsal attention and frontoparietal control networks in autism spectrum disorder

Presented by Braxton Hartman, York University

Autism spectrum disorder (ASD) is a neurodevelopmental condition characterized by difficulties in social interaction and communication, and by restricted and repetitive behaviours. We used resting-state functional connectivity fMRI to investigate the functional organization of three intrinsic brain networks which subserve domains of behaviour known to be impacted in ASD; the antagonistic "default" and "dorsal attention" networks—which subserve internally and externally directed cognition, respectively—and the "frontoparietal control" network which flexibly couples with either the default or dorsal attention network in order to dynamically direct the locus of attention. Participants were individuals with ASD (n = 25) and typically developing (TD) individuals (n = 25). Using agglomerative clustering, we characterized the hierarchical organization of the three networks in each group separately. Then, using a novel method of analysis to compare the hierarchical organization between groups, we demonstrated that there is a statistically significant difference in the intrinsic organization of these networks between ASD and TD individuals. Our findings revealed that ASD participants exhibited a fragmented frontoparietal control network, with its nodes abnormally clustering with either the default or dorsal attention network, rather than forming an independent network. Additionally, the typical anticorrelation between the default and dorsal attention networks was significantly reduced in ASD. This intrinsic network architecture may reflect a decrement in neural capacity to flexibly modulate between internal and external attention in response to task demands. These results suggest that ASD is associated with atypical hierarchical organization of large-scale intrinsic brain networks, potentially contributing to cognitive and behavioral symptoms.

Integration of Functional Connectivity for Multimodal Cues during a Reach-to Grasp Task

Presented by Gaelle Luabeya, York University

Real-world behavior requires the integration of multiple cues for coordinated action, for example object location cues to aim a reach combined with object-orientation cues to form a correct grasp. To understand how the brain might integrate these different sensory and motor components, we employed a cue-separation event-related fMRI task in which twelve participants were visually cued to the object shape (square) and Location (L: left or right to center), and verbally instructed how to manually Orient the grip (O: horizontal or vertical), with each cue followed by a delay in randomized temporal order (OL vs. LO). We then employed standard univariate analysis and graph theory analysis (GTA) of 200 cortical nodes to understand how the cortex integrates these action cues over time. Widespread sensorimotor activation occurred during the action period, independent of cue order. GTA revealed two significant network modules (clusters of nodes with similar time BOLD series): one spanning occipital-parietal cortex (with important hubs in V1, SPOC and pIPS), and one spanning auditory / somatomotor cortex (with important hubs in M1, PMd and ACC). These results show how different instructions are integrated into the reach plan, i.e., bottom-up visual cues through 'dorsal stream' parietal reach areas and top-down auditory task instructions through the frontal cortical reach network. Supported by the Canadian Institutes of Health Research (CIHR), the National Science and Engineering Research Council (NSERC) and the Vision: Science to Applications (VISTA) program.

Maternal Exposure to Acetaminophen Affects Neuronal Morphology Within the Cerebellum and Associated Behaviours

Presented by Hannah Wynen, York University

The lipid prostaglandin E2 (PGE2) is important for healthy brain development. Abnormal levels are linked to Autism Spectrum Disorder (ASD). Studies show that prenatal acetaminophen (APAP) exposure inhibits the PGE2-producing enzyme cyclooxygenase 2 (COX-2), increasing ASD incidence. We have previously shown that COX-2-knockin mice (COX-2KI) exhibit ASD-like behaviour. This study aims to examine neuronal morphology in the cerebellum and related motor deficits in COX-2KI mice and mice prenatally exposed to APAP. We measured cell density, primary branch density and length within the molecular, Purkinje, and granular layers of the cerebellum at postnatal day 30 using Golgi-Cox

staining. We used the grid walking test to examine motor skills. We observed a male-specific increased cell density in COX-2KI mice in the Purkinje layer and APAP-exposed mice in the Purkinje and granular layers. COX-2KI male mice had increased branch density and length in the molecular layer. APAP-exposed males had decreased branch density in all three layers but increased molecular layer branch length. APAP-exposed female mice had decreased branch density in the Purkinje and granular layers. APAP-exposed mice slipped more often during the grid-walking test indicating motor deficits similar to those found in COX-2KI mice. This study shows that reduced PGE2 levels in the developing cerebellum of COX-2KI and APAP-exposed mice contribute to sex-dependent neuronal abnormalities and motor deficits. We provide evidence that maternal APAP exposure may negatively impact brain development and contribute to ASD.

Decoding Neuronal Diversity from Extracellular Recordings: A Novel Approach Integrating Neuropixels, Optogenetics and Intracellular Recordings

Presented by Michael Feyerabend, University of Western Ontario

Single cell electrophysiological recordings are crucial for understanding how neurons encode information in behavioral contexts. While extracellular recordings (EC) have provided significant insights into cortical function, they fall short in identifying distinct cell types. Traditionally, studies have classified neurons as narrow or broad spiking based on action potential duration, often equating these types with inhibitory and excitatory neurons, respectively. However, this classification is problematic because broad spiking interneurons and narrow spiking pyramidal neurons also exist. Recent efforts using unsupervised clustering techniques for cell type classification in vivo have struggled to align identified clusters with a consensus cell type taxonomy. The development of dense multi-electrode probes, such as Neuropixels, has led to EC recordings with much higher yield and a richer multi-channel signature of the action potential.

In this project, we utilize the “Visual Coding – Neuropixels” dataset from the Allen Institute for Brain Science, which includes optogenetic stimulation of specific subpopulations, namely vasoactive intestinal polypeptide (VIP), somatostatin (SST), parvalbumin (PV) expressing neurons. In addition, we were able to obtain a sparse label for excitatory cells (EXC) based on cross-correlograms. We leverage the characteristic feature profiles of these non-overlapping subpopulations for supervised cell type classification of EC units with high accuracy in mouse V1. Our ultimate goal is the application of a classification across species, informed by a dataset of single-cell in-vitro characterizations in marmoset

V1. Prediction outcomes of classification were evaluated by cross-referencing labels with functional connectivity.
Our results provide a proof of concept that EC unit classification can be applied to species lacking transgenic tools. This approach is particularly useful for studies in primates, where neuronal diversity is less understood and by offering a probabilistic readout of neuron types during in vivo experiments, enhancing the interpretation of behavioral and sensory responses. These techniques will be invaluable for systems neurophysiologists studying the cerebral cortex of behaving animals.

Lower microstructural integrity in cortical brain regions implicated in decision-making is associated with an exploitative decision-making bias in older adults

Presented by Patrick Hewan, York University

The exploration–exploitation (EE) trade-off is a decision-making process that relies on cortical regions involved in reward processing and monitoring, and their integration with subcortical nuclei involved in attention and learning. In recent work, we used quantitative MRI (qMRI) to examine the microstructural integrity of the locus coeruleus (LC), a core subcortical node in the EE circuit, and showed that this brain measure robustly predicts performance on a foraging-based measure of EE. Here, we investigated whether a similar relationship exists across cortical regions implicated in EE, examining cellular microstructure as it relates to foraging performance in the medial orbitofrontal cortex (mOFC), rostral middle frontal gyrus (rMFG), frontopolar cortex (FPC), and dorsal anterior cingulate cortex (dACC)—core cortical regions identified in a recent meta-analysis from our lab and related theoretical models. We found that lower microstructural integrity of the mOFC, rMFG, and FPC was associated with suboptimal decision-making performance, marked by an exploitation bias in older adulthood.

Investigating children's temporal memory accuracy for autobiographical events: Implications for forensic settings and future directions in developmental cognitive neuroscience

Presented by Riya Trikha, York University

Children as young as 4 years old are witnesses in legal proceedings. In instances they are the sole witnesses, their testimonies hold the power to build or disprove existing evidence.

It is important for police interviewers and legal practitioners to have a knowledge-base about what ages children recall accurate details and the types of memory questions that produce reliable testimonies. This type of data for children's temporal memory (when past events occurred) is especially lacking, but critical. Temporal memory retrieval relies on the hippocampus (Davachi et al., 2003) and the prefrontal cortex (PFC; Blumfield & Ranganath, 2007), however, the development of the hippocampus and PFC is protracted (Ghetti & Bunge, 2012). With this in mind, the present study aims to create a forensic knowledge base by testing children's temporal memory accuracy, while also informing developmental researchers about the developmental trajectory of temporal memory. Parent-child dyads (4-15-year-olds: n=123, so far) were recruited. In session 1, parents provided documentation (e.g., timestamped photographs) for four unique past events varying in valence (positive, negative) and distance (recent: occurred within past two years; distant: occurred 2-4 years ago). In session 2, children freely recalled the events and were asked additional questions about temporal details (e.g., time, day, duration, month and season the event took place). We found memory accuracy improved with age, but patterns differed based on the type of temporal information assessed, valence and temporal distance. Implications for the intersection of developmental and forensic psychology, and future directions in developmental neuroscience, will be discussed.

Learning reflects the reconstructive capacity of the hippocampus

Presented by Zeeshan Haqqee, McGill University

Memory is traditionally described as encoded information in the brain, whereas planning involves the flexible representation of encoded knowledge. How learning from prior experiences benefits our capacity for flexible and novel predictions remains a paradox. Traditional studies focus on overtrained animals in tasks with few degrees of freedom, masking how an internal model of the world could emerge with experience. We deviated from this approach by training freely-behaving mice in a complex goal-directed task while tracking hundreds of cells from the hippocampus (dCA1) using Miniscope calcium imaging. Mice developed highly stereotyped behaviors as they became experts on the task. Generalized Linear Models revealed how much each neuron's variability in activity could be explained by these behavioural features, such as position, head direction, etc. Most neurons became tuned to a progressively larger set of behavioral features, from over 90% tuned to position alone during pretraining to <15% in expert mice. However, the same neurons also developed this multiplexed tuning during free exploration in the inter-trial-interval, when mice were disengaged from the task and did not demonstrate planned

behaviours. Tuning profiles also emerged days before animals became experts and generalized to span the entire feature space of behaviors, rather than those overrepresented during the task, akin to forming a sharper, but unbiased, internal model of possible actions. Our findings challenge traditional theories of learning. Rather than directly encoding experience for later recall, learning highlights a more general role of improving the capacity of the hippocampus to flexibly plan behaviour.

Poster presentations

Posters presented in the Convention Centre

1. **Brain Expression and Integrated Physiological Responses Mediated by the Endocannabinoid System and the Metabolic Ghrelin/GHSR Axis**

Author: Camila Saenz

Background: The growth hormone secretagogue receptor (GHSR) and cannabinoid receptor type 1 (CB1R) are highly expressed in the brain, regulating energy homeostasis, appetite, reward, and stress. While their individual roles are well characterized, the potential for co-expression in the same neuronal subsets and its functional implications remains unexplored.
Methods: We conducted a neuroanatomical analysis using GHSR-eGFP mice, Fr-ghrelin labeling, and CB1R-specific immunostaining, complemented by transcriptomic datasets, to investigate their co-expression in the brain. To explore functional implications, we assessed the behavioral effects of co-administration of their agonists, ghrelin (15 pmol/g) and THC via voluntary oral administration (5 mg/kg THC) in 300 mg peanut butter in adolescent mice. Mice were fasted 2h prior to cannabis consumption. The average time to consume the cannabis/peanut butter mixture was X + X min.
Results: We identified significant overlap between GHSR+ and CB1R+ neurons in the cerebral cortex, hippocampus, and amygdala. Transcriptomic data revealed distinct Ghsr+/Cnr1+ glutamatergic neurons in the hippocampus and amygdala, as well as diverse subtypes co-expressing these receptors in the midbrain, hypothalamus, pons, and medulla. These findings suggest that GHSR and CB1R may mediate region-specific physiological responses, such as feeding. Voluntary oral cannabis significantly increased food intake, and reduced body temperature. Future experiments will address the interaction of ghrelin on cannabis-induced food intake.
Conclusion: These results highlight the neuroanatomical convergence of GHSR and CB1R, that may be influencing acute cannabis-induced appetite and may highlight novel therapeutic targets for cannabis addiction.

2. **A Multivariate Approach to Understanding Cognitive Functioning in High-Performance Youth Athletes**

Authors: Carmel Camilleri, Kathryn Johnston, Nick Wattie, Joseph Baker, Magdalena Wojtowicz

Growing evidence indicates that athletes demonstrate heightened cognitive abilities in executive functioning. Most research relies on mean-based analyses, offering a limited perspective on cognition within this population. This study adopts a multidimensional neuropsychological approach, providing a more nuanced and comprehensive examination of cognitive profiles in high-performance athletes. 162 athletes from the Canadian Sport Institute Ontario (64% female; aged 17-25) completed a cognitive battery encompassing 12 tasks evaluating: verbal reasoning, inhibition, spatial planning, mental rotation, deductive reasoning, paired associate learning, visual attention/search, visuospatial processing, and verbal/spatial working memory. Scores were age and sex matched to a normative sample of non-athletes (n ~ 5,000) and converted into T-scores. High-score proportions were examined, and multivariate base rates (MVBs) were calculated at three cutoffs (75th, 84th, and 91st percentiles). Additionally, an exploratory factor analysis (EFA) was conducted to identify athletes' latent cognitive profiles. A higher-than-expected proportion of athletes achieved top scores, with 34.0% surpassing the 75th percentile in visuospatial working memory and 29.0% in mental rotation. Most athletes reached at least one score at the 75th (81.5%), 84th (67.9%), or 91st (59.3%) percentile. Notably, many excelled across multiple domains, with 47.5%, 26.5%, and 10.5% attaining three or more scores at these thresholds. As well two distinct latent profiles emerged: multimodal working memory and spatial-cognitive integration. MVBs and EFA provide a multi-domain lens of cognitive profiles in athletes that can reveal the strengths and weaknesses of athletes. Further research is required to explore how sport type, training history, and athlete characteristics may impact cognitive performance.

3. **Modulation of hippocampal neuronal activity and local field potentials during 3D head movements and jumps in the common marmoset**

Authors: Diego B. Piza, Benjamin Corrigan, Julio Martinez-Trujillo

The primate hippocampus CA1 and CA3 subregions contain neurons that encode view and head direction during spatial navigation in 3D environments. In the same regions a large proportion of interneurons seem to encode dynamic variables such as translation body speed and angular head velocity (AHV). The latter suggests that the primate hippocampus

may have a specialized machinery for encoding idiothetic signals. These signals may preferentially carry information about changes in gaze position in 3D space resulting from natural movements (e.g., head movements and jumps).
Here we test this hypothesis by recording hippocampal CA1 and CA3 single neuron and LFP activity in 2 common marmosets as we measured 3D head and body position during a foraging task and eye position while they were sitting on a primate chair during a free viewing task. We found that 36.3% and 12.5% of pyramidal cells and 87.4% and 36.2% of interneurons were significantly modulated by head movements and jumps respectively (ANOVA, $p<0.01$). 95% of jump-responsive cells were modulated by head movements. We found a large proportion of cells that preferentially encoded turning direction. Importantly, we found a larger proportion of cells encoding directional AHV in the vertical tilt plane compared to the azimuth plane. Finally, we found a significant amplitude modulation of the LFP as well as a significant power modulation of the average time-frequency response that peaked within the theta band, mean = 8.7, 7.8 and 7.1Hz for saccades, head movements and jumps respectively.
Our findings extend current models of hippocampal function, highlighting its critical role in integrating diverse movement-related information in 3D environments. The synchronization of theta oscillations to the arrival of this information suggests a common mechanism for efficiently encoding incoming visual and movement-related signals.

4. The Role of the Marmoset Dorsolateral Prefrontal Cortex in Memory-Guided Navigation

Authors: Ehsan Aboutorabi, Susheel Vijayraghavan, Julio Martinez-Trujillo

Episodic memory—often known as the ability to recollect features such as the time and location of specific past events—is integral to advanced cognition and is particularly vulnerable in Alzheimer's disease. To explore this capacity, we trained a marmoset on a memory-guided navigation task and wirelessly recorded (1) the animal's location (OptiTrack Motion Capture System) and (2) single-unit activity from the dorsolateral prefrontal cortex (Blackrock Microsystems). The animal was trained to navigate a maze with four reward spouts, requiring strict adherence to spatiotemporal sequences to obtain rewards. In the simpler (2 spouts) condition, the animal learned to collect rewards by licking two specific spouts in sequence and achieved 93% performance accuracy, while in the more complex condition, it navigated a sequence of 3 spouts and performance dropped to 70%. Behavioral analysis revealed a nearly sevenfold increase in the average number of misses before licking the correct spout during the 3 spouts relative to the 2 spouts condition. The latter suggest a memory capacity limitation. Dorsolateral prefrontal

recordings revealed heightened activity at decision points, i.e., when the animal paused to evaluate choices complying with the correct sequence experienced in the past, implicating this region's role in remembering back in time to past experiences. While the subjective "mental time travel" central to human episodic memory remains unconfirmed in marmosets, these findings demonstrate their ability to encode and retrieve spatiotemporal sequences in a manner consistent with episodic-like memory.

5. **Neural Predictivity of Artificial Neural Networks (ANNs) in Active and Passive Task Conditions**

Authors: Ezgi Fide, Shayna Rosenbaum, Kohitij Kar

Artificial neural networks (ANNs) are widely used to model primate ventral stream responses, particularly for object recognition. While it is well-established that neural representations in the inferior temporal (IT) cortex differ between passive viewing and active tasks, it remains unclear how the task state influences the neural predictivity of these models. To investigate this, we recorded neural activity in the IT cortex of two macaque monkeys during passive fixation and active object discrimination tasks involving 10 objects. High-performing ANNs were used to predict neural responses in the 70-170 ms time window, a key period for visual processing (Majaj et al., 2015).
We hypothesized that ANNs would predict neural activity better in active task states, given the task-specific training of these models. Contrary to expectations, neural predictivity was significantly higher during passive fixation than during the active task. We further investigated whether these differences were driven by the time phase of neural responses. Consistent with prior studies suggesting the role of recurrent processing in late-phase activity (Kar et al., 2019), we observed that the differences in predictivity were most pronounced during the late-phase (150-210 ms), with minimal differences in the early-phase (80-130 ms).
These results demonstrate that the neural predictivity of ANNs is modulated by task state, with late-phase activity playing a crucial role in task-dependent differences. Our findings emphasize the importance of considering behavioral task states when using ANNs to model brain responses, suggesting that the influence of task state on neural representations should be incorporated into future model designs.

6. **Game as Healing Medium: Reimagining Meditation Exergame Design Through Taoist Practice**

Author: Chang Haoran

My research-creation dissertation project explores the game as a healing and reparative medium through the lens of Taoist practice and philosophy. In this poster, I present my work-in-progress VR game, Zhan Zhuang Exergame. This game adapts Zhan Zhuang (standing meditation), a traditional Chinese practice rooted in the Taoist tradition, into a virtual reality experience that encourages physical exercise and mindful movement. The creation of this game employs ethnographic methodology and a participatory approach to address issues of gamification in health applications. By drawing from the Taoist tradition, this game reimagines the possibilities of designing games for healing purposes.

7. **Using LIPv and LIPd to divulge the microcircuitry of persistent activity in visuospatial working memory**

Author: Holly Crowson, Martin Paré

Working memory is the cognitive ability to store temporarily limited information for goal-directed behaviour and it is essential for our daily functioning. Its neural substrate is the subject of intense investigation. One mechanism proposed for visual working memory is persistent neuronal activity, which has been observed in a cortical network that includes the posterior parietal cortex, particularly the lateral intraparietal (LIP) area. This area is subdivided into a dorsal (LIPd) and a ventral (LIPv) portion based on connection with the processing streams for object and spatial vision respectively, as well as quantitative differences in neurotransmitter receptor density and myelin content. Here we characterize the spiking statistics of LIPv and LIPd neurons recorded while rhesus monkeys perform a memory-guided saccade task, in which a saccade must be made to the remembered location of a visual stimulus. We found that the persistent activity of LIP neurons located more dorsally possess stronger tuning, larger signal-to-noise ratio, and lower signal variability. Neurons located more ventrally showed greater bursting activity. These findings provide new constraints for modelling the mechanisms underlying persistent activity. In addition, they suggest that the cortical processing streams for object and spatial vision, including the oculomotor system, rely on neural signals of different qualities.

8. **Probing Motion-Form Interactions in the Macaque Inferior Temporal Cortex and Artificial Neural Networks for Complex Scene Understanding**

Authors: Jean de Dieu Uwisengeyimana, Kohitij Kar

Traditionally, object motion and form processing have been attributed to dorsal and ventral visual pathways, respectively. However, recent evidence challenges this separation; studies reveal that the ventral stream also encodes spatial and motion information. To further investigate the ventral pathway's role in integrating motion and form, especially in natural contexts, we recorded neural activity from rhesus macaques and assessed several artificial neural networks (ANNs). Our hypothesis was that motion enhances form detection in camouflaged scenes where static recognition is challenging. Two rhesus macaques viewed 132 videos from the Moving Camouflaged Animals (MoCA) dataset, each 500 ms long, depicting moving camouflaged objects and static scenes. Neural recordings were taken from 95 reliable sites in the inferior temporal (IT) cortex (neuron reliability threshold: 0.4). Results showed motion significantly improved form-related attribute representation in IT cortex. Object size decoding from neural responses had a higher correlation with moving stimuli (Pearson R = 0.63) than static frames (R = 0.57). Similar trends emerged for decoding object X- and Y-positions. Moreover, IT cortex responses significantly predicted object speed (R = 0.26, p = 0.002). We also tested various image-based and video-based ANNs, finding that video-based models like S3D, R2plus1D_18, and Swin3D outperformed others and aligned closely with primate behavioral data, effectively modeling spatial and temporal dynamics. Our research represents initial steps towards understanding dynamic scene perception in both biological and artificial systems, providing valuable insights for developing robust vision systems capable of handling complex, dynamic environments.

9. **The Neurotechnology Microcredential Program: An Innovative and Interdisciplinary Pedagogical Approach to Prepare Learners for Responsible Innovation in the Emerging Field of Neurotechnology**

Authors: Jonathan D Coutinho, Pauline Gaprielian, Susan Boehnke

Neurotechnology is an emerging growth industry that applies brain sensing, imaging or modulating technologies to solve real world problems, such as diagnosing and treating brain disorders, understanding and modifying brain states, and even interfacing the brain with machines. Applications of neurotech raise novel legal, ethical, and social considerations, but there are limited accessible training programs to develop the necessary transdisciplinary core-competencies for responsible neurotech innovation. To

bridge this gap, we have developed the Queen's University Neurotech Microcredential Program (NTMC), offering asynchronous, online courses on key neurotech topics, plus an in-person capstone project course offering hands-on experience with neurotech and networking opportunities with academic and industry experts. Our enrollment demographics (113 survey respondents) reveal diverse learners with near gender-parity (45% female), only 47% university students, 26% >35 yrs old, and 48% based outside Canada (US:21% Europe:14%, Australia:9%). This highlights the widespread demand for neurotech training across the globe and at various career stages. In our upcoming Neurotech Ethics course, learners explore the basics of neuroscience, neurotech, and applied ethics before investigating case studies of applications of neurotech devices across different sectors (medical, consumer, organizational). To facilitate learners' transdisciplinary evaluation of benefits, concerns, and risks, we developed a unique neurotech impact assessment tool (TALES - Tech, Analysis, Legal, Ethics, Social).

10. Functional architecture of areas V1, V6 and the dorsolateral prefrontal cortex in the common marmoset

Author: Juan Pimiento Caicedo, Jarrod R. Dowdall, Julio Martinez-Trujillo

The primate visual system is hierarchically organized with thalamic inputs reaching area V1 and propagating through different areas until reaching the lateral prefrontal cortex (LPFC) (Felleman & Essen, 1991). A classical view is that each area contains microcircuits composed of canonical motifs, and differences in function across areas are due to their distinctive intra- and inter-area connectivity. An alternative view is that cortical microcircuits vary in their structural and functional properties across the visual processing hierarchy, with variations of the canonical circuit motif impacting the function of individual neurons and population dynamics. To test this hypothesis, we used simultaneous neuropixel recordings in areas V1, V6, and LPFC (Area 8a/46) of common marmosets (Callithrix jacchus, n=2) in two conditions: resting state (gray screen) and passive viewing of static images and animated cartoon clips (5-20 s).
We observed that:

1. V1 and V6 had higher firing rates and spike train variability than LPFC cells ($p < 0.05$).
2. We found two main discharge patterns: Bursting and regular spiking. Bursting cells fired in clusters with ISIs < 10 ms, while regular spiking cells could be modeled with an inhomogeneous Poisson process.

3. There is a functional gradient where cortical units near the occipital pole exhibit a bursting discharge pattern, whereas cells LPFC tend to show regular discharge patterns.
4. Using spike train and waveform parameters, we classified cells from these areas with > 80% accuracy.

These results suggest that firing patterns differ across brain regions, accounting for the specific computations these areas perform.

11. The effects of movement perception on balance responses and its interaction with dynamic visual cues

Authors: Kayton Jaksic, Nora Pourhashemi, Taylor W. Cleworth

Background: Detecting changes in self-motion is essential to maintain balance [1]. While individuals can accurately perceive movement during dynamic balance [2], it is unknown how movement perception affects balance responses, and how this interacts with changes in visual information. This study aims to examine how perceiving movement impacts balance responses under dynamic visual conditions.
Methods: In experiment 1, young adults stood on a tilting platform under conditions varying visual conditions (eyes open/closed), stance type (static/dynamic), and tracking task (tracking/non-tracking). Cortical activity (EEG), muscle activity (EMG), kinematics, and subjective measures were recorded. In experiment 2, participants stood on a translating platform tracking trunk position during visual perturbations (anterior/posterior). Balance responses were analyzed across three windows post-stimulus (0-1s, 1-2s, 2-3s). Perceived-to-objective displacement ratios and cross correlations quantified the relationship between perceived and actual postural responses.
Results: In experiment 1, the secondary tracking task minimally impacted postural movements during static and dynamic balance tasks. Movement amplitude and cortical activity remained constant, but balance confidence decreased. In experiment 2, participants exhibited strong postural responses to visual stimuli. Perceived position lagged actual position in the first and third windows but led in the second window, where the perceived-to-trunk displacement ratio was highest.
Conclusions: Perceiving movement influenced subjective, but not objective, postural responses. Visually evoked postural responses and their interaction with movement perception may be altered 1-2s post-stimulus. Further research is required to better

understand perceived movement during upright stance with manipulated sensory cues. **References:** [1] Peterka (2002) J. Neurophysiol. [2] Cleworth & Carpenter (2019) Neurosci.

12. Sex differences in the developing human visual cortex

Authors: Leanne Monteiro, Rachel Kwan, Adam Gee, Kathryn M. Murphy

The human visual cortex is >20% larger in males than in females, yet, no studies have addressed sex differences during its development. Here we studied the molecular development of the human visual cortex to determine if mechanisms that govern growth and experience-dependent plasticity differ between females and males. We used proteomic dataset of human post-mortem tissue samples (n=30, F=12, age range: 20 days to 80 years) to characterize the development of mechanisms that regulate plasticity in the visual cortex, including 23 synaptic proteins and 72 cytokines, chemokines, and growth factors. Using hierarchical clustering, we found that 7 trajectories captured the range of development, and many of those trajectories followed undulating patterns of change across the lifespan. Unexpectedly, there was minimal overlap between the female and male proteins within a trajectory, including one trajectory with only female proteins and other trajectories strongly dominated by one sex. The female-only or female-biased clusters were enriched for immune and inflammatory processes while the male biased cluster was enriched for synaptic signaling. Differential Expression Sliding Window Analysis was applied to unpack the proteins driving the age- and sex-related differences. We found that females and males exhibited sexually dimorphic patterns of development, especially in childhood (<5 years). The significant sex differences in childhood suggest that the female and male visual cortex may use different mechanisms to regulate experience-dependent developmental plasticity. Furthermore, these findings underscore the pressing need for a more diverse approach to visual neuroscience research.

13. The role of schemas in extrapolating beyond visual boundaries

Authors: Maria Orlando, Jabeen, Syeda; Rosenbaum, R. Shayna.

We sample the world through our vision and can quickly (and automatically) extrapolate beyond what is right in front of us to form a coherent, continuous understanding of a scene. This extrapolation process draws on conceptual knowledge structures or schemas to guide perceptual processing, leading an observer to remember more than what was available

from the visual sample of a given scene. Boundary extension (BE) is an error in scene memory, such that participants retrieve details beyond the boundaries of a scene image, thus "extending" the view in their internal representation. Schemas inform expectations about what likely exists beyond the arbitrary boundaries of a scene image. To test the role of schemas in BE, we present participants with a set of images in which there is a focal object placed within a scene that is either matched (scene-congruent) or mis-matched to the scene context (scene-incongruent) and test their memory using a recognition paradigm. If forming spatially coherent internal representations of scenes relies on schemas, we expect differences in the extent of BE exhibited for images in which contextual details fit an observer's expectations for the scene context, compared to images in which the observer's expectations are violated by irregularities in the scene. We predict BE will be attenuated in the scene-incongruent condition, as the mismatch between focal object and surrounding context will disrupt the extrapolation process supported by schemas. This comparison will offer insight into how schemas contribute to scene processing and has implications for the involvement of the hippocampus.

14. Repeated within-session intra- and extra-dimensional learning in marmosets

Authors: Marium H. Alvi, Ryley P. Nathaniel, Karmen Rai, Liya Ma

Cognitive flexibility is the brain's ability to suppress current strategies in favor of better alternatives when the context changes. Reductions in cognitive flexibility are a transdiagnostic deficit in several neuropsychiatric disorders. How the primate brain supports this process is not well understood.
We trained 4 marmosets on a touchscreen-based Wisconsin Card Sorting Task (WCST) involving 2 dimensions: 3 shapes (star, square, heart) and 3 colors (yellow, red, blue). Marmosets underwent shape training, choosing the correct black shape from pairs to obtain a reward, followed by training on the remaining shape pairings. Similarly, they were trained on colors presented as circular patches. Once learned, they progressed to the full marmoset WCST (mWCST), in which they identify and select the compound stimulus with the target feature ignoring the irrelevant dimension. When they choose 8 correctly in a 10-trial block, the target feature shifted either within dimensions (e.g. red to blue) or across dimensions (e.g. red to heart). All marmosets quickly learned to perform multiple intra- and extra dimensional switches within a daily session. Afterward, animals were introduced to 6 new features, 3 shapes and 3 colours. Marmosets applied their learned skills to make multiple switches within their first two sessions. Next, we will implement a feature

reinforcement learning model to simulate rule switching behaviour during the mWCST, providing insights into how animals adapt to intra- and extra- dimensional shifts.

15. Comparative Analysis of Intrinsic Electrophysiological and Morphological Properties of Fast-Spiking and Pyramidal Neurons in the Dorsolateral Prefrontal Cortex and Primary Visual Cortex of Non-Human Primates

Authors: Michelle Jimenez-Sosa, Michael Feyerabend, Julia Sunstrum, Sam Mestern, Sara Matovic, Meagan Wiederman, Benjamin Corrigan, Pavel Truschow, Stefan Treue, Jochen Staiger, Guillermo Gonzalez-Burgos, Stefan Everling, Wataru Inoue, Julio C. Martinez-Trujillo.

Parvalbumin neurons (PV) are crucial inhibitory interneurons in the brain's cortex that maintain the excitation-inhibition balance. While their electrophysiological characteristics are thought to be preserved across cortical areas, their density varies between sensory and association regions like the primary visual cortex (V1) and the dorsolateral prefrontal cortex (dlPFC), particularly in primates.

We used whole cell patch clamp to study PV interneurons and pyramidal neurons (PN) in macaque V1 and dlPFC (pPV: n=54; PN: n=70). Using a classifier trained on mouse genetically labeled neurons, we identified putative PV cells in primates and compared their morphology across species.

PN exhibits higher excitability in V1 compared to dlPFC. Conversely, pPV neurons in the dlPFC displayed higher input resistance (Rin) than those in V1. Interestingly, dlPFC pPV neurons had significantly higher Rin than PN, while V1 PN had higher Rin and lower rheobase than pPV cells.

PV neuron size increased progressively from mouse to macaque to human. In primate association areas, neurons showed larger dendritic fields but shorter dendrites and fewer primary branches. These changes likely adapt PV neurons to the sparse cell density and expanded cortex of dlPFC versus V1.

These results indicate that PV neurons are finely tuned to the specific functional demands of different cortical areas. V1 neurons are optimized for signal detection, while dlPFC neurons prioritize signal selectivity. This study highlights distinct electrophysiological and morphological features of PV neurons across V1 and dlPFC in non-human primates, supporting the existence of a gradient of intrinsic properties along sensory and association areas.

16. The role of modified optic flow gain during static and dynamic balance control

Authors: Nora Pourhashemi, Taylor W. Cleworth

Background: Vision provides critical feedback to maintain balance. Optic flow gain, the amount of visual motion relative to head movement, can be manipulated using virtual reality (VR) [1]. Amplified optic flow gain tightens postural control [1], while reduced gain increases sway amplitude [2]. This study aimed to determine the minimum amount of optic flow gain required to maintain stability comparable to baseline (gain of 1) during static and dynamic stance.
Methods: Participants wore a VR head-mounted display that modified optic flow gain ranging from 0 to 1. In experiment 1, 36 participants stood on a force plate under firm and foam conditions. In experiment 2, 26 participants stood on a force plate mounted on a platform translating in the anteroposterior (AP) direction (± 5cm, <1Hz). Centre of pressure (COP) displacements were analyzed using root mean square (RMS), mean power frequency (MPF), sample entropy (SE), and detrended fluctuation analysis (DFA)-derived scaling exponent (α).
Results: In experiment 1, AP COP RMS, MPF, and SE increased, while DFA-α decreased on foam compared to firm surfaces. A gain of 1 resulted in the lowest DFA-α on foam. In experiment 2, AP COP RMS decreased when optic flow gain was <0.5x, while DFA-α decreased with increasing gain.
Conclusions: Optic flow gain influences balance under challenging and dynamic conditions. During challenging conditions, DFA-α decreased as gain increased. Half the amount of optic flow gain was sufficient to sustain baseline sway characteristics.

17. Investigating the Effects of Concussion on Cerebral Blood Flow Using Doppler Ultrasound

Author: Ravneet Kalkat, Alison Macpherson, Nick Reed, Loriann Hynes

Background: Concussions can significantly affect cerebral blood flow (CBF). However, most research is focused on the acute or subacute stages of injury, leaving a gap in understanding long-term implications of concussion on CBF. Given that changes in CBF have been proposed as potential biomarkers for concussion injury, monitoring CBF beyond the symptomatic threshold could provide valuable insights into recovery trajectories.

Objective: To evaluate blood flow volume (BFV) in cervical arteries that contribute to CBF (Internal Carotid Artery; ICA and Vertebral artery; VA) between male and female athletes with history of concussion (HOC) and athletes with no history of concussion (controls).
Methods: 94 asymptomatic university athletes were recruited during pre-season for baseline-testing (49 females, 45 males); 36 athletes reported having HOC and 58 athletes had none. Doppler ultrasound was utilized to evaluate BFV in the cervical arteries contributing to CBF. Total CBF was calculated as the sum of BFV in these supplying vessels (bilateral ICA and VA).
Results: When adjusted for sex, athletes with HOC were found to have significantly higher CBF compared to controls. Males with HOC reported significantly higher CBF compared to male controls ($\beta=186.69$; $p < 0.05$) and females with HOC reported significantly higher CBF compared to female controls ($\beta=213.41$; $p < 0.01$).
Conclusions: These findings indicate that while clinical symptoms of concussion may resolve significant alterations in CBF may persist. More research is warranted to explore if this mismatch between clinical recovery and physiological healing persists long term and its effects on overall brain function.

18. Medial frontal neuronal activities during repeated rule switches in rats

Author: Ryley Nathaniel, Yiping Zhang and Liya Ma

To study the neural mechanisms underlying cognitive flexibility, we developed a novel rule-switching task, in which rats learned to switch between blocks of trials under either Stay or Shift rules. Under the Stay rule, the correct side—left or right, remained the same for every trial in the block. Under the Shift rule, rats must alternate their choices from trial to trial to win a reward. In each trial, prior to the response period, rats nose-fixated in the central port for a 1-second delay period. Rats learned the Shift rule within three (3) days. We then conduct single-unit recordings from the medial frontal cortex (MFC) while they learned to switch from the Shift to the Stay rule, which they learned on the first or second day of training. Over 16 days, they progressed through Training Stages from Beginner to Expert on rule switching. To identify the factors that contributed to performance, we evaluated a total of 16 multilinear regression (MLR) models using Akaike Information Criterion. Response accuracy was best predicted by the model with Training Stage, Rule, Trial Position after a switch, and Rule-Side interaction as factors. Reaction time was best predicted by the model with Training Stage as the sole factor. Expert animals committed much less perseverative errors and relatively more regressive errors. We then applied linear regression models to the activities of MFC neurons. The most influential factor was Side of choice, best explaining the activities of 35% of neurons. The second-biggest factor was Rule, which

optimally explained the activity of 29% of neurons. Additionally, neuronal activity during the delay period can be used to predict whether the animal was about to make an error. Our novel task is well suited for the analysis of the single-neuron, population and network-level mechanisms that support this training-related improvement in cognitive flexibility.

19. Exploring adult hippocampal neurogenesis in the common marmoset

Authors: Sarah Enright, Sarah Parylak, Fred Gage

Adult hippocampal neurogenesis (AHN) has been extensively reported in rodents, with several studies documenting the developmental and maturation processes of adult-born cells. In mammals, AHN occurs in the dentate gyrus (DG) and has been implicated in learning, memory, and other hippocampal-specific processes. However, studies have reported that AHN seems to present at lower levels in humans, and neurogenic rates are widely disputed. Additional research analyzing AHN in non-human primate (NHP) models is necessary to further understand species-specific differences to effectively translate this knowledge to humans. Here, we use dual labelling with bromodeoxyuridine (BrdU) and ethynyl deoxyuridine (EdU) to quantify AHN and explore survival rates of adult-born neurons in a small primate, the common marmoset (Callithrix jacchus). Our results show several adult-born neurons within the subgranular zone (SGZ) of the DG. These cells express neuronal markers and differ from proliferating glial cells, demonstrating distinct neurogenesis in the marmoset. Neurogenic rates differ between mice and marmosets, suggesting differences in AHN are likely related to the species' lifespan and may be an evolutionary adaptation to optimize stability in neuroplasticity. We also explore novel methods to examine morphological distinctions between adult-born neurons of NHPs and rodents and the resulting impacts on circuits and behaviour. We propose that the common marmoset may serve as an essential intermediate model to translate data from rodent models to human studies to provide insight into neuropsychiatric and neurodegenerative disorders that affect AHN and memory.

20. Linking Inferior Temporal Cortex Activity to Object Recognition Behavior under Variable Task Demands

Authors: Soroush Ziaee, Kohitij Kar

The inferior temporal (IT) cortex is a critical brain area that supports object recognition, with prior studies linking IT responses (70–170 ms post-stimulus) to behavior. However, it remains unclear whether the exact linkage between IT and behavior can explain object recognition performances in primates when the delay between stimulus presentation and the decision-making is increased. To investigate this, we designed a delayed match-to-sample task presenting Test images to macaques for 100 ms, followed by a delay of 100, 400, 800, or 1200 ms. After the delay, the animals had to choose between a target and distractor object, indicating the object they had seen. We also simultaneously recorded large-scale IT activity to probe the underlying neural mechanisms. First, we observed that as the delay increased, recognition accuracy declined. Interestingly, the image-level accuracy patterns changed significantly (as measured by correlation across delays). Are these shifts in behavior driven by changes in the IT responses? To address that, we generated the standard IT population activity-based linear decoders integrating responses from 70-170 ms post image onset (similar to Majaj et al. 2015). IT-based decodes remained stable across all delay conditions, suggesting that object representations in IT during the image presentation do not change across delays. Therefore, additional neural mechanisms in the IT cortex during the delay period or other brain areas (e.g., ventrolateral prefrontal cortices) must be needed to account for the observed behavioral differences. Ongoing work will use ANN model-based predictions to test the delay activity at IT and vlPFC.

21. Remembering the past and imagining the future: Children's and adults' inclusion of time and space details in memory narratives

Authors: Tarnpreet Virk*, Lina Deker*, Christine Coughlin, Simona Ghetti & Thanujeni Pathman (*shared first authors)

Two features of episodic memory (memory for past events; Tulving, 1972), supported by the hippocampus, are the ability to remember spatial (e.g., where an event occurred) and temporal (e.g., when an event occurred) contexts (Eichenbaum, 2017). There are consistent age-related improvements in episodic memory across childhood (Picard et al., 2012), and episodic memory studies suggest differing developmental trajectories for temporal compared to spatial memory accuracy (Lee et al., 2015). In the autobiographical

memory (AM) literature, these details contribute to the formation of coherent life narratives (Habermas & Bluck, 2000), as expressed through children's AM narratives (Newcombe & Reese, 2004). A growing number of studies have shown that imagining future events, activates the same brain regions that are needed for remembering the past (Schacter & Addis, 2007). However, little is known about how children's inclusions of time and space details compare, and whether patterns differ for past compared to future events in narrative contexts. Our study examined the number of time and space details included in narratives for past, future and, as a comparison, make-believe events. Participants' (5-, 7-, 9-, 11-year-olds and adults; N = 157) narratives were coded for time and space details. An Age x Event-Type x Context ANOVA revealed a three-way interaction; follow-up analyses showed different patterns based on age group and event type, as well as well when controlling for amount of narrative talk. Results across age will be discussed in relation to research on the developing hippocampus and prefrontal cortex in childhood.

22. Neural Substrates of Working Memory Capacity Limitations of the Freely Moving Marmosets

Authors: Tsz Wai Bentley Lo, Susheel Vijayraghavan, Lyle Muller, Julio Martinez-Trujillo

Working memory (WM) is a crucial cognitive function that supports the retention and manipulation of information necessary for goal-directed tasks. This capacity is inherently limited, with constraints varying across species and sensory modalities. We trained two common marmosets on a touchscreen-based delayed non-match-to-position task to investigate these limitations. During each trial, one to four stimuli were successively presented on the screen, and in each iteration, the subject had to select the stimulus at the novel location. Performance declined as stimuli increased, with errors occurring more frequently when the novel stimulus appeared on the same side as a previously presented stimulus, consistent with prior findings on visuospatial attention and WM capacity.

To explore the neural basis of this behavior, two marmosets were implanted with multi-shank electrode arrays targeting the lateral prefrontal cortex (area 46). Neural responses were recorded using a wireless system. Prefrontal neurons exhibited significant modulation during three task epochs: pre-touch, post-touch, and post-reward. Neurons tuned to specific quadrants of the screen were responsive across memory loads, with these selective neurons distributed across the array. This suggests that spatial information is maintained through distributed prefrontal activity rather than localized retinotopic organization. Moreover, the observed firing rate modulations across memory loads suggest

a dynamic updating of spatial representations, potentially contributing to memory load-dependent performance limitations.

Posters presented in the lobby area

23. Neuroplastic Effects of Dance Training in Parkinson's Disease: Functional and Structural Adaptations in Speech-Related Brain Regions

Authors: Ashkan Karimi, Xianze Meng, Karolina A. Bearss, Sarah Robichaud, Rachel J. Bar, Joseph FX DeSouza

Background: Parkinson's disease (PD) is a neurodegenerative disorder characterized by progressive motor and non-motor impairments, including speech deficits. Dance-based interventions have shown promise in improving motor function, cognitive engagement, and neuroplasticity, yet the neural mechanisms underlying these effects remain unclear.
Objective: This study used multi-modal neuroimaging to investigate the impact of an 8-month dance training program on functional brain activity, cortical structure, and white matter integrity in individuals with PD.
Methods: Ten individuals with PD participated in dance training and underwent functional MRI (fMRI) and cortical thickness analysis (T1-weighted MRI) at four-time points. Four participants underwent diffusion-weighted imaging (DWI) at the last two time points. fMRI assessed BOLD signal changes in the Motor Cortex (Inferior Frontal Gyrus) during a dance-imagery task. Cortical thickness was measured in Broca's Area (Brodmann Area 44) and the Left Supplementary Frontal Language (SFL) Area. White matter integrity between these regions was evaluated using Fractional Anisotropy (FA), Axial Diffusivity (AD), Radial Diffusivity (RD), and Mean Diffusivity (MD).
Results:

- Functional Activity: BOLD signal reductions in the Motor Cortex from September to January ($p = 0.021$), with no further changes in May.
- Cortical Thickness: No significant differences in Broca's Area or the SFL Area ($p > 0.05$).
- White Matter Integrity: FA significantly increased from January to May ($p = 0.025$), with a marginal AD increase ($p = 0.056$), while RD and MD remained unchanged.

Conclusion: Dance training may have led to functional and structural neuroplasticity in people living with PD, enhancing motor-related activity and white matter connectivity between motor and language networks. While cortical thickness changes were not

observed, findings suggest possible training-induced neuroplasticity. Dance may serve as a promising intervention for improving neural efficiency and motor-linguistic integration in PD, warranting further investigation in larger, more controlled studies.

24. Posterior Intraparietal Sulcus activity during a head unrestrained, memory guided reach task

Authors: Brando Sheldrick, Veronica Nacher-Carda, Jennifer Lin, Hongying Wang, Saihong Sun, Xiaogang Yan, J. Douglas Crawford

The purpose of the current study is to investigate how local field potential (LFP) activity along the mid-posterior intraparietal sulcus (IPs) is modulated by visual landmarks before and during reaches to remembered visual targets. We recorded both action potentials and LFPs using 32-channel neural probes in one female Rhesus monkey. A landmark (four identical dots positioned at the vertices of a virtual square) was displayed at one of fifteen locations within reach on a touch screen. A visual target then appears, either within or outside of the landmark square, followed by a visual mask. After the mask disappeared, the landmark reappeared either at the same location (stable landmark condition) or shifted by 8 degrees in one of eight directions (landmark shift condition). Gaze and head position were allowed to move freely, and the animal was rewarded for reaching within 4.7 cm of the target. In the 'no-landmark' control trials, the procedure was the same, but the landmark is not presented. In parallel array recordings from posterior ventrolateral prefrontal cortex, LFP activity displayed decreases in delta band power during the memory-delay phase and an increase in both delta and theta power during the planning and execution of the reaching movement (Lin et al., *CAN-ACN* 2025). Preliminary analysis of the current IPS LFP dataset suggests a decrease in beta band power that is time-locked to the reaching movement. Additionally, there appears to be an increase in delta and theta band power before reward in the landmark task conditions compared to no-landmark controls.

25. Neuroplasticity in Eye Dance Learning

Authors: Danna Robayo, Salwa Beheiry, Eesha Qamer, Bethel Negash, Udichi Das, Joseph DeSouza

This study addresses whether a learning paradigm centered on the visual-motor system can lead to neuroplastic changes with implications for motor and neurocognitive function in Parkinson's Disease (PD). It aims to fill the gap in research on visual-motor-based learning paradigms and their potential to enhance neuroplasticity and performance in PD

patients. Eye movements of 12 participants (9 female, 3 male) were tracked using the Eyelink 1000 Plus system during a 1 minute and 8-second eye-dance sequence. The experiment consisted of a learning phase, where participants observed the sequence five times with 30-second breaks, and a performance phase, where they performed the sequence from memory on a grey screen without visual cues. Music was incorporated into both phases to aid memorization. Data were analyzed using R 4.3.1 and Experiment Builder: Data Viewer software. Results showed significant improvement in performance accuracy between the first session (dr0702g1; M = 51.3%, s = 10.03%) and the second session (dr0403g2; M = 80.0%, s = 13.35%), with a paired-samples t-test yielding t(4) = -3.23, p = 0.032, and a strong effect size (Cohen's d = 1.44). These findings suggest that visual-motor-based interventions have the potential to enhance motor and neurocognitive functions in neurodegenerative diseases such as PD. The results provide a foundation for developing targeted therapies that integrate learning paradigms to improve outcomes, warranting further exploration of their long-term efficacy in clinical settings.

26. Dynamics of Eardrum Vibrations Evoked by Both External Sound and Active Forces from the Inner Ear

Authors: Esther Sule, Rebecca E. Whiley, Natasha Mhatre, Christopher Bergevin

The tympanic membrane, commonly known as the eardrum, and the ossicles (small bones spanning the middle ear space) serve as key constituents in the transformation and transmission of sound energy. Together, they provide a forward pathway for external sound energy to propagate to the inner ear efficiently, such that sound is optimally transduced into electrical signals, ultimately going to the brain. It is well-established that the inner ear's sensory cells also actively generate force that improves the ear's ability to encode sound. As a result, healthy inner ears can create coherent sound in the absence of external stimuli, known as spontaneous otoacoustic emission (SOAE). These emissions effectively leak back out through the middle ear in the reverse direction, and thereby, the eardrum plays the double role of a diaphragm acting both as a microphone and speaker. Here, we report TyM motions measured from the inner ear of an anole lizard using a sensitive laser Doppler vibrometer. Tym motions were measured in response to external sound, and spontaneous motions were also recorded. These measurements are of biophysical interest for several reasons, including robust SOAE activity, despite anoles having several orders of magnitude fewer sensory cells compared to humans. Additionally, in anoles, the left and right eardrums are directly coupled via an acoustic cavity called the interaural canal (IAC). Here we report measurements of spontaneous tympanic membrane motion with displacements as small as several picometers and their relationship to SOAE measured simultaneously from the contralateral ear. Further, we measured motions induced by

external sounds, allowing us to compute the associated transfer function and input impedance, as well as map out how these motions vary across the surface of the tympanic membrane. Together, these results will help inform theories of how the inner ear achieves its remarkable functionality and how the two ears can cooperatively work together binaurally in non-mammals such as lizards.

27. Humans actively reconfigure neural task states

Authors: Harrison Ritz, Aditi Jha, Nathaniel Daw, & Jonathan Cohen

We can flexibly switch between tasks, e.g., switching from French to English, but the neural mechanisms supporting this 'task reconfiguration' remain poorly understood. Cognitive psychologists are increasingly modeling task switching using dynamical systems theory and neural networks, however the neural correlates of these task dynamics remain poorly understood. To fill this gap, we first developed a gated recurrent neural network (RNN) model of task switching, training pools of RNNs to optimize task performance under a set of curricula exploring different components of task switching. To characterize the latent task dynamics in these artificial networks, we fit latent dynamical systems to RNN activity. Using control-theoretic analyses of the fitted model, we found hypothesized signatures of previous-task interference and next-task preparation. Next, we tested whether similar signatures of task control were present in EEG recordings of the human brain. Reanalyzing two EEG datasets with the same latent dynamical models, we found that EEG-inferred neural dynamics appear to be in close agreement with the predictions from artificial networks, capturing both within- and between-experiment signatures of task control. These analyses provide evidence for a new phenomenon in task preparation: both humans and neural networks appear to prepare for upcoming trials by entering a 'task-neural' brain state during the ITI, analogous to a tennis player returning to the center of the court after a shot. This work provides new insights into flexible information processing in brains and machines, and a new paradigm for comparing representations between natural and artificial modalities.

28. An fMRI meta-analysis of aggression and violent behavior

Authors: Helen Kliewer, Adam M. Croom

Aggression and violent behavior remain critical public health concerns, with emerging evidence suggesting that biological mechanisms particularly resting state functional connectivity (RSFC) play key roles. However, the extent to which specific RSFC patterns consistently predict aggression and violent behavior across different studies and diverse populations remains unclear. To address this issue, we followed PRISMA guidelines and conducted a systematic literature review and meta analysis of all relevant fMRI studies that have investigated RSFC correlates of aggression and violent behavior (n = 19). Activation likelihood estimation (ALE) results from our fMRI meta-analysis of 19 studies showed that aggressive and violence prone individuals, compared to controls, exhibited significantly increased BOLD activity in the right amygdala ($Z = 4.3185$ $p = 0.00000785$), orbitofrontal cortex ($Z = 3.9629$ $p = 0.00000788$), and ventral striatum ($Z = 3.6998$ $p = 0.00000621$). Further, we found distinct connectivity patterns for different forms of aggression and violent behavior, such as reactive violence versus proactive revenge. The results from our fMRI meta-analysis contribute to the neuroscience literature by identifying key neural circuits and distinct patterns of activation involved in different forms of aggression and violent behavior. This contributes to our understanding of the neural basis of aggressive and violent behavior and can also contribute to the development of more effective targeted interventions. Today we discuss the results and implications of our research along with limitations and prospects for future work.

29. Individual Differences in Visual Evoked EEG Explained by Variation in Cortical Folding

Authors: Isimeme Okonofua, Peter Kohler, Jeffrey Schall, Michelle Schall

EEG signals index human behavior, perception, and cognition, justifying their use as scientific and diagnostic tools. These signals originate from cortical pyramidal cell activity, which generates current dipoles. Dipoles perpendicular to the scalp produce stronger EEG signals than those with other orientations. Due to cortical folding patterns variation between individuals, EEG data interpretation is challenging. We aim to assess the impact of cortical folding variability on EEG signal generation. We analyze EEG and MRI data from a study in which participants viewed visual texture stimuli in a steady-state design. This design isolates low-level activity from image updates and symmetry-related activity in distinct frequency components. Although all participants viewed the same stimuli, we

observed marked differences in their EEG signals. We are investigating the contribution of V1 and V2 cortical folding variation on the pattern of the image update response, under the assumption that low-level activity originates primarily from those areas. To examine this, we apply an inverse solution method to localize the cortical sources of the image update response. We then perform dipole simulations in cortical regions with varying location and orientation to model the even harmonic signal, revealing properties of its neural generators. We expect stronger contributions from regions of visual cortex oriented perpendicular to the scalp. Our findings will enhance understanding of EEG signal origins, improving their application in neuroscience and healthcare. By clarifying how cortical folding affects EEG responses, this study will inform methods for better interpreting individual variability in EEG data.

30. LFP Recording in the Ventrolateral Prefrontal Cortex during a head-unrestrained memory guided reach task

Authors: Jennifer Lin, Nácher, V., Wang, H., Sun. S., Yan, X., Martinez-Trujillo, J., Crawford, J.D.

The main purpose of the current study is to understand how local field potential (LFP) signals are coordinated in time and neural space, i.e. across a memory delay. We implanted a 128-channel Plexon Array over posterior ventral prefrontal cortex (pVLPFC). Single unit activity and LFPs were recorded simultaneously in a female Rhesus monkey trained to perform a memory guided reaching task. The hand was initially placed at 1 of 3 varying locations of a waist level LED bar while gaze fixated centrally A landmark was presented at 1 of 15 locations on a touch screen. A visual target then appeared transiently at a variable location within or outside this virtual square, followed by a visual mask. After the mask, the landmark either reappeared at the same location (stable landmark condition) or shifted by 8 degrees in one of 8 directions (landmark shift condition). The fixation light then extinguished, signaling a reach to the target. 'No-landmark' controls were the same, but without the landmark. Neural and behavioral (eye, head, hand) signals were then recorded daily for three months while the animal performed this and other related tasks. Preliminary analysis of the LFP signals reveal band-specific decreases in power during the delay before reach and increases in power peaking near movement onset. Task-dependent modulations were also observed in the preparatory activity as visual complexity increased and in the presence of a landmark. This suggests that prefrontal LFP signals contains visual context-dependent information for reach planning and execution.

31. Compound Gain Fields in Memory-Guided Reaching - A Recurrent Neural Network Simulation

Authors: Kathrin Pabst , Parisa Abedi Khoozani, Kohitij Kar, Gunnar Blohm, John Douglas Crawford

Visually guided reaching requires a transformation from eye-centred visual inputs to effector-centred motor plans. Early physiological and modelling studies proposed that gain fields—modulations of tuned neuronal responses by postural signals—support such reference frame transformations (Zipser & Andersen 1988 *Nature*). More recent work has shown that eye and hand gain fields in the parietal reach region form a compound gain field proportional to the distance between gaze and hand position in visually guided reaching, a property that could also be replicated by a feedforward model (Chang et al. 2009 *Neuron*). However, it remains unclear how these compound gain fields develop over time. To address this, we investigated whether similar properties emerge in a recurrent neural network. As a first step, we reimplemented Chang et al.'s feedforward model and trained it on a visually guided reaching task. Its units developed gaze-centred response fields with gaze gain fields aligned with the retinal vector (presumably to compute position in space) and hand gain fields with opposite tuning (presumably to compute the reach vector). In the second step, we have extended the model with recurrent dynamics and trained it on a memory-guided variant of the task. Preliminary inspection suggests that the recurrent network develops similar compound gain field properties near the end of each trial, after the go-signal. Ongoing work will quantify how gain field modulations evolve across trial phases from target presentation, through memory retention, to movement initiation, to better understand how internal dynamics support behavioural output.

32. The Influence of TMS-Induced Perturbation of Egocentric and Allocentric Brain Hubs on Reach Accuracy and Precision

Authors: Musa, L., Luabeya, G.N., Sheldrick, B., Rezaei, A., Sun, S., Yan, X., Crawford, J. D.

Reach target locations can be encoded in egocentric (EGO) or allocentric (ALLO) reference frames. Musa et al. (2025) identified distinct brain hubs, part of the visual peripheral network (VP) (Schaefer et al., 2018), associated with these reference frames: EGO - ExstrSup-2 and ALLO - ExstrInf-2. This study uses TMS perturbation to investigate their causal influence on behavior. We hypothesized TMS to ExstrSup-2 influences EGO reaching, while both hubs impact ALLO reaching, due to ALLO-to-EGO conversion for

action (Chen et al., 2018). We also explored the relationship between VP network modularity and TMS-induced behavioral changes, which could be mitigated by stability afforded by modularity.
Sixteen participants performed a delayed reach-to-touch task under EGO (relative to self) and ALLO (relative to a visual landmark) instructions, with similar sensory and motor demands (Musa et al., 2024). Resting-state scans were used to localize TMS targets above and determine modularity. TMS (triple-pulse, 1Hz, 110% motor threshold) was applied during the delay to dorsal / ventral hubs, and control (no stimulation). Reaching performance was measured by accuracy and precision in pointing to a remembered target. TMS to the superior hub reduced accuracy and precision in both tasks, while TMS to the inferior hub affected only ALLO. Modularity in the VP network was inversely related to error.
These causal results suggest that 1) dorsal stream functions are shared by both egocentric and allocentric reaching, 2) ventral stream processes are more specific to landmark-based reaching, and 3) increased network modularity diminishes the influence of perturbations to these networks.

33. Examining the Multifaceted Nature of Episodic Memory Through Photo-Taking at a Living History Museum

Authors: Michael Grbic, Casey Aurin, Riya Trikha, Thanujeni Pathman

Episodic memory (EM), critical for daily functioning, allows us to remember various aspects of past events, including what happened, when and where. Most memory studies focus on one aspect of EM (e.g., temporal memory); few studies allow us to examine how memory performance compares for different aspects of EM. Further, memory studies are typically lab-based which may not accurately reflect real-world memory processing (Gilboa, 2004). In an fMRI study, St. Jacques et al. (2008) investigated temporal order memory by asking participants to take photographs at campus locations, and then were scanned while making temporal order judgements. In the present study, we used this photo-taking approach to test memory for dynamic events outside of the lab, using a broad range of memory tasks. Young adults (n=41, so far) went on a guided tour of the Village at Black Creek where they visited various locations, heard facts, and took photographs. Five days later, participants completed several memory tasks (free recall, recognition memory, temporal and spatial memory, semantic memory for facts learned and autobiographical narratives). For example, to test recognition, participants were shown photos (20 their own; 20 from another participant) and asked to identify photographs they took. To test temporal

and spatial memory, participants were asked to order locations and mark each location on a map. This study allows for a more complete assessment of EM, and compare individual differences across tasks, Results will be discussed in relation to neural processes involved in EM; future work will measure event-related potentials during test.

34. Maternal Thyroid Antibodies in Pregnancy and Child Cognitive Function

Authors: Mila Valcic, Meaghan Hall, Christine Till

Background: Maternal thyroid hormones are crucial for fetal brain development. Elevated thyroid peroxidase (TPOAb) and thyroglobulin antibodies (TgAb) can reflect maternal thyroid dysfunction, but few studies have examined the association between maternal antibodies to both TPO and Tg and intellectual abilities in children.
Objective: We investigated associations between maternal TPOAb and TgAb levels during early pregnancy and children's intellectual abilities among Canadian mother-child dyads enrolled in the Maternal-Infant Research on Environmental Chemicals study.
Methods: We measured TPOAb and TgAb concentrations in 577 maternal first-trimester plasma samples. We assessed child Full-Scale (FSIQ), Verbal (VIQ) and Performance (PIQ) IQ at ages 3-4 years using the Wechsler Preschool and Primary Scale of Intelligence, 3rd edition. We used multivariate linear regression to test the associations between maternal TPOAb and TgAb concentrations and child IQ, controlling for relevant covariates. We also explored effect modification by child sex through inclusion of interaction terms.
Results: Median TPOAb and TgAb concentrations were 0.45 (range= 0.11–905.03) and 1.08 (range= 0.05–896.82) IU/mL. A 100 IU/mL increase in TPOAb concentration was associated with a 1.3-point decrease in FSIQ (95%CI: -2.4,-0.2) and a 1.4-decrease in VIQ (95%CI: -2.4,-0.3), with higher TPOAb related to lower VIQ among boys (B=-2.4; 95%CI: -4.0,-0.9), but not girls. Additionally, a 100 IU/mL increase in TgAb concentration was associated with a 1.9-point decrease in VIQ (95%CI: -3.7,-0.1).
Conclusions: Higher maternal TPOAb and TgAb may adversely impact cognitive development in children, with potential sex-specific vulnerabilities. Further investigation of risk factors contributing to elevated thyroid antibodies is needed.

35. Cortical Dynamics of Reaching and Placement Hand Movements

Authors: Petros Georgiadis, Erez Freud, Peter Kohler, Douglas Crawford

Successful interactions with our environment rely on coordinated movements, such as grasping and placing objects, yet most research has focused on object acquisition, overlooking the relocation phase. While both actions share common features—such as hand localization, orientation, and sensitivity to task complexity—they differ in sensory reliance and movement intention. Grasping is **typically** guided by visual input and concludes with haptic feedback at contact, whereas placement often depends on an internal representation of the target location. To investigate the neural mechanisms underlying these processes, EEG data were recorded from four right-handed young adults (mean age: 22, SD: $\pm$ 2.4) performing a sequential grasp-and-place task with pseudo-randomized object orientation and placement location. We expected differential engagement of parietal and frontal areas during planning and execution. Source localization analyses in the time and frequency domains revealed distinct neural activity patterns between the two tasks. During movement preparation, our preliminary results suggest that grasping and placement differed in (1) frontal activation of the contralateral hemisphere, (2) occipital activity related to target encoding, and (3) motor engagement in the ipsilateral hemisphere. During execution, (1) the trend of frontal activity differences persisted, and (2) motor regions exhibited greater desynchronization during placement, possibly indicating increased demands for online control. To further investigate how these regions interact dynamically, we will apply graph theory analysis to uncover task-specific network configurations over time. These findings will enhance our understanding of movement control in the human brain and support dynamic movement classification for assistive devices.

36. Laminar architecture of error responses in medial frontal cortex

Authors: P. Thirunavukkarasu, S. P. Errington, A. Sajad, B. Corrigan, J. D. Schall

Hubel and Wiesel's seminal work in cat primary visual cortex established the concept of columnar organization, forming the foundation of the canonical cortical microcircuit. However, cortical cytoarchitecture is not uniform—the presence of a clearly defined granular layer 4 varies across regions, and laminar profiles identified in sensory cortices do not consistently apply to agranular frontal areas responsible for cognitive functions such as error monitoring. This challenges the notion of a universal canonical microcircuit. We address this gap by using laminar probes to record spikes from individual neurons and local field potentials (LFPs) across layers in the medial frontal cortex (MFC), including the supplementary eye field and the dorsal and ventral banks of anterior cingulate cortex of

four macaque monkeys performing a stop-signal task. Although interconnected, these regions are functionally, cytoarchitecturally, and anatomically distinct. Combining converging evidence from 1) single-unit data characterized by spike waveform shape, spike timing patterns, and cross-correlations between distant and neighboring neurons and 2) LFP measured as current source density and spectrolaminar profile, we localized the laminar origins of error-related signals with high confidence. Our findings refine the canonical framework in MFC and present a biologically plausible microcircuitry model that monitors and refines behavior.

37. Dancing Through Time: Cognitive Change Over Six-Years of Community Dance in Parkinson's Disease

Authors: Simran Rooprai, Harsimran Dogra, Emily D'Alessandro, Rachel Bar, Karolina Bearss, Jenna Smith Turchyn, Nicole Anderson, Joseph FX DeSouza

Introduction: Parkinson's disease (PD) is a progressive neurodegenerative disorder marked by motor and non-motor impairments. Among the most debilitating symptoms are cognitive decline and gait dysfunction. Although previous research has demonstrated that dance can improve motor and non-motor symptoms in PD, the long term impact of dance has not been investigated across a six-year period in a community dance setting.
Methods: The dance group (persons with PD; n=43) attended weekly 75-minute dance classes at Canada's National Ballet School between 2014 and 2019, and completed the Mini-Mental State Examination (MMSE) and the Movement Disorder Society—Unified Parkinson's Disease Rating Scale (MDS-UPDRS). For an objective comparison, a reference group of 28 PwPD were selected from the PPMI database (matched on age, gender, and Hoehn & Yahr scores). The reference group completed the UPDRS and Montreal Cognitive Assessment (MoCA), and cognitive scores were standardized. Cognitive and gait outcomes were analyzed using generalized estimating equations.
Results: There were no group differences in cognitive scores at baseline and 2015. The dance group demonstrated significantly higher cognitive scores than the reference group in 2016 ($p = 0.008$), 2017 ($p = 0.001$), and 2018 ($p = 0.0042$). However, no significant differences were found in 2019. Gait performance remained stable in the Dance group, but no significant relationship was found between gait and cognition.
Conclusion: Long-term dance engagement may help preserve cognitive function in PwPD. With the observed stability in gait performance, the findings further suggest potential neuroprotective benefits of continued dance participation.

38. TAcetaminophen-exposure affects dendritic morphology in the developing medial prefrontal cortex

Authors: Srushti Patel, Hannah Wynen, Dorota A. Crawford

Prostaglandin E2 (PGE2) is a major lipid signalling molecule in the developing brain. It plays an important role in neuronal proliferation, migration, differentiation and synaptic plasticity. Various environmental risk factors known to increase (infections) or decrease PGE2 levels (acetaminophen (APAP)) have been linked to Autism Spectrum Disorder (ASD). Previous research in our lab in mouse offspring prenatally exposed to increased PGE2 levels and knockin mice lacking the PGE2 producing enzyme COX-2 (COX-2KI; low levels) showed altered dendrite and dendritic spine morphology in the hippocampus and cerebellum along with ASD-like behaviour. The objective of this research is to examine the sex-dependent effects of prenatal APAP exposure on dendritic morphology in developing medial prefrontal cortex (mPFC). Pregnant mice were exposed to APAP on gestational day 11 (GD11) until birth. At postnatal day 30 brain tissue were stained using the Golgi-Cox technique to examine dendritic morphology including cell density, soma size and primary branch length and density. Our findings show that APAP-exposed females had significantly increased cell density coupled with decreased soma size compared to age matched control females. Moreover, both APAP-exposed males and females had significantly reduced primary branch lengths. There were significant sex differences observe in branch density, but there was no effect of treatment. Overall, there is a female-specific effect of APAP-exposure on cell density and soma size and an effect of treatment on primary branch length in the developing mPFC.

39. Iconicity and Causal Perception

Author: Taylor MacNicholas

Iconicity is often taken to mark the border between perception and cognition (Block 2023). But what counts as an icon? The two leading accounts—the parts principle and analog mirroring— struggle to accommodate causal representations. According to the parts principle, a representation is iconic if parts of the vehicle represent parts of the content. Analog mirroring holds that a representation is iconic if degrees of change in the vehicle correspond functionally to degrees of change in the content (Block 2023). However, neither framework straightforwardly accounts for causation. Analog mirroring struggles to explain how causation might come in degrees (Gross 2025), and the parts principle, in focusing on part-whole structure, risks excluding causation entirely.
This is a problem because empirical evidence suggests that perception represents causation. Adaptation effects—a marker of perceptual representation (Block 2023)—have been demonstrated for causal events (Rolfs et al. 2013). If perception is constitutively

iconic, then any account of iconicity must explain how causation is iconically represented. The parts principle, in its standard form, relies on spatial parts, failing to accommodate causal representations. A revised version, appealing to extensive magnitudes (Maley 2023), allows for spatial and temporal parts but does not clarify how causation might be included. Kulvicki's (2014, 2015, 2020) abstraction-based account can accommodate causal parts but requires that icons have only integral, non-separable features—contradicting evidence that perceptual representations include separable features (Fougnie & Alvarez 2011). Thus, none of the three dominant versions of the parts principle satisfactorily accounts for causal representations in perception.

40. Effects of C-Section Birth Method on Visual Attention as Measured by the Attention Network Task

Author: Ursula Hegge

Relatively little is known about the effects of birth methods on human cognition, despite the increasing prevalence of Caesarean section (C-section) births. Certain birth processes may be disrupted during C-section delivery and deficits in visual attention have been found in those born via C-section, compared to those delivered vaginally. Chevalier (2021) compared C-section and vaginally delivered young adults on various visual tasks, including the Attention Network Task, which measures three different attention networks: alerting (cued attention to an upcoming stimulus), orienting (cued attention to the location of an upcoming stimulus), and conflict (attention to a relevant stimulus in the presence of distracting vs. facilitating information). Supervised by PhD candidate Mylann Guevara, this project's aim was to re-analyse and build upon the work of Chevalier (2021). Our findings indicate that, contrary to previous research, C-section delivered participants achieved better scores on alerting and orienting when compared to vaginally delivered participants. These results provide further insight into the relationship between birth method and visual attention, a growing field that is highly relevant within developmental science and beyond.

41. Mapping visual search errors to covert operations with frontal eye field neurophysiology and double factorial design

Authors: Wanyi Lyu, Jeffrey D. Schall

Behavior is the outcome of covert perceptual, cognitive, and motor operations that can be described by mathematical models and are produced by brain circuitries. To resolve the processing stages underlying visual decision-making, we designed a task to independently modify two critical operations — target localization ("Where is the informative item?") and response selection ("What does that item instruct me to do?"). Two macaque monkeys were trained to search for a color singleton among distractors. Target localizability was manipulated by varying the similarity of singleton and distractor colors. Response selection was manipulated by varying the discriminability of search array shape, signaling GO/NOGO response. The organization and termination rule of the two operations were determined using System Factorial Technology (SFT). However, the logic of SFT is confounded by errors, so we describe the neural origin of errors with single-units in Frontal Eye Field (FEF). Monkeys made two common errors: failure to locate the target on GO trials and failure to inhibit the saccade on NOGO trials. Localization and response inhibition errors arise through distinct neural processes. This shows that visual attention and decision making are distinct, which challenges the canonical accumulator model of decision-making.

42. Spatial Tuning of Visual Responses to Symmetries in Textures

Authors: Iskandar, Lee, Bosse and Kohler

Symmetry is a biologically significant feature that relies on the visual grouping of spatially separate elements. It has been shown to play a role in numerous domains of visual perception in both humans and other animals. Neuroimaging studies have revealed that several regions in the visual cortex exhibit robust and precise responses to different types of symmetry. The current study explored spatial mechanisms that mediate symmetry perception by measuring Steady-State Visual Evoked Potentials using high-density EEG. Our stimuli were taken from a class of regular textures, known as wallpaper groups, which are a set of 17 unique combinations of symmetry types in 2D images. Specifically focusing on groups PMM and P4, we generated examples from each group based on random noise patches that varied in spatial frequency between 1 to 8 cycles per degree. All wallpaper groups contain translation symmetry, which is expressed as a lattice structure that is repeated to tile the plane. We assessed the influence of this repeating structure by varying the ratio of the lattice to the overall wallpaper area between 1/12 and 1/2. Consistent with

previous findings, symmetry-specific responses were weaker overall for rotation compared to reflection. We also found a clear modulation of responses by spatial frequency and lattice ratio, such that responses were weaker with increasing spatial frequencies. Interestingly, the differential responses in both spatial frequency content and lattice scale could possibly suggest a distinct mechanism for each symmetry type, which we will probe further in future research.

43. Increased frontal alpha asymmetry: Examining polygenic risk as a moderator between environmental stressors and infant neurodevelopment

Author: Zahra Wakif, Mary Desrocher, Patricia Silveira, Charles Nelson, Pat Levitt, Lara Pierce

Previous research has explored how different forms of early adversity such as poverty and caregiver depression can impact infant neurodevelopment, as measured through electroencephalography (EEG). However, relatively little research has been conducted on the role of polygenic risk (PRS). The current study includes data from 116 infant participants from Boston Children's Hospital and Children's Hospital Los Angeles, testing how environmental and genetic risk can interact to predict neurodevelopment, particularly in two-month-old infants. Linear regression analyses will be conducted to test the associations between PRS, environmental variables (i.e. maternal depression and socioeconomic variables), and neurodevelopmental outcomes, particularly frontal alpha asymmetry (FAA). A moderation analysis will unveil whether PRS acts as a moderator between environmental risk and neurodevelopment. We hypothesize that i) environmental risk will predict increased levels of FAA, ii) PRS will predict increased levels of FAA, and iii) PRS will moderate the associations between environmental risk and FAA. Exploring interactions between environmental and genetic risk very early on during key developmental stages bridges current research gaps, and holds implications for earlier detection of who may be at increased risk for depression later in life.