

2018 MIND BRAIN BEHAVIOR POSTER SHOWCASE

4:00-6:00 PM · April 23rd

**William James Hall Library
33 Kirkland Street Cambridge**

WHERE POINTING MATTERS: ENGLISH AND KOREAN DEMONSTRATIVE

Dorothy Ahn

When using demonstrative descriptions like "that boy" or pronouns like "he", speakers can point to the intended referent, resulting in what is called the "exophoric reference", or simply refer to familiar entities in an "anaphoric reference". The presence and absence of co-speech pointing has semantic consequences, such as blocking a covarying reading: when the pronoun "his" is accompanied with pointing in the sentence "Everyone talked to his dog", the reading where for every x x talked to x's dog disappears. While such exophoric use has been assumed to be part of a more general meaning of a demonstrative, we show that the anaphoric vs. exophoric distinction is orthogonal to the pronoun vs. demonstrative distinction and present experiments that further explore the role of pointing in reference.

NOVEL BIOMARKERS FOR VISCERAL AND LIVER FAT: ESTABLISHING A FRAMEWORK FOR TESTING THE ROLE OF ECTOPIC FAT IN COGNITIVE IMPAIRMENT

Defne Altan

Age-related dementia is among the most individually feared and publicly costly consequences of the aging process. Growing evidence indicates that the inflammatory activity of visceral fat may be associated with mild cognitive impairment and dementia. This study leverages a unique dataset encompassing adiposity, cognitive, and metabolomic data from the Multiethnic Cohort-Adiposity Phenotype Study (n = 1776) to identify visceral and liver fat biomarkers and to test their associations with cognitive performance assessed using pen-and-pencil tests and brain metabolism determined by magnetic resonance spectroscopy. Two unknown molecules that highly predicted both visceral and liver fat were identified, and several novel associations between plasma biomarkers and fat depots were discovered in this study. Five metabolites, including xanthine and tryptophan, robustly distinguish individuals with over 5.5% liver fat, the clinical threshold for fatty liver disease ($p = 10^{-5} \sim 10^{-16}$). Seven metabolites, including xanthine, kynurenine, paraxanthine, and s-5-adenosyl homocysteine, distinguish upper and lower tertiles for mean visceral fat area ($p = 10^{-5} \sim 10^{-14}$). Within the limits of the experimental design, visceral and liver fat biomarkers showed no association with neurometabolism or cognitive impairment. An additional screening for other cognition-related blood biomarkers showed that elevated plasma levels of serotonin and guanosine were associated with cognitive impairment and decreased scores in specific cognitive domains such as memory and computational abstraction. This study yields important information about novel plasma biomarkers potentially useful in constructing screening tools for liver fat and visceral fat, and begins to establish mathematical constraints on the link between obesity and mild cognitive impairment.

THE NEUROBIOLOGY OF NESTING BEHAVIOR IN PEROMYSCUS: STRIATAL ACTIVITY DURING NESTING AND CANDIDATE GENE EXPRESSION PATTERNS IN PEROMYSCUS POLIONOTUS AND P. MANICULATUS BRAINS

Julie Baldassano

Peromyscus polionotus and *Peromyscus maniculatus* display species-specific thermoregulatory nesting behavior, and the neural basis of this difference remains largely unknown. Understanding this behavior requires knowledge of which brain regions are involved and which genes act in these regions. This study investigated which striatal regions were differentially active during thermoregulatory nesting behavior. We quantified the percentage of neurons expressing Immediate Early Gene *cfos* mRNA in animals who recently nested and control animals who were not given nesting material. Our results showed significant differences in total striatal activation between the test and control experimental groups (ANOVA: $F_{1,67.75} = 1.9e-08$), including significant increases in *cfos*⁺ cells in the nucleus accumbens (Student's *t*-test: $t_{5.39} = 5.15$, $P=0.0029$), caudate putamen (Student's *t*-test: $t_{4.85} = 5.96$, $P=0.0021$), and lateral septum (Student's *t*-test: $t_{4.25} = 2.95$, $P= 0.039$) of nesting animals. These results suggest that striatal regions, especially the nucleus accumbens and caudate putamen, could be thermoregulatory nesting-related brain regions. Next, to identify differences in gene expression that may underlie the species difference in behavior, we performed histology to visualize the spatial expression patterns of nine candidate genes identified in a previous mapping experiment. While three genes had very similar expression patterns across species and data is pending for two more, *Dct*, *Gpc5*, *Ndfip2*, and *Slitrk6* had region-specific differences when the two species were compared. Together, these findings implicate the nucleus accumbens and caudate putamen in *Peromyscus* thermoregulatory nesting behavior and increase the priority of *Dct*, *Gpc5*, *Ndfip2*, and *Slitrk6* for future study of species-specific variation in nesting.

A BAYESIAN RESPONSE TO THE "GROUP-TO-INDIVIDUAL" OBJECTION TO NEUROSCIENTIFIC DATA IN THE COURTROOM

Matthew Baum

Across the globe, courtrooms are seeing an increasing thrust of expert testimony and testing based upon research in the neurosciences. A common objection to the relevance of neuroscientific data to legal proceedings is predicated on the claim that it is categorically invalid to infer things about an individual based on differences between groups in a study; this categorical objection to reasoning about individuals from data on groups is often called the "group-to-individual" objection. I include one of the better-argued instances of the "group-to-individual" objection below, which is from Campbell and Eastman (2014) in considering studies on the bioprediction of violent behavior: "However, even if a sufficiently large sample is used, the outcome [of many studies] is expressed in terms of averages based on group data. This is in itself problematic as the law is concerned with evidence regarding a specific individual. And it is not the case that specific inferences, or predictions, regarding the individual can validly be drawn on the basis of observed statistically significant differences between a group to which the individual belongs and a relevant control group. Indeed, the differences with regard to the variable in question may be greater within groups than between experimental and control groups." (Campbell & Eastman 2014, p. 97). Given the strength of the claim, that this type of inference is always invalid, and the frequency in which it is invoked in the neuroethics literature, it is surprising to observe that the claim is more often asserted (without citation) than systematically argued. Using theoretical methods from analytic philosophy and grounding in neuroethics literature, I aimed to consider the strongest justifications for upholding vs quashing the "group-to-individual" objection. Arguments in favor of upholding include 1) differences within groups are often larger than differences between groups, 2) uncertainty whether a given individual is part of the group in question (e.g. a biomarker result that defines a group in a study but age, sex, ethnicity, environmental modifiers, etc may not match). I

observe that the practice of medicine, like the practice of law, is about finding the right course of action in regards to a single individual (this time, a particular patient), and that inferences about individual patients are routinely made from observations of effects in groups to which the individual is likely to belong (e.g. a certain diagnostic category based on the presence of certain signs, symptoms, and biomarkers). That they are routinely made, of course, does not make such inferences valid. I put forth the argument, increasingly seen in the theory of diagnostic decision-making, that such inferences can be valid (though not always informative) if viewed through a Bayesian statistical framework; that is, able to inform the likelihood that a given fact or prediction about this individual is true. I cautiously conclude that the “group-to-individual” objection should be quashed and replaced with debate about the degree to which neuroscientific data on groups inform the likelihood that a legally relevant fact is true about an individual. Campbell, C., and Eastman, N., 2014. The limits of legal use of neuroscience. In: I. Singh, W. P. Sinnott-Armstrong, and J. Savulescu, eds., *Bioprediction, Biomarkers, and Bad Behavior: Scientific, Legal, and Ethical Challenges*. New York; Oxford: Oxford University Press, pp. 91-117.

INFLUENCES OF TRANSMISSION AND LEARNABILITY ON HUMAN SPEECH

Gaspar Begus

I propose a framework that combines statistical and experimental modeling to address one of the central topics in phonology: what aspects of typology are influenced by cognitive biases and what aspects emerge from transmission of language? I also explore implications of this framework for MaxEnt models of phonological learning.

DECISION BY SAMPLING IMPLEMENTS EFFICIENT CODING OF PSYCHOECONOMIC FUNCTIONS

Rahul Bhui

The theory of decision by sampling (DbS) proposes that an attribute's subjective value is its rank within a sample of attribute values retrieved from memory. This can account for instances of context dependence beyond the reach of classic theories which assume stable preferences. In this paper, we provide a normative justification for DbS that is based on the principle of efficient coding. The efficient representation of information in a noiseless communication channel is characterized by a uniform response distribution, which the rank transformation implements. However, cognitive limitations imply that decision samples are finite, introducing noise. Efficient coding in a noisy channel requires smoothing of the signal, a principle that leads to a new generalization of DbS. This generalization is closely connected to range-frequency theory, and helps descriptively account for a wider set of behavioral observations, such as how context sensitivity varies with the number of available response categories.

PROSODIC MARKING OF THE FIXED FOCUS POSITION IN GEORGIAN

Lena Borise

In this work, I show that Georgian, a language with a fixed structural position reserved for the focused element (immediately preverbal), also uses prosody to signal focus. Specifically, data from a preliminary study reported here shows that various types of foci – wh-questions (WHQ), yes-no questions (YNQ), and contrastive contexts – bear the same prosodic marker of focus: the phrase accent L, rigidly aligned with the penultimate syllable of the predicate. The advantage of the approach advocated here is that it provides a unified account for the prosodic realization of different types of focus in Georgian. The double-marking of the same feature in syntax and prosody raises questions as to why language does not rely on just one of these strategies.

BAYESIAN JUDGMENTS BUT EGALITARIAN PREFERENCES

Jack Cao

When two individuals from different social groups exhibit identical behavior under identical circumstances, egalitarian codes of conduct call for equal judgments of both individuals. However, this moral imperative is at odds with the statistical imperative to consider prior beliefs based on group membership: insofar as these priors differ, Bayesian rationality calls for unequal judgments of both individuals. Across 10 studies ($N = 4,592$), participants not only preferred equal judgments, they also negatively evaluated the morality and intellect of someone who makes unequal judgments, shared less money with this person, and incurred financial costs to punish this person. However, these very same participants made unequal judgments precisely as a Bayesian statistician would, thereby undermining their own egalitarian preferences. This dissociation between preferences and judgments demonstrates that people unwittingly consider group membership in a way that reflects the savvy of a Bayesian but also the disrepute of a bigot.

A NOVEL MICRODIALYSIS REPORTER ILLUMINATES GENETIC EXPRESSION OF THE DOPAMINE TRANSPORTER IN THE BRAIN OF AWAKE, FREE-MOVING RATS

Lucas Conti

Current measurements of gene expression in the brain are widely limited to the use of DNA, RNA, and protein quantification techniques which often require animal sacrifices for access to brain tissue. Until now, no in vivo reporter techniques had been developed to analyze genetic expression in a time-dependent manner in the brain of awake rats or in any other living animals. In this thesis, I present the development of a novel in vivo technique to measure the expression of a reporter for the dopamine transporter gene (DAT) in the brain of awake, free-moving rats. We show that an adapted microdialysis technique illuminated time-dependent increases in the expression of a DAT reporter following intracranial administration of the psychiatric drug valproate. Most importantly, this method can be extended as an in vivo reporter for the expression profile of nearly any extra-cellular protein of interest. To accomplish this, a rat model was engineered to express the luminescent protein Gaussia luciferase (GLuc) under the DAT promoter, enabling GLuc synthesis in dopaminergic neurons. GLuc is then secreted to the extracellular space; so, we used valproate to increase DAT/GLuc expression in the dorsal striatum and collected the extracellular GLuc with an adapted microdialysis technique. Measurements of GLuc enzyme activity could then be correlated with DAT expression. In order to confirm that GLuc enzyme activity actually followed expression levels for DAT mRNA, we measured mRNA from dissected brain tissues via qRT-PCR and saw expression profiles that paralleled that of GLuc activity.

AUTONOMIC AND BRAIN ACTIVITY CONCORDANCE IN PATIENT/CLINICIAN DYADS - A HYPERSCAN FMRI STUDY

Melanie Fu

The patient-clinician interaction has been shown to modulate clinical outcomes both in acute and chronic disease, but its neural correlates-in particular the neural circuitry of empathy, concern, and social communication-are poorly understood. This thesis aims to use functional magnetic resonance imaging (fMRI) to explore how the patient-clinician interaction may modulate neural processing relating to empathy and analgesia in fibromyalgia patients and clinicians, with the long-term goal of identifying a paradigm for clinically-effective interaction. We investigated this phenomenon within the framework of the social placebo effect, the concept that aspects of the therapeutic encounter outside of specific active ingredients can also play a role in healthcare efficacy, by using quantitative assessment of behavioral intake videos via the constitutional and relational empathy (CARE) Observer Scale and other behavioral scoring metrics, which were then correlated with brain imaging and autonomic concordance metrics. Additionally, we: 1) assessed clinical analgesic outcomes using a "Hyperscan" fMRI setup

involving simultaneous scans of a patient and clinician, 2) examined brain activity and autonomic concordance and how this was associated with ratings of empathy and analgesia, and 3) correlated fMRI activity and concordance with variables of interest in the patient-clinician interaction-such as the use of appropriate humor, perceived warmth as measured from an adapted 9-factor warmth-competence scale, and clinician use of the patient's own words. The long-term goal of this research is to provide a mechanistic understanding of how the patient-provider interaction is related to successful health care communication and improved clinical outcomes.

PRIMARY VISUAL CORTEX ENCODES DETAILED MOVEMENT PLANS

Grigori Guitchounts

Organisms that move through the world and experience it through sensory organs must coordinate the motor and sensory systems. While neural activity in rodent primary sensory cortices has been found to be modulated by movements, with either an increase or decrease in activity during locomotion, it is unclear if early cortical sensory processing encodes detailed plans of upcoming movements. We recorded activity of populations of neurons in V1 of rats freely moving in the dark, and show that a deep neural network can decode detailed information about the animal's movements using V1 activity. Pharmacological silencing of secondary motor cortex (M2) abolished the network's decoding ability, suggesting that M2 contributes movement information to V1. Furthermore, neural activity is suppressed during orienting movements, reminiscent of saccadic suppression reported in cats and monkeys. These results support predictive coding theories of cortical function and reconcile apparent discrepancies in V1 activity during movements between rodents and higher mammals.

THE DYNAMIC NATURE OF GEOMETRIC REASONING

Yuval Hart

Geometric reasoning has an inherent dissonance: its abstract axioms and propositions refer to perfect, idealized entities, whereas its use in the physical world that we experience relies on dynamic interactions with imperfect, noisy statistics. How do immutable rules, dynamics, and statistics interplay to support our commonsense geometric reasoning? Here, we address this question using a simple geometric task – planar triangle completion. An analysis of the distribution of participants' errors in localizing a fragmented triangle's missing corner reveals scale-dependent deviations from Euclidean rules. By considering the physicality of the localization process through the simulation of a correlated random walk, we can explain these results and further predict the participants' estimates of triangle's missing angle, measured in a second task. Strikingly, our model also predicts participants' categorical reasoning about changes in triangle's vertices and angles even when such completion strategies for mental simulations need not be invoked. We conclude that commonsense geometric reasoning may depend on dynamic-statistical models describing mental simulations, rather than on static, formal rules such as those learned in school.

SOCIAL DOMINANCE ORIENTATION IS ASSOCIATED WITH DECREASED EMPATHY AND INCREASED SCHADENFREUDE TOWARDS OUTGROUPS

Sa-kiera Hudson

The capacity to empathize with others is a major driver of prosocial and altruistic behavior. This capacity, however, can be contingent upon group memberships, as we are less empathic towards those who we categorize as out-group members. Feeling reduced empathy, and even counter-empathy (e.g. pleasure at others' pain), is likely functional, as it can facilitate the creation and maintenance of intergroup bias. Social dominance orientation (SDO), or the extent to which people accept and promote group-based inequalities, is an ideological variable that is associated with increased prejudicial attitudes

and decreased empathy. Thus, higher levels of SDO should lead to reduced state empathy and increased state counter-empathy in general, but especially towards outgroup members. Across four studies we show that for White individuals, the higher their SDO levels, the less they displayed empathy, and the more they displayed counter-empathy in response to in-group and out-group members' good and bad fortunes. More importantly, these reductions in empathy and increases in schadenfreude were significantly stronger for out-group targets compared to in-group targets. This research is one of the first to examine the relationship between SDO and state empathy, as well as modulation of SDO and empathy by the group membership of the target.

ELUCIDATING THE THERAPEUTIC BENEFITS OF DOCOSAHEXAENOIC ACID FOR MAJOR DEPRESSIVE DISORDER USING HUMAN IPSC-DERIVED NEURONAL CELL MODELS

Norma Hylton

Major depressive disorder (MDD), a common mental disorder that affects 10-15% of the population worldwide, has become an increasing public health concern. The leading medical treatments for MDD—selective serotonin reuptake inhibitors (SSRIs)—show inadequate benefit with undesirable side effects for many patients. Given these limitations, some MDD patients manage their symptoms with complementary and alternative medicines (CAMs). However, the molecular and cellular mechanisms of most CAMs have not been established. We began to address this knowledge gap by gaining insight into the efficacy of the widely-used CAM docosahexaenoic acid (DHA), an omega-3 fatty acid with reported antidepressant activity, in potentially disease-relevant cell types—human iPSC-derived neural progenitor cells (NPCs) and post-mitotic neurons. Utilizing these ex vivo cellular models, we identified that DHA enhanced both WNT and CREB signaling pathways that play important roles in neuronal development, adult neurogenesis, and memory. We further observed that DHA treatment increased neuronal survival and promoted neurite outgrowth. To generate a molecular signature of DHA, we applied multiplexed gene expression profiling technology (L1000) to identify genes regulated by DHA, and validated genes including the key neuroplasticity and memory gene *EGR1* and multiple stress-related genes. Finally, we showed that DHA could counteract the detrimental effect of oxidative stress in patient-derived MDD cell lines. In conclusion, our study indicates that DHA may elicit multiple mechanisms for its antidepressant effect. Future investigation holds promise for providing insight into the mechanisms of other CAM natural products, with implications for treatment efficacy.

TREATING IDIOCY: THE ORIGINS OF AMERICAN SPECIAL EDUCATION

Rebecca Krane

In the second half of the 19th century, training schools were founded across the United States to provide education, treatment, and supervision for people who would now be called disabled, and were then diagnosed with idiocy or imbecility. My work focuses on the third such institution, the Pennsylvania Training School for Feeble-Minded Children, and the work of the superintendent Dr. Isaac Newton Kerlin. Through the lens of his time as superintendent, I explore medical and educational models of approaching and understanding disability, particularly intellectual disabilities, and follow a trend towards pessimism and segregation that would lead into the eugenics movement of the early 20th century.

IMPLICIT ATTITUDES AND REINFORCEMENT LEARNING: A FIRST INVESTIGATION

Benedek Kurdi

Implicit attitudes are evaluations of categories activated automatically upon encountering category members. Existing evidence on implicit attitude formation treats humans as passive consumers of information without considering how hedonic consequences of behaviors may shape implicit attitudes. This project informs future work by (a) investigating differences across social and nonsocial choice behaviors in a reinforcement learning (RL) task and (b) probing the effects of implicit attitudes on choice behavior under uncertainty. Participants (total $N = 2,064$) were randomly assigned to one of four targets in a between-subjects design: nonsocial targets (blue vs. green squares), novel social targets (Longfaces vs. Squarefaces), known social targets high in social desirability (White vs. Black), and known social targets low in social desirability (young vs. elderly). Participants completed an Implicit Association Test (IAT) measuring their implicit attitudes toward the target categories and completed an RL task. Each round of this task presented a binary decision between targets from the contrasting categories. Rewards were determined by separate random walks for each target category, with participants attempting to maximize long-term rewards. An interaction between target category and optimal choice predicted choice behavior in the RL task: Behavior in the nonsocial condition was nearly optimal, whereas square-faced, Black, and young targets were selected beyond optimality. Moreover, deviations from optimality in favor of selecting the suboptimal, but implicitly preferred, group were associated with magnitude of implicit bias. These results reveal systematic differences across social and nonsocial choice behaviors under uncertainty and suggest that implicit attitudes may contribute to suboptimal decision-making.

WOMEN ARE LESS RISK-AVERSE IN GENDER-CONGRUENT DECISION CONTEXTS

Heidi Liu

Risk aversion is generally treated as a gender-linked "trait" such that women are assumed to be more risk-averse than men. We propose that this stereotype may be overstated by a propensity to examine gender differences in risk preferences in male-dominated decision contexts. In a set of laboratory experiments and one archival study of Jeopardy! contestants, we show women are less risk-averse in more gender-congruent decision contexts. We discuss the implications of our findings for practice and future research.

IS CATEGORY CONFUSION A MECHANISM OF UNCANNY VALLEY EFFECTS?

Maya Mathur

The proposed project will investigate why people have "eerie" reactions to certain human-like robots (a phenomenon termed the "Uncanny Valley") by introducing an interdisciplinary approach that integrates the fields of human-robot interaction, classic human psychology, and cutting-edge statistical methods. Specifically, a controversial theory proposes that people naturally attempt to categorize faces as "human" or "nonhuman" and that robots imperfectly resembling humans create uncomfortable ambiguity during categorization. In contrast, conspicuously mechanical robots are unambiguously categorized as "nonhuman" and therefore do not provoke unpleasant reactions characteristic of the Uncanny Valley. Previous studies have attempted to address the role of category ambiguity in causing Uncanny Valley aversion, but had important shortcomings in experimental design and a lack of rigorous statistical analysis. In the present proposal we describe an interdisciplinary approach to the question that will apply advanced statistical methods in the analysis of experimental psychology data. The first proposed experiment will assess the "category confusion" hypothesis using validated stimuli, sensitive measures of perceptual category confusion imported from other literatures, and principled statistical mediation analysis. A second experiment will develop a novel paradigm for experimentally manipulating category confusion, which would allow randomized manipulation of the proposed mediator for the first time, thus enhancing mechanistic assessment of category confusion in the Uncanny Valley.

ALL FOR ONE AND SOME FOR ALL? USING EEG AND THE N400 RESPONSE TO TRACK ONLINE SCALAR IMPLICATURE CALCULATION IN ADULTS

Jerry Nelluvelil

While the process of scalar implicature calculation (the application of pragmatic knowledge to a scalar quantifier) is well-established in psycholinguistic research, the time course of these calculations is controversial. Huang and Snedeker (2009a) suggest that this calculation takes time from the onset of a scalar quantifier, while Grodner, Klein, Carbary, and Tanenhaus (2010) find that it is immediate. Huang and Snedeker (2018) observe the differences in these findings to be due to the predictability of the scalar quantifiers. These studies present evidence from Visual World eye-tracking Paradigms. We aimed to present converging data on these findings by using electroencephalography (EEG), a rapid measurement tool of neural activity, to detect a real-time response. More specifically, we investigated the N400 event-related potential (ERP), which is argued to index semantic incongruences. We adapt the Grodner et al. (2010) paradigm by 1) switching the methodology from eye-tracking to EEG and by 2) introducing sentence prompts that elicit scalar implicature violations at a point of disambiguation. From the use of additional violations, which induced semantic incongruences, we predicted the N400 to be an informative measure of a scalar implicature calculation. We then predicted a greater N400 response to violations relative to pragmatically-licensed responses as soon as the violation is presented. We instead found a positivity at the implicature violation in the first half of the study that disappeared as the study went on. We conclude participants may have reevaluated the scalar quantifier terms due to the implicature violations as the study went on, cancelling an observable N400. The results open up potential EEG investigations of online scalar implicature processing.

THIRD-PARTY COMPENSATION SIGNALS TRUSTWORTHINESS

Indrajeet Patil

Third-party responding plays a significant role in promoting group cooperation. But third-party behavior is also costly, thus raising the question of why third-parties intervene. We provide a comprehensive examination of the different benefits third-parties accrue based on their choice of response, as well as certain beliefs third-parties hold regarding how to respond. We find that in contrast to many other types of third-party behavior, third-party compensating leads to greater reputational and cooperative benefits. We also find that the signal that is sent via third-party compensating is an honest signal; third-party compensators are more trustworthy than third-party punishers. Additionally, we examine whether these results vary depending upon the participants' own preference for how to respond as a third-party. Interestingly, we find that while third-party compensators are seen as more moral and are chosen more often as cooperation partners, irrespective of participant personal preference, participants who personally prefer to punish behave in a more trusting manner with third-party punishers. Together, these findings provide an extensive analysis of the causes and consequences of third-party behavior.

NEURAL AND BEHAVIORAL EFFECTS OF OLFACTORY MASKING AGENTS

Daniel Pohl

Off-flavors arise from impurities in various foods and are generally associated with distinct odors that provide cues regarding potential dangers related to our environment, ranging from toxic algae in water supplies to rancid foods. These olfactory compounds have important global health implications, as off-flavors can negatively influence food and drink consumption habits and, therefore, contribute to the growing, worldwide food waste problem. Many studies point to the apparent aversive and masking nature of off-flavors; however, little is known about the neural and subsequent, specific behavioral responses to these compounds. We examined the cellular response profiles of neurons that provide input to olfactory bulb (OB) glomeruli in the presence of 2,4,6-trichloroanisole (TCA), one of the most potent off-flavors, using 2-photon microscopy. We also assessed the behavioral responses of mice to

TCA using a free-running arena. We found that TCA had a modest impact on innate odor preference in mice, but had minimal effects on the response profiles of neurons providing input to the OB. In addition, despite a lack of observable effects on OB input, my experiments demonstrate that mice do indeed exhibit a behavioral aversion to the presence of TCA alone. Based on my findings, the effects of TCA on input to the olfactory system are unlikely to result from non-specific interactions with sensory neurons, but might be the result of interactions with the trigeminal sensory system.

PAY-FOR-MONOPOLY? A BEHAVIORAL ECONOMICS REASSESSMENT OF REVERSE PAYMENTS BY PHARMACEUTICAL FIRMS

Sana Rafiq

Over the past 15 years, pharmaceutical firms have developed a blueprint to impede competition in order to maintain their monopoly profits. Under this scheme, the firms producing branded drugs indirectly pay, through “side deals,” the producers of generic drugs to stay out of the market. In these side deals, the generic-drug entrant agrees to stay out of the market in return for overpayment on some unrelated agreement from the branded drug company. These agreements are signed at the same time or even within the same legal agreement. While the Federal Trade Commission has often asserted that these “combination” agreements restrict trade by keeping the generic off the market at the expense of consumers, traditional expert economists have developed a number of defenses for such practices. Based on behavioral negotiation research, behavioral economics, and psychology, we provide reasons that these agreements should not be allowed. We believe that a behaviorally informed perspective would lead generics to the market faster, providing more medicine to those that need them, at a more affordable price. We also discuss a range of solutions, both judicial and legislative, that can address this public policy concern.

NEURAL CORRELATES OF STEREOTYPE CONFIRMATION

Niv Reggev

Why are stereotypes hard to change? Here, we show that one reason may be we experience the confirmation of our stereotypes as rewarding. In this study, participants judged stereotype-consistent and –inconsistent information while undergoing neuroimaging. Reward-sensitive regions were differentially activated by this manipulation, highlighting their influence on the processing of social information

NEURAL CORRELATES OF THE "30 MILLION WORD GAP": CHILDREN'S LANGUAGE EXPOSURE IS RELATED TO WHITE MATTER STRUCTURE

Rachel Romeo

Behavioral research has shown that the quantity and quality of young children’s language input predicts their later linguistic ability, and that children from lower socioeconomic status (SES) backgrounds receive less language exposure than their higher SES peers, which translates into a measurable gap in children’s language skills. The present study investigated which structural neural mechanisms underlie this input-output relationship. Forty SES-diverse children aged 4-6 years completed verbal and nonverbal standardized assessments, followed by a diffusion-weighted imaging (DTI) scan. Families then completed two full weekend days of real-world audio recordings from the child’s perspective, from which three measures were derived: the number of words spoken by any adult, the number of child utterances, and the number of conversational turns between the child and any adult. Behaviorally, SES was strongly correlated with both language exposure and verbal and nonverbal scores. However, when SES was partialled out, only conversational turns predicted additional variance in children’s verbal scores, even when additionally controlling for adult words and child utterances. Furthermore, the

number of conversational turns, independent of SES, was positively correlated with the fractional anisotropy (FA) of the left arcuate fasciculus, which connects “Broca’s” and “Wernicke’s” area. FA was in turn correlated with children’s language skills. This suggests that some qualitative aspect of dialogic communication has a greater impact children’s brain and behavior than the sheer volume of adult speech. To our knowledge, this is the first evidence directly linking children’s language environments with a brain structure known to underlie language development, and which may in turn contribute to the SES language gap.

SELF-DENIAL, SUPERNATURAL POWER, AND RELIGIOUS CREDIBILITY

Manvir Singh

Religious practitioners frequently refrain from sex and food across human societies. This pattern is especially puzzling given that these individuals can leverage religious systems for self-serving ends. Evolutionary, cognitive, and anthropological researchers commonly posit that community members infer traits such as cooperativeness, sincerity of belief, and supernatural power from self-denial, but no research has quantitatively examined whether and how ascetic practice promotes religious credibility. We investigated costly prohibitions on shamanic healers, known as sikerei, among the rainforest horticulturalist Mentawai people of Siberut Island (Indonesia). Interviewing participants across four cultural regions, we show that although shamans are considered experts on religious rules, they must observe permanent taboos on various meat items, as well as additional prohibitions on sex and food during initiation and ceremonial healing. We test among three leading hypotheses for why these taboos develop: cooperative costly signaling, credibility-enhancing displays, and supernatural otherness. We find support for all three: Mentawai participants infer self-denying shamans to be (1) cooperative and trusting, (2) more likely to believe in other supernaturally-enforced rules, and (3) less similar from normal humans and with greater supernatural powers. These data provide the first quantitative evidence that self-denial culturally evolves to promote perceptions of practitioners’ supernatural abilities and credibility. Because we assume that self-denying shamans do not possess greater supernatural powers, our results also raise questions about whether ostensible signals must in fact be honest.

A Computational Model of Neural Network Pruning: A Biological Path to Efficient Artificial Intelligence

Duncan Stothers

Recent reports have emphasized that a promising path towards achieving the next generation of Neural Network grounded Artificial Intelligence is to build upon cognitive developmental “start-up software” (CBMM, 2016). Turing also suspected that it could be easier to build and educate a child machine than to fully construct an adult mind from scratch, but at the time the stages of neurobiological development were not known, and computational neural processing systems were primitive. Within the last fifteen years this has changed as our understanding of the neurobiological stages of development has dramatically increased and the performance of computational neural processing systems has similarly increased. One important stage of neurobiological development is synapse pruning, the computational role of which is still not clearly understood. We present a biologically plausible neural network model with a two-stage objective function that computationally models development in the human visual system by first optimizing for accuracy with a high number of synapses and then optimizing for efficiency by implementing synapse pruning. Our findings suggest that computationally a large number of synapses and a high degree of connectivity is initially needed to increase the size of the solution space searchable when learning, but that once a high accuracy solution is found, synapse pruning can be used to increase parameter efficiency by decreasing the size of the solution space with only a negligible drop in accuracy.

PATTERNS OF CORTICAL METABOLISM AND THEIR ASSOCIATION WITH LONGITUDINAL NEURODEGENERATION IN THE THREE CLINICAL VARIANTS OF PRIMARY PROGRESSIVE APHASIA

Lauren Sweetland

Frontotemporal dementia (FTD) is a neurodegenerative disease that primarily affects the frontal and temporal lobes of older adults. FTD can be further divided into a primary progressive aphasia (PPA) category, which causes language deficits. PPA currently has three known variants that have unique combinations of atrophy and behavioral effects, however these variants have significant overlapping characteristics, which can make diagnoses and further research difficult. In this paper we analyze the metabolic rates in the cortex of PPA patients with each variant to try to describe the differences in metabolic activity between the variants as well as explore the correlation between metabolic rates and longitudinal atrophy in PPA generally. We found that there is a significant association between hypometabolic rates in brain regions and subsequent atrophy in those areas longitudinally, regardless of variant. We also found regional hypometabolic differences between variants that significantly mapped onto known connectivity networks in major language centers of the brain that each variant has been previously thought to affect.

A SKILLED MANIPULANDUM-BASED TASK FOR MOTOR LEARNING IN MICE

Yixuan (Melody) Tong

Understanding how we learn new motor skills is crucial for developing therapeutic interventions for patients with motor learning and control deficits. A well-established animal model for studying motor learning involves training rodents on a skilled forelimb reaching task: the animal learns to reach for and grab a food reward. However, due to the difficulty in quantifying this behavior computationally, it remains hand-scored for success rate only, which is tedious and inefficient with regard to the data collected. Furthermore, knowledge of the motor learning circuitry and brain regions of interest remains limited. To address these shortcomings, we developed a novel manipulandum-based task in *Mus musculus*, the Precision Pull Task, to study the neural landscape of motor learning. In this task, water-deprived mice were trained to reach for, grab, and pull a joystick manipulandum above a velocity threshold to receive a water reward. Movements of the joystick were recorded and analyzed as a proxy for forelimb kinematics, providing high-precision behavioral data. Here, we present the rapid, stereotyped acquisition of the Precision Pull Task and the corresponding whole-brain activity maps showing task-responsive brain regions. Finally, we offer a hypothesis on the functional roles of promising regions of interest that warrant further investigation. Ultimately, we aim to provide evidence for a novel mouse model with which to study the motor learning circuitry.