Collin Allen, UCSB

On the unreasonable ineffectiveness of mathematics in Psychology.

This talk draws on interviews and other work that is being done for a project in the history & philosophy of "mathematical psychology." Mathematical psychologists form an identifiable community or sub-discipline of psychology, united by approaches to mathematical modeling, mentoring lineages. and institutional structures such as a journal, and societies on three continents organizing conferences and summer schools. Mathematical psychologists have recently been vocal about the need for psychology to move in a more mathematical direction, inspired partly by the so-called “replication crisis” or what some believe is actually a “theory crisis.” I look at the arguments of three prominent mathematical psychologists and argue that while mathematical psychology does not lack small “t” theories, it has been arguably less successful in formulating big “T" Theories that have the kind of scope, generality, and predictive power that led Wigner to write of the unreasonable effectiveness of mathematics in physics. I end by examining how philosophy of science and mathematical psychology can each contribute to the other.

Anthony Atkinson, Durham

Identifying facially expressed emotions from a single glance: The differential contributions of foveal and extrafoveal visual processing.

Assessing another’s emotional state from their face requires integra/ng spa/ally distributed information of varying spa/al frequencies. The distribution of this information varies depending on the expressed emo/on, such that certain facial features are differentially informative of different emotions (e.g., Gosselin & Schyns, 2001; Smith et al., 2005). Yet, at normal interpersonal distances all features of a face cannot fall within one’s fovea simultaneously. Two questions that follow from this are: (1) Does the ability to identify facially expressed emotions vary according to the feature fixated? (2) Do saccades preferentially seek emotion-informative features? In this talk, I will present data from two sets of studies that have begun to answer these questions. In one set of experiments (Atkinson & Smithson, 2020; Duran & Atkinson, 2021), we presented faces for a brief /me, insufficient for a saccade, at a spatial position that guaranteed that a given feature – an eye, cheek, the central brow, or mouth – fell at the fovea. In another set of experiments (Atkinson, in prep.), I took a more data-driven approach. On each trial, participants classified the emotion on a briefly presented face following enforced fixation at a point randomly selected from anywhere on the face, rather than at one of a few pre-defined locations. To visualize and quantify the classification accuracy data in this second set of studies, statistical parametric maps, thresholded with classification image statistics, were generated and overlaid on morphed average faces for each emo/on to highlight the regions where fovea/on led to higher emo/on classification accuracy. In answer to our first ques/on, the results of both sets of studies show that emo/on recognition performance does vary according to the feature fixated. More specifically, we found that beXer emo/on classification performance was afforded by fixation at locations determined by not only the presence of previously identified ‘emotion-diagnostic’ facial features, but also the spatial distribution of emotion-relevant information across the face constrained by the varying spa/al resolution of visual processing across the retina. In answer to our second ques/on, we found no evidence that reflexive first saccades from initial fixation on the face preferentially targeted emotion-distinguishing facial features.

Michele Basso, U. Washington

The role of the primate superior colliculus in perceptual decision-making.

Perceptual decisions arise after considering the available sensory evidence. When sensory information is unreliable, a good strategy is to rely on previous experience in similar situations to guide decisions. What brain areas are involved in how people combine experience and sensory information to make perceptual decisions is unknown. We developed a novel, perceptual decision-making task and manipulated the statistics of the sensory stimuli presented to people with Parkinson's disease (PD), a neurodegenerative disease involving the basal ganglia and healthy participants to determine the influence of experience on decision-making. We discovered that people with PD are impaired at combining previously learned information with current sensory information to guide decisions. We modeled the results using the drift-diffusion model (DDM) and found that the impairment corresponds to a failure in adjusting the amount of sensory evidence needed to decide. These results led us to explore how decision thresholds are established in the brain. To understand this, trained monkeys performed different decision-making tasks, involving detection as well as discrimination. Applying a signal detection theory analysis as well as computational modeling of behavioral data using the DDM, we found strong evidence that the superior colliculus, a brainstem structure that received strong modulatory input from the basal ganglia, plays a causal role in perceptual decision making by regulating how evidence is computed for form decisions.

Dirk Bernhardt-Walther, University of Toronto

Shape cues for understanding complex scenes: Evidence from psychophysics, neuroscience, and computer vision.

Research in the past three decades has propelled our understanding of both human and machine vision: We can describe much of the neural mechanisms of human visual perception, and state-of-the-art machine vision can detect objects with high accuracy. Yet research on both human and machine vision lacks a detailed understanding of how visual features are grouped into shapes and linked to the rich details of meaning that humans naturally assign to visual information. Such grouping is believed to be essential for the fast, efficient parsing of visual information by decreasing the computational complexity of this process. The human brain manages to group the primordial soup of visual features that make up a complex scene into meaningful objects. I will present results from psychophysics, neuroscience, and computer vision that demonstrate the importance of mid-level shape cues for scene categorization, memorability, emotional scene content, as well as aesthetics.

Josh Brown, IU

Monkey prefrontal cortex learns to minimize sequence prediction error.

In this study, we develop a novel recurrent neural network (RNN) model of prefrontal cortex that predicts sensory inputs, actions, and outcomes at the next time step. Synaptic weights in the model are adjusted to minimize sequence prediction error, adapting a deep learning rule similar to those of large language models. The model, called Sequence Prediction Error Learning (SPEL), is a simple recurrent neural network (RNN) that predicts world state at the next time step, but that differs from standard RNNs by using its own prediction errors from the previous state predictions as inputs to the hidden units of the network. We show that the time course of sequence prediction errors generated by the model closely matched the activity time courses of populations of neurons in macaque prefrontal cortex. Hidden units in the model responded to combinations of task variables and exhibited sensitivity to changing stimulus probability in ways that closely resembled monkey prefrontal neurons. Moreover, the model generated prolonged response times to infrequent, unexpected events as did monkeys. The results suggest that prefrontal cortex generates internal models of the temporal structure of the world even during tasks that do not explicitly depend on temporal expectation, and that it uses a sequence prediction error minimization learning rule to do so. As such, the SPEL model provides a unified, general-purpose theoretical framework for modeling the lateral prefrontal cortex.

Johannes Burge, U of Penn

The Spectral Ideal Observer and Applications.

Perception science has long appreciated that amplitude and phase relationships carry critically important information about behaviorally-relevant properties of proximal stimuli and the distal environment, ranging from edge structure, to focus error, to fixation error (binocular disparity), to face identity. But it has not been clear how to make optimal use of phase information. Here, we report a new class of image-computable ideal observers—spectral ideal observers—that make optimal use of both amplitude and phase. They operate on the real and imaginary coefficients of a stimulus' Fourier transform—rather than on amplitude and phase, or on pixels—, by characterizing the joint probability distributions of these coefficients across frequency and the latent variable of interest. Significant computational advantages are obtained. For noise images (e.g. 1/f noise), the coefficients are conditionally Gaussian; for natural images, appropriate normalization Gaussianizes them. From these distributions, the posterior over the latent variable, or the optimal Bayesian-theoretic decision variable, can be computed. The results provide principled predictions of human performance, and of the supporting neural computations. They can also be used to quantify the information that phase provides over-and-above amplitude alone. Spectral ideal observers are well-suited for problems in which the transformation from scene- to image-space is naturally modeled as a (possibly shift-variant) convolutional operation. To demonstrate the effectiveness of spectral ideal observers, we develop one for the joint task of estimating focus error and pupil size from individual images blurred by the optics of human eyes. We show that both focus error and pupil size can be accurately estimated with exquisite precision from L- and S-cone responses to individual images; performance differences can be predicted on an eye-by-eye basis. In addition to this application in optics, the spectral ideal observer should have broad application to other estimation and discrimination tasks, including binocular disparity in stereo-depth perception and binaural sound localization in audition.

Matt Chafee, U. of MN

Synaptic mechanisms of cognitive control in prefrontal cortical networks.

Drugs that block NMDAR mimic many of the symptoms of schizophrenia, including deficits in cognitive control that have been widely described in the disease. However, it is not known how loss of NMDAR synaptic function disrupts the activity of neurons in prefrontal cortical networks to produce the deficits in cognitive control that have been frequently observed. To address that question, we trained monkeys to perform a task that measures cognitive control deficits in schizophrenia and investigated how blocking NMDAR disrupted neural activity in the prefrontal-parietal network leading to errors in performance. In this task, a combination of cue and probe stimuli presented sequentially (and separated by a delay) dictated the correct response each trial. At the single neuron level, blocking NMDAR weakened the activity of neurons in prefrontal and parietal cortex that encoded the cue stimulus held in working memory. At the population level, blocking NMDAR reduced the accuracy with which the cue stimulus could be decoded from patterns of population activity, particularly during the probe period (when information about the cue and probe had to be combined to determine the correct response). Blocking NMDAR also reduced the strength of 'switch' neuron activity both in prefrontal and parietal cortex that was associated with the occurrence of infrequent, unexpected cue and probe stimuli requiring engagement of cognitive control to override prepotent responses in the task. Systemic blockade of NMDAR produced area and neuron specific effects. Blocking NMDAR reduced working memory and switch neuron activity more prominently in prefrontal cortex than parietal cortex. In contrast, blocking NMDAR had relatively little effect on neural signals encoding the probe in both cortical areas. These findings suggest that NMDAR mediated synaptic transmission is particularly essential for neural signals that mediate cognitive control in prefrontal cortex.

Todd Constable, Yale University

Insights into both Brain and Behavior through construct isolated brain-behavior models.

Brain-behavior modeling with functional MRI connectivity data has chiefly focused on the question of how such modeling can reveal the circuits supporting specific behaviors. To do this most models take the entire connectivity matrix, representing all possible connections in the brain for a given atlas, and then determine which connections vary across subjects as a function of behavioral score. It is possible however to gain much more information from this type of modeling and in doing so we can not only learn about the circuits supporting behavior, but also about the cognitive systems (constructs) that the behavioral tests rely on for differential performance. By pre-defining circuits associated with specific cognitive constructs, we can understand the contribution of each circuit to performance on the behavioral test and therefore gain insights into the tests themselves. The results of such analyses can aid in developing new cognitive behavioral tests that more directly rely on specific circuits of interest, and they can inform us as to how to combine tests that appear to rely on the same circuit combinations in order to support performance. Combining tests that rely on circuits in a similar manner leads to better stability of the behavioral measures and better brain-behavioral modeling in terms of predictive power. The application of these methods in understanding both normal behavior and psychiatric illness will be discussed.

David Crowe, Augsburg College

Drift diffusion modeling of behavior in an animal model of schizophrenia.

Recent work in our lab has centered on a drug model of schizophrenia wherein we administer the NMDAR blocker phencyclidine (PCP) to monkeys and record neural data while they perform a cognitive control task. People with schizophrenia (and other forms of psychosis) performing this dot pattern expectancy (DPX) task show a characteristic pattern of errors. Monkeys injected with NMDAR blocking drugs (ketamine or PCP) show the same pattern of errors. Our collaborators at the University of Minnesota have recently studied differences in decision variables in this task across groups of subjects with and without psychosis by using a drift diffusion model. The goal of the present study was to replicate this analysis of human data in the behavioral data of four monkeys who performed the DPX task under control conditions and after PCP injection. In this model the decision-making parameters drift rate, boundary separation, non-decision time, and response bias were all allowed to vary with respect to the four specific combinations of task stimuli. The results of the same drift diffusion model across species were remarkably similar, both in terms of the general pattern of parameter values across stimulus combinations (e.g. rank order of parameter magnitude) and with respect to how parameters differed between control and psychosis/PCP conditions. For example, drift rates in both people with psychosis and monkeys after PCP injection were markedly lower than in controls, and were particularly lower in trials thought to elicit proactive control. These similar results across species can potentially allow us to better understand the neural mechanisms underlying decision-making deficits in people with schizophrenia by, for example, correlating trial-by-trial variations in neural activity with decision-making variables.

Alejandro De La Vega, UT Austin

Expert-driven tools for automated synthesis of the neuroimaging literature.

Over 5,000 neuroimaging articles are published yearly, representing a vast but unwieldy knowledge base. Meta-analysis can help make sense of this deluge, but curating article sets and annotating relevant information is painstaking and time consuming. We present Neurosynth Compose, a platform for semi-automated neuroimaging meta-analysis that substantially speeds up the meta-analysis process, while simultaneously crowd-sourcing expert annotations for subsequent large-scale analyses. In addition, we present ongoing efforts to leverage breakthroughs in large language models (LLM) to enable high-quality information retrieval from neuroimaging articles with little labeled training data, enabling fully automated, yet precise syntheses of the neuroimaging literature.

James Elder, York

Scaling Perceptual Curvature.

Curvature describes local shape and is thus fundamental to object perception. Prior work has shown that curvature discrimination acuity falls off with curvature magnitude according to a power law. Here we argue that this may reflect the optimized curvature tuning of neural populations in intermediate shape-selective areas of visual cortex to the power-law statistics of natural object shapes. It remains unclear, however, how the brain integrates local curvature over space to yield percepts of global shape, and whether this process might take into account correlations (smoothness) over space. To study this integration we have been exploring a distortion effect in which under certain conditions a circle begins to appear polygonal. We hypothesize that this circle-polygon illusion emerges from competitive interactions between curvature-tuned neural mechanisms, and that the side length of the perceived polygon reflects the spatial sampling of these mechanisms. We find that perceived side length decreases as a function of curvature, suggesting an increased sampling rate for high-curvature features, consistent with a predictive coding framework based on the statistical smoothness of natural object shapes.

Chris Fetsch, Johns Hopkins

Cortical dynamics during concurrent deliberation for choice and confidence.

Confidence plays a key role in flexible behavior, but it remains unclear exactly how and when it arises in the brain. Sequential sampling/accumulator models posit a systematic relationship between the amount of accumulated evidence—discounted by elapsed time—and probability correct. This leads to the hypothesis that confidence can be read out from the same evolving process that governs the choice, and predicts concurrent and overlapping neural representations of this process. We designed a peri-decision wagering (peri-DW) assay where monkeys discriminated the direction of random-dot motion and reported choice and confidence with a single saccade as soon as they were ready. Behavioral analyses were consistent with concurrent deliberation for choice and confidence, and the data were well fit by a 2D bounded accumulation (anticorrelated race) model. Neural activity in LIP showed classic signatures of a diffusion-like process, and these did not differ in their timing when grouped by preferred saccadic target (i.e., high vs. low wager), arguing against a purely post-decisional confidence computation. Poisson-GLM and population decoding approaches lent further support to a concurrent process, and we failed to find evidence for temporal multiplexing (i.e., alternating integration for choice and wager). The results generally favor a so-called ‘common mechanism’ for choice, RT, and confidence, though I will discuss implications for perceptual metacognition per se versus a more motor-preparatory perspective.

Michael Frank, Brown.

Beyond drift diffusion: fitting a broad class of neurally informed decision making models with likelihood approximation networks.

Computational modeling can formally adjudicate between theories and affords quantitative fits to behavioral/brain data. This talk has two parts: in the first I describe an example of how simplified models of brain function can be useful for linking neural circuits to decision making functions. The models provide a mechanistic interpretation of changes in decision making in patient populations. However, for quantitative fitting purposes, the space of plausible generative models considered is dramatically limited by the set of models with known likelihood functions. For many models, the lack of a closed-form likelihood typically impedes Bayesian inference methods. As a result, standard models like the drift diffusion model are often fit to data for convenience even when other models might be superior. In the second part of the talk I will present a new method using artificial neural networks that learn approximate likelihoods for arbitrary generative models, allowing fast posterior sampling with only a one-off cost for model simulations that is amortized for future inference. We show that these methods can accurately recover posterior parameter distributions for a variety of neurocognitive process models. We provide code allowing users to deploy these methods for arbitrary hierarchical model instantiations linking brain mechanisms to behavior and for interrogating alterations in patient populations.

Brian Garibaldi, Johns Hopkins

Racial disparities in pulse oximetry.

Pulse oximetry is commonplace in both inpatient and outpatient medicine, and became even more widely used during the COVID-19 pandemic. It has been suspected for years that darker skin pigmentation might impact the accuracy of pulse oximeters, particularly at lower oxygen levels. Using data from the JH-CROWN COVID registry, the HCA CHARGE registry and ICU data from The Johns Hopkins Hospital, we explored the performance characteristics of pulse oximeters in critically ill patients. We first examined pulse oximeter accuracy in COVID-19 patients from Hopkins and HCA and found that when compared to arterial blood gas samples drawn within 10 minutes, pulse oximeters were almost 3 fold more likely to underestimate hypoxemia in self-reported Black patients. This led to an under-recognition of eligibility for COVID specific treatments, and a delay in receipt of those treatments. In one study using HCA data, such occult hypoxemia was significantly associated with a higher risk of readmission after an initial hospitalization for COVID-19. In a small prospective study we then showed that darker skin pigmentation (as quantitatively measured using a colorimeter) was significantly associated with occult hypoxemia. These data, and others studies, provide strong eviednce that current pulse oximeters need to be re-evaluated in order to ensure equitable performance across different racial and ethnic groups. The FDA must tighten regulations for the approval of new pulse oximeters and work with manufacturers to update both the hardware and software of existing pulse oximeters to overcome inaccuracies introduced by different skin tones.

Xiaoping Hu, Jason Langley, Ilana Bennett, Aaron Seitz and Megan Peters, UC Riverside

Locus Coeruleus Integrity and Cognition in Aging.

Locus coeruleus (LC) plays an important role in cognition and arousal. It has also been implicated in both Parkinson's disease and Alzheimer's disease. Utilizing neuromelanin MRI, we are able to image the structure of LC. Here, using neuromelanin contrast, we defined regions of interest corresponding to the LC and examined the structure integrity and connectivity using high-resolution diffusion tensor imaging. Within LC, we found the LC to have lower radial diffusivity (and hence higher fractional anisotropy) in older adults than in young adults and that these DTI measures were correlated with delayed recall, a cognitive measure. Furthermore, using tractography from LC to the thalamus, we identified the central tegmental tract and found the tract to have reduced radial diffusivity in older adults compared with young adults. These diffusion measures in the tract also correlated with the delayed recall. In summary, our LC based analysis of high-resolution DTI images show that aging leads to a reduction in axonal diameter and such reduction is correlated with cognitive decline.
This work was supported in part by NIH (R01AG072607).

David Kennedy, U. Mass.

The consequences of Small Data and Bad Behavior and What to do about it.

In this presentation we look at the general topics and implications of small data and 'bad' publishing behavior in the reproducibility of the published literature. Starting from examples of concept that 'everything matters', in the context of what data, what processing, what statistics, etc. We review the concept of the 'reexecutable publication' (a publication that includes pointers to all necessary elements of a publication) as a cornerstone for systematic understanding of the generalizability of a published finding. We close by reminding the community of some of the existing tools and procedures that span the best practices of planning, use of standards, version control, annotation and publication that span the experimental stages of study planning, data collection, data analysis, statistical processing and publication. Together, we hope to push the adoption of enhanced reproducibility practices throughout the neuroscience community.

Peter J. Kohler, York University

Investigating local and configural shape processing with Steady-State Visual Evoked Potentials.

The perception of object shape underlies our ability to detect, recognize and manipulate objects. Both local shape (curvature) and non-local (configural) shape contribute, and recent work has used specialized stimuli and behavioural methods to dissociate these contributions. Here we used high-density EEG to explore the cortical mechanisms involved in both local and configural shape perception. Adult human participants passively viewed object shape silhouettes in an SSVEP paradigm that allowed us to isolate differential brain processing between pairs of stimulus conditions. Stimuli included natural animal-shape silhouettes (upright or inverted) as well as synthetic maximum-entropy shapes that progressively match the local curvature statistics of natural shapes but lack non-local configural regularities (Elder et al., 2018). We also used another class of stimuli in which the top and bottom half of natural shapes have been flipped. This 'Frankenstein' procedure preserves local curvature statistics, but partially disrupts configural shape as well as human performance on a shape categorization task (Baker & Elder, 2022).
Our findings so far reveal differential activity over occipital and temporal cortices emerging ~170–280 msec post-stimulus, influenced by both local curvature and configural shape. We find clear effects of matching the local curvature statistics on brain processing, especially for the variance. Configural shape is a more dominant factor, however, as responses to natural animal shapes are clearly distinct from both local-curvature-matched and Frankenstein stimuli. These configural responses to inverted natural animal shapes are reduced and delayed relative to upright shapes, an inversion effect that highlights the potential influence of semantic and holistic processing. After presenting our current results, I will discuss planned next steps, including functional MRI experiments to tease apart the contribution of distinct brain areas.
Acknowledgement: This research was supported by the Canada First Research Excellence Fund and the Natural Sciences and Engineering Research Council of Canada.

Kevin Lande, York U

The Spatial Unity of Perception.

We seem to perceive things as related within a common, unified space. Not only do I see the cat as here on the mat and the lamp as there on the desk; I also see the cat as to the right of the lamp. Yet the perceptual system codes space with respect to a diversity of reference frames, based on one's body, one's environment, and the objects themselves. The visual system locates the cat and lamp egocentrically relative to the direction of my gaze, my head, and my torso. Parts of the scene are also represented allocentrically in vision: the cat's tail is located in cat-space and the lamp's shade in lamp-space. How does the spatial unity of perception emerge from this diversity of perceptual spaces? I argue that the standard responses to this question are inadequate. One response is that the spatial relations between things are ultimately perceived all within a single uniform framework. Another response is that perception is not so spatially unified as it seems. Perhaps we simply know how to skillfully shift from one reference frame to another in navigating our world. Neither of these approaches can handle what I call "multiplex percepts," as when I experience the tilted orientation of the lamp by representing it as sitting upright on a tilted desk. Multiplex percepts depend on a capacity to represent spatial features (location, orientation, shape, motion) in a structured way, by composing together representations that have different frames of reference. This capacity to combine representations with different frames of reference is integral to the spatial unity of perception, though it has been under-theorized and under-investigated in vision science.

Mike Landy, NYU

Two interesting effect in multisensory integration and recalibration: asymmetric likelihoods and overconfidence.

I'll discuss two recent discoveries about multisensory cue integration and recalibration from my lab. (1) In a study of audiovisual integration for localization, we included conditions with a range of audiovisual discrepancies in space and time. A variety of effects can modulate the degree to which auditory stimuli are localized closer to a nearby visual stimulus (the "ventriloquist effect") including casual inference, priors, miscalibration, etc. But, in analyzing the extent of ventriloquist effect in our data, we made a surprising finding: the responses were most consistent with a model in which participants were overconfident: they behaved as if they used estimates of temporal and spatial auditory variability that were smaller than the true values. (2) We did a study of temporal recalibration -- a shift of relative audiovisual timing that is perceived as simultaneous -- after exposure to a series of stimuli with a fixed auditory lead or lag relative to a visual stimulus. We found that our data could only be explained if the likelihood function (range of leads/lags consistent with a temporal measurement) was asymmetric. Surprisingly, for most participants the data imply a faster time constant for detection of visual compared to auditory stimuli.

Tai Sing Lee, CMU

The role of sparsity in neural cues on shape representation.

Recent neurophysiological observations in the macaque primary visual cortex on the high degree of sparsity of the population responses. The neurons exhibit a great deal of diversity and complexity of neuronal tunings, tuned not just to oriented edges, but to local junctions and shapes. This finding challenges the conventional notion that neurons primarily serve as basis functions to represent images using distributed codes. It revives the notion of “grandmother” cells for representing prototypes, structures and symbols. We studied the information embedded in the sparse top responses in biological recordings as well as in neural networks. We assessed the impact of training neural networks with sparsified responses, both for image synthesis and image analysis. The results reveal that sparsification indeed fosters the development of neural codes within networks that exhibit heightened sensitivity to global structures and shapes, and semantic decomposition of parts and subparts. This, in turn, leads to greater robustness against noise, greater generalizability and more coherent structures in image generation.

MaryAnn Martone, UCSD

An international ecosystem for open neuroscience.

Over the past 20 years, neuroscience as a field has made great strides in embracing principles of open science and recognizing the power of data science to transform our understanding of the brain. Steady progress will only be accelerated with the new data mandates. With the large investments into neuroscience through the large international brain projects, from genes to behavior, neuroscience is entering a golden age where large repositories of open data are becoming available. The question is now not whether we should share our data but how to do it effectively, from the individual lab to large well-funded consortia. In this presentation, I will challenge and opportunities in coordinating the necessary physical and human infrastructure required to extract full value from these investments.

Cory Miller, UCSD

How the brain works.

Brian Odegaard, UFL

Perceptual Decision Making Across the Visual Periphery.

Misconceptions about perception and metacognition in peripheral vision abound. In the scientific literature, results and anecdotes from different tasks present a complex picture about how much we perceive in the periphery, and how confident we are in perceptual judgments about stimuli in regions outside the fovea. In this talk, I will review recent experimental work from my lab which estimates perceptual sensitivity, criterion bias, and metacognitive efficiency across the visual field, using two distinct tasks. Some results revealed what we hypothesized in advance: perceptual sensitivity declines with increasing eccentricity, and also declines for unattended areas of visual space. However, results also show surprisingly idiosyncratic decision criteria at different eccentricities, which are minimally influenced by the allocation of attention. Further, while metacognitive sensitivity (measured by the metric meta-d') declines with eccentricity, measures of metacognitive efficiency were remarkably robust across the visual field. I will discuss how our behavioral work using both Gabor patches and colored stimuli shed light on the "rich vs. sparse" debate about peripheral vision and discuss how addressing questions about decision complexity in various tasks may lead us to different answers regarding the question of how much we truly perceive in eccentric regions of visual space.

Tim Oleskiw, NYU

Neural code for natural planar shape in the ventral stream.

Planar shape, i.e., the silhouette contour of a solid body, carries rich information important for object recognition, including both local and global shape cues. It is well known that neurons of area V4 encode the local curvature of figure-ground contrast, representing boundary conformation in an object-centric reference frame. However, it is unknown how V4 computes its tuning from upstream visual areas or if V4 shape tuning is sensitive to global shape features.

To investigate this, our lab has recorded multi-unit activity from populations of V2 and V4 neurons in the awake monkey using an array of synthetic shape stimuli used previously to characterize curvature tuning. Surprisingly, we find a model of local curvature tuning to account well for activity in both areas, suggesting that V4 is equipped to integrate planar shape cues beyond local curvature.

We also used a unique array of shape stimuli to dissociate tuning for local and global shape properties and to assess how model neurons, trained on single-unit V4 responses, encode the curvatures of these stimulus categories. A mutual information analysis reveals that these model neurons extract information more efficiently from shapes with natural curvature distributions, suggesting that they might be optimized to encode the ecological statistics of curvature.

To directly measure neuronal selectivity for natural shape, we recorded activity from area V4 of a juvenile Macaca nemestrina observing natural and synthetic shapes. Consistent with our model neuron analysis, we found that synthetic shapes with natural curvature distributions evoked stronger responses than synthetic shapes with more random curvature distributions. Remarkably, we also found that natural shapes evoked stronger V4 responses than synthetic shapes with matching curvature statistics, indicating selectivity for non-local shape features. Together, our findings demonstrate that V4 neurons preferentially encode the ecological statistics of both local and non-local object shapes, in a way that is not explained by existing models of V4 shape selectivity.

Ellen Payne, Moravian U.

Environmental Emergencies: Cold.

Context: Environmental emergencies take many forms and may not be isolated to just one type at a time. One the most common environmental emergency types for both traditional and non-traditional athletes and active individuals are cold emergencies. Cold emergencies take various forms including frostnip, frostbite, chilblains, and hypothermia. These conditions can be exacerbated by wind, moisture, and preexisting conditions. The purpose of this presentation is to review the physiology of thermoregulation and cold related conditions. Methods: The physiology of thermoregulation will be reviewed along with methods of heat transfer and intrinsic and extrinsic factors effecting thermoregulation. The effects of wind and moist on cold conditions will be addressed. The pathophysiology, prevention, and treatment of frostnip, frostbite, chilblains, and hypothermia will be discussed. Practical advice for the outdoor enthusiasts will be provided. Conclusions: Knowledge is power and prevention is key. This presentation will help attendees understand cold related environmental emergencies.

Franco Pestilli, UT Austin

Center for Meso-Scale Connectivity.

Understanding complex neural pathways and networks can reveal the brain’s remarkable ability to generate a rich variety of human behaviors. To advance our understanding of the brain, the Center for Mesoscale Connectomics (CMC) will establish anatomical connectivity by combining data from advanced techniques in ultra-high field MR imaging, anatomical tract-tracing, optical imaging, and computational analysis tools. The project will collect, analyze and share brain connectivity data at the mesoscale – microns to millimeters.

Megan Peters, UCI

How to induce — and measure — “overconfidence” in perception.

Under typical, everyday scenarios, we ought to feel more confident when we are more likely to correctly perceive the world. But we also know that clever lab-based tasks can pull these capacities apart, creating conditions where observers’ confidence fails to adequately track their task accuracy. When, why, and how would you feel more confident than you “should”, or less confident than you “should”? And how can we quantify this phenomenon, and use it to study how confidence judgments are constructed in the first place? In this talk I will discuss recent findings probing these questions from perspectives of experimental paradigm design, analysis approaches, and theory.

Zyg Pizlo, UCI

How different is Artificial Intelligence from Human Intelligence?

Artificial Intelligence (AI) started as a field of computer science in 1956 when Newell and Simon presented an algorithm for proving logic theorems. Over the years AI's mission has been changing. Sometimes Natural (human) Intelligence (NI) seemed too good to be emulated by AI. Other times, it seemed that AI would have no problems bypassing the cognitive limitations of NI by avoiding visual illusions, not being subject to paradoxes of decision making, using transistors that are much faster than neurons in the brain, and by using memory that exceeds the extremely small capacity of human working memory. Both attitudes discouraged researchers from making comparisons between AI and NI. This talk summarizes several well-established empirical results and theoretical claims characterizing NI. Here is a partial list: humans form abstract mental representations of problems, they change the representation in order to solve insight problems, humans never perform search when they solve problems with large search spaces such as TSP, they use multiscale pyramids to navigate search spaces and to trade speed for accuracy in perception and action, they use symmetry and invariance in scientific discovery, they use common sense as represented by intuitive geometry and intuitive physics, as well as analogy when they solve problems. This list sets the stage for evaluating the question posed in the title. If the current AI does not address these characteristics, then it may be impossible for AI and NI to interact.

Nicholas Port, IU

Optimizing use of the use of the SCAT symptom checklist.

Stefan Posse

Towards Mapping Resting-State Connectome Dynamics in Real-Time – from Neuroscience Discovery to Clinical Applications.

Resting-state functional MRI (rsfMRI) is a rapidly developing task-free approach for presurgical mapping1-5. It can complement task-based functional MRI (tfMRI) in patients who have difficulties performing tasks and efficiently map resting state networks6-11 in regions that are not typically mapped with task-based tfMRI due to time constraints, such as frontal cortex. It has the potential to provide iterative intra-operative guidance during progressive resection, enables connectome mapping in anesthetized patients, and holds promise for intra-operative guidance of minimally invasive surgery where intra-operative electrocortical mapping may not be possible. Recently, several studies using high-speed fMRI techniques have reported resting-state networks at higher than traditional frequencies (up to 5 Hz) 12-20, suggesting that functional integration between brain regions at rest occurs over broader frequency bands than previously thought 15,17,21. High frequency connectivity provides new insights into neurovascular coupling and expands applications of resting-state fMRI for neuroscience and clinical studies.

Doby Rahnev, Georgia Tech

The computations underlying confidence judgments.

Humans have little trouble providing a confidence rating for virtually any decision they make. An enduring mystery is how these confidence judgments are formed. In other words, how is confidence computed? This talk will explore the popular theories in the field and present recent research that challenges most of them. The talk will demonstrate that while much progress has been made in the last few years, we still lack definitive answers regarding how humans compute confidence.

Keith Schneider, U. Del.

Decision confidence is reflected in the entropy of the psychometric Function.

Metacognition is the self-assessment of one's own decisions. Typically, these confidence data have been analyzed and described by arbitrary qualitative functions. Here we show that subjects' confidence reports can be predicted by the entropy of the psychometric function with higher entropy reflecting higher uncertainty. As an application, we measured subjects' decision confidence as they judged the relative appearance of two stimuli in three different scenarios: subjects performed comparative judgments with either an attentional pre-cue for one stimulus (Experiment 1) or biased instructions to choose a post-cued stimulus (Experiment 2), or the subject performed equality judgments (Experiment 3). We show that a quantitative description of subjects' confidence assessments can clearly differentiate between different decision mechanisms that may lead to nearly identical psychometric functions, and that our new method is generalizable for different decision mechanisms that yield different forms of the psychometric function. The results also show that attention can alter the decision mechanism without interfering with veridical perception.

Thomas Serre, Brown

Aligning deep neural networks with human vision will require better training data and learning algorithms.

The many successes of deep neural networks (DNNs) over the past decade have largely been driven by computational scale rather than insights from biological intelligence. While DNNs have nevertheless been surprisingly adept at explaining behavioral and neural recordings from humans, there is a growing number of reports indicating that DNNs are becoming progressively worse models of human vision as they improve on standard computer vision benchmarks. Here, we provide evidence that one path towards improving the alignment of DNNs with human vision is to train them with data and objective functions that more closely resemble those relied on by brains. We find that DNNs trained to capture the causal structure of large spatiotemporal object datasets learn generalizable object representations that exhibit smooth equivariance to 3-Dimensional (out-of-plane) variations in object pose and are predictive of human decisions and reaction times on popular psychophysics stimuli. Our work identifies novel data diets and objective functions that better align DNN vision with humans and can be easily scaled to generate the next generation of DNNs that behave as humans do.

Jessica Witt, Colorado State

Visualizations for Weather-Related Decisions Under Uncertainty.

People must make important decisions despite uncertainty in the available information. One example concerns medical decisions such as whether to do screening tests such as mammorgrams and colonoscopies or which treatments to select. Another example has to do with weather such as whether to evacuate in advance of a hurricane or salt the roads in advance of freezing temperatures. The medical decision making literature emphasizes the value of using visualizations to present uncertain information, particularly icon arrays. I tested whether icon arrays and other visualizations improved decision making for weather-related events. As predicted, the visualizations helped decision making. In Experiment 2, I tested whether people preferred the visualizations by giving them a choice. The rate of selecting visualizations was approximately 25%. The research raises questions about what kind of information portals should be displayed.