Association for the Scientific Study of Consciousness

New York University, June 22-25, 2023

List of Abstracts

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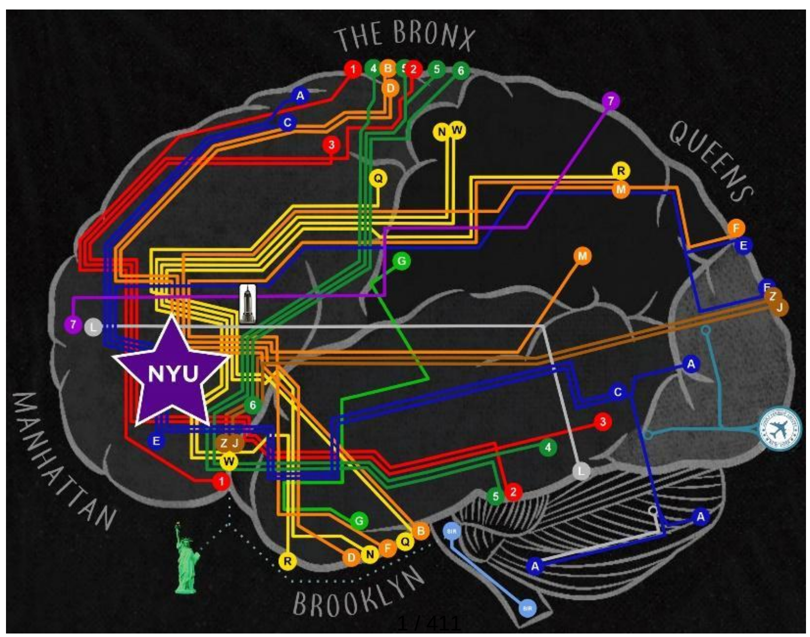

Keynote Talks

Sources of Richness and Ineffability for Phenomenally Conscious States

Yoshua Bengio (Université de Montréal; Mila – Quebec AI Institute; IVADO; Canada CIFAR AI Chair)

Keynote Lecture, Sunday June 25th, Tishman Auditorium, 9:00am-10:00am

Conscious states (states that there is something it is like to be in) seem both rich or full of detail, and ineffable or hard to fully describe or recall, as well as personal. The problem of ineffability, in particular, is a longstanding issue in philosophy that partly motivates the explanatory gap: the belief that consciousness cannot be reduced to underlying physical processes. Here, we provide an information theoretic dynamical systems perspective on the richness and ineffability of consciousness. In our framework, the richness of conscious experience corresponds to the amount of information in a conscious state and ineffability corresponds to the amount of information lost at different stages of processing. We describe how attractor dynamics in working memory would induce impoverished recollections of our original experiences, how the discrete symbolic nature of language is insufficient for describing the rich and high-dimensional structure of experiences, and how similarity in the cognitive function of two individuals relates to improved communicability of their experiences to each other. While our model may not settle all questions relating to the explanatory gap, it makes progress toward a fully physicalist explanation of the richness and ineffability of conscious experience: two important aspects that seem to be part of what makes qualitative character so puzzling.

Our Four Realms of Existence: A Fresh Look at the Science of What and Who We Are

Joseph LeDoux (NYU)

Presidential Address, Thursday June 22nd, Tishman Auditorium, 4:45pm-5:45pm

Humans have long thought of their bodies and minds as separate spheres of existence. The body is physical—the source of aches and pains. But the mind is mental; it perceives, remembers, believes, feels, and imagines. Although modern science has largely eliminated this mind–body dualism, people still tend to imagine their minds as separate from their physical being. Even in research, the notion of a "self" that is somehow distinct from the rest of the organism persists. But such ideas are increasingly barriers to discovery and understanding, and a new framework is needed. I propose that a human being can be characterized as a composite or ensemble of four fundamental, parallel, entwined realms of existence that reflect our evolutionary past and account for our present ways of being—biological, neurobiological, cognitive, and conscious. All four are, deep down, biological. But the neurobiological realm transcends the mere biological, the cognitive transcends the mere neurobiological, and the conscious transcends the mere cognitive. We each exist uniquely within our own realms every moment of adult life, and together our realms account for all of what and who we are. The four realms also give us a novel understanding of how we, as an individual person, social group, culture, or species, are similar to, and different from, other individuals, social groups, cultures, and species.

The Hippocampal Formation and Space, Time and Memory

May-Britt Moser (Kavli Institute for Systems Neuroscience NTNU)

Keynote Lecture, Friday June 23rd, Tishman Auditorium, 9:00am-10:00am

The hippocampus of the mammalian cortex is involved in episodic memory (memory for events) and spatial navigation. This brain structure is linked to the rest of the cortex through the entorhinal cortex.
In this lecture, I will give some background on what neurons in the entorhinal cortex respond to in animals exploring an environment.
The entorhinal cortex contains neurons that map self-motion, self-location, and objects, and time (duration of an episode). In order to understand how such functions are generated we recorded large populations of cells either with Neuropixels probes or portable miniature 2-photon microscopes (MINI2P). With these methods, we were able to record neural activity from many hundreds to thousands of cells. We used dimensionality reduction methods and topological data analysis to demonstrate how activity of populations of entorhinal grid cells moves across a low dimensional manifold with the shape of a torus, in agreement with predictions of continuous attractor networks for grid cells. Using dimensionality reduction methods, we also show that activity in the lateral entorhinal cortex drifts along non-periodic trajectories with time, enabling each time point of an event to be represented with a unique population signature.
These findings suggest that entorhinal cortex provides the hippocampus with information about location in a navigational setting ready to be associated with experiences in order to form episodic memories.

Psychophysical Monism as an Ideal

Thomas Nagel (NYU)

Keynote Lecture, Saturday June 24th, Tishman Auditorium, 9:00am-10:00am

A possible path forward for the mind-body problem, if one accepts the irreducible subjectivity of consciousness, is to seek a necessary connection between mental and neurophysiogical properties through a more fundamental type of property which is neither mental nor physical but necessitates them both as essential aspects. In other words, a property that is physical from the outside and mental from the inside. This would be a form of monism, requiring the formation of new concepts, since our present concepts of the mental and the physical seem to exclude such a necessary connection. The question is whether the idea is intelligible.

The neural bases of motor awareness

Elisabeth Parés Pujolràs (University College Dublin)

William James Prize Lecture, Sunday June 25th, Tishman Auditorium, 5:00pm-5:45pm

Some accounts of voluntary action control imply that agents have conscious insight into their motor preparation processes before an action is executed. In this talk, I will discuss three EEG studies investigating the link between the subjective feeling of readiness and two motor preparation signals: the readiness potential (RP) and beta desynchronisation. I will argue that each signal may reflect a specific computational component of the decision-making process that leads to spontaneous action triggering, and may in turn contribute to distinct aspects of motor awareness.

The Origin of Consciousness in the Breakdown of the Cortical Hierarchy

Doris Tsao (UC Berkeley and Howard Hughes Medical Institute)

Keynote Lecture, Thursday June 22nd, Tishman Auditorium, 5:45pm-6:45pm

Sensory information is noisy and ambiguous, yet our conscious perception of the world is clear, unambiguous, and ineluctably self-consistent. This conundrum holds a key to understanding perceptual consciousness: it strongly points to the analysis-by-synthesis theory, which contends that our conscious experience is generated during top-down-feedback and actively constructed to be self consistent. I will present fresh evidence for this old, deep, and yet unproven theory from an exploration of face processing by the ventral stream of both monkeys and humans, in paradigms ranging from degraded face perception to binocular rivalry to cued imagination. In particular, recordings using high-channel count "Neuropixels" probes suggest that analysis-by-synthesis occurs in discrete phases, such that conscious perception is temporally multiplexed with feedforward processing of the physical stimulus.

Symposia

SYMPOSIUM: Mathematical Spaces for Conscious Experiences

Catharine Tallon-Boudry (Ecole Normale Supérieure), Andrew Lee (Australian National University), David Rosenthal (City University of New York), Johannes Kleiner (Ludwig Maximilian University of Munich & Association for Mathematical Consciousness Science)

Friday June 23rd, Classroom 210, 2:00pm-4:00pm

A central goal for the science of consciousness is to investigate the structures of conscious experiences. A crucial part of this project is the use of mathematical spaces—sets of elements endowed with some structure—to model conscious experiences. In recent years, there has been increased interest in the use of mathematical spaces for the science of consciousness. Prominent examples include quality spaces (such as the three-dimensional space of color experiences), multidimensional analyses of conscious states (especially in discussions of disorders of consciousness and animal consciousness), applications of topological tools to conscious experiences, and spaces of states of consciousness (used in frameworks such as that of IIT). However, research here is still fragmented, with progress spread across several different disciplines including philosophy, mathematics, neuroscience, and psychology. The goal of this symposium is to unify the fragmented lines of research within this emerging field. The proposal invites four speakers from philosophy, neuroscience, and mathematics to give talks that aim to build common terminology and to identify basic empirical and theoretical questions that need to be addressed in a cross-disciplinary manner. Lee develops a philosophical analysis of dimensions of consciousness. Tallon-Baudry discusses how empirical data could be used to identify the topological dimensions of conscious experiences. Rosenthal discusses how to use just-noticeable differences in perceptual discrimination tasks to construct quality-spaces for different sensory modalities. Kleiner develops a general framework for unifying different applications of mathematical spaces to conscious experiences. Together, the talks aim to integrate these emerging lines of research into a unified program.

Talk 1: The Topological Space of Subjective Experience

Catherine Tallon-Baudry (Ecole Normale Supérieure Inserm)

Symposium: Mathematical Spaces for Conscious Experiences, Friday June 23rd, Classroom 210, 2:05pm-2:30pm

Subjective experiences often feel rich, yet are most often quantified with simple metrics, such as a few levels on a predefined scale. What are the dimensions and topological organization of subjective experience? How do they relate to behavioral output? And how do they map onto the classical cognitive domains?

Talk 2: Dimensions of Consciousness

Andrew Lee (Australian National University)

Symposium: Mathematical Spaces for Conscious Experiences, Friday June 23rd, Classroom 210, 2:30pm-2:55pm

I explain what it means to talk about "dimensions of consciousness." I first argue that a dimension, in the most general sense, is a universal set of incompossible values that captures variations with respect to some property. Then I distinguish two senses of ‘phenomenal consciousness’, which I call subjectivity and phenomenal character. Subjectivity is what makes an entity feel like something at all, while phenomenal character is how it feels to be an entity. I argue that while there are innumerably many dimensions of phenomenal character, subjectivity may turn out to be multidimensional, or one-dimensional, or even zero-dimensional.

Talk 3: Quality Spaces and the Appearance-Reality Distinction for Consciousness

David Rosenthal (CUNY)

Symposium: Mathematical Spaces for Conscious Experiences, Friday June 23rd, Classroom 210, 2:55pm-3:20pm

Relative location in a quality space provides a useful and informative way to identify and individuate mental qualities. But quality spaces are often constructed from subjective assessments of those relative locations, whose reliability is questionable. Still, there is a powerful commonsense tie between mental qualities and perceptual discrimination. So we can use just noticeable differences (JNDs) between pairs of stimulus properties to construct quality spaces, identifying mental qualities as those mental properties that enable the relevant discriminations. Since we can control stimulus properties, JND-based quality spaces are precise and replicable. And since perceptual discrimination occurs both consciously and unconsciously, this technique in effect dissociates mental qualities from consciousness. Mental qualities are independent of what it's like for one.

Talk 4: Unifying Spaces for Conscious Experience

Johannes Kleiner (Ludwig Maximilian University of Munich)

Symposium: Mathematical Spaces for Conscious Experiences, Friday June 23rd, Classroom 210, 3:20pm-3:45pm

Mathematical spaces that represent conscious experiences have started to surface as an important empirical and conceptual tool in virtually all disciplines engaged in the scientific study of consciousness. While differences abound, specifically in terminology, intended application, conceptual underpinning and mathematical framing, when viewed from a formal axiomatic perspective, the applications all follow one grand scheme. The goal of this talk is to lay out this scheme, and to discuss how it may furnish a unification of the various approaches, both in theory and in experimental practice.

SYMPOSIUM:
The Interplay between Consciousness and Learning

Lina Skora (Heinrich Heine University) and Ryan Scott (University of Sussex), Răzvan Jurchiș (Babeș-Bolyai University), Gaetan Mertens (Tilburg University), Eva Jablonka (Tel Aviv University)

Friday 23rd, Tishman Auditorium, 2:00pm-4:00pm

Despite decades of research, the extent to which learning requires conscious awareness remains an unresolved question. Given that learning is a fundamental substrate of adaptive behaviour, both phylogenetically and ontogenetically, elucidating the relationship between consciousness and learning could provide important insights into the function of consciousness. In this symposium, we seek to overview the advances in the field with a multidisciplinary approach. We start by discussing recent evidence demonstrating the requirement for conscious awareness across types of learning of increasing complexity, starting with simple associations and classical conditioning, and ending with different types of instrumental learning (Lina Skora/Ryan Scott). Next, we discuss how different levels of conscious access may bring about even complex forms of unconscious learning (Razvan Jurchis). Next, we delve into an assessment of the state of the art, and the impact of methodological and statistical choices on the available evidence for and against unconscious conditioning (Gaetan Mertens). Finally, we provide an overarching framework for the function of consciousness from the perspective of Unlimited Associative Learning as an evolutionary marker of minimal consciousness (Eva Jablonka). We hope this symposium can contribute a modern, comprehensive perspective on the interplay of learning and consciousness, informing our understanding of the functions of consciousness.

Talk 1: The need for conscious access across different types of learning: From associative to instrumental learning -- Lina Skora and Ryan Scott.

Lina Skora (Heinrich Heine University) and Ryan Scott (University of Sussex)

Symposium: The Interplay between Consciousness and Learning, Friday 23rd, Tishman Auditorium, 2:05pm-2:30pm

Learning is a crucial component of adaptive behaviour on many levels. At the simplest end of the spectrum, it permits agents to learn associations between stimuli or events to navigate in the world and form appropriate responses, e.g. through reflexes in classical conditioning. Together with increasing complexity, agents learn how the world changes in response to their behaviour, and to engage that behaviour instrumentally in pursuit of rewards. The extent to which consciousness is required for different forms of learning is essential to understanding its function and role. Yet, empirical evidence has been inconclusive and riddled with methodological issues. Here, we present evidence for and against unconscious learning at increasing levels of complexity, from associative learning, to classical conditioning, to different types of instrumental conditioning. Crucially, maintaining the methodology as similar as possible allows to determine the boundary conditions for learning without consciousness. We discuss the implications for adaptive behaviour both in human and non-human animals, and the implications for the function of consciousness.

Talk 2: Implicit learning of complex structures supports evaluative conditioning and instrumental responding effects

Răzvan Jurchiș (Babes-Bolyai University)

Symposium: The Interplay between Consciousness and Learning, Friday 23rd, Tishman Auditorium, 2:30pm-2:55pm

Unconscious learning has been proposed to play a central role in human adaptation, but its reach and very existence remain controversial. Recent conditioning studies, relying on the subliminal exposure of the conditioned stimuli, have found evidence against the unconscious learning of the affective and reward-predictive value of stimuli. We propose that unconscious learning effects can also be studied with a different methodology, in which unconscious processing is stimulated by employing predictive regularities that are complex and difficult to detect consciously. Different from subliminal exposure, this allows for the conscious perception of the stimuli, and, possibly, for more complex forms of learning related to the unconscious contents. In a first study, we paired strings from a complex artificial grammar with positive, and strings from a different grammar with negative unconditioned stimuli. In a subsequent affective evaluation task, participants rated more positively novel strings from the positively-conditioned grammar, compared to strings from the negatively-conditioned grammar, even when trial-by-trial subjective measures revealed they were unaware of the grammars. In a different study, letter strings from one artificial grammar were incidentally rewarded, and those from a different grammar were not. In a subsequent instrumental responding phase, participants were able to adaptively choose between strings from rewarded and non-rewarded grammars. This result appeared only when participants held unconscious knowledge of the predictive structures, but which enabled conscious judgments about the reward-predictive character of the stimuli. In sum, we find that implicit learning of complex structures might support evaluative conditioning and instrumental responding effects.

Talk 3: A critical assessment of the evidence for contingency unaware fear conditioning: Methodological and literature-wide problems

Gaetan Mertens (Tilburg University)

Symposium: The Interplay between Consciousness and Learning, Friday 23rd, Tishman Auditorium, 2: 55pm-3:20pm

There is ongoing debate about whether fear conditioning can occur without awareness of the contingency between the conditioned stimuli (CS) and the unconditioned stimulus (US). This talk will provide a critical assessment of the methodological challenges and literature-wide problems related to this debate. Particularly, methodological challenges include problems with masking procedures, insensitive contingency awareness measures, and trial-order effects, which can all result in (partial) contingency awareness. Furthermore, literature-wide problems (i.e., small samples, researcher degrees of freedom, and publication bias) will also be considered. Combined, these problems pose a serious problem to the evidence-base for contingency unaware fear conditioning. Some solutions (i.e., multiple awareness measures, larger samples, and preregistration) will be discussed as well.

Talk 4: The evolution of learning and the emergence of consciousness: predictions and implication of the UAL model.

Eva Jablonka (Tel Aviv University)

Symposium: The Interplay between Consciousness and Learning, Friday 23rd, Tishman Auditorium, 3: 20pm-3:45pm

I present the thesis that UAL (unlimited Associative Learning) is an evolutionary marker of minimal consciousness. I start by explaining the rationale of this proposal and focus on the predictions and implications of the UAL model for studying consciousness in non-human animals. Predictions can be tested by (i) comparing success in UAL tasks (e.g., trace conditioning, discrimination learning, incentive learning, causal learning, reverse learning) with predictive cues presented subliminally and superliminally; (ii) studying illusions which require multimodal integration, transfer or causal inference; (iii) comparing interactions among brain areas during stages of awakening from anaesthesia in representatives of all vertebrate classes, some arthropods and the cephalopod mollusks; (iv) assessing the timing, distribution and co-evolutionary dynamics of UAL during animal evolution. I will then discuss some of the implications of the UAL thesis such as the emergence of consciousness during embryogenesis and the evolution of sexually and socially selected composite patterns of percepts and action.

SYMPOSIUM:
Affective impact on perception

Frédérique de Vignemont (Institut Jean Nicod), Marisa Carrasco (NYU), Judith Domínguez-Borràs (University of Barcelona), Patrick Vuilleumier (Geneva University), Hilla Jacobson (Hebrew University of Jerusalem)

Saturday June 24th, Classroom 210, 10:30am-12:30pm

How does our affect modify the way we perceive the world? Hearing footsteps behind us in a dark alley is not simply our hearing a soft sound. It is hearing something bad approaching. Many sensory experiences somehow involve an affective dimension, but at which level does it kick in? Is it only post-perceptual or could it be that sensory experiences themselves are affectively loaded? In favour of this latter view, it has been recently found that the visual system is influenced by the outcome of early appraisal in the amygdala, which automatically evaluates what is seen as being harmful or beneficial for the organism. As a consequence, participants are better able to attend, search, and track affectively salient visual stimuli than neutral ones.
Early appraisal tags stimuli that have relevance for the well-being of the organism and potentiates attentional effects. However, the fact that the visual system processes more effectively affective stimuli does not suffice to demonstrate that the phenomenal character of visual experiences itself can be affective. Is the impact of affect on perception only a matter of attentional salience, or does it also introduce valence in our sensory experiences?
In this symposium, we shall explore the interactions between sensory, evaluative and affective processes. It will be organized around three main issues: (i) do objects look different when they are appraised positively or negatively? (ii) what is the relation between the sensory and the affective characters of the charged perceptual experiences? And (iii) in what sense do they then differ from emotions?

Talk 1: Emotion potentiates the effects of attention on visual perception and appearance

Marisa Carrasco (NYU)

Symposium: Affective impact on perception, Saturday June 24th, Classroom 210, 10:35am-11:00am

The ability to swiftly detect and prioritize the processing of relevant information around us is critical for the way we interact with our environment. Covert attention is a key mechanism that serves this purpose, selectively processing information and improving performance and appearance in numerous visual tasks. Reflexively attending to sudden information helps detect impeding threat or danger, a possible reason why emotion strengthens the way selective attention affects perception. For instance, the sudden appearance of a fearful face potentiates the effects of covert exogenous (involuntary, stimulus-driven) attention on an orientation discrimination task–the benefits at the attended location are more pronounced when the cue consists of a fearful face than a neutral face (Phelps, Read & Carrasco, Psych Sci 2006). Importantly, attention does not only improve performance; it also alters the way visual information appears to us, e.g., by enhancing perceived contrast (review, Carrasco & Barbot, Curr Opin Psych 2019). Exogenous attention has stronger effects on both perceived contrast and an orientation discrimination task when the cue consists of a fearful face than a neutral face, and such differential effects disappear with inverted faces. Moreover, we found that trait anxiety mediates these effects, with stronger influences of attention and emotion in anxious observers. Finally, changes in performance and appearance correlate with each other, likely reflecting common attentional modulations (Barbot & Carrasco, Sci Reports 2018). Altogether, our findings show that emotion potentiate the effects of selective attention on visual performance and appearance.

Talk 2: Emotional influences on perception and attention: amygdala and neural circuits

Judith Domínguez-Borràs (University of Barcelona)

Symposium: Affective impact on perception, Saturday June 24th, Classroom 210, 11:00am-11:25am

Attention mechanisms encompass multiple biasing signals that modulate perception, not only based on physical features or spatial position, but also on emotion or stimulus-value. Abundant evidence indicates that emotional and motivationally relevant stimuli may be more readily detected than neutral stimuli across many conditions, a phenomenon that has been related to enhanced activity of sensory cortices under direct influences of emotional brain systems, in particular the amygdala. This neural structure is key for saliency detection through its widespread modulatory signals onto multiple areas of the brain, and acts together, or in parallel with, the attention systems in selecting behaviorally relevant information for conscious awareness. Recent work also points to more long-lasting impact in sensory pathways whereby emotional signals may trigger plasticity in neural connections and perceptual tuning that can also alter reactivity to future sensory inputs. We will review neuroimaging and electrophysiological evidence supporting these effects, with insights from both healthy and pathological (e.g. amygdala lesion, neglect) conditions, and discuss their implication for understanding the affective component of perceptual experiences.

Talk 3: Seeing Danger

Frédérique de Vignemont (Institut Jean Nicod)

Symposium: Affective impact on perception, Saturday June 24th, Classroom 210, 11:25am-11:50am

According to a standard account, visual experiences can give rise to emotions, desires, and evaluative judgments, but they themselves represent only basic sensory features. However, it has recently been proposed that there might be more to visual experiences than previously assumed, including evaluative, affective, and motivational components. Danger is possibly the most basic evaluative property from an evolutionary standpoint. To be able to detect it is the first – although not the only – objective to meet for an organism to survive. Because of the primacy of danger detection, one can easily conceive that it needs to occur very early on, that it does not require much conceptual resources and that it needs to be in direct connection with action. This gives some prima facie plausibility to the hypothesis that danger can be visually experienced. But how to differentiate the visual experience of danger from fear itself? For some indeed, fear should be conceived as perceptual awareness of danger. Here I shall argue that there is conceptual and empirical space for a notion of danger perception that does not collapse into fear.

Talk 4: Intrinsically Valenced Perception

Hilla Jacobson (Hebrew University of Jerusalem)

Symposium: Affective impact on perception, Saturday June 24th, Classroom 210, 11:50am-12:15pm

Tradition contrasts ‘cold’ perception with ‘hot’ emotion and affect. Against this backdrop, it has recently been argued that perceptual experiences have another significant phenomenal aspect, over and above their sensory aspects – perceptual experiences in all sense-modalities are 'affectively-charged' or 'intrinsically valenced'. An appropriate starting point is the case of pain, but other perceptual experiences – e.g., delicious gustatory experiences and horrible olfactory experiences – are phenomenologically and motivationally similar to pains. Furthermore, there is evidence – arising from the literature on micro-valences (Lebrecht et. al. 2012) – that suggests that, even in the case of vision, sensory experience standardly involves an affective aspect. Yet, what is required for perception itself to be valenced? Specifically, if perception is intrinsically valenced, what should be the relations between its valenced and sensory aspects? The paper offers a Determination-Dimension Model, according to which valence is a determination-dimension along which the phenomenal characters of experiences with specific sensory aspects (or the same ‘sensory profiles’) vary. On this model, the phenomenal character of each experience is determined according to both its sensory and its valenced aspects (just as a specific shade is determined according to both its hue-plus-saturation profile and its level of brightness), in a manner entailing that valences are ways of having experiences with those sensory aspects.

SYMPOSIUM:
Broad-spectrum introspection: Metacognition and self-awareness across diverse domains

Jorge Morales (Northeastern University), Elisa Filevich (Humboldt-Universität zu Berlin), Tony Cheng (National Chengchi University), Sarah Garfinkel (UCL)

Saturday 24th, Tishman Auditorium, 10:30am-12:30pm

We introspect mental states from a wide range of sensory and cognitive domains: visual, auditory, olfactory, haptic and proprioceptive experiences, memories, decisions, etc. Self-knowledge (via introspection and nearby constructs such as self-awareness and metacognition) has received lots of attention in psychology, neuroscience and philosophy—both recently and historically. However, contemporary debates about introspection (especially within the sciences) have been narrowly focused (e.g., on vision and memory). By limiting ourselves to studying a reduced number of domains using just a few paradigmatic experimental paradigms, we risk creating an incomplete, or even distorted, image of what self-knoweldge abilities are like and how they relate to each other. In this interdisciplinary symposium, we aim to shed light on the importance of a broader approach to self-awareness by considering interactions across domains as well as modalities that have typically received less attention. Does introspection operate in the same way across domains? Can we expand our knowledge of sensory modalities themselves by studying how we introspect them? How does awareness of sensorimotor and proprioceptive signals influence awareness in general? To address these interlinked questions we will revisit the fundamental issue of whether metacognition is domain-general or domain-specific. We will also explore important features of haptic, bodily, and motor self-awareness, how they differ from self-awareness in other sensory modalities and how reflection upon their features can reshape how we conceptualize these domains. Introspection and conscious experiences are complex and multidomain, and this symposium aims to broaden our understanding of them by exploring these often-neglected facts.

Talk 1: How Many Metacognitive Capacities There Are? Challenges for A Domain-General Metacognition

Jorge Morales (Northeastern University)

Symposium: Broad-spectrum introspection: Metacognition and self-awareness across diverse domains, Saturday 24th, Tishman Auditorium, 10:35am-11:00am

Is there just one or are there many metacognitive mechanisms? Metacognition—the ability to monitor and control our own cognitive states—operates over a wide range of domains: we can monitor what we see, hear, feel, remember, decide, etc. A fundamental question about any cognitive capacity that operates over radically different domains is whether it is in fact sustained by a single, domain-general mechanism or rather by a cluster of independent domain-specific specialized systems. Despite a recent push in the field to find a unified, all-encompassing capacity responsible for all metacognitive access, in this talk I will argue that the extant evidence, when taken as a whole, tips the balance in favor of a rather fractionated set of domain-specific metacognitive capacities. Evidence from psychophysics, neuroimaging, animal physiology and neuropsychological patients suggests we have largely independent capacities for assessing cognitive performance across domains. A new large-scale analysis of over half a million trials from the Confidence Database reveals that metacognition across sensory and cognitive domains displays different profiles. Importantly, the results from this large scale analysis highlights the dire urgency of moving the field beyond visual and memory tasks. Making room for new experimental designs that probe a wider range of modalities is necessary for improving our understanding of the nature of metacognition.

Talk 2: The Contribution of Different Sensory Modalities to Motor Metacognition and What That Tells Us About The Relationships Between Domains

Elisa Filevich (Humboldt-Universität zu Berlin)

Symposium: Broad-spectrum introspection: Metacognition and self-awareness across diverse domains, Saturday 24th, Tishman Auditorium, 11:25am-11:50am

To understand the relationships between metacognitive domains, one approach has been to measure correlations in metacognitive performance across task pairs. This approach is inefficient: There are simply too many possible tasks and domains that can be tested. A more efficient approach would be to identify general principles that allow for valid predictions about the relationships between any two domains. But, because the literature has focussed mostly on visual and memory tasks, it is impossible to extrapolate from these tasks alone. Instead, we must sample the landscape of metacognitive tasks to try to interpolate the points between them. I will present a series of studies where we measured metacognition of motor control, and aimed to understand its relationships to metacognitive monitoring in other domains. Unlike the case of vision for simple stimuli, motor representations are inherently multimodal, as they may be informed by efferent motor commands, afferent proprioceptive feedback, or potential differences between sensory predictions and observations. In turn, these sensory predictions can be either visual or tactile. We tested the relative contributions of these different sources of information to metacognitive judgments, and in particular the prediction that tactile information contributes more strongly to metacognitive representations than other modalities. I will highlight how investigating motor metacognition has informed our understanding of metacognition in general, and of the relationships between domains.

Talk 3: Tactile Introspection: A Case for Perspectivalism in Touch

Tony Cheng (National Chengchi University)

Symposium: Broad-spectrum introspection: Metacognition and self-awareness across diverse domains, Saturday 24th, Tishman Auditorium, 11:00am-11:25am

There was a time in philosophy and psychology when introspection was deemed as entirely problematic: phenomenologists considered themselves different from introspective psychologists; behaviouralists held that psychology should entirely abandon introspective reports. Recently, introspection has regained its legitimacy to a large extent: it has been argued, for example, that introspection is signal detection (Morales, in press), so it can fail for sure, but it is not especially problematic compared to other psychological episodes or faculties. In this talk, I will argue that perspectivalism – the idea that we perceive perspectival spatial properties as well as objective spatial properties (Schwenkler and Weksler, 2018; Morales, Bax, and Firestone, 2020) – is more defensible in touch than in vision, and tactile introspection provides a more reliable guidance in the relevant domain because introspection provides better signals for touch than for vision. This has profound implications for other debates. For example, different introspective reliability across modalities speaks in favor of a heterogeneous domain-specific self-awareness capacity. This result also offers a partial response to a recent attack from Burge and Burge (2022), according to which perspectivalism is committed to the existence of some problematic entities, and is therefore obsolete from the viewpoint of vision science. The result here contributes to the general idea of “broad-spectrum introspection”: at a very abstract level, introspection might be domain-general in the sense that it provides self-knowledge of a wide psychological realm, but at a more concrete level it is domain-specific in that introspection in different domains provides signals with different strengths.

Talk 4: The divergence between interoceptive accuracy and interoceptive awareness in autistic individuals

Sarah Garfinkel (University College London)

Symposium: Broad-spectrum introspection: Metacognition and self-awareness across diverse domains, Saturday 24th, Tishman Auditorium, 11:50am-12:15pm

Exteroceptive senses, such as vision and audition, assist us in navigating the world. In contrast, interoception refers to the internal sense, encompassing the detection of signals originating from the gut and heart. Our brains engage in constant and dynamic communication with afferent signals from the body, many of which do not reach conscious awareness. Individuals with autism often exhibit differences in sensory processing, such as both hypo- and hypersensitivity towards touch, light, and sounds. Additionally, interoception can also be affected in autism; studies have demonstrated reduced interoceptive accuracy in autistic adults. Interestingly, despite this reduced accuracy, autistic individuals frequently claim to be hyper "aware" of interoceptive signals. By training autistic individuals to improve their interoceptive accuracy, their level of self-reported interoceptive awareness can be reduced. These findings suggest a contrasting relationship between interoceptive accuracy as determined through behavioural tests and the self-reported awareness of these signals. Speculatively, enhancing the precision of body-brain mapping could potentially diminish interoceptive surprise, subsequently reducing the awareness of signals originating within the body.

SYMPOSIUM:
The Richness Debate

Michael Cohen (Amherst College), Ned Block (NYU), Liad Mudrik (Tel Aviv University), Michael Pitts (Reed College)

Saturday 24th, Tishman Auditorium, 4:30pm-6:30pm

This symposium will be a lively, interactive debate between the four speakers (and the audience) about whether visual perception is "rich" or "sparse" (i.e., the richness debate). Rather than give four full-length talks, each speaker will give a relatively short talk (i.e., 10-12 minutes) that provide specific empirical findings in support of different sides of the debate. Specifically, each speaker will present results from the last few years using new paradigms and experimental methods that have not traditionally been included in the richness debate such as virtual reality, convolutional neural networks, and infant studies. The goal of these brief talks is to set the terms of the debate and ensure that each position is properly articulated and accurately represented by the most up to date results. After these concrete examples have been described, the remainder of the symposium will involve the four speakers actively engaging with one another, asking follow-up questions, looking for common ground, searching for testable predictions, etc. A major motivation for a symposium of this format stems from the fact that in published articles and individual talks, theorists often speak past one another, making it difficult for definitive progress to be made. Thus, the focus of this public debate will be to identify the key disagreements between theorists on different sides of this debate in order to determine how to propel this debate forward.

Talk 1: Pinpointing the sparseness of perceptual awareness

Michael Cohen (Amherst College)

Symposium: The Richness Debate, Saturday 24th, Tishman Auditorium, 4:30pm-4:45pm

For over 20 years, researchers have debated whether conscious perception is "rich" or "sparse." The first part of this talk will highlight numerous recent findings from psychophysics, virtual reality (VR), and computational modeling with deep convolutional neural networks that all suggest perception is remarkably sparse. In the last few years, several studies have shown that observers can look out onto the world for several seconds and fail to notice that over 90% of the visual world is missing any color whatsoever or that the periphery is so scrambled that no individual item can be identified. The second part of this talk will focus on setting the stage of the richness debate more broadly by initially focusing on results such as these and asking questions like: How can we differentiate between these distinct explanations? Are there any experimental approaches that could be used to support one explanation over the other? When researchers use terms like "rich" and "sparse," how much are they truly disagreeing on? What exactly do "rich" theorists believe is seen that "sparse" theorists believe goes unnoticed? As a group, we will openly debate these questions with one another in hopes of taking the richness debate into new domains and forming concrete hypotheses and testable predictions.

Talk 2: The case for phenomenal richness

Ned Block (NYU)

Symposium: The Richness Debate, Saturday 24th, Tishman Auditorium, 4:45pm-5:00pm

This talk will give a new experimental argument for phenomenal richness. The argument starts with ignoring phenomenology and consciousness altogether. We know that perception has a higher capacity than cognition because Sperling's and Lamme's experiments have shown that more items can be held in perceptual memory storage than that gateway to cognition, working memory. Perception has a higher capacity than cognition, i.e. perception "overflows" cognition, though that fact does not show that the overflow is conscious or phenomenal. The excess capacity in perception might be unconscious. Here is the evidence that it is conscious: Children have near adult level color perception by 4 to 6 months of age but do not normally have color concepts or color cognition until around 12 months. And there is evidence that the color perception in the 6 month period between 6 months and 12 months is conscious. So in that period, there is conscious color perception that is not cognized, and if that is right, cognitive theories of consciousness such as the global workspace (and global playground) and higher order thought views are wrong. If there is time, I will also present evidence that adult color perception is not conceptual and need not be cognized to be perceived.

Talk 3: How rich is perceptual experience?

Liad Mudrik (Tel Aviv University)

Symposium: The Richness Debate, Saturday 24th, Tishman Auditorium, 5:00pm-5:15pm

Is our perception rich or sparse? To answer this question, researchers have typically relied on different types of indirect evidence; claims that perception is sparse are typically backed up by findings that it is non-veridical. That is, participants' failure to correctly perceive the environment - even when large changes are introduced - is used as evidence for sparseness. On the other hand, the richness of perception is held to be substantiated by studies showing that we are actually able to process much more information than we can report. In both cases, some hidden assumptions are at play; in the first, that if perception is non-veridical, then it is also non-rich. In the second, that the non- reported yet still processed information is consciously rather than unconsciously processed. In this talk, I will try to challenge both assumptions, and ask if more direct evidence can be obtained to prove them either wrong or right. To do so, I will also present findings from our lab, trying to directly tease apart phenomenal and access consciousness, while controlling for unconscious processing.

Talk 4: Attention, awareness, and the richness debate

Michael Pitts (Reed College)

Symposium: The Richness Debate, Saturday 24th, Tishman Auditorium, 5:15pm-5:30pm

My talk will focus on two issues relevant to the rich/sparse debate: The ubiquitous nature of inattentional blindness outside of the lab, in everyday life; and, the complications with measuring perceptual overflow inside the lab, using dual-task paradigms. Appreciating how much we fail to consciously perceive in everyday life is difficult. How can we notice what we don't notice? I will share some tricks to identify real-life inattentional blindness and reveal the relative sparseness of everyday perception. In the lab, whenever a study claims to find that we "see more than we can report" or that we have "cost free awareness" outside of attention, the next step should be to repeat the same experiment but with a more thorough and systematic manipulation of attention, including the extreme case of inattention. In the few cases in which this was done, a minimal amount of attention appears to be necessary for perceptual awareness and there are always attentional "costs" in dual-task situations. At the center of this debate is the relationship between attention and awareness. If perceptual awareness is primary and tightly linked with accessibility, while attention is secondary and associated with access, the rich-view could be correct. If attention is what makes perceptual information accessible, while awareness is tightly linked with access, the sparse-view could be on the right track. Recent empirical and theoretical work on this issue will be discussed.

SYMPOSIUM: Animal Consciousness Beyond Mammals

Jonathan Birch (LSE), Andrew Crump (LSE), Matilda Gibbons (University of Pennsylvania), Peter Godfrey-Smith (University of Sydney), L. Syd Johnson (Upstate Medical University)

Sunday June 25th, Tishman Auditorium, 2:00pm-4:00pm

The neocortex—the part of the brain most strongly linked to consciousness in humans—evolved in mammals. This does not mean non-mammalian animals (such as birds, fish, and invertebrates) are zombies, but it does mean the neural basis of consciousness is likely to be significantly different in these animals. This leads to serious methodological challenges, and ongoing disagreement about how they can be overcome. This work has great ethical and societal importance, since new evidence of consciousness/sentience is often taken to justify stronger welfare protections. This symposium asks: How should we study consciousness in non-mammals scientifically? It showcases cutting-edge scientific work from researchers on the frontline of the search for non-mammalian consciousness, together with analysis of the theoretical foundations of the work, and ethical reflection on its wider consequences.

Philosopher of science Jonathan Birch (Foundations of Animal Sentience (ASENT)), will examine how the prospects for affective experience in non-mammals depends on our background theory of emotion, contrasting the cortex-centred theory of LeDoux with the midbrain-centred theory of Panksepp. Biologist Andrew Crump (ASENT), will present an experiment that explores whether bumblebees have separate conscious and unconscious visual pathways. Neuroscientist Matilda Gibbons will present evidence for indicators of pain in bumblebees, including motivational trade-offs, self-protective behaviour, and sensitivity to analgesics. Finally, ethicist L. Syd M Johnson will consider the ethical limits on research into animal consciousness and sentience, given that this research often makes heavy use of aversive stimuli, and might be harmful, but can also help inform animal welfare guidelines.

Talk 1: Insects as a model system for the study of consciousness

Jonathan Birch (LSE)

Symposium: Animal Consciousness Beyond Mammals, Sunday June 25th, Tishman Auditorium, 2:05pm-2:20pm

My aim in this talk is to give a brief update on what I have called "the search for invertebrate consciousness" (Birch 2022), showcasing the latest evidence from insects.

Insects (especially bees and Drosophila fruit flies) are showing great promise as model systems for the study of working memory, attention, and forms of learning that have been linked in the mammalian case to conscious perception, such as trace conditioning. Recent work has identified distinct pathways for trace and delay conditioning, showing differential sensitivity to distraction in the former pathway, a marker of the involvement of working memory (Grover et al. 2022; Paoli et al. 2023). It is conceivable (and will always be conceivable) that these functions are performed "in the dark", entirely without consciousness. However, if evidence accumulates in favour of a pathway in the insect brain that closely reproduces the facilitative profile of conscious perception in the mammalian brain, it will be reasonable to infer (by inference to the best explanation) that the insect analogue also supports a form of conscious perception.

What are the next steps? It would be valuable to know whether that same pathway supports a diverse cluster of abilities linked to conscious perception in the human case, including metacognitive abilities. It would also be valuable to know whether the working memory-involving pathway has a distinctive gating mechanism: are there analogues of backward masking that can stop a stimulus reaching this pathway, while still allowing it to reach lower-level pathways? Finally, it would be valuable to know whether the task performance of insects in free flying conditions surpasses their performance in the highly constrained conditions of these recent experiments. My “Foundations of Animal Sentience” team has been exploring these lines of inquiry.

References

Birch, J. (2022). The search for invertebrate consciousness. Noûs 56(1):133-153.

Grover, D., Chen, J. Y., Xie, J., Li, J., Changeux, J.P., & Greenspan R. J. (2022). Differential mechanisms underlie trace and delay conditioning in Drosophila. Nature, 603 (2022), pp. 302-308.

Paoli, M., Macri, C., & Giurfa, M. (2023). A cognitive account of trace conditioning in insects. Current Opinion in Insect Science 57:101034.

Talk 2: Conscious and Unconscious Vision in Bumblebees?

Andrew Crump (LSE)

Symposium: Animal Consciousness Beyond Mammals, Sunday June 25th, Tishman Auditorium, 2:20pm-2:35pm

Do animals have separate conscious and unconscious visual pathways? In humans, subliminal stimuli fall between a subjective threshold (where the subject reports perception) and an objective threshold (where the subject detects the stimulus, without reporting perception). Here, we introduce a new method to distinguish conscious and unconscious vision in animals. We tested 39 forager bumblebees (Bombus terrestris) in two interconnected arenas, with Arena 1 leading into Arena 2. Both arenas had black screen floors showing four grey dots, which yielded sugar rewards, and four no-dot locations, which yielded aversive quinine. Once bees learnt to approach the grey dots, we reduced the dots' luminance, thereby reducing contrast with the black background. We took opting-out behaviour (leaving Arena 1 for Arena 2) to indicate the bees' subjective visual threshold. Arena 2 was a forced version of the same task, so chance performance here indicated the objective visual threshold. If bees have separate subjective and objective vision, we would predict a higher luminance threshold for opting-out in Arena 1 than the chance performance threshold in Arena 2. However, there was no difference between the opt-out and chance thresholds. We, therefore, found no evidence of distinct subjective and objective visual thresholds: bees' metacognitive assessments were remarkably close to actual task performance. These findings may suggest that bees have no conscious vision, that they have no unconscious vision, or that our paradigm did not detect distinct conscious and unconscious visual pathways.

Talk 3: Can Insects Feel Pain?

Matilda Gibbons (University of Pennsylvania)

Symposium: Animal Consciousness Beyond Mammals, Sunday June 25th, Tishman Auditorium, 2:35pm-2:50pm

Whether insects feel pain is an important ethical, legal, and scientific question. We tested whether bumblebees (Bombus terrestris) fulfill three indicators of pain. Our first experiment investigated motivational trade-offs. Bees avoided 55 °C feeders when offered differently-coloured, unheated feeders containing high sucrose concentrations. However, when sucrose concentration at unheated feeders decreased, they increasingly fed from noxiously-heated feeders. A memory test revealed that bees' feeder preference relied on the colour cues, so the motivational trade-off was based on a conditioned memory. Our second experiment explored whether bees groom a noxiously-stimulated body part. We touched bees' antenna with a 65℃ or unheated probe. Bees in the heat-probe treatment groomed their touched antenna more than their other, untouched antenna. Bees in the unheated-probe treatment did not groom their touched antenna more than their untouched antenna. Therefore, bees direct grooming towards a noxiously-stimulated body part. Our third experiment used a similar protocol, but recorded behaviours associated with pain in vertebrates. Bees in the heat-probe treatment exhibited behaviour patterns similar to vertebrates in pain (e.g. increased durations of grooming, resting and defensive behaviours), compared to bees in the unheated-probe treatment. Collectively, all three lines of evidence are consistent with insects feeling pain.

Talk 4: Finding consciousness in phylogenetically distant organisms

Peter Godfrey-Smith (University of Sydney)

Symposium: Animal Consciousness Beyond Mammals, Sunday June 25th, Tishman Auditorium, 3:10pm-3:25pm

I will look at recent work on the vexed problem of assessing hypotheses of conscious experience in animals far from us in evolutionary terms. How do neuroscientific and behavioral evidence relate, in their bearing on this problem? Recent research on arthropods, gastropods, cephalopods, and others will be discussed.

Talk 5: Inductive Risk and Equipoise in Potentially Harmful Consciousness Research

L. Syd M Johnson (Upstate Medical University)

Symposium: Animal Consciousness Beyond Mammals, Sunday June 25th, Tishman Auditorium, 3:25pm-3:40pm

Pain and pleasure have asymmetrical moral valence given widespread moral intuitions and moral prohibitions on causing unnecessary harm and suffering to sentient creatures. The presence of pain and distress (as opposed to unconscious nociception), and consciousness remain scientifically controversial for numerous non-mammal animals, and many of those same animals are outside the scope of welfare guidance and legislation. Thus, scientific evidence for sentience and consciousness may be valuable for shaping welfare guidance and legislation, and, to the extent that moral considerability depends on sentience or consciousness, informing ethical obligations to non-mammal animals in several areas in which those animals are currently used by humans, including scientific research. Pain and distress are also important considerations in animal welfare guidance and legislation, which generally require limiting pain and distress in research to the extent possible for achieving scientific aims. There are numerous potential harms associated with sentience and consciousness research, including inducing aversive states like pain and distress, and deprivations associated with captivity in impoverished environments. Whether those harms occur can very much depend on the sentience and consciousness of the animals in question. Considering specifically research on fish pain, I outline how inductive risk and uncertainty about sentience/consciousness limit permissible risk-taking in pain research on fish, and consider whether equipoise, used to justify some medical research in human subjects, provides an adequate justificatory framework for potentially harmful research, where there is genuine scientific doubt about the sentience/consciousness of an animal.

Concurrent Session Talks

Covert detection and investigation of brain networks in auditory conscious perception

Shanae Lyndell Aerts (Interdepartmental Neuroscience Program, Yale University), Anjali Mangla (Yale University), Kate L. Christison-Lagay (University of New Hampshire), Sharif I. Kronemer (National Institute of Mental Health), Thomas Xin, Taruna Yadav, Lauren Kim, Hal Blumenfeld

Concurrent Session: Neural Correlates of Consciousness, Sunday June 24th, Classroom 210, 11:30am-11:45am

Magnetic resonance imaging (MRI) and other neuromonitoring methods can provide some insight into a patient's level of consciousness, yet the exact brain areas and timing of events responsible for conscious awareness are still in fierce debate. The reliance on subject report in consciousness research biases previous work towards the search for brain areas responsible for perceptual report. To assess perception without the requirement of questioning participants, auditory stimuli will be classified as perceived or nonperceived by a machine learning model trained on reflexive pupil/eye movement. Subjects are presented at-threshold auditory stimuli and instructed to report their perception in the target ear only (Report Condition); during the same trial, an asynchronous sound is presented to the nontarget ear (No-Report Condition). Eye metrics are recorded throughout. In the Report condition, we found that subjects (n=25) performed well: perception rate was 55% when a threshold stimulus was present; false positive rate (blank trials) was 10%; sound identification accuracy for perceived target sounds was 88%, and accuracy for nonperceived targets was 34% (chance: 33%). Further, eye metrics differed between perceived and nonperceived auditory stimuli, despite the loud background noise of the MRI. Permutation testing resulted in significantly different post stimulus eye responses between perceived and nonperceived pupil diameter (200-2500ms), blink rate (1130-1880ms) and microsaccade rate (153-510ms). Ongoing work will use eye-metric data from the Report condition to train a machine learning model to classify trials as perceived or not; this model will then be applied to the data from No-Report stimuli to classify these trials as perceived or nonperceived. Under No-Report conditions, overt report is replaced by machine learning-based predictions of stimuli perception. Based on preliminary data, pupil dilation, a pause in microsaccades, and increased eye blink rate are hypothesized to be predictive of perceived auditory stimuli in the absence of report. The classifier will be used to investigate functional MRI for reported perceived vs. classified perceived vs. nonperceived auditory stimuli. Based on previous work from our lab in the visual domain, report-independent conscious perception is expected to involve transient engagement of subcortical arousal networks, including the thalamus and striatum which provide a neuromodualtory pulse to cortical salience networks initiating conscious-linked cortical state changes. If eye metrics can be used to classify auditory perception, it has the potential to be used widely to study conscious perception purified from the confound of overt report. The proposed study benefits clinical groups by (1) offering new treatment approaches (e.g. identifying targets for neurostimulation) and (2) developing new methods to detect consciousness practical for distinguishing between vegetative and minimally conscious states.

Featural blindsight in a 2-Interval Forced-Choice task

Pietro Amerio (Université Libre de Bruxelles), Matthias Michel (New York University), Stephan Goerttler (Coventry University), Megan A. K. Peters (University of California Irvine), Axel Cleeremans (Université Libre de Bruxelles)

Concurrent Session: Unconscious Processes, Sunday June 24th, Classroom 204, 11:15am-11:30am

Evidence of unconscious perception is often criticized for falling prey to the criterion problem. 2-Interval Forced-Choice (2IFC) tasks were proposed to solve the criterion problem and enable the bias-free measurement of stimulus awareness. 2IFC designs expose participants to two stimuli presented in successive intervals. On each interval, subjects discriminate some feature of the stimulus. Next, they indicate which interval contained the most visible stimulus. By presenting a stimulus in only one of the two intervals, unconscious perception can be demonstrated whenever participants show above-chance discrimination of the task-relevant feature while not judging the feature to be more visible in the feature present interval. Crucially, recent investigations using the 2IFC paradigm failed to report any evidence of discrimination in the absence of awareness (Peters and Lau, 2015; Knotts et al. 2018; Rajananda et al. 2020). However, merely measuring stimulus awareness might make tests of unconscious perception too conservative: participants might be aware that something (vs. nothing) was present, yet be unaware of the task-relevant feature (Michel, 2022). To address this issue, we designed a "featural blindsight" task (as in Rajananda et al. 2020). Each trial required participants to discriminate the offset direction of two successive Vernier stimuli and to report which of the two offsets (i.e. the task-relevant feature) was more visible. Both stimuli were equally detectable, but only one of them actually had an offset. Our results suggest that subjects can identify offset directions better than chance while remaining unaware of which interval contained an offset. This obtains both for backward masked stimuli, and for unmasked stimuli when presented for 0.9-3.0 milliseconds using a modern-day tachistoscope. To further explore participants' behavior, we compared their performance to that of seven Bayesian observer models based on 2D Signal Detection Theory. Two models emerge as accounting best for various aspects of the behavioral data. One is an adaptation of the confidence model by Peters and Lau (2015). The other is designed to provide visibility ratings (rather than decisional confidence) and allows the assessment of both stimulus awareness and featural awareness within the same representation space. Further, we tested whether the models' fits would improve by injecting noise in the visibility judgment process only (i.e. after a discrimination decision had been made). This process is designed to mimic making the observers unaware of part of the sensory evidence. However, in line with past literature, this manipulation did not improve model fits significantly. In summary, we used a 2IFC task design to show evidence of featural blindsight in healthy participants. Two observer models were found to account well for our data; their implications will be discussed at the conference.

High-order functional connectivity: a data-driven approach for studying states of consciousness

Rubén Herzog Amunátegui (ICM, Paris, France), Carla Pallavicini (Departamento de Física y Departamento de Química Biológica, FCEyN, UBA, Argentina), Thomas Andrillon (Sorbonne Université, Institut du Cerveau - Paris Brain Institute - ICM, Inserm, CNRS, Paris, France), Fernando E. Rosas (Imperial College London, London, UK), Rodrigo Cofré

Concurrent Session: Altered States of Consciousness, Saturday June 24th, Classroom 210, 2:30pm-2:45pm

A major challenge in the neuroscientific study of consciousness is to identify and distinguish different states of consciousness based only on specific and relevant neurophysiological signatures. Typically, these signatures reflect different aspects of the collective activity of the brain, such as functional connectivity, oscillations, or complexity. Because different states of consciousness involve functional reconfigurations of brain dynamics with widespread effects at multiple spatial scales, measures limited to the analysis of single regions and/or their pairwise interactions may miss all the information encoded in their high-order interactions. However, accounting for all possible combinations of high-order interactions among regions becomes prohibitive for a moderate brain atlas ($\sim 10^{30}$ interactions for 90 regions), hindering the use of high-order functional connectivity (HOFC) as a practical signature of states of consciousness. Using a greedy algorithm for the combinatorial problem of HOFC, we aim to reveal the specific changes in the collective activity of the brain induced by various mind-altering drugs. We analyzed resting state fMRI data from subjects who received placebo or one of four drugs (LSD, N=16; psilocybin, N=13; MDMA, N=18; ketamine, N=14). The data was preprocessed using FSL, partitioned with the AAL90 atlas, and filtered between 0.01-0.1 Hz. We calculated the dual total correlation (DTC) between time series of 3 to 20 brain regions to measure HOFC. A greedy algorithm was used to identify drug-affected interactions in terms of decreased or increased HOFC (hypo or hyper connectivity), quantified by Cohen's d effect size. All drugs induced significant changes in HOFC ($p\text{-value}<10^{-3}$) at different orders of interactions (from 3 to 20), both in terms of hypo and hyper connectivity. Serotonergic drugs (LSD, psilocybin and MDMA) showed mainly hypoconnectivity, while ketamine was dominated by hyperconnectivity. The topographic analysis of these interactions revealed that each drug elicited a specific pattern of hypo and hyper connectivity, but all of them involved hypo connectivity of frontal regions. Our results show that HOFC with a greedy examination of the combinatorial space can reveal valuable information about brain interactions across different states of consciousness. Each of the studied drugs displayed a unique pattern of hypo and hyper connectivity. Drugs with similar pharmacological mechanisms (i.e. serotonergic) were dominated by hypo connectivity, while ketamine by hyper connectivity. This suggests that HOFC could also reflect the underlying mechanisms behind different states of consciousness and should be further studied with different drugs, multimodal recordings, and larger sample sizes. Establishing specific neural signatures of different states of consciousness could be a crucial step in understanding the brain-consciousness relationship and developing effective biomarkers for neuropsychiatric conditions.

Sleep-like brain activity in wakefulness shapes the dynamics of attention and consciousness

Thomas Andrillon (Sorbonne Université, Institut du Cerveau - Paris Brain Institute, Inserm, CNRS, Paris, France)

Concurrent Session: Sleep, Dreaming, Anesthesia, Friday June 23rd, Classroom 204, 11:30am-11:45am

Sleep and wakefulness are not mutually exclusive, all-or-nothing phenomena. Rather, both during sleep and wakefulness, regional brain activity can contrast with the global state of an individual. For example, individuals getting tired can show a pattern of brain activity reminiscent of sleep, here referred as sleep-like slow waves, while still behaviourally and physiologically awake. These sleep-like slow waves have been paired, in animals, with periods of neuronal silencing, which could explain their association with lapses of attention. These slow waves have also been associated with changes in subjective experience as they predict instances of mind wandering or even mind blanking. Here I will present a set of new studies that sought to better characterise these slow waves in wakefulness. First, I will detail how sleep-like slow waves increase in a time-dependent and use-dependent fashion. Indeed, healthy individuals performing a one-hour sustained attention task (n-back), five times during the day, showed an increase in sleep-like slow waves throughout the day (time-dependent). This increase was faster for individuals engaged in a difficult (3-back) vs easy (1-back) task, predominantly in brain regions involved in the task (use-dependent). Second, I will show how sleep-like slow waves can account for inter-individual differences in the fluctuations of attention. To do so, I compared neuro-typical and ADHD adults performing a sustained attention task. ADHD individuals displayed more sleep-like slow waves than non-ADHD adults and the amplitude of these slow waves correlated with attentional deficits across individuals. Accordingly, local sleep intrusions could play a key role in the expression of ADHD symptoms and inter-individual differences in attentional focus. Third, I will present pharmacological and non-pharmacological interventions devised to suppress or enhance sleep-like slow waves. In the placebo-controlled pharmacological interventions, drugs promoting arousal (i.e. increasing noradrenaline and dopamine) decreased slow waves whereas a drug decreasing arousal (i.e. increasing serotonin) increased slow waves. Thus, sleep-like slow waves are influenced by the same neuromodulatory pathways regulating attention and arousal. In the non-pharmacological intervention, acoustic stimuli were used to amplify slow waves during sleep, which reduced sleep-like slow waves during subsequent wakefulness. This result suggests that slow waves are homeostatically regulated across wakefulness and sleep. In conclusion, local markers of sleep within wakefulness can help tracking fluctuations of cognitive performance and subjective experience. These so-called local sleep episodes also provide a mechanistic framework to understand the relationship between the regulation of arousal and attention. Finally, they represent an interesting target for interventions aiming at improving cognitive performance.

Detection of Covert Cortical Processing of Novel Stimuli Using Electroencephalography in Critically Ill Unresponsive Children

Brian Appavu (Phoenix Children's, University of Arizona College of Medicine - Phoenix), Sarah Wykhoff, PhD (Phoenix Children's), Geetika Chahal, MBBS (Phoenix Children's), Jacobo Sitt (Institut du Cerveau et de la Moelle epiniere)

Concurrent Session: Disorders of Consciousness 1, Friday June 23rd, Classroom 202, 6:15pm-6:30pm

Background: Challenges exist for detecting covert consciousness in critically-ill children. Emerging electroencephalographic techniques exist to evaluate covert cortical processing using the auditory local-global oddball paradigm (LGOP). These evaluate for event-related potentials (ERPs) such as mismatched negativity responses (MMN) to assess for pre-attentive unconscious processing and P300b responses to evaluate for attentive conscious processing. Method: We enrolled unresponsive children (Glasgow Coma Scale scores < 8) in the Phoenix Children’s intensive care unit undergoing electroencephalography. Each patient underwent daily testing with the LGOP. In this paradigm, a series of 5 brief sounds is presented via headphones in successive blocks with the first four sounds identical, and with the fifth sound being either identical (local-standard) or different (local-deviant). Global standard trials were delivered pseudorandomly on 80% of trials with no change in the pattern of blocks (global-standard) and 20% of trials with a change in the fifth sound of the last block (global-deviant). MMN responses were evaluated by contrasting local-deviant from local-standard trials and summarized at a time window between 140-192 milliseconds following onset of the 5th sound as the average voltage over the electrodes of Fz, and Cz. P300b responses were evaluated by contrasting between global deviant and global standard trials at a time window between 400-600 milliseconds following onset of the fifth sound. To assess for presence of ERP responses, experimental conditions were compared by using sample-by-sample t-tests, with a first criterion of $p < 0.05$ for a minimum of 10 consecutive samples. Enrolled patients underwent functional outcome assessments at 10-12 months post-injury using the Glasgow Outcome Scale Extended – Pediatrics (GOSE-Peds) score, with higher scores suggestive of favorable outcome. Differences in GOSE-PEDs scores among patients with MMN and P300b responses was assessed using the Wilcoxon Signed-Rank test. Results: 30 children were prospectively enrolled and underwent LGOP testing. Underlying conditions included anoxic-ischemic encephalopathy, hepatic encephalopathy, traumatic brain injury and meningitis. MMN responses were identified in 7 patients (23.3%) whereas MMN and P300b responses were identified in 4 patients (13.3%). Higher GOSE-Peds scores were associated with the presence of MMN responses (median 1.0, interquartile range [1.0, 4.0]) as compared with absent responses (median 6.0 [3.8, 6.5], $p<0.0001$). Higher GOSE-Peds scores were associated with the presence of both MMN and P300b responses (median 1.0, [1.0, 1.3]) as opposed to the absence of MMN and P300b responses (median 6.0 [3.5, 7.0], $p<0.0001$). Conclusion: Detection of covert cortical processing is feasible in critically-ill unresponsive children. Recovery from coma may be associated with detection of MMN or combined MMN and P300b responses.

Experience machines and reality: the finishing touch

Nicholas Barrow (UCL, Institute of Cognitive Neruoscience), Patrick Haggard (UCL, Institute of Cognitive Neuroscience)

Concurrent Session: Virtual Reality and Neurotechnology, Friday June 23rd, Classroom 218, 10:30am-10:45am

With the emergence of virtual and augmented reality (collectively *R) technologies, the capabilities of Nozick's 'experience machine' thought experiment are within our grasp. *R allows for first-person experiences that seem real, enabling us to view situations from other perspectives and providing opportunities for innovative therapies to confront phobias and anxiety. However, although *R allows for a degree of realism, some suspension of disbelief is still required. Although experiences in *R seem real, they do not feel real. While *R allows for a degree of visual immersion, it cannot yet deliver all of the physical sensations associated with interacting with the real world. Our sense of immersion is immediately and abruptly interrupted when we, for example, reach to touch something but cannot actually feel it. The next logical step in virtual realism, therefore, is to facilitate the sense of tactile, touch sensation – haptic technology. We outline three ways in which touch facilitates our sense of immersion, presence, and realism. That touch (1) provides our sense of agency; (2) complements and confirms our other sensory modalities (such as vision); and (3) provides privileged information that corresponds to our sense of self and body ownership. We also consider the limitations current haptic technology – such as haptic gloves – has in delivering realism and identify future research agendas. An important implication of Nozick's experience machine is its illustration that we seem to value real experiences over virtual ones. However, although we might not value touch-enabled *R experiences as much as real experiences, they clearly still matter to some degree. Regardless of their source, for example, they still evoke real emotions. The implications of tactile realism for consciousness science, therefore, are particularly important because digital touch technology raises several ethical concerns. We identify the key concerns as tactile unreliability, tactile selfhood, and tactile autonomy respectively. First, because touch provides an ultimate arbiter of presence in the real physical world, we ought to be cautious about how digital touch disrupts our ordinary understanding of touch's confirmatory role. As an example, we consider 'tactile deepfakes' and how these might produce particularly problematic experiences. Second, touch is deeply involved with key aspects of self-consciousness such as bodily self-awareness and agency. Touch technologies could generate the experience of trying to touch your own body but finding nothing there: this could provoke a crisis of self-consciousness. Third, a distinctive feature of our sensory experiences is the degree of autonomous control we have over them. Although touch is "always on" (and perhaps because it is always on) we carefully control what (and who) we allow to touch us. Tactile technologies risk individuals being subjected to unwanted experiences, with implications for both autonomy and privacy.

Exploring states of consciousness through EEG harmonicity: Novel insights from sleep recordings

Antoine Bellemare-Pepin (Concordia University), François Lespinasse (Université de Montréal), Perrine Ruby (Centre de Recherche en Neurosciences de Lyon), Jean-Baptiste Eichenlaub (Univ. Savoie Mont Blanc, LPNC), Karim Jerbi (Université de Montréal)

Concurrent Session: Sleep, Dreaming, Anesthesia, Friday June 23rd, Classroom 204, 11:15am-11:30am

The Binary Hierarchy Brain Body Oscillation Theory (BHBBOT; Klimesch, 2013) proposes that biological systems rely on harmony to communicate and facilitate integrative functions. According to this theory, the binary hierarchical relation between spectral peaks (e.g. 1:2, 1:4, and 1:8) could be indicative of particular brain states (Klimesch, 2013). Binary multiple ratios have been observed between delta, theta and alpha peaks in an acoustic novelty detection task (Isler et al. 2008). Here, we explore the harmonic relationship between EEG frequency peaks to test its utility as a framework to characterize brain dynamics associated with sleep stages and wakefulness. We hypothesize that sleep will be associated with increased harmonicity as compared to wakefulness. To test this hypothesis, we applied metrics inspired by music theory to capture more subtle harmonic properties of brain signals. We extend the concept of binary ratios by considering more complex frequency ratios to describe the dynamics between different regions of the frequency spectrum. We propose an analysis pipeline that combines a data-driven signal decomposition technique with computational models of harmonicity to differentiate stages of sleep. Specifically, we utilized Empirical Mode Decomposition (Rilling et al. 2003) to decompose the signals into a set of Intrinsic Mode Functions (IMF), from which we derived frequency peaks. We then assessed the configuration of these peaks through novel metrics that capture their arithmetic proportions, namely harmonic similarity (Gill and Purves, 2009), inter-harmonic concordance, and subharmonic tension (Chan et al. 2019). Drawing from music theory, we implemented these metrics in order to summarize all pairwise relationships between peak frequencies. We obtained a dataset of 179,418 annotated EEG epochs of 1 second from 19 channels, recorded throughout entire nights from 36 participants. We relied on Generalized Linear Mixed effect models (GLMM) to assess how harmonicity metrics can distinguish sleep conditions (S1, S2, Slow-Wave-Sleep, REM) and wakefulness. We incorporated Power Spectrum Density (PSD) estimates, as well as mean peak frequency values in the model, to evaluate their confounding effect on measures of harmonicity. We found that harmonicity metrics, and their interaction terms, significantly differentiate sleep conditions and wakefulness. Specifically, subharmonic tension systematically distinguishes sleep stages, with a trend towards less tension when transitioning from wakefulness to slow-wave sleep, while harmonic similarity and inter-harmonic concordance significantly differentiate conditions particularly in central and frontal regions. To conclude, our model seems to offer insights beyond conventional PSD measurements, suggesting that the intricate configurations of frequency peaks ratios in the brain may be indicative of more nuanced states of consciousness, that can be captured by harmonicity metrics.

How Qualities and Content Interact in Perception

Jacob Berger (Lycoming College)

Concurrent Session: Philosophical Foundations, Friday June 23rd, Classroom 220, 12:00pm-12:15pm

We often perceive so-called low-level perceptible properties such as colors and shapes. But we also perceive high-level properties such as the property of being a dog. Much recent debate has focused on which types of high-level property we perceive (e.g. Siegel 2010; Helton 2016), debate that has eclipsed the question of how perceiving operates. Some thus simply posit a single sui-generis type of perceptual content (e.g. Burge 2022; Block 2023). I propose here that we can best explain all perceiving by appeal to two types of folk-theoretical resources already on hand for other explanatory purposes: mental qualities and the ordinary conceptual content that figures in thinking. The idea that perceiving operates by a combination of more than one type of content or representational property is by no means altogether novel (e.g. Kant 1781/1996; Quilty-Dunn 2020). But the current proposal differs in significant ways from extant views. Perhaps most important, many theorists either deny that mental qualities exist or maintain that they do not represent anything (see respectively, e.g. Harman 1990; Levine 2001). I begin by arguing, by contrast, that mental qualities represent the low-level properties they enable us to perceive, though in a different way from the way concepts represent things, a view that I and others have developed elsewhere (e.g. Rosenthal 2010; Author 2018). Then, I expand this account by arguing that high-level perception takes place because of the types of representational interactions between mental qualities and conceptual content. These interactions enable the account to avoid objections that might seem to support a dedicated type of perceptual content. As an illustration, I discuss the oft-cited argument that we cannot perceive high-level properties by way of conceptual content because what we perceive is typically unaffected by background beliefs in the way one might expect if perception did exhibit such content, as the Müller-Lyer illusion or other visual phenomena seemingly illustrate (e.g. Siegel 2010; Helton 2016). I propose that the presence of representational mental qualities explains why the contents of perception are often resistant to revision in light of background beliefs. I close by explaining why this view is superior to perhaps the leading alternative account of the way that conceptual content operates in perception, explained in terms of mental architecture (e.g. Mandelbaum 2018; Quilty-Dunn 2020).

Theta oscillations and minor hallucinations in Parkinson’s disease reveal decrease in frontal lobe functions and later cognitive decline

Fosco Bernasconi (École Polytechnique Fédérale de Lausanne (EPFL)), Javier Pagonabarraga (Universitat Autònoma de Barcelona (UAB)), Saul Martinez-Horta (Universitat Autònoma de Barcelona (UAB)), Jaime Kulisevsky (Universitat Autònoma de Barcelona (UAB)), Olaf Blanke; affiliation: École Polytechnique Fédérale de Lausanne (EPFL)

Concurrent Session: Disorders of Consciousness 2, Saturday June 24th, Classroom 214, 2:15pm-2:30pm

Cognitive decline and hallucinations are common and debilitating non-motor symptoms, occurring during later phases of Parkinson’s disease (PD). Minor hallucinations (MH), appear at early phases and have been suggested to predict cognitive impairment in PD, however, this has not been well-established by clinical research. Here, we investigated whether non-demented PD patients with MH show altered brain oscillations and whether such MH-related electrophysiological changes are associated with cognitive impairments that increase over time. Combining model-driven EEG analysis with neuropsychiatric and neuropsychological examinations in 75 PD patients, we reveal enhanced frontal theta oscillations in PD patients suffering from MH and link these oscillatory changes with lower cognitive frontal-subcortical functions. Neuropsychological follow-up examinations over five years revealed a stronger decline in frontal-subcortical functions in MH-patients, its severity was anticipated by specific stronger frontal theta alterations measured during baseline assessments, defining an MH and theta oscillation-based early marker of a cognitive decline in PD.

Pre-movement alpha oscillations shape the sense of agency by gating sensorimotor binding

Tommaso Bertoni (Italian Institute of Technology & Lausanne University Hospital), Marcia Bockbrader (Ohio State University), Sam Colachis (Ohio State University), Bastien Orset (École Polytechnique Fédérale de Lausanne), Carolina Foglia, Jean-Paul Noel, Ali Rezai, Stefano Panzeri, Cristina Becchio, Olaf Blanke & Andrea Serino

Concurrent Session: Action, Decision, Volition, Friday June 23rd, Classroom 202, 11:15am-11:30am

The sense of agency (SoA), the subjective experience of causing and controlling our actions, is thought to play a key role in human self-awareness. SoA arises from the comparison between efferent motor commands and afferent sensory feedback. In order to perform such comparison, the brain must integrate sensory and motor information at a large scale, gating the information flow between different functional areas. The dynamics of such large scale process is to the present day largely unknown. Theta-alpha oscillations play a key role in orchestrating long-range information integration, and the pre-stimulus phase has been shown to modulate subsequent perception, behavioural responses and neural connectivity. Here, we hypothesized that pre-movement neural oscillations are also involved in the comparison between motor prediction and sensory feedback underlying SoA. We tested such hypothesis in two experiments, using brain-machine interfaces (BMIs) as a tool to investigate sense of agency in humans. Experiment 1 was conducted in a tetraplegic proficient user of an intracortical (BMI), restoring hand movement by decoding primary motor cortex (M1) activity and translating it into functional hand movements through neuromuscular electrical stimulation (NMES). The participant executed a cued motor command through the BMI system and rated his SoA. We found that the phase of 8 Hz oscillations up to 500 ms before the movement predicted subsequent agency ratings. In Experiment 2, we extended our investigation to whole brain dynamics by conceptually replicating Experiment 1 in an EEG setup, where participants used motor imagery to move a virtual hand and provided agency ratings. We confirmed that the phase of pre-movement alpha-band oscillations modulated participants' agency ratings for virtual hand movements. We replicated the effect found in M1, and localised its strongest source in the contralateral SMA. Importantly, virtual movements starting in the optimal SMA phase for agency were associated with an increase of post-movement functional connectivity between SMA and the contralateral frontal, temporal and parietal lobes. According to behavioural literature, predictive signals play a key role in SoA, but their neural underpinning is poorly understood. Our results provide novel evidence that alpha oscillations may constitute the neural substrate for such such predictive components. Our connectivity analyses suggest that the pre-movement SMA phase may gate the information exchange involved in sensorimotor comparisons, modulating the amount of binding between intentions and sensory afference and therefore the SoA. This is in line with evidence about the role of slow neural oscillations for brain-wide communication, constituting an increasingly solid mechanistic framework. Our findings show a path towards the application of such framework to a phenomenological aspect of motor control which plays a central role in self-awareness.

The social and affective modulation of bodily self-awareness

Sahba Besharati (University of the Witwatersrand), Mark Solms (Paul Jenkinson), Aikaterini Fotopoulou ()

Concurrent Session: Body and Embodiment, Sunday June 24th, Classroom 206, 10:30am-10:45am

In recent decades, the research traditions of (first-person) embodied cognition and of (third-person) social cognition have approached the study of self-awareness with relative independence. However, neurological disorders of self-awareness offer a unifying perspective to empirically investigate the contribution of embodiment and social cognition to self-awareness. The neurological syndrome of anosognosia for hemiplegia (i.e. lack of awareness into one's paralysis) will be used as an avenue to explore the neurocognitive basis of bodily self-awareness. In this talk a series of experimental studies using a large sample of right-hemisphere stroke patients (n = 54) will be presented to demonstrate the intersecting relationship between bodily self-awareness and self-and-other perspective-taking. The main argument presented is that in anosognosia there is a fundamental disconnection between a 1st person embodied and 3rd person allocentric perspective that is influenced by non-updated premorbid beliefs and emotions about the self. A new account of bodily self-awareness is proposed that moves away from traditional modular theories towards a dynamic model of the construction of the bodily self. These dissociations observed in anosognosia offer unique insights into normally unconscious and automatic processes of integration and affective drive that underlie everyday self-experiences.

Virtual Reality Hypnosis Reduces Electrophysiological and Subjective Pain Perceptions of Healthy Participants

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Concurrent Session: Virtual Reality and Neurotechnology, Friday June 23rd, Classroom 218, 11:30am-11:45am

Background and aims: Virtual Reality Hypnosis (VRH) has aroused the curiosity of researchers and clinicians as it is a new promising tool to modulate pain perception. The aim of this study is to assess the effects of VRH on pain modulation, anxiety, and phenomenological variables. Methods: Forty-two healthy participants (26.5±4.31yo; 25 women) received 60 electrical painful stimulations to the foot (n=20) or the shoulder (n=22), during ordinary consciousness (OC, eyes open) and VRH conditions (Aqua©, Oncomfort, following a whale in an underwater world). Visual Analogue Scales (VAS) on pain intensity and unpleasantness, dissociation, absorption and an open-ended question on time perception were asked after each condition. The level of anxiety was assessed before and after each condition (VAS). High-density EEG (256 electrodes, EGI Geodesics) was also recorded. Repeated measures ANOVAs were performed for behavioral data. Event related potentials (ERPs) following painful stimulations were measured at the individual and group (shoulder and foot) levels for both conditions using cluster based non-parametric test ($p<0.05$). Results: Pain intensity and unpleasantness, anxiety (post condition) and time perception were reduced in VRH compared to OC. Dissociation and absorption were higher in VRH compared to OC. No significant group effect (foot vs. shoulder) was found. Regarding pain-related ERPs, lower amplitudes at frontal (P100, N200), central and posterior (N100, P200) electrodes were observed during VRH as compared to OC in both groups. Conclusion: VRH decreases pain perception both behaviorally and electrophysiologically. These results suggest that VRH is an effective approach to reduce experimental pain and pave the way for clinical applications of VRH.

The impact of notch filters on color perception in anomalous trichromacy

Jenny Bosten (University of Sussex), Lucy Somers (University of Sussex)

Concurrent Session: Perception, Friday June 23rd, Classroom 206, 5:15pm-5:30pm

Manufacturers of notch filter-based aids for color vision claim that their products can enhance color perception for people with anomalous trichromacy, a form of color vision deficiency (CVD). Anecdotal reports imply that people with CVD can experience radically enhanced color vision when using the filters, and there have been claims that certain “new” colors can be experienced for the first time. However, existing empirical research has largely focussed on the effect of notch filters on performance on diagnostic tests for CVD, and has not found that they have any substantial effect. We created a model to predict the effect of EnChroma notch filters on the color perception of anomalous trichromats when exposed to different combinations of observer, surface reflectance, illumination, and filter, and when exposed to natural scenes. Our model predicted that EnChroma does usually confer expansions of chromatic gamuts for anomalous trichromats, but its precise effects depend on the particular spectra created by the combination of factors included in the model. We tested the model predictions on 10 anomalous trichromats in three experiments: (i) color discrimination measured using four alternative forced-choice, (ii) asymmetric color matching between test and control filter conditions, and (iii) subjective color spaces reconstructed using multidimensional scaling from pairwise color dissimilarity ratings. To investigate potential effects of long-term adaptation or perceptual learning, participants completed all three experiments at two time points, on first exposure to the filters, and after a week of regular use. We found a significant effect of the filters on color matches in the direction predicted by the model, implying that the filters do have the effect of enhancing the anomalous trichromatic color gamut. However, we found minimal effect of the filters on color discrimination. We found an effect of the filters on enhancing the red-green axis in subjective color space, but only at the first time point, and not after a week of regular use. Our model and empirical results provide the first good evidence that notch filters can enhance color perception for anomalous trichromats.

Large-scale cortical deactivations precede episodes of mind-blanking during ongoing mentation

BOULAKIS Paradeisios Alexandros (Physiology of Cognition Lab, GIGA CRC In Vivo Imaging, University of Liege), MORTAHEB Sepehr (Physiology of Cognition Lab, GIGA CRC In Vivo Imaging, University of Liege), MAJERUS Steve (Psychology and Neuroscience of Cognition Research Unit, University of Liege), VAN CALSTER Laurens (GIGA CRC In Vivo Imaging, University of Liege), DEMERTZI Athena

Concurrent Session: Imagery and Mind Wandering, Friday June 23rd, Classroom 220, 5:30pm-5:45pm

Our ability to report on mental activity occasionally fails, a phenomenon known as Mind Blanking (MB). It was previously shown that, when people were asked to think of nothing, these “empty” periods were preceded by consistent fMRI deactivations in cortical areas responsible for internal speech (Broca’s area, L hippocampus), and activations in frontal areas, such as the anterior cingulate cortex (ACC) and the ventromedial prefrontal cortex (vmPFC). The ACC/vmPFC cluster is systematically implicated in evaluative and metacognitive judgments, which is counter-intuitive to MB, where we experience an inability to evaluate mental content. We here aim at delineating the neural sites associated with spontaneous MB occurrences, in the absence of instructions to self-induce it. We re-analyzed fMRI experience-sampling data collected from 31 participants, who had to lay restfully (~40s) and, after an auditory probe, report their mental content, choosing among a) absence of thoughts, b) stimulus-independent thoughts, c) stimulus-dependent thoughts and d) sensations. A univariate fMRI analysis revealed widespread cortical deactivations in the ACC, the calcarine cortex, the thalami, the R anterior insula, the precentral gyrus, and the L superior parietal lobule (voxel puncorrected<.001, cluster pFDR<.05). A contrast analysis comparing absence of thoughts with the remaining 3 states yielded deactivation in the angular gyrus (voxel puncorrected<.001). Finally, based on our a priori hypothesis of prefrontal deactivations, we opted for a Bayesian region-of-interest analysis on previously reported coordinates around the ACC/vmPFC, the L Hippocampus and Broca’s area: a linear model with different intercepts for each mental state and plausible priors Norm(0,1) for the intercepts provided better fit compared to the null model only at the ACC/vmPFC (FittedWAIC:-130.438<NullWAIC:-130.790), providing further evidence for prefrontal deactivations during non-induced MB. Principally, this effect was driven by differences between MB and stimulus-independent thoughts (median:-0.367, SD:0.168, HDI (0.025): -0.690, HDI (0.975):-0.028). Taken together, our results show that MB is linked to widespread thalamocortical deactivations. Honing in on the differences between MB and the other mental states, we uncovered unique contributions of the angular gyrus. As this region is widely implicated in semantic processing and mentation during rest, we propose that the observed deactivations are the neural counterpart of our inability to formulate mental content. Finally, an examination of previously reported frontal sites followed the hypothesis of frontal disengagement during MB. This further supports the idea of distinct cortical contributions during self-induced and spontaneous MB. In conclusion, we propose that MB may originate from multiple avenues during ongoing experience, capturing brief periods of mental absences where we cannot evaluate and formulate our thoughts coherently.

Model-based approach for extracting performance-independent metacognitive sensitivity from meta-learning data

Nora Bradford (University of California, Irvine), Megan Peters (University of California, Irvine), Brian Maniscalco (University of California, Irvine)

Concurrent Session: Metacognition, Friday June 23rd, Classroom 206, 12:00pm-12:15pm

Metacognition, or reflection on our own thoughts, is important for learning. Research has shown that many students struggle with accurately assessing their own performance and making smart study decisions based on their knowledge. It has been claimed that students whose metacognition, measured by confidence judgments or point wagers, accurately reflects their performance are more successful in the classroom. Unfortunately, however, existing analytical practices in education research tend not to control for performance and metacognitive bias, which has led to contaminated measures of metacognitive sensitivity and, therefore, unclear results in education-based studies. In perceptual and lab-based memory research, these two factors can be controlled for via a measure called meta-d’, which measures metacognitive sensitivity (the relationship between confidence and task accuracy) on the same scale as actual performance capacity (d’), thereby allowing correction for different performance capacities across conditions or individuals. However, thus far this measure has only been used in laboratory settings, due to its analytical constraints of requiring questions to have only 2 choice alternatives and a large number of trials at a given difficulty level per participant. Finding a way to bring this method – or an approach similarly motivated to control for performance capacity – from the lab into the classroom could reveal fundamental insights into the efficacy of metacognitive training in real world settings and, consequently, drive development of more effective teaching strategies. In this project, we are developing a model-based approach to correct for type-1 performance capacity and confidence bias in real-world, education-based metacognitive data. The model flexibly accounts for datasets with multiple choice questions, varying engagement with confidence reporting, and varying trial counts to estimate metacognitive noise (metacognitive inefficiency) for each subject. Ongoing research seeks to test the model using secondary datasets from metamemory and meta-learning experiments. Bridging these two domains of metacognitive research – the lab and real-world settings – is imperative in gaining a full understanding of how metacognition affects learning across performance levels, and eventually how its positive effects can be maximized.

Signal detection measures can (!) distinguish perceptual biases from response biases

Marianne Broeker (University of Oxford), Dr. Paul Azzopardi (University of Oxford)

Concurrent Session: Methods and Measures, Saturday June 24th, Classroom 220, 2:00pm-2:15pm

A common assumption when looking at visual after effect or other perceptual effects is that these are purely perceptual and will be reflected in changes of d' or correspondingly meta d', when coupled with the awareness of that perceptual change or bias. Against that common assumption, Witt et al. (2015) argued in their paper that Signal detection measures cannot discriminate between perceptual biases, such as a motion aftereffect, and criterion setting, hence response bias. They propose that an effect on perception may effect measured bias instead of d'. If it effects bias, there would consecutively be no way to discern perceptual bias, for instance to measure the strength of a motion after effect, and response bias, such as internal criterion setting. Hence, we would not be able to tell to what extent a perceptual effect is purely perceptual and not conflated with response bias. Especially when using perceptual bias in psychopathology or perceptual tasks, to discriminate between the two is crucial and can lead to incorrect results when neglected. In our paradigm, we propose a task design and modelling approach that dissociates perceptual bias, here in the form of a motion after effect illusion, from response bias. Using a motion after effect illusion, induced by moving spirals, we show that measuring the strength of the motion after effect with d' as well as with psychometric functions and models building on psychometric functions, such as Bayesian models, is conflated with responses, hence criterion setting bias, which has never accounted for in previous studies.   , With a dissociation in the task design, presenting the task as 1-Interval (1AFC) and 2-Interval (2AFC) and b.) by controlling for the additional noise of the two 2-AFC with a SDT vs. a Bayesian modelling approach, we were able to dissociate pure perceptual bias from response bias within a motion after effect illusion, which represents a broader class of task unfolding around perceptual biases. Additionally, we modelled confidence responses, as a proxy of awareness, to test whether confidence ratings are closer aligned with the purely perceptual bias or with the criterion setting bias. We find that circumventing the criterion setting process, and controlling for additional 2-AFC induced noise, strongly and significantly enhances perceptual bias effects.The paradigm has firstly being established with health controls (n = 50), but will be tested with a clinical group (psychosis) shortly.

A HOROR Theory for Introspective Consciousness

Richard Brown (LaGuardia and City University of New York), Adriana Renero (New York University and City University of New York)

Concurrent Session: Theories and Models, Sunday June 24th, Classroom 218, 10:30am-10:45am

Higher-order theories of consciousness typically account for introspection in terms of one's higher-order thoughts being conscious, which would require a third-order thought—i.e. a thought about a thought about a mental state. In this work, we offer an alternative account of introspection that builds on the recent Higher-Order Representation of a Representation (HOROR) theory of phenomenal consciousness. According to HOROR theory, phenomenal consciousness consists in having the right kind of higher-order representation. We claim that this theory can be extended to introspection by recognizing that there is a distinctive kind of consciousness—i.e. introspective consciousness—which can be accounted for as the theory does for phenomenal consciousness generally. We call this novel view: Higher-Order Representation Intentionally for Introspective Consciousness (HORIFIC). We argue that there are independent reasons for thinking that introspective consciousness can be either 'stimuli-induced' or 'self-triggered' and that one of the benefits of the view we develop is that it can embrace a pluralist approach. Our view also accounts both for which a specific mental state is represented by a particular higher-order representation, and for the way in which we are aware of changes, transitions, and boundaries between mental states in specific cases of introspective consciousness.

Animal Points of View in Spatiotemporal Structures of Experience

Simon Brown (Johns Hopkins University)

Concurrent Session: Animal and Infant Consciousness, Sunday June 24th, Classroom 220, 11:15am-11:30am

How can we characterize the phenomenal experience of an animal such as a bat, bird, or bee? , It is commonly assumed that if consciousness science can characterize an animal's experience, it will do so in two stages: identifying which mental states the animal has, and determining which of those are conscious. We might discover that bats use echolocation to form a representation of the location, and kind of nearby flying objects, and then use a well-confirmed theory of consciousness to tell us which of those representations are conscious — for example, it might be that some are globally broadcast, and that this is the mark of consciousness. , It is also common to suspect that any answer along these lines will be incomplete. Sometimes, this suspicion is articulated as the idea that science may identify which states are conscious, but not why. Sometimes it is articulated in terms of such answers leaving out qualia. I suggest that what such an account would really miss is the structure of the animal's experience. Using bees and corvids as case studies and building on insights in Akins (1993) and Birch et al. (2020), I show that structural aspects of experience are empirically tractable, and that investigating them alongside the first two stages can illuminate what it is like to be the animals in question. Two kinds of structure which could vary radically across species are the spatial structures of their sensory fields, and the temporal structure of their stream of experience. , The visual field can be structured in many ways across species, with different overall shapes and richer levels of detail in different parts of the field. Some variation results from such factors as the placement of eyes on the head and the distribution of different kinds of receptors: crows have more binocular overlap than other birds, while bees can detect the polarization of light in the upper part of their visual field. Debates about the richness of experience across the human visual field suggest many subtle factors, including filling-in and inflation, which imply that we cannot simply read off the structure of experience from the physiology or even sensitivity. However, we can gain insight into a creature's visual field through careful investigation, and when we do, this gives us considerable insight into what it is like to be them, of a different order to learning which stimuli they can consciously discriminate. It is also likely that the temporal structure of experience differs importantly between species. Bees' vision has higher temporal resolution than ours, and is possibly integrated over a shorter temporal window. Furthermore, their representation of broader temporal context is likely to be highly truncated compared to humans and to corvids, and may be more tied to circadian cycles. As with spatial structure, the temporal structure of animals' experience is empirically tractable, and investigating it may be key to characterizing their overall experience.

An Interdisciplinary Collaborative Report on Consciousness in AI

Patrick Butlin (Future of Humanity Institute, University of Oxford), Robert Long (Center for AI Safety)

Concurrent Session: Artificial Intelligence, Friday June 23rd, Classroom 204, 5:00pm-5:15pm

In the past year, we have assembled a group of around 25 consciousness scientists, philosophers and AI researchers to write a collaborative report on the prospect of consciousness in current and near-future AI systems. We held a workshop to discuss the first draft of this report in Oxford in December 2022. We are now preparing the second draft, and we intend to publish the report before ASSC 26. This talk will present some results from the project. The report aims to convince readers that artificial consciousness is a serious topic for scientific inquiry. We suspect that many engineers working in AI labs believe that consciousness cannot be studied scientifically, or that conscious AI is too unlikely a prospect to take seriously; we hope that our report will convince them otherwise. A further aim is to provide a foundation and impetus for future research on the topic. We focus on the issue of whether AI systems might meet conditions for consciousness drawn from scientific theories, partly because we judge that this theory-driven approach is more promising than an approach focusing on behavioural tests. In the first part of the report, we present leading scientific theories of consciousness and consider how their conditions could be met by AI systems. There is particular interest at present in how a global workspace might be implemented in AI (Bengio 2017, VanRullen & Kanai 2019, Goyal et al. 2022) and whether existing systems might already do so (Juliani et al. 2022). We analyse and build on this work, as well as considering how AI systems might meet the conditions of other theories, such as perceptual reality monitoring theory (Lau 2022) or attention schema theory (Wilterson & Graziano 2021). This section also considers possible 'background conditions' for consciousness, such as agency and embodiment. The second part of the report sketches an AI system which could plausibly be built in the near future and would plausibly be conscious. This sketch synthesises the conditions for consciousness identified in the first part. Our aim here is to show how the conditions relate to one another in practice and to give a concrete illustration of the kind of system which would, in our collective view, be a good candidate for consciousness. In this part we also briefly discuss arguments for and against consciousness in some notable current systems. Finally, we discuss the significance of our work. If conscious AI systems are a realistic prospect there is a pressing need to consider their moral status. But meanwhile, it is likely that in the near future many people will come to believe on highly questionable grounds that AI systems with which they interact are conscious. For both of these reasons, more well-informed research and public engagement work on consciousness in AI, which draws on the best available science, is urgently needed. Our project serves as a proof of concept for such work; we call for further efforts on these lines from members of ASSC.

Decoding spontaneous and voluntary imagery in the visual cortex of aphantasics and non-aphantasics

Giulia Cabbai (Sussex Neuroscience, School of Psychology, University of Sussex), Chris Racey (School of Psychology, University of Sussex), Carla Dance (School of Psychology, University of Sussex), Julia Simner (School of Psychology, University of Sussex), Jamie Ward (School of Psychology, University of Sussex), Sophie Forster (School of Psychology, University of Sussex)

Concurrent Session: Imagery and Mind Wandering, Friday June 23rd, Classroom 220, 6:00pm-6:15pm

Mental imagery has classically been conceived and investigated as voluntary and intentional, however, in everyday life, its occurrence is often involuntary. It can range from intrusive, negative images to spontaneous images elicited by stimuli in another sensory modality. While brain regions involved in voluntary imagery have been extensively explored, the neural correlates of spontaneous imagery are still understudied. Moreover, differences between voluntary and spontaneous imagery-related brain activity between people with and without imagery (aphantasics) have not been reported yet. In the present fMRI study, we investigated the role of the primary visual cortex (V1) in spontaneous and voluntary visual imagery and how this varies between individuals. To elicit visual imagery we employed different natural sounds (e.g. dog barking) which participants listened to while blindfolded in the scanner. The sounds were pre-selected through extensive piloting based on their evocative power of imagery. During the main experimental session, 24 aphantasics and 26 non-aphantasics listened to the evocative natural sounds and subsequently rated the degree to which they spontaneously experienced visual mental imagery in response to them (spontaneous imagery condition). Participants were then asked to rate voluntary imagery vividness for each natural sound, before listening to the sounds again while simultaneously generating visual imagery of the sounds' content (voluntary imagery condition). Our results show that it is possible to decode information about different natural sounds in V1 during both spontaneous and voluntary imagery. Furthermore, in non-aphantasics decoding in V1 was positively associated with the subjective vividness of both spontaneous and voluntary imagery, suggesting that the decoding performance reflected mental imagery. In this group, voluntary imagery decoding accuracy in V1 was greater than spontaneous imagery, and it was also greater than that of aphantasics. Notably, however, decoding was also successful during both spontaneous and voluntary imagery conditions in aphantasics, despite these participants reporting no subjective imagery in either condition. Our findings hence establish a common role of V1 in voluntary and spontaneous mental imagery, while also suggesting that V1 activity alone may not be sufficient to produce the conscious experience of imagery.

Conscious processing of global and local auditory irregularities causes differentiated heartbeat-evoked responses

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Concurrent Session: Body and Embodiment, Sunday June 24th, Classroom 206, 10:45am-11:00am

Detecting residual consciousness in brain-injured patients without relying on overt behavior remains a clinical challenge. Recent research in brain-injured and healthy subjects suggests that brain-heart interactions are associated with perceptual and self-consciousness. In this line, the neural responses to visceral inputs have been hypothesized to play a leading role in shaping our subjective experience. In this study we aimed to investigate whether the contextual processing of auditory irregularities modulates both direct neuronal responses to the auditory stimuli (ERPs) and the neural responses to heartbeats, as measured with heartbeat-evoked responses (HERs). ERPs and HERs were computed in patients with disorders of consciousness, diagnosed with a minimally conscious state (MCS) or vegetative state/unresponsive wakefulness syndrome (VS/UWS). We tested whether HERs reflect conscious auditory perception, which can potentially provide additional information for the consciousness diagnosis. EEG recordings were taken during the local-global paradigm, which evaluates the capacity of a patient to detect the appearance of auditory irregularities at local (short-term) and global (long-term) levels. The results show that local and global effects produce distinct ERPs and HERs, which can help distinguish between MCS and VS/UWS patients. Furthermore, we found that ERPs and HERs responses were not correlated suggesting that independent neuronal mechanisms are behind them. These findings suggest that HER modulations in response to auditory irregularities may be used as a novel neural marker of consciousness and may aid in the bedside diagnosis of disorders of consciousness with a more cost-effective option than neuroimaging methods.

Can we discard sentience-based ethics?

Daniel Cappell (Northern Illinois University)

Concurrent Session: Ethics, Value, Valence, Pain, Saturday June 24th, Classroom 206, 2:30pm-2:45pm

Investigation into whether an entity is phenomenally conscious carries great practical significance. For example, evidence that a particular animal, machine, or comatose patient is sentient—that is, has the capacity for phenomenal experience such as that of pleasure or pain—seems to have urgent legal, political, or clinical implications. Consequently, neuroscientific authorities declare such findings to broader society, such as in the “Cambridge Declaration” (Low et al. 2012). One salient view is that ethical considerations always have something to do with sentient beings. While such a sentience-based view of ethics is a mainstay (as suggested by endorsement from figures as diverse such as Korsegaard, Singer, Einstein, and Schrödinger), this view is challenged, particularly by those advocating illusionist theories of consciousness (e.g. Kammerer 2022, Lee 2019, Humphrey 2006, Dennett 1991). However, I argue that sentience-based ethics is still a formidable position. First, I address challenges to sentience-based ethics. Some have proposed ethical considerations not having to do with sentience (e.g. Kammerer 2020, Kagan 2019, Routley 1973), but I show these proposals are contaminated by biases: phenomenal embellishment, where appeals to phenomenal consciousness are snuck in, or by sympathetic magic (a la Rozin et al. 1986) where something is unjustifiably assumed to be ethically similar to a sentient being because of superficial resembelences. Furthermore, I rebut three challenges that Kammerer (2022) raises for sentience-based ethics. Kammerer plausibly argues that sentience-based ethics lead to difficulties in determining the ethical status of indiviudal animals, but I show that competing ethical positions suffer the same uncertainties. Kammerer also argues that beause phenomenal consciousness would likely be indeterminate, moral properties would be unacceptably indeterminate in a sentience-based view. I respond that this issue can be avoided insofar as one holds an independently-motivated view that some conscious entities do not require ethical consideration. Lastly, Kammerer argues that, under reductive materialism, we are greatly mistaken about the nature of our phenomenal states, and thus unjustified in attributing ethical significance to them. I argue, however, that ethics is thoroughly laden with phenomenal concepts, so Kammerer’s claims have implausibly wide import. I argue that sentience-based ethics best accounts for why exemplars of ethical frameworks, like deontology and consequentialism, most readily produce norms in reference to sentient individuals, and that only sentience-based ethics accounts for the extreme badness of the suffering of sentient beings. In conclusion, I assess the influence of sentience-based ethics on the normative challenge for illusionism (Kammerer 2020), and propose that sentience-based ethics is promising because it strongly implies that developments in consciousness science can enrich ethical deliberation.

Regaining sight after zolpidem: a problem of access consciousness or a new conscious state?

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Concurrent Session: Disorders of Consciousness 2, Saturday June 24th, Classroom 214, 2:30pm-2:45pm

We present the case study of a 64-years old patient with chronic acquired hemianopia following an occipital stroke, who shows transient visual improvement upon intake of zolpidem. Zolpidem is a GABAA agonist used as a sleeping drug that in some individuals induces a paradoxical increase in arousal. Previously, we showed in this patient an increased FDG-PET occipital metabolic level after zolpidem intake, suggesting a re-activation of vision-processing regions, and a small decrease in metabolic rate in the frontal cortex, supporting the involvement of high-level cognitive processes. Here, we aimed to disentangle if the amelioration of sight was sensory- (restoration of bottom-up occipital processing) or rather attention-mediated (top-down frontal process). We investigated the mechanisms of this phenomenon via neuropsychological testing, EEG, and tDCS. We tested for neglect before and after zolpidem. We recorded high-density EEG 1) at baseline, 2) after taking zolpidem (effects increasing), 3) when the effects were stable, and 4) when the effects were fading away. We calculated regional Lempel-Ziv complexity (LZC) and whole-brain alpha power and centrality. Finally, we targeted the occipital cortex with anodal, cathodal, and sham tDCS without zolpidem to simulate the effects of the drug. Vision was assessed with an automated static visual perimetry and self-report. The neuropsychological examination found a low probability of neglect. Compared to baseline, the EEG after zolpidem showed lower whole-brain alpha power and centrality, and higher LZC in parietal and occipital regions. When the effect of zolpidem was rising, we observed a decrease in occipital alpha concurrent with sight improvement. We did not observe an increase of alpha while zolpidem effects were fading and vision was lost. Regarding tDCS, the patient reported sight recovery (less than zolpidem) with both anodal and cathodal occipital stimulation (strongest effect after cathodal stimulation). Nevertheless, the patient reported visual amelioration following sham stimulation, although shorter and weaker. While the neuropsychological assessment suggests the phenomenon is unlikely caused by attentional modulation, assessment of attention via visual stimuli is challenging due to hemianopia. EEG results hinted at a possible role of alpha: high alpha is a hallmark of consciousness, as well as a sign of active attentional inhibition. Whether the decrease of alpha causes the regain of vision (absent top-down inhibition) or the way around (higher bottom-up processing), is difficult to establish. The increase in complexity is in line with expectations of a richer phenomenological state. While occipital tDCS partially reproduced zolpidem effects, sham stimulation demonstrated a concurrent psychological component. Altogether the results draw a complex picture of this phenomenon, suggesting that while the primary force of restoration of sight is low-level, there might be a higher-level component.

Using meditation and psychedelic science to examine dimensions of consciousness

Olivia Carter (University of Melbourne), Toby Woods (Monash University), Jennifer Windt (Monash University), Tim Bayne (Monash University)

Concurrent Session: Altered States of Consciousness, Saturday June 24th, Classroom 210, 3:15pm-3:30pm

The study of altered states of consciousness has long had the potential to provide important insight into the nature of consciousness. In recent years there has been a resurgence of research and public interest in atypical or altered states of consciousness. These have focused both on conditions in which consciousness is impaired due to brain trauma or enhanced in some way through meditation or ingestion of psychedelics. This presentation focuses on the latter as an avenue to examine the relationship between different features of consciousness in altered states, with the aim of addressing current debates regarding the uni-dimensional vs multi-dimensional nature of consciousness. First, we identified key changes in perceptual and cognitive function associated with the acute phase of psychedelic drug use (psilocybin and LSD) measured through lab-based experiments and subjective psychometric scales (Bayne & Carter 2018). We then used an evidence synthesis approach to systematically select and review 135 expert texts within 3 traditions (Shamatha, Transcendental and Stillness Meditation) to identify 65 features reported or implied in one or more practice (Woods, Windt & Carter 2022). Finally, we compared the psychedelics and meditation findings. Some interesting commonalities were found to exist relating to experiences of unity and loss of ego as well as more mundane but central features of experience such as wakefulness. However, striking differences were also identified between the psychedelic and meditation states. Most notably the intensity and diversity of perceptual imagery and conscious contents experienced was found to be increased by psychedelics whereas these elements were greatly reduced or absent in meditation states. Similarly in the case of cognition, the psychedelic state was associated with disorganisation, diversity and rapidity of thought, while the meditation state was characterised by a stillness of mind with a complete absence of thoughts. Together these findings suggest that i) the psychedelic state does not mimic the goal states of expert meditators and ii) considering either or both of these states as "higher" or "enhanced" is inappropriate. In conclusion we argue that this analysis provides further evidence that a multi-dimensional conception of consciousness states enables a more nuanced and accurate framework to investigate and understand consciousness.
Bayne, T. & Carter, O. Dimensions of consciousness and the psychedelic state, Neuroscience of Consciousness, Volume 2018, Issue 1, 2018, niy008, https://doi.org/10.1093/nc/niy008 Woods, T.J. Windt, J.M. & Carter, O. Evidence synthesis indicates contentless experiences in meditation are neither truly contentless nor identical. Phenom Cogn Sci (2022). https://doi.org/10.1007/s11097-022-09811-z,

Does the current evidence for unconscious processing invalidate a clinical assessment of consciousness based on behaviour?

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Concurrent Session: Disorders of Consciousness 2, Saturday June 24th, Classroom 214, 2:45pm-3:00pm

Recent claims have argued that behaviour and cognitive functions can be, and often are, dissociated from consciousness. These allegations, which at first glance may seem confined to a purely academic debate, carry dramatic implications for patients with disorders of consciousness (DOC). The current gold standard for diagnosis of these patients is in fact based on the identification of cognitively mediated behaviours; if claims supporting such marked dissociation prove true, the use of behavioral tests to assess consciousness at the bedside would have to be discarded, with major consequences for treatment choices and end-of-life decisions. We reviewed the current literature supporting these claims and identified three main kinds of methodological confounds that potentially invalidate any conclusions: 1) the use of consciousness rating scales that were not validated against subjective reports to accurately track changes in phenomenology; 2) post-hoc data selection and/or over-reliance on a failure to reject the null hypothesis; and 3) a failure to consider alternative explanations for a dissociation between awareness ratings vs. behavioural/cognitive scores (such as differences in response bias and/or task demands). When examining studies free of these biases, a picture seems to emerge in which behaviour and cognitive functions are closely associated with consciousness: when no subjective experience of the stimuli is reported, using appropriate awareness scales validated against subjective reports - e.g. the Perceptual Awareness Scale (PAS) – performance is at chance. Similar conclusions are reached by studies circumventing the aforementioned statistical pitfalls by resorting to alternative statistical models (e.g. Bayesian). , These findings hold significant implications for bedside consciousness detection, theories of consciousness and cognitive science in general: 1) they validate the current gold-standard for the bedside diagnosis of DOC patients which is currently based on the detection of cognitive-mediated behaviours; 2) they seem to corroborate theoretical predictions of certain theories of consciousness while disproving others': e.g. while the Global Neural Workspace Theory of Consciousness predicts a strong dissociation between behaviour/cognitive functions and consciousness, Information Integration Theory predicts that while they can in principle dissociate in artificial machines, consciousness and purposeful behaviors should be closely associated in biological systems. 3) If it was indeed confirmed that, far from an epiphenomenon, consciousness is a prerequisite for most if not all purposeful behaviors humans can perform, consciousness mechanisms would have to be explicitly integrated into any cognitive framework, ending the current separation between consciousness and cognitive sciences.

Amplitude modulation of sound implicitly biases perception as music or speech

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Concurrent Session: Perception, Friday June 23rd, Classroom 206, 5:30pm-5:45pm

Music and speech are complex and distinct auditory signals that are foundational to the human experience. The mechanisms underpinning each domain are widely investigated. However, what acoustic information is in fact required to distinguish between them remains an open question. Here we tested the hypothesis that a sound's amplitude modulation (AM) rate is a critical implicit acoustic feature. If the hypothesis is true, the artificially generated perceptually ambiguous noise-synthesized audio signals should be categorized as music or speech according to their AM parameters. The participants were instructed that the audio stimuli were converted from realistic music or speech recordings, and they were asked to judge them as either music or speech. Across four experiments (N = 335), excerpts with a lower peak AM frequency (< 2 Hz) and higher temporal regularity tend to be judged as music; the opposite holds for speech. Furthermore, the effect of peak AM frequency is associated with musical judgements, especially among musically sophisticated participants. The data suggest that the auditory system implicitly relies on a low-level acoustic property as basic as AM to distinguish music from speech, a surprising principle that provokes both neurophysiological and evolutionary experiments and speculations.

Dual-task paradigm reveals unconscious speech perception during Inattentional Deafness

Gal Chen (Hebrew University of Jerusalem), Ran Hassin (Hebrew University of Jerusalem), Leon Deouell (Hebrew University of Jerusalem)

Concurrent Session: Perception and Attention, Saturday June 24th, Classroom 204, 2:30pm-2:45pm

The study of consciousness and unconscious processing has prospered during recent decades. Yet, an overwhelming majority of the studies examined unconscious perception only for visual stimuli, which limits our understanding of both non-visual domains and unconscious processing. Only a few studies examined unconscious speech perception, despite the crucial role speech plays in our daily lives. These studies relied on the degradation of the auditory stimulus and did not find evidence for semantic processing. Here, we examine a novel paradigm that relies on cross-modality dual tasks, and allows multiple measurements of spoken words during inattentional deafness. Our paradigm includes a visual task while a stream of pseudowords was played in the background. Another task was answering subjective and objective questions regarding the presence of real Hebrew words that were embedded in the stream. We show that, under those conditions, subjects experience Inattentional Deafness – they miss a substantial amount of the task-relevant spoken words, which were validated to be completely audible and not subliminal. In four behavioral and two EEG experiments, we examined which contents are prioritized to consciousness and the neural processes involved in the conscious detection of spoken words. We provide the first evidence that semantic factors can play a role in the unconscious prioritization of speech – prioritization by word valence. Unintuitively, people tend to hear more neutral, compared to negative words. We found a consistent and highly replicable influence of word valence, which dissociated from the influence of valence when subjects were attentive to the words without performing a dual task. The effect held when controlling for possible confounds linguistic and low-level confounds. It suggests that unconscious processes dissociate from the perception of attended speech and the visual modality. We present this paradigm as the first tool to study consciousness and unconscious perception of undegraded speech while relying on inattentional deafness. It can be further used to explore the perception of unknown factors (e.g. different languages, pitch, emotional prosody) in the absence of awareness. This study highlights the importance of studying unconscious processes and consciousness with speech, revealing novel effects and challenging the current body of knowledge on unconscious processing.

How to Compare and Falsify Theories of Consciousness: A Novel Method for Inter-theoretic Empirical Translations

Robert Chis-Ciure (International Center for Neuroscience and Ethics, Madrid, Spain), Georg Northoff (Institute of Mental Health Research, University of Ottawa, Canada)

Concurrent Session: Comparing Theories of Consciousness, Friday June 23rd, Classroom 210, 5:45pm-6:00pm

Explaining consciousness is perhaps the holy grail of 21st-century science. Its scientific study registered an exuberant growth of theories with disconcerting variability in methodologies, what is to be explained, and the concepts, formalisms, mechanisms, and empirical measures that explain (Northoff & Lamme, 2020; Seth & Bayne, 2022). Nevertheless, this growth and heterogeneity might be malignant and an obstacle when comparing them as each idiosyncratically develops its framework, methodology, and measures. Indeed, several authors raise the worry that theories of consciousness continue a siloed coevolution without cross-talk and with minimal points of explicit and testable comparison. The field seems highly biased toward confirmatory rather than disconfirmatory evidence of any given theory, exhibiting a strong focus on single theories (Yaron et al. 2022). Moreover, theory-driven studies aiming to evaluate a theory's predictions empirically are meager, with one-versus-one setups the scantiest of all. To alleviate some of these worries, many established researchers strongly emphasize the need for empirical discrimination between theories, which amounts to distilling currently tractable predictions and testing them head-on in an adversarial collaboration fashion (Reardon, 2019). Consciousness science would greatly benefit from targeting the methodological problem of designing experiments to assess and compare different theories. Therefore, this project aims to establish a framework for testing specific hypotheses involving direct inter-theoretic empirical comparison. Our initiative complements and expands some recent proposals at pitting theories against each other (Melloni et al. 2021). We put forward an experimental program and novel methodology to distinguish between theories of consciousness that are candidates for becoming the paradigm-theory of the field. It primarily involves elaborating and implementing experiments in which conflicting predictions made by the theories are analyzed against the same data sets to (in)validate some. The project’s first iteration targets the Integrated Information Theory (Albantakis et al. 2022), Global Neuronal Workspace (Mashour et al. 2020), and the Temporospatial Theory of Consciousness (Northoff & Zilio, 2022), with a systematic focus on empirical measures. Specifically, the conceptual innovation is that we take theory-specific measures from each framework and generalize them to the others to distill determinate empirical predictions. For example, we translate IIT’s native Lempel-Ziv Perturbational Complexity Index or TTC’s Autocorrelation Window in the other two frameworks, discussing testable hypotheses these theories could make for those measures. In other words, some inter-theoretic “empirical translations,” in which measures proposed by a theory are also considered in the context of the others, give the foundation of an arena where they are put in direct opposition.

Postdictive Explanations?

Philippe Chuard (Philosophy Dept. SMU)

Concurrent Session: Philosophical Foundations, Friday June 23rd, Classroom 220, 12:15pm-12:30pm

In the past decade, philosophers and psychologists have developed what they've called "postdictive explanations" for various conscious perceptual phenomena (flash-lag effect, visual asynchrony, backward masking, iconic memory, etc.). One striking aspect of such proposals is that many appear to operate on the assumption that the existence of postdictive mechanisms was well-established by Eagleman & Sejnowski's (2000) influential explanation of the flash-lag effect. They aim to extend such postdictive explanations to other perceptual phenomena. I want to highlight three difficulties facing this assumption:, (a) many such proposals do not mean by "postdictive" what is distinctively postdictive in Eagleman & Sejnowski's account of the flash-lag effect, by virtue of which it demarcates itself from rival accounts of the flash-lag effect. There seems to be at least four different senses of "postdictive" used across such proposals, only one of which latches onto the kind of substantive postdictive mechanism posited by Eagleman & Sejnowski. It might help if we distinguished between Big-p Postdictive mechanisms and little-p postdictive mechanisms. The problem is that the latter seem to trivialize what it means to be "postdictive": in most of these senses, all rival accounts of a given perceptual phenomenon will end up being postdictive; in some of them, large swaths of information-processing mechanisms in the visual cortex will too. (b) Eagleman & Sejnowski's case for a postdictive explanation of the flash-lag effect relies essentially on the argument that rival accounts—such as Nijhawan's motion-extrapolation account, or Ögmen et al.'s differential latency account—cannot properly explain why there is a flash-lag effect in the flash-initiated condition, but not in the flash-terminated condition. Yet, both alternatives, it's been shown, can accommodate these alleged difficulties. Worse, there's evidence that the postdictive "motion-biasing" mechanism, which is central to Eagleman & Sejnowski's revised approach to the flash-lag effect, cannot apply in some cases of motion. Moreover, such mechanism has little explanatory purchase when it comes to cases of the flash-lag effect without motion, or where both the target and flashed stimuli are moving. Nor can it explain the flash-lead case. (c) The distinctively postdictive "motion-biasing" mechanism at the heart of Eagleman & Sejnowski's account is not easy to characterize for the following reasons. Under one natural characterization, it seems to imply that processing of the location of a moving stimulus is impossible. Under another, it is possible but seems to imply that moving stimuli should look rather "jumpy", and implausibly so. On a third, it fails to achieve the kind of advantage Eagleman claims on its behalf. In this short presentation, I will only be able, at best, to outline (a) and some of the difficulties in (c).

Back to Square One: the Bodily Roots of Conscious Experiences in Early Life

Anna Ciaunica (University of Lisbon), Adam Safron (Johns Hopkins University)

Concurrent Session: Animal and Infant Consciousness, Sunday June 24th, Classroom 220, 10:30am-10:45am

Most theoretical and empirical discussions about the nature of consciousness are typically couched in a way that endorses a tacit adult-centric and vision-based perspective. This paper defends the idea that consciousness science may be put on a fruitful track for its next phase by examining the nature of subjective experiences through a bottom-up developmental lens. We draw attention to the intrinsic link between consciousness, experiences and experiencing subjects, which are first and foremost embodied and situated organisms essentially concerned with self-preservation within a precarious environment. Our paper suggests that in order to understand what consciousness 'is', one should first tackle the fundamental question: how do embodied experiences 'arise' from square one? We then highlight one key yet overlooked aspect of human consciousness studies, namely that the earliest and closest environment of an embodied experiencing subject is the body of another human experiencing subject. We present evidence speaking in favour of fairly sophisticated forms of early sensorimotor integration of bodily signals and self-generated actions already being established in utero. We conclude that these primitive and fundamentally relational and co-embodied roots of our early experiences may have a crucial impact on the way human beings consciously experience the self, body and the world across their lifespan.

Dissociation between conscious and unconscious self-face processing in Developmental Prosopagnosia: evidence from Binocular Rivalry and breaking-Continuous Flash Suppression

Tommaso Ciorli (University of Turin), Claudia Pulcini (University of London, Goldsmiths), Ashok Jansari (University of London, Goldsmiths), Lorenzo Pia (University of Turin)

Concurrent Session: Unconscious Processes, Sunday June 24th, Classroom 204, 11:00am-11:15am

Our own face has privileged cognitive processing, both in conditions of visual awareness or unawareness (Tong & Nakayama, 1999; Bola et al. 2021), and recent evidence seems to suggest that the self-face advantage might rely on different brain mechanisms when stimuli are consciously or unconsciously perceived. Previous research support for holistic face processing before awareness (Axelrod et al. 2015), and a work which found self-face prioritization in conscious access suggested that unconscious face discrimination might not depend on configural processing (Geng et al. 2012). Moreover, unconsciously perceiving self-other faces was found to activate subcortical areas such as the Ventral-Tegmental Area (self) and the Amygdala (other; Ota & Nakano, 2021). Indeed, face familiarity processing is not only related to memory and perceptual systems, but involves also affective factors. It has also been suggested that, whereas the cortical pathway relies on more complex identity processing, the subcortical one relies on fast and coarse holistic processing evaluating whether a face is novel or not (Nakano et al. 2013). An open question is whether the conscious and unconscious self-face advantages are anatomo-functionally dissociable. To test this, we recruited 4 patients (F=4; Age=47.8 ± 11.3) with developmental prosopagnosia (DP - impairment in explicit face identity recognition, but spared implicit identity processing; Tranel & Damasio, 1985). All 4 patients showed deficits in face memory test (CFMT), among which 2 had impaired also face perception (CFPT). To test for dissociations between unconscious and conscious face discrimination, patients were administered a breaking-Continuous Flash Suppression task (bCFS) in which the timing for visual awareness of self vs other face stimuli was assessed, and a Binocular Rivalry (BR) task to assess conscious perceptual prioritization of such face stimuli. We hypothesize a faster access to consciousness of the self-face compared to stranger faces in the bCFS, but no effects on conscious predominance in BR. CFPT score clusterization revealed, in bCFS, a self-face unconscious prioritization in the below cut-off group ($p<.05$), while no prioritization was observed in the other group ($p=.37$). In BR, both groups revealed no conscious prioritization for the self-face ($p=.72$). Results shows that unconscious face identity discrimination is preserved only in the DP subtype without face-perception deficits, suggesting that unconscious face perception might be independent from memory-based face processing. However, this was not the case when stimuli were consciously perceived. This seems to suggest a dissociation between memory based DP and memory/perception based DP on unconscious face processing, and a dissociation between conscious and unconscious face identity processing in DP. These findings provide insights into the relation between self-face processing and visual awareness from a neuropsychological perspective,

Well-Formed N2 Sleep Architecture is Associated with a Higher Likelihood of Cognitive Motor Dissociation

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Concurrent Session: Sleep, Dreaming, Anesthesia, Friday June 23rd, Classroom 204, 11:00am-11:15am

Background and Purpose , Loss of N2 sleep architecture has been associated with more severe encephalopathy and higher odds of death in ICU patients, while the presence of sleep spindles has been suggested to predict better functional outcome and mortality. Similarly, cognitive-motor dissociation (CMD) detected on EEG has been associated with a markedly different recovery trajectory in acutely brain injured patients. We aimed to assess the relationship between the presence of N2 sleep architecture and CMD. Methods , In this observational cohort study, we prospectively studied 210 unresponsive patients with acute brain injury from 07/2014- 09/2022. Machine learning was applied to EEG recordings to identify CMD by detecting brain activation in response to verbal commands. The EEG recording from 19:00-07:00 the night prior to CMD testing was assessed for sleep background features, and the presence of N2 sleep architecture. Results, A total of 498 EEG segments were reviewed, 43 of which were excluded secondary to presence of significant artifact or if missing >4 hours of the targeted time block. When compared to patients with absence of sleep elements or with burst-suppression pattern, patients with rudimentary or well-structured elements of NREM had higher odds of having CMD (6/95 without sleep architecture versus 20/115 with sleep architecture; OR 3.1, 95%-CI 1.2-8.2, p=0.014). Assessing specifically for the presence of sleep spindles, CMD was present in 6% (6/97) without sleep spindles, 3% (1/31) with rudimentary sleep spindles, and 23% (19/82) with well-formed sleep spindles (OR 5.2 for CMD with well-formed sleep spindles, 95%-CI 2.1-13.1, p=0.00015). Conclusion , Patients with well-formed sleep spindles had a higher likelihood of CMD positivity than those without; assessment of sleep architecture may increase the pre-test probability of CMD detection. Intact, well-formed sleep architecture implies integrity of the thalamocortical projections; these results suggest that a similar mechanism may play a role in the presence of CMD.

The value of consciousness

Axel Cleeremans (Université libre de Bruxelles), Catherine Tallon-Baudry (Ecole Normale Supérieure)

Concurrent Session: Ethics, Value, Valence, Pain, Saturday June 24th, Classroom 206, 2:15pm-2:30pm

Why would we do anything at all if the doing was not doing something to us? In other words: What is consciousness good for? Does phenomenal experience have a function? Surprisingly, perhaps, many have answered “no”. In philosophy, epiphenomenalist and illusionist positions have gained strength, and so have panpsychist perspectives, which, while neither denying phenomenology nor its functions, paradoxically deflate it by ascribing it to all matter. The concept of free will has likewise been deconstructed to the point that it has become commonplace to think it simply does not exist. In psychology, while Freud’s influence has now waned, most relevant research nevertheless seems dedicated to documenting what we can do without awareness rather than because of it. This is reinforced by the stupefying advances of artificial intelligence research, which are suggestive that feeling things is simply unnecessary to carry out complex information processing. Finally, even consciousness research itself has fallen prey to deflationist views. The “search for the neural correlates of consciousness” — the main empirical program in consciousness research for over three decades — has been exclusively focused on identifying the neural basis of the differences between conscious and unconscious processing, so eluding the essential fact that experiences cannot exist independently of the subject whose experiences they are. Contra such views, we propose that subject-level experience—‘What it feels like’—is endowed with intrinsic value, and that it is precisely the value agents associate with their experiences that explains why they do certain things and avoid others. And because experiences have value and guide behaviour, consciousness has a function. Congruently, Block (2023) writes, about Global Workspace Theory, that “[..] it may be conscious phenomenology that promotes global broadcasting, something like the reverse of what the global workspace theory of consciousness supposes.” Perhaps then, is it the case that the functions associated with consciousness are a consequence, rather than the cause, of phenomenal experience. Under this hypothesis of ‘phenomenal primacy’, we argue that it is only in virtue of the fact that conscious agents ‘experience’ things and ‘care’ about those experiences that they are ‘motivated’ to act in certain ways and that they ‘prefer’ some states of affairs vs. others. As Siewert (1988) pointed out, few would accept to be zombified for a reward, for what would be the point? Thus, phenomenal experience might act as a mental currency of sorts that not only endows conscious mental states with intrinsic value but also makes it possible for conscious agents to compare vastly different experiences in a common subject-centred space—a feature that readily explains the fact that consciousness is ‘unified’. Our perspective perhaps makes the ‘hard problem’ of consciousness more tractable, since it may then be reduced to a problem about function.

An innovative approach to investigate the spatio-temporal dynamics of conscious vision

Elisabetta Colombari (University of Verona), Giorgia Parisi (University of Verona), Alessandra Tafuro (University of Verona), Sonia Mele (University of Verona), Chiara Mazzi, University of Verona and Silvia Savazzi, University of Verona

Concurrent Session: Neural Correlates of Conscious Vision, Friday June 23rd, Classroom 210, 10:30am-10:45am

The search for the Neural Correlate of Consciousness (NCC) is one of the unsolved problems of neuroscience. Although great efforts have been made to seek to answer this fundamental question, theories of neural basis of consciousness provide different and competing answers. The heterogeneity of the interpretations about the NCCs could be due to a methodological gap, since so far studies trying to unveil such neural correlates have employed techniques that can reach a high level of resolution only in one dimension (i.e. space or time). The present study aimed to move beyond these issues, elucidating the controversial search for the neural correlates of visual awareness using two different but complementary techniques: the Event-Related Optical Signal (EROS), that is an optical imaging technique which permits recording the fast optical signal related to the neuronal activity and the Electroencephalography (EEG), which allows recording the brain electrical activity elicited by a specific event with high temporal resolution. Thus, availing of these techniques, we seek to unravel the spatio-temporal dynamics occurring when a stimulus enters consciousness. To do so, participants' brain activity was recorded during the performance of a discrimination task by means of EEG and EROS in separate sessions. Results obtained contrasting neural activity occurring in Aware trials (i.e. trials in which the stimulus was perceived) with neural activity occurring during Unaware trials showed that extra-striate visual areas seem to play a dominant role in the emergence of a conscious visual percept. EROS results revealed that Aware vs. Unaware contrast elicited a significant increase of activation in the lateral occipital complex (LOC), an extra-striate area known to be involved in object recognition. Interestingly, such activity occurred in the temporal window of the ERP component commonly thought to represent the electrophysiological signature of visual awareness, i.e. the Visual Awareness Negativity (VAN), identified in the EEG experiment. EROS results also revealed that later on, activity in LOC was followed by significant activity in the primary visual cortex and in motor areas. In addition, Granger causality analysis was performed. This analysis unveiled that neural processes relating to conscious perception mainly originated in LOC and subsequently spread towards visual and motor areas. Taken together, the results of the present study suggest that when a stimulus enters consciousness it elicits a sustained activation in LOC. Granger causality results highlighted also that activity in LOC predicted activity both in striate and extra-striate areas and in motor areas, suggesting that these areas are involved in later stages of stimulus processing. Moreover, combining EROS and EEG results allowed to unveil that the sustained activation in LOC occurs in the temporal window of VAN, suggesting that LOC could represent a reliable neural correlate of consciousness.

Interrogating brain-body-behaviour interactions during fluctuations of attention and arousal

Andrew Corcoran (Monash Centre for Consciousness and Contemplative Studies, Monash University), Jakob Hohwy (Monash Centre for Consciousness and Contemplative Studies, Monash University), Thomas Andrillon (Sorbonne Université, Institut du Cerveau - Paris Brain Institute, Inserm, CNRS, Paris, France)

Concurrent Session: Body and Embodiment, Sunday June 24th, Classroom 206, 11:30pm-11:45pm

Subjective experience characteristically oscillates between periods of attentive task engagement and periods of spontaneous or interrupted thought. While lapses of attention are sometimes conceptualised as a shift from external, task-related processing to internal, self-related cognition, the neurophysiological mechanisms underpinning such events remain poorly understood. In this study, we investigated the dynamics of attentional regulation from an integrative brain-body-behaviour perspective. 23 healthy adults performed a Sustained Attention to Response Task in which they were instructed to withhold prepotent responses to infrequently-presented target stimuli. Task performance was interrupted at irregular intervals to elicit subjective reports of sleepiness and mental state (on-task, mind wandering, mind blanking). High-density electroencephalography (EEG), electrocardiography, and pupillometry were co-registered during the session. Response times to nontarget stimuli tended to slow and become more variable as participants felt less awake; signal detection theoretic measures of sensitivity and response criterion likewise decreased as a function of sleepiness. Independent of these effects, increased heart rate variability was associated with faster responding and decreased sensitivity and criterion. Mind wandering and mind blanking were associated with increased sleepiness and slowing of the heartbeat; however, mental state reports did not depend on heart rate variability. Preliminary analysis of the EEG revealed clear cortical evoked responses to the heartbeat, but no effect of mental state or sleepiness on these responses. However, sleep-like slow waves, a marker of the transition to sleep that has been associated with lapses of attention and mind wandering or mind blanking, covaried with cardiac dynamics. Together, these findings suggest that the behavioural and subjective correlates of task-disengagement may be driven by subcortical networks that regulate physiological arousal states, but do not necessarily imply the enhanced processing of internal (bodily) states.

The Role of Metacognition in Embodied Joint Decision Making

Nicolas Coucke (Université Libre de Bruxelles), Mary Katherine Heinrich (Université Libre de Bruxelles), Axel Cleeremans (Université Libre de Bruxelles), Marco Dorigo (Université Libre de Bruxelles)

Concurrent Session: Action, Decision, Volition, Friday June 23rd, Classroom 202, 11:30am-11:45am

Many of the choices that we make every day are made together with other people. How should we interact with others so as to optimize such collective decisions? Recent studies have highlighted the importance of sharing metacognitive judgments. That is, collective decisions have been shown to improve when people accurately estimate their own levels of confidence in their opinions and communicate those confidence levels to others. In most experimental paradigms, confidence is communicated explicitly, after which a joint decision is made. In most real-life decisions, however, people do not explicitly share their confidence levels; instead, people implicitly convey confidence during a continuous decision process. In this work, we present a new experimental setup that requires people to make collective decisions in the absence of explicit communication. Groups of 2, 3 or 4 individuals make a joint decision by moving their fingers towards one of several locations on a touch screen. We find that participants' initial opinions and confidence levels are both encoded in their actions, that is, in the speed, timing, and trajectory of their movement. We show that a group's collective accuracy surpasses the accuracy of individual judgments despite relying exclusively on implicit movement cues. These results suggest the importance of implicit metacognitive signals for joint decision making.

DREAM: A Dream EEG and Mentation database

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Concurrent Session: Sleep, Dreaming, Anesthesia, Friday June 23rd, Classroom 204, 10:30am-10:45am

Subjective experiences, or dreams, occur repeatedly throughout the night and during all stages of sleep. Electroencephalography (EEG) studies of dreaming are integral to the study of neurocognitive processes of human sleep and consciousness. However, we still struggle to determine, based solely on EEG activity, whether or not a sleeping person is having a dream experience at any given moment, let alone the content of that experience. The lack of objective markers for dreaming is partly attributed to methodological challenges. First, sleep studies often include experience sampling protocols that require a huge amount of time, skills and resources. As such, experimenters have to rely on relatively small sample sizes, leading to low statistical power. Second, substantial variability in the way dreams are defined and reported across sleep labs exacerbates discrepancies in findings. To address these issues, we present the DREAM database—an expanding collection of standardized datasets on human sleep EEG combined with dream report data. Currently, DREAM comprises 11 datasets, composed of 256 participants and 1593 awakenings. These datasets were collected by leading research centers in the field, including the Wisconsin Institute for Sleep and Consciousness (USA), Northwestern University (USA), the Paris Brain Institute (France), Monash University (Australia), Turku Brain and Mind Center (Finland), University of Cambridge (UK), and Sapienza University of Rome (Italy). Each datum consists, at minimum, of sleep electroencephalography (≥20 s, ≥100 Hz, ≥2 electrodes) up to the time of awakening and a standardized dream report classification of the reported sleep experience. To enable comparability between datasets, we propose a novel classification system that distinguishes different types of dreams, along with instructions for researchers aiming to use this classification system on existing data or for subsequent studies. We hope this initiative facilitates the standardization of operational definitions of dreaming in the future. Overall, this database will provide access to a larger pool of data than any single research group can collect and increase the statistical power of studies focusing on the neural correlates of dreaming. It will also provide useful criteria for methodological choices in future dream laboratory research projects. Ultimately, DREAM will offer a way to accelerate research on the nature and function of dreams, as well as enhance its theoretical and clinical contribution to the fields of sleep and consciousness.

Fundamental constraints on distinguishing reality from imagination

Nadine Dijkstra (Wellcome Centre for Human Neuroimaging, University College London), Stephen Fleming (Wellcome Centre for Human Neuroimaging, University College London)

Concurrent Session: Imagery and Mind Wandering, Friday June 23rd, Classroom 220, 5:00pm-5:15pm

Several lines of research have demonstrated that internally generated sensory experiences – originating from memory, dreaming or mental imagery – activate similar neural representations as externally triggered perception. This overlap raises a fundamental challenge: how is the brain able to keep apart signals reflecting imagination and reality? In a series of online psychophysics experiments, amongst which an innovative single-trial/large N experiment, combined with computational modelling, we investigated to what extent imagination and reality are confused when the same content is simultaneously imagined and perceived. We found that simultaneous congruent mental imagery consistently led to an increase in perceptual presence responses, and that congruent perceptual presence responses were in turn associated with greater imagery vividness. We explain these findings within a simple signal detection model in which imagined and perceived signals are intermixed. Such an account suggests that self-generated sensory signals are not discounted when determining reality. Instead, perceptual reality monitoring may be implemented by evaluating whether an intermixed signal is strong or vivid enough to pass a ‘reality threshold’. The idea that what governs the difference between imagination and reality is simply vividness or intensity of internal signals has profound implications for our understanding of reality monitoring and perception in general.

Representational similarity across visual cortex explains the attentional blink

Adrien Doerig (University of Osnabruck), Emmanuel Lebeau (Université de Montréal), Daniel Lindh (University of Amsterdam), Ilja Sligte (University of Amsterdam), Kimron L. Shapiro, Ian Charest

Concurrent Session: Neural Correlates of Conscious Vision, Friday June 23rd, Classroom 210, 11:15am-11:30am

The attentional blink (AB) is a widely studied phenomenon in the field of consciousness science, where the perception of a first target (T1) can impact the ability to consciously process a subsequent target (T2). Despite its widespread recognition, the underlying interactions between T1 and T2 and the neural mechanisms behind the AB remain unclear, as do the factors that distinguish "non-blinkers" from "blinkers." To shed light on these questions, we combined behavioral responses in an AB paradigm with electroencephalography (EEG), functional magnetic resonance imaging (fMRI), and deep neural networks (DNNs). Participants (n=16) performed an AB task while EEG was recorded (4 sessions of EEG, 3840 trials per participant). The AB task consisted of a rapid serial visual presentation, where participants classified two natural scene target images (each depicting one of 40 object classes) embedded in a stream of scrambled distractors. In addition, whole-brain fMRI (3T, 3mm3 ; TR=0.764s; multi-band 4) data were collected in two separate sessions, while participants performed a simple working memory task. Critically, the same natural scenes were used in the fMRI and EEG experiments, and modeled through the DNNs, enabling the use of Representational Similarity Analyses. Our findings indicate that low-level target similarity, as evidenced by early visual response patterns in the brain, decreases AB magnitude. In contrast, target similarity in higher visual areas increases AB magnitude. Building on this finding, we discovered that the strength of the AB can be predicted from neural activities in the temporal-parietal junction (TPJ) through representational similarity analysis, providing the first neural signature of blinkers vs. non-blinkers. Next, we show that the activity dynamics in a category-trained Recurrent Convolutional Neural Network (RCNN) have a representational structure that matches the human AB results: when T1 and T2 are represented more similarly in early layers of this network, humans blink less; when they are more similar in late layers, humans blink more. Interestingly, a feedforward CNN only replicates the early layer effect and not the higher-level one, suggesting a possible role for recurrence in the AB by shaping representations in the higher visual cortex. Accordingly, we find that this late interference effect is only present after 150 ms in EEG, a timescale compatible with human recurrent processing. Together, these results highlight that the AB may be explained by the degree of representational similarity at different stages of visual processing, with low-level similarity leading to a priming effect and high-level similarity resulting in an interference effect. The difference between blinkers and non-blinkers is largely driven by the latter. Our findings offer for the first time a neural based, image-computable mechanistic explanation of the attentional blink, supported by cutting-edge neuroimaging data and computational models.

Hidden in plain sight: on the elusive nature of valence in perceptual experience

Krzysztof Dolega (Université Libre de Bruxelles)

Concurrent Session: Ethics, Value, Valence, Pain, Saturday June 24th, Classroom 206, 2:00pm-2:15pm

A growing body of work within psychology (Lebrecht et al. 2010, 2012; Barbot & Carrasco 2018) suggests that perceptual experiences can not only produce emotional responses or evaluative judgements, but are themselves affectively colored or valanced. In other words, our perceptual experiences are not neutral, but laden with varying degrees (and perhaps kinds) of value. Most authors try to capture this affective aspect of perceptual phenomenology in intentional terms, but disagree whether differences in perceptual valence result from differences in the *contents* of perceptual experiences or differences in the *attitudes* directed at those contents. Furthermore, proponents of the content view disagree whether the affective character of experiences depends on representations with *evaluative* content (Bain 2013; Carruthers 2018) or representations with *imperative* content (Klein 2015; Barlassina & Hayward 2019; Martínez 2022). The main objection to the content proposal is that two subjects can accurately represent the same object yet have opposing experiences in regard to its valence. The same food item that looks tasty and enticing to me can seem disgusting and off-putting to someone else, suggesting that what distinguishes the two experiences is not a difference in *what* is perceived, but in *how* it is perceived. According to the attitude view, such differences in valence of perceptual experiences result from evaluative attitudes which are bound or fused with sensory experiences (de Vignemont 2021; Jacobson 2021). What is controversial, however, is that proponents of this view claim that perceptual valence is a *sui generis* modality which is distinct, yet inseparable, from the contents of perceptual experiences (de Vignemont 2021, 12). In this talk, I aim to do justice to de Vignemont's claim that "once you have put on affective mental paint, you cannot go back to the [neutral] image" (2021, 13) by defending a more radical version of the attitude approach to perceptual valence on which the affective character of experiences is identified with the causal-functional properties of the vehicles of perceptual representations, and not with additional attitudes layered onto such representations. This view is not only supported by early findings locating neural correlates of perceptual valence in regions associated with processing of object features, such as the lateral occipital cortex (Lebrecht 2005), but is also compatible with prominent proposals about the nature of phenomenal properties (Block 1996; Pappineau 2014) and the function of conscious experience more generally (Cleeremans & Tallon-Baudry 2022). Finally, identifying perceptual valence with the properties of the vehicles of perceptual content is well poised to stimulate empirical research, as it suggests that the same content can be represented by functionally and effectively different assemblies of brain networks to opposing behavioral effects.

What is the contribution of attention to Perceptual Awareness Negativity?

Łucja Doradzińska (Nencki Institute of Experimental Biology PAS, Pasteur 3 street, 02-093 Warsaw Poland), Michał Bola (Nencki Institute of Experimental Biology PAS, Pasteur 3 street, 02-093 Warsaw Poland)

Concurrent Session: Perception and Attention, Saturday June 24th, Classroom 204, 3:00pm-3:15pm

Perceptual Awareness Negativity (PAN) is considered a robust correlate of phenomenal awareness. However, in terms of its spatio-temporal features and underlying mechanism, PAN is very similar to the previously described ERP correlates of selective attention (e.g. SN and N2pc; Bola & Doradzińska, 2021). To establish whether PAN is indeed a specific index of perceptual consciousness we designed two EEG experiments in which stimulus awareness and various attentional mechanisms were manipulated orthogonally. In the first experiment we investigated whether PAN is affected by inherent saliency and task-relevance of a stimulus. Participants (n = 41) were presented with images of faces, which were either fearful (salient) or neutral (non salient), defined as task-relevant targets or task-irrelevant distractors, and backward-masked or unmasked. Single trial ERP analysis revealed that the early PAN (140-200 ms) was dependent on attentional amplification to the point that it was completely attenuated for neutral faces presented as distractors. The late part of PAN (200-350 ms) was observed in all conditions, but its amplitude was significantly lower in response to neutral faces, when compared to emotional ones, and to task-irrelevant face images, in comparison to task-relevant ones. In the second experiment we investigated the impact of spatial attention and task relevance on PAN. Participants (n = 20) were presented with letters, which were either backward-masked or unmasked, presented either in the attended or unattended visual field, and defined either as targets or task-irrelevant distractors. The early PAN (140-190 ms) was again absent for stimuli that did not engage attention (i.e, distractors presented in unattended visual-field). In line with the first experiment the late PAN (190-285 ms) was present in all conditions, but its amplitude was lower in response to letters presented in the unattended visual field, in comparison to letters in the attended field, and letters defined as distractors in comparison to targets. In conclusion, both experiments provide a coherent pattern of results indicating that PAN's amplitude is highly dependent on both exogenous (stimulus saliency) and endogenous attention (spatial attention focus and task requirements). Therefore, our results challenge the interpretation of PAN as an attention-independent correlate of phenomenal awareness.

We need a better definition of consciousness

Paula Droege (Pennsylvania State University)

Concurrent Session: Comparing Theories of Consciousness, Friday June 23rd, Classroom 210, 5:00pm-5:15pm

Exciting new collaborations to test adversarial theories of consciousness aim to advance consciousness research. However, without a parallel effort to agree on a definition of consciousness, the experimental results are unlikely to resolve the theoretical debates. In particular, significant definitional disagreements exist about whether the target of explanation is phenomenal or access consciousness, whether conscious experience is rich or sparse, and whether conscious processing is global or local. The Recurrent Processing Theory (RPT) and the Neuronal Global Workspace Theory (NGWT) take opposite positions on these critical features of conscious experience. Resolution of this deep opposition requires each to give up a central theoretical commitment in order to reach agreement on what counts as evidence of consciousness. I propose a resolution to the definitional debate by combining phenomenology and function. Begin with agreement that consciousness is a unified, multimodal, integrated representation and connect that description with the function of facilitating flexible action. The result is a definition of consciousness as a representation of the present moment. RPT will have to give up the claim that recurrent processing is sufficient for consciousness; an intermediate level of integration is required to generate a single, unified representation. NGWT will have to give up the access requirement for consciousness; conscious representation occurs prior to selection into working memory, so contents are not limited to one or a few reportable items.

Dissociable behavioral responses to virtual hallucinations suggest that sense of reality relates to perceptual priors

Gadi Drori (Bar Ilan University), Paz Bar-Tal (Bar Ilan University), Oded Hirsh (Bar Ilan University), Roy Salomon (Haifa University), Noa Shmueli, Denis Lissitsa, Yair Zvilichovsky

Concurrent Session: Virtual Reality and Neurotechnology, Friday June 23rd, Classroom 218, 11:00am-11:15am

In everyday life we are usually able to judge if our perceptions are accurate representations of the environment, by virtue of our Sense of Reality (SoR). However, monitoring perceptual reality can be quite a challenge, since sensory information is inherently noisy and vague. Predictive coding accounts of perception posit that an optimal perceptual system will attempt to predict environmental regularities based on previously sampled sensory input in order to minimize uncertainty (e.g. noise) and maximize efficiency. In the case of perceptual reality monitoring - perceived events may be judged as real or unreal based on previously sampled probability distributions of similar occurrences (i.e. world models). Certain domains of experience may be perceived as more variable and noisy than others, for instance our experience of color is far more variable and noisy than our experience of gravity which is usually stable across environments. Consequently, SoR may be judged differently during aberrant perceptions from different domains of experience. In this study, 32 neurotypical participants completed two tasks (1-10 days apart) while sitting in a highly realistic virtual reality environment (VR). During the first session, participants completed a 2AFC staircase procedure with 9 parametrically controlled virtual hallucination conditions, categorized as three types of perceptual domains with different real world probability distributions: Nature (e.g. changes in laws of nature such as gravity), Self (e.g. changes in first person perspective such as height) & Perception (e.g. changes in appearance such as color). The responses were then modeled to estimate the participants' psychophysical thresholds for each alteration, resulting in five levels of magnitude per condition. The thresholds were then used as the intensity levels of the stimuli in the second task – a reality rating task. Participants sat in the same VR environment and rated the subjective realness of their experience across 360 randomized alteration trials with varying levels of magnitude. We hypothesized 1. Subjective ratings of realness would decrease with increased level of alteration. 2. Responses to different alterations from the same perceptual domain would be similar. 3. Responses to similar magnitudes of alterations would differ between domains that are assumed to be more or less noisy or variable (for example perceptual changes in color are more common and noisy than changes in 1pp or gravity, therefore more realistic). Results showed 1. Significant decrease in reality ratings with increased magnitude of alterations 2. Ratings are classified into three discrete domains above chance level. 3. Domain ratings differ significantly in the hypothesized direction on levels 2-4. The apparent separation between perceptual domains may imply distinct reality priors which can be useful in furthering our understanding of clinical symptoms involving abnormal SoR such as hallucinations.

Activation Bias

Sascha Benjamin Fink (Otto-von-Guericke-Universität Magdeburg)

Concurrent Session: Comparing Theories of Consciousness, Friday June 23rd, Classroom 210, 5:15pm-5:30pm

Activation is currently in the limelight: Most theories of consciousness focus on activation as that which brings about consciousness. Activations in specific areas, as predicted by some theory X, are considered evidence for X (Yaron et al. 2022). An increase in activation in specific brain areas is seen as an indicator for the locus of an NCC. And so on. Activation is where the action is. Is "activation bias"? I evaluate if this narrow focus on activation is justified. Likely, inactivation, decreased activation, inhibition, and default mode activation – i.e. task-unassociated neural default or reduced activations (TUNDRA) – play an equally important role for consciousness. TUNDRAs deserve a share of the limelight. Several arguments aemphasise the importance of TUNDRAs, based on the definition of "NCC", methodology, and philosophy of mind. For example: (1) Correlationis, statistically, simply the dependence of two variables. While we prefer positive correlation with activation, a negative correlation is equally possible. (2) In functionalism, a conscious experience is partly individuated by its effects. But in order for area A affect more remote areas, TUNDRAs in other areas are crucial in order to not interfere with A-activation's causal power. TUNDRAs then co-determine whether activation in A is bringing about consciousness. (3) In information based theories associate conscious experiences with patterns of informational values which are in turn associated with activation values. As Tononi (2004) stressed, inactivations also carry information and therefore may contribute to consciousness. (4) Holistic accounts like neurophenomenal structuralism (Fink et al. 2021, Lyre 2022) or connectionism (and associated methods like RSA, see Kriegskorte et al. 2008) identify conscious experience with structures in neural activation spaces. Here, inactivation contribute to the specifics of these structures. There is no principled reason to discard TUNDRAs as being crucial for consciousness. A stronger focus on TUNDRAs is demanded. (This differs from other critiques of activation focus, e.g. that activation does not differentiate conscious from unconscious perception, e.g. Block 2017.), But then, subtracting resting state data from task-related activation in order to find NCCs is problematic. Additionally, studies on default mode networks deserve more prominence. We also need to reconsider our understanding of "activation". I end with suggestions for future research.

Characterising the structure and dynamics of global metacognition

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Concurrent Session: Metacognition, Friday June 23rd, Classroom 206, 11:00am-11:15am

Metacognition refers to a capacity for self-knowledge of performance and abilities. This self-knowledge can be expressed "locally" – such as confidence in an individual trial of an experiment – or "globally", referring to longer timescale self-beliefs. How global confidence is formed and the degree to which it informs and interacts with local confidence across different task domains remains unknown. Here we sought to isolate the effects of different local factors (feedback, local confidence) on global metacognition across two different cognitive tasks (perception and memory), as well as a (distal) affective self-evaluation task. We manipulated the probability with which participants received veridical feedback on correct and incorrect trials such that each participant underwent a "positive" feedback block (more correct than incorrect feedback) and a "negative" feedback block (more incorrect than correct feedback). Positive and negative feedback blocks were immediately followed by "test" blocks with no feedback. In both an initial (n = 230) and a replication (n = 278) experiment, we found that participants' global self-performance estimate (SPE) was systematically higher following positive than negative feedback blocks. We also found that participants' local confidence on test blocks was significantly greater following positive than negative feedback blocks for both the same and different tasks, demonstrating that changes to global metacognition impact subsequent local metacognition in a domain-general fashion. In the second experiment, we also asked participants to rate how much a set of positive and negative affective words describe them before and after the first feedback block. Participants who received negative performance feedback increased their endorsements of negative relative to positive words, with no such difference in participants who received positive feedback. This indicates that feedback on local performance may have broader consequences for self-evaluation beyond confidence in cognitive tasks. We also measured participants' self-reported anxious-depression (AD) symptoms. Using computational modelling, we tested if AD symptom scores were related to individual asymmetries in incorporating positive vs. negative feedback and high vs. low local confidence when forming SPEs. We found that in both samples individuals with higher AD scores were more sensitive to lower rather than higher local confidence when forming SPEs – potentially explaining why AD individuals are often globally underconfident. Interestingly, higher AD scores were not associated with overweighing negative vs. positive feedback when forming SPEs, suggesting a specific relationship between AD and interactions between local and global metacognition. Together our findings provide a comprehensive first overview of the structure and dynamics of global metacognition and highlight how understanding these dynamics may shed light on the drivers of common mental health symptoms.

Blinded and deafened by our thoughts? Amodal and modality-specific competition for internal and external sensory representations

Sophie Forster (University of Sussex), Giulia Cabbai (University of Sussex), Chris Racey (University of Sussex), Jamie Ward (University of Sussex), Jessica Lunn

Concurrent Session: Perception and Attention, Saturday June 24th, Classroom 204, 2:15pm-2:30pm

During daily life our conscious experience may include both the external environment and thoughts unrelated to our immediate surroundings. Prior research suggests that our conscious experience is at least partly focused on unrelated thoughts ~60% of the time, and is primarily focused on these thoughts ~20% of the time. These periods of ‘mind wandering’ are associated with attenuated processing of the external environment (termed ‘perceptual decoupling’). Often these irrelevant thoughts may include sensory components, in the form of mental imagery. Recent research has highlighted an overlap in the neural mechanisms underlying mental imagery and external perception, particularly with respect to visual mental imagery. As such, an interesting question is the extent to which perceptual decoupling may reflect direct competition for the representation of sensory information (whether this is imagined or present in our external environment), versus amodal attentional effects. Here I report a series of studies using fMRI and signal detection theory approaches to address this question. We asking participants to engage in a series of naturalistic thought tasks designed to elicit varying levels of visual and auditory imagery and examined the impact on processing of external stimuli, in terms of both activity in visual and auditory cortex, and conscious awareness (detection sensitivity) . Overall, our results imply that both amodal and modality-specific effects may be present, particularly in the case of visual mental imagery where imagery-induced attenuation was observed from primary visual cortex onwards. I will also present evidence as to how the impact of perceptual decoupling may vary between individuals, as a function of individual differences in both imagery and attentional traits.

Dexmedetomidine-induced loss of consciousness is characterized by increased structure-function coupling and decreased cerebral blood flow

Panagiotis Fotiadis (University of Pennsylvania), William Tackett (University of Pennsylvania), Alexander Proekt (University of Pennsylvania), Andrew McKinstry-Wu (University of Pennsylvania), Max B. Kelz (University of Pennsylvania), John A. Detre (University of Pennsylvania), Dani S. Bassett (University of Pennsylvania)

Concurrent Session: Sleep, Dreaming, Anesthesia, Friday June 23rd, Classroom 204, 12:00pm-12:15pm

Objective—We utilize multimodal non-invasive neuroimaging to investigate the regional structural, functional, and cerebrovascular alterations that occur in the human brain as it transitions from the awake to the unconscious state. Methods—Subjects (n=14; mean age: 28.2±5.6 years; 10 female) underwent magnetic resonance imaging (MRI) on a 3T Siemens Prisma. Baseline scans (1 structural, 1 resting-state functional, 6 diffusion, and 3 arterial spin labeling sequences) were first acquired while each subject was awake. Each subject then received administration of the anesthetic agent dexmedetomidine (1mcg/kg/hr intravenously) to pharmacologically enter a sedated state resembling stage II sleep. After drug infusion—and while the subjects were unconscious—the same MRI sequences were re-acquired. Structural and functional connectivity matrices were generated for each subject using the Harvard-Oxford cortical/subcortical parcellation. Each brain region's structure-function coupling (SFC) at each session was defined as the correlation coefficient between its structural and functional connectivity to all other regions. Mean cerebral blood flow (CBF) was also extracted for each brain region. Results—(1)There was a step-wise increase in SFC across the brain as the subjects transitioned from the awake to the unconscious state (percent-change [PC]:14%;p<0.0001); notably, the brainstem displayed the largest increase in SFC compared to all other brain regions, with an average increase of 169% in magnitude across subjects (p=0.0003). Brain regions within the somatomotor (PC:17%;p<0.0001), limbic (PC:28%;p=0.0044), and cerebellar networks (PC:21%;p<0.0001) also significantly increased their SFC. (2)Furthermore, there was a widespread drop in CBF across the brain as the subjects transitioned from the awake to the unconscious state (PC:-10%;p<0.0001); this decrease was pronounced within the brainstem (PC:-20%;p=0.001)—and especially the locus coeruleus (PC:-36%;p=0.0069), thalamus (PC:-18%;p=0.0013), and cerebellum (PC:-20%;p=0.0153). In contrast to SFC, CBF continued decreasing with increasing levels of unconsciousness (p=0.0691). (3)Lastly, we examined whether there was a regional correlation between SFC and CBF. Indeed, there was a significant association between the two variables during the awake (r=0.39;p<0.0001) and the unconscious (r=0.17;p<0.0001) states, indicating that brain regions displaying stronger SFC towards other regions are perfused by higher levels of CBF. Critically, baseline CBF levels during the awake state strongly correlated with how much SFC changed from the awake to the unconscious state (r=-0.33;p=0.0045), pointing towards CBF's potential role in mediating SFC changes during loss of consciousness. Conclusions—The transition from the awake to the dexmedetomidine-induced sedated state in humans is characterized by widespread changes in SFC and CBF; structures where such changes are particularly prominent are the brainstem and cerebellum.

The Computational Neuropsychology of Self-Awareness: From Sensory to Metacognitive Predictive Errors

Aikaterini (Katerina) Fotopoulou (Universiy College London)

Concurrent Session: Metacognition, Friday June 23rd, Classroom 206, 11:15am-11:30am

Computational theories of brain function have become very influential in neuroscience and in psychiatry. More recently such approaches, and particularly those employing Bayesian inference, have been applied in neuropsychology (Parr et al. 2018; Kucikova et al. 2022). These approaches provide a novel means for computational phenotyping of symptoms within and across syndromes, as well as psychiatry. In this talk, I will focus on the understanding of disruptions of self-awareness in neurology and psychiatry. Specifically, I will present a series of studies in which, using a Bayesian learning framework, we formalized and empirically investigated the hypothesis that failures to update explicit anosognosic beliefs about sensorimotor loss following right-hemisphere stroke, or self-efficacy beliefs about interoception in anorexia nervosa can be explained by abnormalities in the relative uncertainty (i.e. precision) ascribed to prior beliefs and sensory information, particularly in the level of ‘prospective’ metacognitive beliefs. Method. Novel, experimental sensory ‘belief updating’ tasks and formal Bayesian computational models have been developed that try to associate case-control, group differences in latent parameters of precision optimisation with specific patterns of lesions in voxel-based, symptom-lesion (VLSM) and structural connectivity studies. Results. Computational modelling results revealed that while sensory prediction errors led to belief updating at ‘local’ perceptual levels, precision-optimisation difficulties led to an inability to update more general, prospective beliefs about one’s motor or interoceptive abilities respectively. Moreover, difficulties in such ‘counterfactual’ belief-updating were associated with disruptions in tracts of the ventral attentional network (i.e. superior longitudinal fasciculus connecting the temporo-parietal junction and ventral frontal cortex) and associated lesions to the insula, inferior parietal cortex and superior temporal regions. Follow-up clinical studies successfully target such parameters and offer further validity to the formal, theoretical models and related neuroimaging findings. Discussion. These results suggest that self-awareness extends beyond local, retrospective monitoring, requiring also convergence of beliefs about the self that go beyond the ‘here-and-now’ of sensorimotor experience (global self-monitoring) and intact connectivity with and within key ‘salience-network’ nodes.

Intersubject consistency as a window into deciphering the neuronal code underlying conscious perception.

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Concurrent Session: Neural Correlates of Conscious Vision, Friday June 23rd, Classroom 210, 12:00pm-12:15pm

A fundamental aspect of our conscious visual perception is that we largely see the world in a similar manner. Such inter-subject agreement is essential for our ability to communicate and cooperate. We can therefore ask: what exactly is kept similar in the neuronal coding of visual information as we move from one individual to another? Conversely, those neuronal mechanisms that are not preserved across individuals likely do not underlie the contents of our conscious percepts. We addressed this question by studying neuronal responses in patients that underwent intra-cranial recordings for clinical diagnostic purposes, a method that provides high spatial and temporal resolution. Specifically, we examined the level of inter-subject similarities under three hypothetical coding schemes: i) population vector coding: perceptual information is coded by the activity patterns (vectors) of functionally tuned cortical neurons, ii) relational coding: the brain encodes the contents of percepts not through the population vector itself, but rather through the set of similarity distances (cosine angles) between the population vectors activated by the conscious percept and all other visual percepts in the relevant cortical area, iii) a straightforward next step along this line of increased model complexity – i.e. coding that is insensitive to affine transformations of the population vector distances. Population coding scheme: we computed the optimal mapping of contacts between pairs of patients, finding the minimum distance over all possible permutations of the recording contacts. Our results reveal a small, positive similarity across patients, for both the training and test sets. Relational coding scheme: searching for the optimal fit of the distances between the population vectors rather than the vectors themselves, revealed a striking and significant increase in the inter-subject similarities. Critically, a robust and significant increase was evident when examining the independent data of the testing set. The effect was consistent across all image categories and highly significant. The third scheme: in the training set, the richer affine transformation produced a slightly higher level of matching compared to the relational code; this is to be expected since the affine transformation has more degrees of freedom. However, when examining the independently measured test set, the match, in most cases, fell significantly below the more constrained relational transformation. This indicates that the enhanced power of the affine transformation likely resulted in over-fitting. To summarize: We demonstrate, using three independent iEEG data sets, that the neuronal coding scheme that is most preserved across individuals is relational coding. These findings offer a robust explanation for the ability of different individuals to perceive the world in a similar manner, and point to relational coding as the essential cortical code underlying conscious perception.

The readiness potential and antecedent pupil dilations reflect two distinct aspects of conscious volition

Jake Gavenas (Chapman University), Aaron Schurger (Chapman University), Uri Maoz (Chapman University)

Concurrent Session: Action, Decision, Volition, Friday June 23rd, Classroom 202, 10:45am-11:00am

When we act voluntarily, we experience a distinct subjective feeling of willing our actions that is noticeably absent from involuntary actions such as reflexes. Notably, the feeling of will (a.k.a. conscious volition) is reliably preceded by the Readiness Potential (RP; Libet et al. 1983), a buildup of brain activity beginning more than one second before movement. How the RP relates to conscious volition remains unclear because two different methodologies for assessing conscious volition have found conflicting patterns of results. “Probe method” studies interrupt participants while they make voluntary movements and ask whether they were preparing to move when the probe occurred (e.g. Matsuhashi & Hallett, 2008; Parés-Pujolràs et al. 2019). Notably, reported awareness of preparation was associated with RP-like buildups (Parés-Pujolràs et al. 2019), suggesting the RP is related to conscious volition. However, the RP does not correlate with the timing of motor intention retrospectively reported using a clock (Haggard & Eimer, 1999; Schlegel et al. 2013), suggesting the RP is not associated with conscious volition. We hypothesized that conflicting results emerge because clock and probe methods target two different types of awareness: clock studies target the phenomenal experience of action initiation, or conscious volition, whereas probe studies target the metacognitive accessibility of preparatory processes. To investigate this hypothesis, we developed a novel probe method that controls for confounds in prior studies. We found that reported awareness of preparation was not associated with RP-like buildups (BF = 0.091), indicating the RP does not relate to conscious volition. Computational modeling found that metacognitive access to the motor-preparatory process can explain these results, whereas a traditional RP model cannot. What physiological process then, if not the RP, could reflect conscious volition? Pupil dilations reflect processing related to awareness (e.g. Wierda et al. 2012; Kang et al. 2015) and were shown to precede volitional actions (Richer & Beatty, 1985). We hypothesized that pre-movement pupil dilations relate to conscious volition and investigated this hypothesis in a modified clock paradigm. Earlier pupil dilations correlated with earlier reported onsets of the urge to move ($p = 0.0359$), suggesting that antecedent dilations relate to conscious volition. Controls demonstrated that such dilations did not reflect general expectation, motor execution, or action awareness. Our results thus indicate that the phenomenal experience of conscious volition may be reflected better by antecedent pupil dilations than the RP, but that the preparatory process the RP reflects may nevertheless be introspectively accessible. Furthermore, conceptually clarifying that clock and probe methods target different types of awareness has major implications for our understanding of volition and interpretation of prior work.

Eliminativism Redux--The Case of Pain

Nada Gligorov (Alden March Bioethics Institute at Albany Medical College)

Concurrent Session: Ethics, Value, Valence, Pain, Saturday June 24th, Classroom 206, 3:15pm-3:30pm

Scientific inquiry has revealed that pain is a complex and heterogonous phenomenon that is neither realized by a unique neurological mechanism nor localized to a circumscribed region in the brain. This discovery inspired the application of a new version of eliminativism--scientific eliminativism--to pain. Scientific eliminativism is purportedly distinct from classic eliminativism because it does not require elimination of pain from its quotidian uses in folk psychology. I challenge the distinction between scientific and classical eliminativism and argue that both versions make the same claims. I argue that classic and scientific eliminativism rest on an empirical assessment of the usefulness of folk-psychological terms in science. The argument for the scientific elimination of pain rests on the claim that neuroscience has shown that pain as characterized by folk psychology is not a natural kind and it not useful in scientific theorizing. This is akin to the claim made by classic eliminativists that developments in neuroscience can be used to show that folk psychology is false and therefore an impediment to the progress in neuroscience. The difference between scientific and classic eliminativism is regarding the impact of scientific elimination on the posits of folk psychology. Classic eliminativists argue that neuroscience should replace folk psychology while scientific eliminativists argue that one can achieve elimination in neuroscience without changing folk psychology. I argue that pain cannot be eliminated from scientific theorizing without being eliminated from folk psychology. This is because quotidian uses of pain intersect with the scientific uses of that term in medical settings, which are also the settings one is most likely to talk about pain. To identify pain treatment, physicians and patients must use a common pain description. During the diagnostic process, the location of pain, its duration, and its intensity aid in determining its etiology. Hence, even if the patient and the physician began the process by using the term pain differently, i.e. the physician uses a neuroscientific term and the patient uses a folk-psychological term, they must converge on a similar description of the phenomenon to diagnose and treat pain. This description would include the biological etiology of pain and the biological means to relieve it, and this recharacterization of the term would carry over into other domains of the patient's life outside the clinical setting. The patient might continue to describe their pain by referring to its biological cause and by stating which pharmacological means lead to pain relief thereby utilizing the scientific characterization learned in the medical setting in everyday parlance. An elimination of the term pain from neuroscience would then lead to a redefinition of pain in folk psychology. Hence, scientific eliminativism for pain leads to classic eliminativism for pain.

Iconic representation and the richness of visual experience

Rui Zhe Goh (Johns Hopkins University)

Concurrent Session: Richness of Consciousness, Friday June 23rd, Classroom 218, 5:15pm-5:30pm

Visual experience seems rich, as if we are simultaneously aware of a multitude of visual objects. On the assumption that such phenomenology outstrips the information available for cognitive access, richness has played a critical role in debates between “local” and “global” theories of consciousness (Block, 2011; Lamme, 2003; Baars, 2007; see Lau (2022) for discussion). Much of this debate involves proponents of global theories denying or recharacterizing richness in order to defend their views (Cohen et al. 2016, Naccache & Dehaene, 2008; for criticism, see Haun et al. 2017). However, local theorists lack a detailed account of what aspects of visual phenomenology constitute richness, and how visual processing gives rise to rich phenomenology. This paper takes on that task. Specifically, I connect an essential aspect of rich visual phenomenology I call spatial coherence with the iconic format of visual spatial representation. First, I argue that spatial coherence–the experience as of all visual objects standing in spatial relations to all other visual objects–is a constitutive aspect of rich visual experience because it underpins our impression of being aware of a coherent scene, all at once. Spatial coherence raises two explanatory questions: 1) How does the visual system represent all permutations of spatial relations between objects? 2) Why is there an essential connection between representing a visual object and representing the object in a network of spatial relations? After arguing for spatial coherence, I propose that visual spatial representation is iconic by virtue of the relations between egocentric spatial attributives (i.e. psychological capacities to characterize objects as being at perceiver-relative spatial locations) mirroring egocentric spatial relations between the perceiver and locations in the external world (see Burge, 2022; Block, 2023). I suggest that the visual system uses these mirrored relations in its default method of securing reference to perceived objects. Finally, I show that this account of spatial representation provides a good explanation for spatial coherence by answering the two explanatory questions raised above. The visual system’s capacity to represent a huge number of spatial relations is explained by all objects being plotted relative to a common anchor point, allowing the spatial relations between any two objects to be represented without any additional cost. The essential connection between representing an object and representing the object in a network of spatial relations is explained by the visual system’s default way of securing object reference using egocentric spatial relations. My account not only gives precise content to claims that visual experience is rich but also explains why visual experience is richer than cognitive access. If richness is a consequence of the iconic format of visual representation, then to the extent that cognitive access requires a change in format, richness is lost.

Combining Higher-Order theory and the Global Workspace model - An alternative view of consciousness and self-awareness.

Robert Van Gulick (Syracuse University)

Concurrent Session: Comparing Theories of Consciousness, Friday June 23rd, Classroom 210, 5:30pm-5:45pm

Higher-order (HO) theories of consciousness and Global Neuronal Workspace (GNWS) models are typically regarded as competing and mutually exclusive accounts of consciousness. In some formulations they do indeed conflict. However, I show that the two views can be combined in a complementary and mutually beneficial way. When properly understood, each enhances the plausibility and explanatory power of the other, while also showing a novel respect in which consciousness involves self-awareness.The relevant version of higher-order theory differs from standard HO accounts in several respects. Standard accounts explain the transition from unconscious mental state M to conscious state in terms of the addition of a distinct meta-mental state that explicitly represents the occurrence of M. On the alternative higher-order global state model (HOGS), the transition occurs when the unconscious state M is recruited into a global state whose organization implicitly embodies meta-intentional content. M is retained within the conscious state, but its content is partially transformed by its embedding within a new dynamic context. Among other advantages, this allows the HOGS model to avoid the misrepresentation problem which poses a serious objection to more standard HO theories. The GNWS theory provides one plausible account of the sort of global state required by the HOGS model. Contents become conscious when they are recruited into the global workspace. Though GNWS is not normally interpreted as involving higher-order meta-cognitive content, I show that doing so is independently motivated by the need to answer a major line of objection to the theory. GNWS is sometimes criticized as offering an account of access consciousness but not of phenomenal consciousness. It supposedly explains the functional aspects of consciousness but not why such states should have any experiential feel. The combined theory offers a possible solution. The response relies on what Galen Strawson calls the “subject thesis”, the view that experience always requires a conscious subject that has the experience. Thus, transforming a nonconscious mental state into an experiential state requires constructing a system that constitutes a conscious self. I show that doing so involves integrating contents in such a way that they cohere as if from the perspective of a virtual self. When an integrated system of states coheres in that way, it constitutes a genuine self. The relevant contents do not exist as experiences prior to being incorporated in that self-perspectival structure. Thus, conscious selves and experiences are mutually dependent upon each other; to create either, one must simultaneously create both. The theory rejects both the Cartesian intuition that the self is prior to experiences and any form of bundle theory according to which experiences are prior to the self. Conscious turns out to essentially involve self-awareness, but in a novel sense, that of being aware in a self-like way.

The vMMN: a neural marker for unconscious processing in cortical blindness

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Concurrent Session: Neural Correlates of Conscious Vision, Friday June 23rd, Classroom 210, 11:30am-11:45am

Introduction: Detecting sudden changes in the visual field, mainly when they breach expected environmental regularities, is fundamental to processing relevant or biologically significant stimuli. Blindsight individuals with lesions to the primary visual cortex (V1) causing cortical blindness can perform above chance level to biologically substantial information, as motion stimuli presented in their blind field, even if they occur without conscious vision. However, their ability to detect a deviant change automatically among frequent, predictable stimuli has yet to be established. We propose assessing such abilities for motion stimuli independently of behavior (no-report paradigm) using the visual mismatch negativity (vMMN) as a reliable electrophysiological biomarker to reflect automatic unpredicted change detection. Methods: Twenty neurotypical individuals and four patients with cortical blindness were tested. Blindsight was assessed in the patient's blind hemifield during a prior behavioral task using motion stimuli. We measured the brain's ability to unconsciously detect motion changes during electro and magnetoencephalography (EEG and MEG) recordings. Such measures were obtained using a high-load central Stroop Test presented simultaneously with a peripheral visual oddball paradigm where any participant did not report motion changes. The oddball paradigm consisted of upward standard/frequent and downward deviant/rare motion stimuli. The analyses included computations of the evoked response and spectral activity (power and connectivity measures: weighted phase lag index) in different frequency bands (theta, alpha, beta, low and high gamma). The vMMN was assessed by the difference in activity between the deviant and standard conditions. Specifically, statistical t-tests using cluster-based permutations were performed across time and electrodes (EEG) or sensors (MEG). To address the statistical difference between the patients and the neurotypical group, a specific test named the Crawford-Howell t-test used in case-control comparisons was performed. Results: The results showed a reliable and consistent vMMN and theta synchronization in both neurotypical controls and blindsight individuals using EEG and MEG. Large-scale functional network modulations were found in different frequency bands with a predominance of the gamma band. Interestingly, posterior theta connectivity was more robust for the patients' blind hemifields than the controls' hemifields suggesting functional theta enhancement in blindsight that could characterize unconscious abilities to detect motion. Conclusions: In summary, this study is significant to blindsight research since the vMMN could be used as an electrophysiological biomarker for automatic unpredicted change detection and could lead to advances in understanding the neural correlates of unconscious processing for intact and for altered vision.

Neural correlates of sustained consciousness in an inattentional blindness paradigm

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Concurrent Session: Neural Correlates of Conscious Vision, Friday June 23rd, Classroom 210, 12:15pm-12:30pm

The vast majority of studies assessing the neural correlates of consciousness (NCC) uses brief stimulus presentations, which only allow investigating onset- or change-related brain responses. These studies revealed a visual awareness negativity (VAN) to be a promising NCC candidate in the visual modality. However, it remains unclear whether the VAN represents a transient response or correlates with the duration of perception. The present study aimed to investigate how the VAN is affected by different stimulus durations in an inattentional blindness paradigm. Thus, we addressed not only onset-driven responses but elucidated how maintenance of a conscious percept is encoded in neural activity. While recording event-related potentials (ERPs), male and female human participants solved a visual distractor task with line stimuli presented in the background, which sometimes contained an abstract human face for either 500 or 1000 ms. Half of the participants were informed of the presence of the face, resulting in faces being perceived by the informed but not by the uninformed participants. Comparing ERPs between the informed and uninformed group revealed a VAN for both short and long stimulus duration. Additionally, the long stimulus condition showed an extended negativity compared to the shorter stimulus duration. Our results suggest a temporal representation of a visual percept beyond its initial onset in visual areas. Furthermore, the findings corroborate the VAN as NCC related to the duration of stimulus awareness.

Towards a computational phenomenology of mental action: modelling meta-awareness and attentional control with deep parametric active inference

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Concurrent Session: Metacognition, Friday June 23rd, Classroom 206, 10:30am-10:45am

Meta-awareness refers to the capacity to explicitly notice the current content of consciousness and has been identified as a key component for the successful control of cognitive states, such as the deliberate direction of attention. This paper proposes a formal model of meta-awareness and attentional control using hierarchical active inference. To do so, we cast mental action as policy selection over higher-level cognitive states and add a further hierarchical level to model meta-awareness states that modulate the expected confidence (precision) in the mapping between observations and hidden cognitive states. We simulate the example of mind-wandering and its regulation during a task involving sustained selective attention on a perceptual object. This provides a computational case study for an inferential architecture that is apt to enable the emergence of these central components of human phenomenology, namely, the ability to access and control cognitive states. We propose that this approach can be generalized to other cognitive states, and hence, this paper provides the first steps towards the development of a computational phenomenology of mental action and more broadly of our ability to monitor and control our own cognitive states. Future steps of this work will focus on fitting the model with qualitative, behavioural, and neural data.

The role of recurrent feedback during conscious perception in binocular rivalry

Janis K Hesse (UC Berkeley), Frank Lanfranchi (UC Berkeley), Doris Y Tsao (UC Berkeley)

Concurrent Session: Neural Correlates of Conscious Vision, Friday June 23rd, Classroom 210, 11:00am-11:15am

Consciousness is arguably the most important reason why it matters to us whether we are dead or alive. Yet, the neural mechanisms of conscious perception remain unknown. Here, we investigate the hypothesis that conscious perception is due to top-down feedback interpreting and recreating incoming sensory inputs. To reveal the mechanisms of how new conscious percepts are generated and coordinated across different nodes of the cortical hierarchy, we use newly developed primate Neuropixels probes to simultaneously record from thousands of neurons across different face patches in macaque IT cortex during a binocular rivalry paradigm. In binocular rivalry, a constant visual input evokes spontaneous changes of conscious perception, allowing to dissociate neural representations of conscious percept and physical input. We employed a novel no-report binocular rivalry paradigm that allowed us to infer conscious percept from eye movements. We find that neural activity during spontaneous perceptual switching in rivalry differs dramatically from activity when physically alternating the stimulus. First, in contrast to physical alternation, where an unambiguous consciously perceived stimulus is encoded, during rivalry cells in face patches encoded not only the consciously perceived but also the suppressed stimulus. Second, response latencies across different levels of the hierarchy during rivalry did not follow the feedforward hierarchy of latencies observed during physically alternated stimuli. Taken together, our results suggest that switches of conscious percept are generated by a recurrent or feedback mechanism and may provide an approach for pinpointing where in the brain a new conscious percept arises first.

More than words - can free reports adequately measure the richness of perception?

Rony Hirschhorn (Tel Aviv University), Prof. Liad Mudrik (Tel Aviv University)

Concurrent Session: Richness of Consciousness, Friday June 23rd, Classroom 218, 5:00pm-5:15pm

How rich is our conscious experience? We feel that we experience the world in great detail, yet whether this is indeed the case is actually widely debated: while some researchers hypothesize that conscious experience is rich and detailed, others claim that experience is coarse and sparse. Despite the increasing diversity of paradigms in experimental cognitive psychology, this question remains unanswered. Previous research has suggested that free verbal reports can be used to ground the intuition that conscious experience is rich. A recent study took this approach to show that even a brief experience of an image is nevertheless a rich, detailed one (Chuyin et al. 2022). In this paradigm, participants were asked to write words describing their experiences. The authors created a metric ("Intersubjective Agreement"; IA) that quantifies the uniqueness of words in describing a specific image. They concluded that this metric demonstrates that experience is rich and intricate, even when brief. Through a series of experiments, we challenge this interpretation, using degraded and intact versions of the original images. We show that the original and degraded stimuli yielded experiences that differ in their perceived richness; however, both rich and sparse experiences scored high in the IA metric. In addition, we found a relationship between IA scores and words' frequency of use in the English language. Our study highlights the limitations of using verbal reports to capture the richness of conscious experience, and raises questions about the validity of using them as a means to support the richness hypothesis.

Effects of low-intensity focused ultrasound (LIFU) stimulation to the central thalamus and the globus pallidus on consciousness

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Concurrent Session: Neural Correlates of Consciousness, Sunday June 24th, Classroom 210, 12:00pm-12:15pm

Subcortical structures may play an important role in the emergence and maintenance of a conscious state. Within the subcortex, emphasis has been placed on the thalamus because intra-thalamic and thalamo-cortical activity grades with level of consciousness. The role of basal ganglion structures in supporting consciousness, however, remains less explored. A few recent studies have demonstrated that within the basal ganglia, the external segment of the globus pallidus (GPe), its activity, and its interactions with the cortex, also shift consistently with consciousness level. The objective of the present study is thus to further investigate the roles of the thalamus and the GPe in maintaining healthy, conscious brain activity. To do so, we are the first in the field to combine low-intensity focused ultrasound (LIFU) stimulation with electroencephalography (EEG) and concurrent single-pulse transcranial magnetic stimulation (TMS) and EEG (TMS-EEG). We stimulate thalamus and GPe with LIFU in healthy and awake human volunteers at inhibitory intensities while tracking changes in power spectrum with EEG complexity across the cortex with TMS-EEG. We predict that LIFU stimulation to each structure will disrupt the cortico-subcortical interactions that may support consciousness, shifting cortical activity to that more typical of drowsiness. Specifically, we expect increased synchronization and power in lower frequencies in the EEG as well as a decrease in whole-brain complexity following LIFU and a return to baseline over time. Preliminary results (n = 3) support this modulatory effect of LIFU to thalamus and GPe on power spectrum and complexity.

Typical and disrupted brain network complexity in human neonates

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Concurrent Session: Animal and Infant Consciousness, Sunday June 24th, Classroom 220, 11:45am-12:00pm

Introduction, Great theoretical and empirical advances have been made in understanding conscious awareness in human adults, but it remains unknown when conscious awareness emerges in neonates. The lack of language and the very limited motor function preclude self-report or behavioral responses and, thus, prevent the assessment of infant awareness from the first days of life. To circumvent these limitations, we investigated the development of a neural marker of consciousness, the dynamic complexity of network architecture, in the early weeks of life and the effects of premature birth on that development. Methods, High-quality resting-state fMRI data from 278 full-term neonates (postmenstrual age at scan = 41.2 weeks ± 12.2 days), 72 preterm neonates at term equivalent age (TEA; 40.9 weeks ± 14.6 days), and 70 preterm neonates before TEA (34.7 weeks ± 12.7 days) from the developing Human Connectome Project were used in our study. 217 brain regions were defined based on the Power atlas to extract time courses from each participant. A sliding window (window length = 90 TR, slide step = 2 TR) and graph theoretical approaches (Muldoon et al. 2016) were applied to capture time-varying network architecture. Then, the dynamic complexity was quantified by sample entropy (Lake et al. 2002). Results, Adjacent‑category logit models showed that full-term neonates had significantly lower sample entropy of small worldness relative to preterm neonates before and at TEA. Similar findings were observed in sample entropy of clustering coefficient and path length. In addition, relative to preterm neonates before TEA, neonates at TEA showed significantly lower sample entropy of path length. Multiple regression models found that sample entropy of network architecture increased with increasing neonate age in full-term neonates. By contrast, the sample entropy of network architecture decreased with neonate age in preterm neonates up to TEA. Conclusions, These findings suggested that prematurity is associated with an over-entropic state (Carhart-Harris, 2018) in neonates from birth up to TEA, relative to full-term neonates. In addition, our data show that complexity scales down with infant age up to TEA. By contrast, the opposite pattern is visible in full-term infants: complexity scales up with infant age. The increasing dynamic complexity observed in full-term neonates from birth onwards is related to an increasing capacity for information integration and conscious experiences.

Semantics induces invisibility in an audiovisual illusion

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Concurrent Session: Unconscious Processes, Sunday June 24th, Classroom 204, 10:30am-10:45am

A surge of empirical data from vision sciences indicates some linguistic constraints on our perception. However, since reading is limited by visual acuity in the periphery, whether impoverished perception entails immunity to reading-based linguistic influence remains unknown. Here we leveraged a peripheral sound-induced flash illusion to directly examine whether the semantic influence of perception occurred with unrecognizable words. In this audiovisual illusion, visual stimuli are flashed in an apparent motion manner and 10 visual degrees away from the fixation with concurrently presented matched or mismatched beeps. When the visual and auditory presentations are mismatched, an additional beep generates an illusory visual percept (seeing 3 flashes with 2 flashes and 3 beeps, Rabbit illusion), or an existing visual percept can be suppressed due to the lack of a corresponding beep (seeing 2 flashes with 3 flashes and 2 beeps, Invisible Rabbit illusion). We first successfully replicated the original illusions with Mandarin characters. More importantly, when the characters formed a meaningful word, the lack of a concurrent beep suppressed the awareness of an existing character to a greater extent. That is, the semantics of the visual stimuli induced a stronger Invisible Rabbit illusion. Distinct from the typical notion that semantics boosts visual awareness, our results pointed to an opposite direction of semantic influence. A separate experiment replicated the effect on participants who showed chance performance on word recognition. Further analysis showed that participants' confidence levels in the illusory and non-illusory conditions were comparable, strengthening the implicit nature of the finding. We speculated that the semantics of peripheral words induced word skipping, as typically observed in reading. Our idea was later confirmed by the disappearance of the effect in a control experiment when the reading was disrupted by reversing the presentation order. These findings demonstrate the capacity of our visual system to implicitly extract peripheral linguistic information, which in turn regulates our visual awareness.

Lateral frontoparietal effective connectivity differentiates and predicts state of consciousness in traumatic disorders of consciousness

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Concurrent Session: Disorders of Consciousness 1, Friday June 23rd, Classroom 202, 5:00pm-5:15pm

Neuroimaging studies have suggested an important role for the default mode network (DMN) in disorders of consciousness (DoC). However, the extent to which DMN connectivity can discriminate DoC states – unresponsive wakefulness syndrome (UWS) and minimally conscious state (MCS) – is less evident. Particularly, it is unclear whether effective DMN connectivity, as measured indirectly with dynamic causal modelling (DCM) of resting EEG, can disentangle UWS from healthy controls and from patients considered conscious (MCS). Crucially, this extends to UWS patients with potentially “covert” awareness (minimally conscious star, MCS*) indexed by voluntary brain activity in conjunction with partially preserved frontoparietal metabolism as measured with positron emission tomography (PET+ diagnosis; in contrast to PET- diagnosis with complete frontoparietal hypometabolism). Here, we address this gap by using DCM of EEG data acquired from patients with traumatic brain injury in 11 UWS (6 PET- and 5 PET+) and in 12 MCS (11 PET+ and 1 PET-), alongside with 11 healthy controls. We provide evidence for a key difference in left frontoparietal connectivity when contrasting UWS PET- with MCS+ patients and healthy controls. Next, in a leave-one-subject-out cross-validation, we tested the classification performance of the DCM models demonstrating that connectivity between medial prefrontal and left parietal sources reliably discriminates UWS PET- from MCS+ patients and controls. Finally, we illustrate that these models generalise to an unseen dataset: models trained to discriminate UWS PET- from MCS+ and controls, classify MCS* patients as conscious subjects with high posterior probability. These results identify specific alterations in the DMN after severe brain injury and highlight the clinical utility of EEG-based effective connectivity for identifying patients with potential covert awareness.

Dynamics of confidence in implicit probabilistic learning

Ivan Ivanchei (Université libre de Bruxelles)

Concurrent Session: Metacognition, Friday June 23rd, Classroom 206, 11:45am-12:00pm

In cognitive neuroscience, metacognition is often studied in static situations, e.g. when task representations are already formed, and the cognitive system can estimate its accuracy (i.e. confidence) based on it. However, little is known about how metacognition develops when task representations are changing, i.e. in the process of learning. What factors influence self-evaluation in such situations? Do the same mechanism underly learning and its evaluation? Do people use additional information to evaluate their behavior? This study addresses these questions by looking at online metacognition in probabilistic learning. Method. The weather prediction task was used as a model of probabilistic learning. Participants were presented with four cues. Different cue combinations were associated with certain probabilities of outcomes (SUN or RAIN). Based on the cues and feedback, participants learned to predict the outcomes. Confidence ratings were collected on each trial. Such an experimental setting allowed us to track the dynamics of metacognition in parallel with the learning process. Single-process (e.g. Sanders, Hangya, & Kepecs, 2016) and dual-process (e.g. Maniscalco & Lau, 2016) models of metacognition were considered for predicting possible results. Signal detection theory was applied to measure learning and metacognition. Computational modeling was used to estimate hidden variables related to learning. Results. The results showed that both probability learning (quantified as sensitivity, d') and metacognitive sensitivity (i.e. ability to discriminate own correct and incorrect responses, quantified as meta-d') increased over time. However, metacognitive sensitivity developed more gradually. This resulted in an interesting phenomenon of a gradual decrease in metacognitive efficiency (meta-d' - d'). This result can be interpreted as evidence that participants used learning representations for their metacognitive reports to a lesser extent at the end of the experiment. Although average d' and meta-d' correlated across participants (r=0.89), learning and metacognition were affected by different factors. The most striking difference was found in the relationship to reward prediction errors (RPE) generated after responses. While accuracy did not depend on the size of the RPE in the previous trial, confidence did – the stronger and more positive the RPE, the higher the confidence in the following trial. In other words, participants felt more confident after surprising correct responses. Conclusions. To sum up, we observed the temporal development of both first-order (probability learning) and second-order (metacognitive) sensitivity in the probabilistic learning process. However, metacognitive sensitivity developed more gradually compared to probability learning. Metacognition and probability learning also depended on different sources of information. The obtained results support the dual-process models of metacognition.

Consciousness as Relation

Carolyn Dicey Jennings (University of California, Merced)

Concurrent Session: Theories and Models, Sunday June 24th, Classroom 218, 11:30am-11:45am

As many have said before, consciousness is not a thing. They retort: it is a process, a function, a seeming. I argue, instead, that it is a relation—a relation between a subject and its world. I call this the Relation View. Much of the inscrutability concerning consciousness is, I believe, from treating this relation like an object or thing. And much of it can be dissolved by acknowledging the role of its relata: the subject and its world. This new metaphysics of consciousness provides a way forward on the problem of consciousness, likewise giving new direction to the associated scientific work. In fact, one advantage of the view is that it allows us to hold onto some of the most prominent scientific theories of consciousness while answering criticisms of those views. I will explicitly discuss both the global workspace theory and integrated information theory in this regard, finding both to track aspects of the subject, rather than consciousness. This nonetheless supports a way forward for the science of consciousness, as endorsed by the Relation View: discover the natural basis of the subject, its world, and the relation between the two. Integrated information theory, especially, provides a head start on this, but more work on the neural basis of the subject is required. I will discuss recent advancements on non-reductive approaches in neuroscience that support the Relation View, and what I take to be needed going forward. Finally, the Relation View resolves old puzzles that have plagued consciousness research: the non-localizability issues of consciousness, for example, are also true of relations. Subjectivity and intentionality will likewise be explicitly discussed as part of the argument in favor of the Relation View. In sum, this talk is aimed at upending what I take to be a deep misconception about consciousness, with the hope of better understanding and progress.

Oxytocin administration in children with autism facilitates the transient incidence of non-harmonic relationships between alpha and theta rhythms in the resting brain

Alaerts Kaat (University of Leuven, KU Leuven), Daniels Nicky (University of Leuven, KU Leuven), Moerkerke Matthijs (University of Leuven, KU Leuven), Prinsen Jellina (University of Leuven, KU Leuven), Bamps Annelies, Debbaut Edward, Rings Pia, Tang Tiffany, Van der Donck Stephanie, Steyaert Jean, Boets Bart

Concurrent Session: Disorders of Consciousness 2, Saturday June 24th, Classroom 214, 2:00pm-2:15pm

Shifts in the peak frequencies of oscillatory neural rhythms have been put forward as a principal mechanism by which cross-frequency coupling and decoupling is implemented in the brain. This notion is based on the mathematical reality that oscillations can only fully synchronize when their peak frequencies form harmonic 2:1 relationships (e.g. f2=f1/2). Non-harmonic cross-frequency relationships, on the other hand (based on the irrational number 1.618.:1), provide the highest physiologically possible desynchronized state (reducing the occurrence of spurious, noisy, background coupling) and are therefore anticipated to characterize the 'resting' default state of the brain, in which no selective information processing takes place. The present study sought to assess whether the transient occurrence of 1.6:1 non-harmonic and 2:1 harmonic relationships between peak frequencies in the alpha (8–14Hz) and theta (4–8Hz) bands are impacted by intranasal administration of oxytocin, a neuromodulator involved in complex modulation of prosocial behavior through facilitating social salience and/or reducing stress/anxiety. Resting-state electroencephalography was acquired before and after four weeks of daily oxytocin administrations (12IU twice daily) in 60 children with autism spectrum disorder (ASD). Compared to controls (n=40), children with ASD displayed a significantly lower incidence of non-harmonic alpha-theta cross-frequency configurations, indicating an increased intrinsic occurrence of spurious, noisy background phase synchronizations in the resting brain in ASD. Notably, after the oxytocin treatment, a significant increase in the transient formation of non-harmonic cross-frequency configurations was observed, indicating a beneficial effect of oxytocin on reducing spurious 'noisy' cross-frequency interactions. The oxytocin group also showed a parallel increase in heart rate variability, confirming a stress-regulatory role of oxytocin in balancing parasympathetic drive. Non-harmonic cross-frequency configurations are put forward to lay the ground for a healthy neural network allowing the opportunity for efficient transitions from resting-state to activity. Precluding the occurrence of noisy couplings among neural rhythms may therefore form an important mechanism by which oxytocin optimally prepares the system for forthcoming active signal processing states; by increasing the signal-to-noise properties of the intrinsic EEG neural frequency architecture.

Neural mechanisms for self-recognition from whole-body movements

Akila Kadambi (Department of Psychology, UCLA), Gennady Erlikhman (Department of Psychology, UCLA), Micah Johnson (Department of Psychology, UCLA), Marco Iacoboni (Department of Psychiatry and Biobehavioral Sciences, UCLA), Martin Monti, Hongjing Lu

Concurrent Session: Body and Embodiment, Sunday June 24th, Classroom 206, 11:00am-11:15am

Humans can distinguish their own actions from the third person from even sparse visual information. In a two-session study, we aimed to identify the corresponding neural correlates for this ability. In Session 1, we motion-captured a range of actions from 20 participants, their close friends, and strangers, which were converted to visually degraded point-light displays. Participants returned after a delay period for functional neuroimaging (fMRI) in Session 2. Univariate results showed that recognition for all identities (self, friend, stranger) recruited the action observation network spanning somato-motor and temporooccipital regions. Specific to self-processing, frontoparietal motoric regions were greater engaged and functionally connected. Using whole-brain representational similarity analysis (RSA), we visualized motoric contributions at a granular level, while accounting for distinct visual features related to the actions. Behavioral dissimilarity matrices based on semantic (proprioceptive familiarity and identity) and visual action features (speed, acceleration, jerk, body posture, and movement distinctiveness) were correlated with whole-brain neural activity patterns using a searchlight approach. Both semantic RSAs and visual feature RSAs for movement distinctiveness and body structure showed widespread activity patterns across the whole brain, localized more posteriorly for movement distinctiveness and more distributed for the semantic and body structure RSAs. After accounting for the visual action features, the semantic RSAs for proprioceptive familiarity and self-identity further showed strong activity pattern encoding in the bilateral primary motor cortices, spanning the primary somatosensory cortices. The results together suggest enhanced motoric requirements for visual self-action recognition, providing functional support to embodied accounts of the self.

Resting state networks predict the recovery of consciousness after acute severe brain injury.

Karnig Kazazian (Western Institute of Neuroscience, Western University, Canada), Matthew Kolisnyk (Western Institute of Neuroscience), Karina Rego (Temerty Faculty of Medicine, University of Toronto, Toronto, Canada), Sergio L. Novi (Western Institute of Neuroscience), Teneille E. Gofton, Derek Debicki, Adrian M. Owen & Loretta Norton

Concurrent Session: Disorders of Consciousness 1, Friday June 23rd, Classroom 202, 5:30pm-5:45pm

Introduction: Predicting the recovery of consciousness for patients with acute disorders of consciousness in the intensive care unit (ICU) is a substantial clinical challenge. As it stands, there are no tools used in clinical practice that can determine whether unresponsive patients in the ICU will regain consciousness and have a good neurologic recovery, or progress to an unresponsive wakefulness state. This make makes discussions regarding the continuation of care and the withdrawal of life-sustaining measures particularly challenging. Resting-state fMRI (rs-fMRI) is one method that may aid with determining outcome for this patient group by objectively evaluating network connectivity within the brain. These measures may serve as markers of cortical integrity and predict outcome. In this work, we evaluate the utility of using rs-fMRI in conjunction with machine learning to predict recovery of consciousness with acutely brain injured patients in the ICU. Method: A 5.5-minute rs-fMRI scan was acquired with 25 patients. Ten resting state networks were extracted from each patient's data using independent component analysis, and the spatial correlation of a patient's resting state network to these templates was used as a proxy for how intact a given network was. To assess a patient's level of consciousness, the Glasgow Coma Scale (GCS) was administered before scanning. The Glasgow Outcome Scale (GOS) was used to determine the extent of recovery of consciousness and functional outcomes within six months following injury. Those with a GOS > 3 were placed into the good outcome group ($n = 10$), whereas those ≤ 3 were placed into the poor outcome group ($n = 15$). The Nearest Centroid classifier was then used to map the resting state network's spatial correlation values to patient outcome. Results: The Nearest Centroid classifier accurately predicted 8/10 patients with good recovery and 12/15 patients with poor recovery (ROC AUC: Mean = 0.793, Median = 0.833) which was significantly greater than standard clinical measures (e.g. GCS; ROC AUC: Mean = 0.371, Median = 0.350). Three visual networks (medial visual: $p < 0.01$; occipital pole: $p < 0.05$; lateral visual: $p < 0.05$) were most predictive for the recovery of consciousness. Demographic and clinical information across patients in the good and poor outcome groups were not significantly different with respect to age ($t(16.91) = 0.314$, $p = .76$), GCS at time of imaging ($t(17.05) = -0.714$, $p = .48$), proportion of patients sedated $t(18.65) = 0.323$, $p = .75$), and log scan time post ictus ($t(22.06) = -1.367$, $p = .19$). Conclusion: Rs-fMRI, in conjunction with machine learning, can be used to predict recovery from acute disorders of consciousness in the ICU. By revealing preserved rs-fMRI networks in the absence of any discernible behavioural signs, functional connectivity measures may aid in the prognostic process and identify which patients will regain consciousness after acute severe brain injury.

Shared subcortical arousal networks across sensory modalities during transitions in attention

Aya Khalaf (Yale University), Erick Lopez (Yale University), Hal Blumenfeld (Yale University)

Concurrent Session: Perception and Attention, Saturday June 24th, Classroom 204, 2:45pm-3:00pm

Subcortical arousal systems are well known for their role in controlling sustained changes in attention. Recently, there has been increasing evidence that these systems also have a major influence on transient and dynamic modulation of attention. However, most studies investigating transient changes in attention focus on cortical networks involved in stimulus salience and top-down control. Therefore, we investigate shared subcortical arousal networks across different sensory modalities (vision, audition, and taste) during transient changes in attention using block and event-related fMRI paradigms. To identify subcortical networks that are common across these sensory modalities, we analyzed fMRI datasets collected while subjects (N=1556) are performing visual, auditory, and taste perception tasks. Ten tasks (6 visual, 2 auditory, and 2 taste tasks) selected from four public datasets were employed for the analysis. The public datasets included Human Connectome Project dataset (5 visual tasks and one auditory task), UCLA Consortium for Neuropsychiatric Phenomics LA5c dataset (one visual task) as well as datasets collected at Yale University (two taste perception tasks), and Glasgow University (one auditory task). We performed a model-free fMRI analysis investigating percentage change in BOLD fMRI signal across time for the whole brain. To identify the statistically significant changes in percentage change BOLD signals with respect to the baseline, we employed a cluster-based spatiotemporal permutation test. A conjunction analysis was performed on the statistically thresholded brain maps to identify the subcortical regions sharing common activity across different tasks within each sensory modality and across sensory modalities at both block-onset and individual task events. Similarly, a disjunction analysis was performed on the statistically thresholded brain maps to identify the brain regions unique for each sensory modality. The disjunction analysis showed that the primary visual cortex, superior temporal gyrus, and insular cortex are the main unique brain regions for visual, auditory, and taste perception tasks, respectively. The conjunction analysis revealed a shared network of subcortical arousal systems that show transient fMRI increases in midbrain tegmentum and thalamus across tasks and modalities, as well as less consistent increases in nucleus accumbens, nucleus basalis and striatum. Identifying such shared subcortical networks is of great importance for understanding fundamental mechanisms of normal attention, and may help facilitate optimal subcortical targeting of therapeutic neuromodulation to restore consciousness in patients with neurological disorders.

Perceptual decisions result from dynamic precision-weighted integration of memory and visual information

Ari Khoudary (University of California, Irvine), Aaron M. Bornstein (University of California, Irvine), Megan A.K. Peters (University of California, Irvine)

Concurrent Session: Perception, Friday June 23rd, Classroom 206, 5:00pm-5:15pm

When viewing a noisy visual stimulus, drawing on prior expectations can help resolve perceptual uncertainty. The degree to which prior expectations are useful can vary during the course of perception, for instance with the fluctuating coherence of visual and memory information. Despite extensive theoretical and empirical work devoted to understanding the role of expectations on perceptual decisions, there has yet to be an investigation into how the dynamics of visual evidence accumulation and memory retrieval interact to support adaptive decisions. We developed a formal framework describing how memory and visual evidence are dynamically integrated over the course of a perceptual decision, and designed a behavioral task to test key predictions of this theory. Drawing on well-established findings in optimal cue combination, we propose that perceptual decisions result from dynamic precision-weighted integration of independent streams of memory and visual evidence, implemented as a time-varying drift diffusion model. We show that this model reproduces dynamic effects of expectations in perceptual decisions made both by humans and primates (Hanks et al. 2011; Deneve, 2012; Bornstein et al. 2023). We next designed an experiment to critically test our theory. Participants learn probabilistic cue-target relationships, which they used to decide which of two images (targets) (targets) dominated a rapidly-alternating stream of visual evidence presented inside colored borders (cues). In 'congruent' trials, the colored border accurately predicts the dominant image; in 'incongruent' trials, the cue predicts the other image of the pair. In 'neutral' trials, the border predicts both targets equally. Critically, the visual evidence stream contains two epochs of pure visual noise. If perceptual decisions result from dynamic precision-weighted integration of memory and visual evidence, then the decision variable during visual noise epochs should continue to accumulate toward the choice predicted by the prior at a rate proportional to the precision of the memory cue. This would result in accuracy being reduced in incongruent trials more than in neutral trials, and that longer periods of noise should result in even longer reaction times in incongruent trials than in neutral trials, despite both trial types containing the same magnitude of perceptual evidence. Pilot data demonstrate feasibility of the study design and analysis approaches, with qualitative trends that are consistent with model predictions; data collection is ongoing. Future work will develop a framework for modeling decision confidence, and investigate how subjective perceptions of evidence reliability modulate memory & visual integration.

Vector embeddings as a representational format

Alex Kiefer (Monash University)

Concurrent Session: Artificial Intelligence, Friday June 23rd, Classroom 204, 5:30pm-5:45pm

Many traditional debates in cognitive science and the philosophy of mind depend on two dichotomies that I argue to be outmoded in light of 21st-century developments in the theory of cognitive systems, specifically those tied to the rise of advanced artificial intelligence and machine learning. The first of these dichotomies is that between iconic and discursive (or language-like) representations or representational formats. The second is that between formal, rule-governed processes or state transitions and associative ones. Vector space embeddings, which are common currency across all successful deep learning systems, function neither as iconic representations (i.e. pictures, in which variations in a representational medium analogically represent variations in the target), nor as language-like representations (i.e. systems of discrete, composable symbols exhibiting Classical constituency). Nonetheless they are capable of doing the jobs traditionally associated with both. Similarly, processes defined over vector embeddings are not formal in the narrow sense of being systematically responsive only to a privileged subset of syntactic features, but they also evidently outstrip the capabilities of associative transitions as traditionally conceived (and in fact seem capable of supporting sophisticated forms of reasoning). In this talk I succinctly present a positive characterization of the ways in which vector space embeddings operate, both in traditional artificial neural networks and in transformer models. I present four key theses which, taken together, elucidate how vector space representations and the processes defined on them relate to more traditional paradigms in cognitive science, and also explain their success. The first is vector space iconicity: the vector space as a whole iconically or analogically represents its domain (e.g. natural language or the space of possible images). The second is algebraic compositionality: token representations do not compose Classically to form complexes that literally contain their parts, but the system satisfies the weaker requirement that complexes can always be computed from simples and vice-versa. With respect to process, I present the view that the linear-algebraic operations that define transitions among vectors function as mass associations, in which fundamentally statistics-driven (e.g. Hebbian) learning at the level of individual weights yields a "productive" system capable of interpolation and extrapolation (i.e. generalization) at the level of the vector space. This is sufficient to model inductive inference. At the same time, we can account for logical entailment as a special case of semantic entailment (e.g. "x is red, therefore x has a color"), in which the semantics in question are those of the logical vocabulary.

Exploring the Simultaneous Multiple Realization Hypothesis

Asger Kirkeby-Hinrup (Dept. Philosophy, Lund University, Sweden / Cognitive Neuroscience Research Unit, Aarhus University, Denmark), Morten Overgaard (Cognitive Neuroscience Research Unit, Aarhus University, Denmark), Sascha Fink (Otto-von-Guericke-University Magdeburg, Germany)

Concurrent Session: Philosophical Foundations, Friday June 23rd, Classroom 220, 11:00am-11:15am

In interdisciplinary consciousness studies there are various competing hypotheses about the neural correlate of consciousness. Much contemporary work is dedicated to determining which of these hypotheses is right (or the weaker claim is to be preferred). The prevalent working assumption is that one of the competing hypotheses is correct, and the remaining hypotheses misdescribe the phenomenon in some critical manner and their associated purported empirical evidence will eventually be explained away. In contrast to this, the Simultaneous Multiple Realization Hypothesis (SMR) proposes that each hypothesis about the mechanism of consciousness — simultaneously with its competitors — may be right and its associated evidence be genuine evidence of NCCs. Importantly, SMR does not claim that every available hypothesis about consciousness is correct, but only that more than one hypothesis is correct. Thus, SMR suggests there may be more than one mechanism instantiated in the brain, that is sufficient for the generation of conscious experience. Initially, candidate mechanisms would be those already proposed by prominent theories of consciousness (e.g. recurrent processing, higher-order representation, information integration, global broadcasting), but the existence of other mechanisms remains a possibility. Following an explication of the SMR hypothesis, we highlight its explanatory power and interesting implications for a range of important issues in consciousness studies, including the unity of consciousness, phenomenal variability and the search for the NCCs.

The Measurement Problem: Its History and Solution

Alexander Klein (McMaster University)

Concurrent Session: Methods and Measures, Saturday June 24th, Classroom 220, 2:30pm-2:45pm

What behavioral criteria can we use to decide whether a creature is conscious? The challenge of finding a compelling answer is called the “measurement problem” (Browning and Veit 2020, Michel 2017, Chalmers 2010, 91 – 92). The problem is actually old. 19th c. vivisection research showed that decorticated frogs are capable of complex, goal-directed behaviors, prompting the question of whether the spinal cord could be an organ of consciousness. I begin with an analysis of the problem drawn from unsuccessful, 19th-c. attempts to solve it. Suppose measurement criterion M says that if a creature instantiates some third-person observable property P (e.g. choosing behavior), then that creature is conscious. A common approach to supporting such criteria was to use induction, which requires collecting many observations of creatures we take to be conscious who instantiate P. But what reason could we have for taking any such creature to be conscious in the first place? We must tacitly appeal to a measurement criterion. If the criterion is M, then the argument is circular. If we are using some different criterion N, then we first need to inductively support N. But this will require putting to use another criterion. If that criterion is either M or N, we are still in a circle. If that criterion is O, we are in a regress. I draw a solution from William James’s work on consciousness (James 1890). Despite the impressive, goal-directed behaviors of decorticated vertebrates, James detected some important deficiencies as well, deficiencies he sought to explain. He pointed out that decorticated pigeons are third-person-observably deficient at distinguishing the relative value of things in their environments—e.g. they interact with other pigeons no differently than they interact with a stone. He hypothesized that if consciousness were playing an evaluative role in the physiological economy of higher vertebrates, and if consciousness were seated in the hemispheres, this would explain the observed behavioral differences between intact and decorticated creatures. James’s P is, in effect, evaluative behavior. But he does not seek to collect confirmatory instances of conscious P behavior. Instead, he offers an argument to the best explanation of how P could arise, showing that the best explanation is that P behaviors are reliably caused by consciousness. But M is just the thesis that behaviors with the property P are reliably correlated with consciousness. So if James’s abductive explanation of P is compelling, that same argument also establishes his M—it establishes evaluative behavior as a measurement criterion for consciousness. It does so in an empirical fashion, and without substantially presupposing this or any other measurement criterion in any steps in his argument. We get empirical evidence for a measurement criterion with no circle and no regress. James’s work thus offers a solution to the measurement problem that is not inductive, but abductive.

Network Localization of Visual and Motor Anosognosia: memory and metacognition

Isaiah Kletenik (Harvard Medical School / Brigham and Women's Hospital), Kyla Gaudet (Brigham and Women's Hospital), Sashank Prasad (Harvard Medical School / Brigham and Women's Hospital), Alexander L. Cohen (Harvard Medical School / Boston Children's Hospital), Michael D. Fox, Harvard Medical School / Brigham and Women's Hospital

Concurrent Session: Metacognition, Friday June 23rd, Classroom 206, 11:30am-11:45am

Background: Anosognosia, or unawareness of a specific deficit, has been described for many brain functions and can occur for both visual and motor deficits. Such cases can lend insight into awareness itself, but the underlying neural correlates remain uncertain. Methods: We analyzed 267 lesion locations associated with either vision loss (with and without awareness) or weakness (with and without awareness). We sought to identify 1) brain network connections associated with domain specific anosognosia and 2) brain network connections associated with anosognosia in general, independent of the specific deficit. The network of brain regions connected to each lesion location was computed using resting-state functional connectivity from 1000 healthy subjects. We performed a voxelwise permutation-based ANOVA to identify domain specific and cross-modal associations with awareness. Results: We found a domain specific network for visual anosognosia defined by connectivity to the posterior cingulate, V2 and lateral occipital cortex and a domain specific network for motor anosognosia defined by connectivity to the anterior cingulate, anterior insula and supplementary motor area (FDR $p<0.05$). We also identified a domain general, cross-modal anosognosia network defined by connectivity to the hippocampus and precuneus (FDR $p<0.05$). Conclusions: Our results identify distinct network connections associated with visual and motor anosognosia, but also a shared network for awareness of deficits centered on memory-related brain structures. Domain specific networks for visual and motor anosognosia demonstrate connectivity to regions that maintain domain specific, topographic representations of sensory data (V2 in vision, insula in motor). The cross-modal findings, which converge on the hippocampus and precuneus, may align with metacognitive models where sensory representations must be compared to prior expectations stored in memory in order to recognize a new deficit.

The structure of consciousness bridges the gap between phenomenality and function

Lukas Kob (OvG University Magdeburg)

Concurrent Session: Philosophical Foundations, Friday June 23rd, Classroom 220, 10:30am-10:45am

This talk aims to bridge the commonly perceived gap between the functional and phenomenal properties of consciousness. It has long been assumed that the phenomenal aspects of consciousness cannot be entirely captured with functional analysis and that functions commonly associated with consciousness are a result of cognitive access mechanisms rather than underlying phenomenal experience (Block 1995). This creates a challenge in the study of the neural basis of phenomenal experience, as scientists often measure and characterize their target phenomena in terms of their functional properties. To address this challenge, I propose a structuralist approach for linking phenomenality and function through the structure of phenomenal experience described in the framework of quality spaces (Rosenthal 2010). In the first part of the talk, I will provide a review of recent neuroscientific research on the neural encoding of psychological structures (Kriegeskorte and Kievit 2013) and offer a mechanistic interpretation for how this encoding through structural similarity can be considered functional within neural processing. In the second part of the talk, I will apply this account to the science of consciousness, exploring how the structure of phenomenal consciousness can be considered functional due to its encoding within the activation structures of specific neural systems, determined by the underlying mechanisms. This structuralist perspective not only aids in identifying potential neural correlates of consciousness (Fink, Kob, and Lyre 2021), but also sheds light on a surprising aspect of the neural basis of phenomenal consciousness. For the structuralist approach reveals a close connection between phenomenal experience and the place and grid cell mechanisms related to functions that enable spatial navigation, time perception, and memory (Bellmund et al. 2018, Lau et al. 2022). I provide additional arguments for this perspective, which has important implications for the science of consciousness.

Adjudicating between first-order and higher-order theories of consciousness: the role of prefrontal cortex

Lua Koenig (NYU Langone), Haley G. Frey (Michigan State University), Vasili Marshev (Michigan State University), Emily R. Thomas (NYU Langone), Ned Block, David Chalmers, Megan A. K. Peters, Rachel N. Denison, Richard Brown, Victor A. F. Lamme, Jan W. Brascamp, Biyu J. He

Concurrent Session: Comparing Theories of Consciousness, Friday June 23rd, Classroom 210, 6:15pm-6:30pm

How the brain gives rise to subjective experiences such as the smell of coffee or the sight of a sunset remains an unresolved scientific mystery. Higher-order (HO) theories maintain that the prefrontal cortex (PFC) has a critical role in perceptual awareness. By contrast, first-order (FO) theories deny a crucial contribution of the PFC, arguing that awareness arises from recurrent sensory processing and that prefrontal activations result from post-perceptual processes including working memory and attention. The present study seeks to assess the role of PFC in perceptual awareness in order to adjudicate between theories of consciousness. We will measure PFC activity using 3T and 7T fMRI under conditions when visual stimuli enter perceptual awareness but trigger minimal post-perceptual cognitive processing. We will rely on a change blindness paradigm which, using retro-cues and post-cues, will provide experimental indices of both phenomenal awareness and cognitive access. The change blindness paradigm involves prompting subjects to respond if a specific image in an eight-image test array was the same as the image presented at that location in a previously shown original array. In retro-cue trials, the cue indicating which image to compare is presented before the onset of the test array. Accuracy in retro-cue trials depends on iconic memory, which is thought to be a reliable proxy of perceptual awareness. Accurate retro-cue responses will hence be taken as indicative that stimulus content entered awareness. Conversely, accurate responses on post-cue trials, in which the cue is presented after the onset of the image test array, require attention to, and encoding into working memory of, the initial stimulus content. Incorrect responses on post-cue trials will hence be taken as indicative of minimal or absent cognitive processing of that stimulus. The experiment will assess prefrontal fMRI decodability of stimulus content in conditions in which observers are unable to report whether the cued image changed if prompted by a post-cue (suggesting lack of working memory access) yet are able to do so if a retro-cue is presented (suggesting perceptual awareness). Under such conditions, if perceived stimuli are decodable from PFC, this will challenge FO theories; conversely, if perceived stimuli are undecodable from PFC, this will challenge HO theories. This study is currently under review for pre-registration. Piloting consisted in validation analyses that showed 1) that retro-cue performance was higher than post-cue performance and 2) that stimuli presented in correct post-cue trials (i.e. which had been encoded into working memory) were decodable from PFC. These results demonstrate the feasibility of the study and its promise in adjudicating between FO and HO theories of consciousness. The study will eventually be conducted independently in two labs, assuring simultaneous replication of the results and generalization across labs and participant populations.

Either visual experience is impoverished, or "upper-deck" PFC Theory is false

Benjamin Kozuch (University of Alabama Philosophy Department)

Concurrent Session: Richness of Consciousness, Friday June 23rd, Classroom 218, 5:30pm-5:45pm

Theories hypothesizing the PFC to be an NCC are increasingly popular (Odegaard et al. 2017; Brown et al. 2019), and data confirming these theories have steadily accumulated (Michel 2022). However, at least one of the two available forms of this “PFC Theory” is probably false. In its more popular form (e.g. Lau & Rosenthal 2011), the PFC plays a role beyond merely enabling the consciousness of visual states located in other parts of the brain (see Lau & Brown 2019), instead actually hosting the representations found in visual experience; i.e. the PFC is the content NCC for vision (Chalmers 2000). But if this were true, the PFC would have to represent as much visual content as appears in visual experience. This is unlikely, for reasons explained now. Note how visual experience seems—at least at first appearance—to contain a great deal of content: Within the typical visual experience, multitudes of visual properties appear to be represented (Siewert 1998; Haun et al. 2017); for example, it might appear as if the shape, color, location, motion, etc. of numerous objects are all being simultaneously represented, with this all appearing against a background that might itself be complex and detailed. On the other hand, if one looks at the functions the PFC carries out, ones such as attention and working memory, each seems geared—not toward preserving the copious visual information represented in the visual system at any given moment—but rather toward the selection of a very small portion of this information for more intensive or sustained processing (Chun et al. 2011a, 2011b; Luck et al. 2013). Here, the PFC theorist might appeal to data meant to undermine the idea that visual experience is “rich,” but these data fail to show visual experience to be as impoverished as it would need to be for the PFC to be plausibly supplying all conscious visual content. For example, the theory of inattentional inflation (Knotts et al. 2019) only shows that what we consciously perceive in unattended peripheral parts of the visual field might be fabricated, not that we fail to consciously represent something to be in these parts of the visual field; and the theory of ensemble statistics (Cohen et al. 2016) only shows that what is represented peripherally might not be as richly detailed or colorful as introspection suggests, but does not show that we lack an informationally rich experience of properties such as hue and brightness throughout much of our visual field. All in all, it seems unlikely that visual experience is impoverished enough to make it plausible that the PFC—whose functions largely consist of discarding a vast majority of available visual information—is the content NCC for vision. If this is correct, then the only version of PFC Theory that still might be true is the one according to which the PFC merely enables visual content, located outside of the PFC, to become conscious. This form of PFC Theory is at present underdeveloped.

Exteroceptive versus interoceptive conscious perception: A 7T fMRI study of afterimages

Sharif I. Kronemer (National Institute of Mental Health), Micah Holness (National Institute of Mental Health), A. Tyler Morgan (National Institute of Mental Health), Javier Gonzalez-Castillo (National Institute of Mental Health), Josh Teves, Victoria E. Gobo, Dan A. Handwerker, and Peter Bandettini

Concurrent Session: Imagery and Mind Wandering, Friday June 23rd, Classroom 220, 5:15pm-5:30pm

The neural mechanisms of interoceptive conscious perception (e.g. memory, imagination, and hallucination) are challenging to study, in part because the experimenter is naïve to the content of conscious perception except by overt report. Previous studies that contrast sensory or exteroceptive versus interoceptive conscious perception (e.g. seeing versus imagining or hallucinating an image) may be confounded by perceptual differences, including the subject, vividness, and duration of experience. To address this concern, we designed a novel paradigm using afterimages – an illusory visual perception with retinal and cortical substrates – as a model of interoceptive perception. Healthy, adult participants ($N = 30$) completed an initial task phase where subjects reported on the sharpness, opacity, and duration of their afterimages using a concurrent face stimulus that the participants controlled. From this information, and unbeknownst to the participants, a so-called mock afterimage – a real, on-screen face stimulus – was created that perceptually matched with the participants' real afterimages. In a main task phase, the real and mock afterimages were shown and participants were instructed to indicate their perceptual onset and offset. Monocular eye-tracking and pupillometry (EyeLink 1000 Plus; right eye; 1000Hz; SR Research, Inc.) and whole brain 7T fMRI (voxel size: 1.2mm3; TR: 1000ms; TE: 22ms; Siemens, Inc.) were concurrently recorded with the behavioral task. Participants also completed the Vividness of Visual Imagery Questionnaire (VVIQ). Preliminary results show that participants reliably reported on their real afterimages such that even when the real and mock afterimages was presented side-by-side, more than 90% of particpants believed the mock afterimage was an illusory perception, similar to their real afterimages. Moreover, hinting at a link between afterimages and imagery, the reported brightness of afterimages was positively correlated with VVIQ scores ($p < 0.05$). Preliminary whole brain, fMRI findings show that both real and mock afterimages correspond with large-scale network dynamics in arousal, attention, salience, and sensory networks, including the insula, thalamus, fusiform gyrus, posterior parietal cortex, and dorsal lateral prefrontal cortex. In addition, both the real and mock afterimages involve responses in primary visual cortex (V1). Future analyses will study differences in V1 activity that may suggest bottom-up versus top-down mechanisms for the real and mock afterimages. Finally, comparable pupil and blink dynamics were found following both the real and mock afterimages. These preliminary findings suggest that the neural networks for exteroceptive and interoceptive conscious perception involve overlapping and distributed cortical and subcortical regions. These results may have translational value for the treatment of people who experience hallucinations by confusing interoceptive perceptions with real world sources.

Why are confidence ratings of visibility non-binary? Understanding the mysterious graded transition between unconscious and conscious perception.

Wiktor Lachowski (Polish Academy of Sciences)

Concurrent Session: Visual Metacognition, Sunday June 24th, Classroom 214, 12:00pm-12:15pm

In a recent discussion between Rosenthal (2019) and Morales & Lau (2022), the former argued that the distinction between conscious and unconscious perception is binary rather than gradual - measuring consciousness with confidence ratings, however, commits to the latter assumption. Therefore, subjective reporting on whether a certain stimulus was seen or not is a more adequate measure than confidence ratings, which (i) ask the question about visibility only indirectly, (ii) usually on a non-binary scale, and (iii) often elicit a rating based on other forms of evidence than conscious perception (e.g. probability estimation). Morales and Lau responded that confidence ratings are superior to report as in practice participants find it hard to judge what seeing a stimulus is and isn't, the so-called criterion content problem (Kahneman 1968). With proper experimental design, confidence ratings allow to capture the "gray zone" between not seeing the stimulus at all and seeing it clearly, where the participant may have seen something, without full confidence in what it was. This is the case with type 2 blindsight sufferers, who perform well when asked to discriminate stimuli presented in type 1 task, but, unlike type 1 blindsight sufferers, display some confidence (stemming from visual data) in the correctness of their answers (e.g. Sahraie, 2010). Such a difference in confidence between the two groups arguably stems from the recollection of certain seen but irrelevant perceptual features from the moment of presentation by type 2 blindsight sufferers (detecting something, without knowing exactly what it was) (Weiskrantz, 2009). However, if a participant perceives something but not the target feature, it raises a difficult question of what exactly such confidence is founded upon . If the distinction between consciousness and unconsciousness is binary, then why would someone have any confidence in seeing the target stimulus - provided that only its irrelevant feature shared with the distractor was seen, e.g. seeing a glimpse of something red in a discrimination task between red circles and red triangles? This may indicate that the transition between consciousness and unconsciousness is not binary in a simple sense. In my presentation, I propose two ways how confidence can take positive values when the target feature is not consciously perceived: 1. Irrelevant feature recollection during judging one's confidence draws with it a vague memory of the target feature that was only unconsciously perceived during presentation. 2. The target features are disclosed to the participant upon presentation, but only fragmentarily. For example, a participant is able to see some straight lines, which make her/him believe that a triangle and not a circle has been displayed, however, without full confidence in this judgment, which would only result from consciously seeing the entire triangle (even if the seen features can only belong to a triangle, not a circle).

Body ownership signals are prioritised for conscious access

Renzo Lanfranco (Karolinska Institutet), Marie Chancel (Université Grenoble-Alpes), August Hägerdal (Karolinska Institutet), Sucharit Katyal (University College London), H. Henrik Ehrsson (Karolinska Institutet)

Concurrent Session: Body and Embodiment, Sunday June 24th, Classroom 206, 11:45am-12:00pm

The sense of owning one's body arises from the integration of multiple sensory signals. Are the signals that carry body ownership information prioritised for conscious awareness? Do they gain access to awareness as soon as they are sensorily processed? To induce and manipulate body ownership, researchers typically use the rubber hand illusion (RHI), which involves stroking a person's hand (hidden behind a screen) alongside a visible fake rubber hand placed in front of them; this induces the feeling that the rubber hand is their own. Most RHI studies rely on subjective reports and indirect measures to assess body ownership. Here we developed a two-alternative forced-choice (2AFC) paradigm that objectively quantifies body ownership processing in a bias-free manner by simultaneously inducing the RHI with two rubber hands. Graded stimulation asynchronies between the two rubber hands are introduced using robot arms, and participants must report which rubber hand feels most like their own. Here, we present four 2AFC experiments that have been analysed under type-1 and 2 signal detection theoretic (SDT) frameworks to test how different visuo-tactile manipulations modulate perceptual and metacognitive body ownership sensitivity; one of these experiments also involved electroencephalography (EEG) to search for neural signatures of body ownership sensitivity and metacognitive body ownership sensitivity using event-related (ERP), multivariate decoding, and functional connectivity analyses. We found that body ownership is very sensitive to visuotactile stimulation incongruencies: stimulation asynchronies of 30-50 ms caused noticeable changes in hand ownership, leading to above-chance perceptual and metacognitive discrimination performance. Both perceptual and metacognitive body ownership discriminations arise together across increasing visuotactile stimulation incongruencies, which suggests that body ownership information becomes available for awareness as soon as is processed in perception. Furthermore, other multisensory manipulations like varying the spatial distance between the rubber hands and the hidden real hand and congruence between the materials stimulating the rubber hands and the real hand, modulated perceptual bias. Using this novel paradigm, we show how the temporal, spatial, and tactile congruence principles of body ownership modulate body ownership processing and perceptual bias during the RHI, and that body ownership information is prioritised for conscious awareness.

No evidence for unconscious rhythmic information processing under monocular entrainment

Yu-Hsin Lee (National Taiwan University), Po-Jang Hsieh (National Taiwan University)

Concurrent Session: Time Perception, Saturday June 24th, Classroom 218, 2:30pm-2:45pm

The ability to unconsciously process sensory information is one of the key capabilities possessed by cognitive systems. In vision, it has been demonstrated that stable fusion can prevent conscious access to information regarding the eye-of-origin. By exploiting this lack of awareness, periodicity can be effectively hidden monocularly outside of consciousness. Meanwhile, rhythm is ubiquitous in biological systems, neural oscillation in particular has been implicated in orchestrating cognitive processes. Previous studies indicated that human subjects could be readily entrained by external periodic events, and their performance oscillated with the different phases of rhythm. However, it is still unclear to what extent and at what level of processing rhythmic entrainment can occur when the rhythmic entrainer is unconsciously presented monocularly. In the present study, we entrained our participants unconsciously with superimposed gratings, then probed with tilted gabor at different phases. In experiment 1, we first identified a strong foreperiod effect across the tested frequencies (i.e. 1Hz, 4.6Hz, 10Hz and 30Hz), as well as possible neuronal adaptations. However, results revealed no concrete evidence of entrainment. In subsequent experiments 2 and 3, we adopted continuous flash suppression (CFS) to tease apart the foreperiod effect from possible entrainment. Additionally, we utilized eye-tracking as an auxiliary measurement, since reduction in oculomotor dynamics has been linked to reflect temporal orientation and time-to-event estimation. Consistent results were obtained after eliminating the foreperiod effect with the two follow-up experiments. Our findings suggest that conscious access is necessary for monocular rhythmic entrainment under the current condition.

Phenomenal Thought and the Unconscious Thought Paradigm in Psychology

Preston Lennon (Rutgers University Center for Cognitive Science)

Concurrent Session: Unconscious Processes, Sunday June 24th, Classroom 204, 11:30am-11:45am

The phenomenal view of thought holds that thinking is a kind of experience with phenomenal character: that is, there is something it is like to think a thought. What's more, this phenomenal character of thought plays a content-determining role: to think the thought that p is to have an experience in the right external circumstances that p. This paper explores the implications for the phenomenal view of the unconscious thought (UT) paradigm in psychology. Beginning with initial experiments by Dijkersterhuis (2006), studies done under the UT paradigm purport to give evidence for unconscious thought. The UT studies give empirical support to a familiar idea: humans frequently report being able to solve a problem or answer a question after a period of not consciously thinking about them, e.g. during sleep or periods of distraction. UT studies initially look to offer a counterexample to the phenomenal view of thought: there are instances of thought that occur under the surface of phenomenal consciousness. In this paper, I canvas responses on behalf of proponents of the phenomenal view. The first response is to maintain that the UT studies pose no threat to the phenomenal view because what they give evidence for is unconscious thinking as a process, while the phenomenal view is about thoughts as states. The second response concedes that there are unconscious thoughts uncovered by the UT studies but to argue that the have their content in virtue of their connections to conscious thoughts. The third response argues that the states revealed by the UT studies are better cast as subdoxastic representations rather than thoughts, because the latter play an important theoretical role in self-knowledge that the latter do not. The upshot of these responses is that unconscious changes in thoughts revealed by the UT paradigm in psychology do not threaten the phenomenal view of thought.

The distinction between first-person perspective and third-person perspective in bodily self-consciousness

Caleb Liang (National Taiwan University), Wei-Kai Liou (Ming Chi University of Technology), Wen-Hsiang Lin (National Taiwan University of Science and Technology), Yen-Tung Lee (Western University), Sufen Chen

Concurrent Session: Body and Embodiment, Sunday June 24th, Classroom 206, 12:00pm-12:15pm

One major insight in the philosophy of mind is that each conscious self is uniquely associated with a first-person perspective (1PP), and correlatively, that all conscious experiences are essentially anchored in a particular 1PP (Nagel, 1974; Zahavi, 2005). This insight is supported by interdisciplinary studies (Legand, 2007; Blanke and Metzinger, 2009; Liang, 2016), including neuroscientific works (Legrand and Ruby, 2009; Christoff et al. 2011). Partly due to these developments, most researchers assume that the distinction between 1PP and 3PP (the third-person perspective) is rigid such that experiences based on 1PP are fundamentally different from experiences based on 3PP. This assumption has become a mainstream view in the study of bodily self-consciousness, and many researchers hold that genuine bodily illusions can only be experienced from the 1PP (Petkova et al. 2011; Maselli and Slater, 2013). We applied VR technology to investigate whether this mainstream view is correct. In our experiments, the participants were immersed in a VR environment in which they saw an avatar either from the 1PP or from the 3PP. In the 1PP condition, when the participant looked down at his/her body, he/she would see a life-sized avatar. In the 3PP condition, the avatar appeared at the right-front side (45°) about 45 cm away, such that when the participant looked down, he/she would see nothing there. Rather, the participant would have to look to the right-front in order to see the avatar. The participants either passively received tactile stimulations and/or actively interacted with a virtual soccer ball. Our VR system created novel visuo-motor-tactile correlations between the real and the virtual world: when the participant interacted with a real plastic soccer ball, he/she would feel corresponding tactile sensations and see the avatar performing the exact same movements. We found that a clear sense of ownership over the avatar was induced not only in the 1PP condition but also in the Passive-3PP and the Active-3PP conditions. We also observed evidence suggesting that it is possible to experience one's body-location, 1PP-location, as well as self-location, both from the 1PP and from the 3PP. These multifarious results demonstrate that there is in fact no fundamental gap between embodied 1PP and embodied 3PP. This will not threaten the philosophical insight mentioned above. It is just that the insight does not imply the mainstream view that is undermined by our study.

Decreased firing in subcortical cholinergic neurons associated with loss of consciousness in an awake behaving mouse temporal lobe seizure model

Shixin Liu (Yale University School of Medicine), Patrick Paszkowski (Yale University), Dana Lee (Yale University), Marcus Valcarce-Aspegren (Yale University School of Medicine), Jiayang Liu, Lim-Anna Sieu, Sarah Mcgill, Waleed Khan, Alvaro Duque, Hal Blumenfeld

Concurrent Session: Disorders of Consciousness 2, Saturday June 24th, Classroom 214, 3:00pm-3:15pm

Human temporal lobe epilepsy is characterized by focal seizures originating from limbic systems and concomitant deficits in consciousness, which often have a major negative impact on quality of life. Approaches to restoring patients' consciousness could have significant benefits, but we must first understand the physiological and neuroanatomical basis of unconsciousness during focal limbic seizures. The prevailing view holds that this disorder impairs consciousness by seizure spread to the bilateral temporal lobes. We propose instead that seizures invade subcortical regions and depress arousal, causing impairment through decreases rather than increases in activity. Previous studies in our laboratory have identified the inhibition of brainstem and basal forebrain cholinergic neurons as potentially responsible for decreased arousal during focal limbic seizures in "lightly anesthetized" rats. Our goal was to determine if this mechanism also plays a role in a new awake, behaving mouse model. In addition, awake mouse models allow the exploration of changes in pupillary diameter and animal behavior to evaluate the loss of consciousness in temporal lobe seizures. Mice were head-fixed on a running wheel. Local field potentials were measured with chronically implanted bipolar electrodes in the right lateral orbitofrontal cortex and bilateral hippocampi. Induction of focal limbic seizures was accomplished by the application of current pulses (2 s, 60 Hz) into the hippocampus. We used glass capillaries filled with 4% Neurobiotin for juxtacellular single unit activity (SUA) recordings in the nucleus basalis of Meynert (NBM) and brainstem pedunculopontine tegmental nucleus (PPT). Animal running wheel behavior and pupillary diameter changes were also recorded. Cholinergic neurons were identified by staining with anti-choline acetyltransferase (ChAT) antibodies. Focal limbic seizures suppressed running-wheel behavior, and orbitofrontal local field potentials exhibited synchronized slow-wave activity similar to that observed in human patients. SUA during focal limbic seizures showed variable firing patterns in NBM and PPT with some neurons showing decreased firing, others showing increases, and others no change. Initial identification of neurons by ChAT staining suggests that cholinergic neurons may show reduced firing during focal limbic seizures, especially in the PPT. These findings demonstrate that stable SUA recordings of deep subcortical neurons are possible during seizures in awake, behaving mice. Additionally, inhibition of neurons in the key subcortical arousal regions, such as NBM and PPT, may play a critical role in regulating consciousness during focal temporal lobe seizures. Further investigations of the specific subcortical neurons and neurotransmitters involved during seizures are necessary to elucidate the mechanisms underlying seizure-related unconsciousness and may offer promising new treatments for people suffering with epilepsy.

Neurophenomenal structuralism

Holger Lyre (University of Magdeburg, Germany)

Concurrent Session: Philosophical Foundations, Friday June 23rd, Classroom 220, 10:45am-11:00am

This is a rather programmatic talk. I will present and defend “neurophenomenal structuralism” (NPS), an agenda for a genuine structuralist neuroscience of consciousness. NPS is based on two assumptions:, 1. The content of any phenomenal experience is fully individuated by its location in a phenomenal quality space. 2. The structure of the phenomenal mirrors the neural structure. The crucial ontological implication of the first assumption is that phenomenal experience is a relational, not an intrinsic affair. In this sense, NPS opposes the traditional view that qualia are intrinsic. Instead, NPS emphasizes the structure and importance of similarity ratings between phenomenal experiences together with the fact that the neural mechanisms underlying our senses mainly perform change detections. A systematic account of the structure of phenomenal experiences leads to the representational geometry of quality spaces. The second assumption of NPS, the mirroring assumption, proclaims a second-order structural similarity between the phenomenal and the neural. A refined formulation is that a surjective homomorphic mapping of the structures of self-organized neural maps in the brain onto quality space structures exists. Because of this mapping, the causal structure of the phenomenal is preempted by the neural structure. Hence, NPS must ultimately be considered a physicalist and reductionist program. It is also important to stress that NPS is about specific rather than generic consciousness. NPS does not tell us when a mental state is conscious in general, but rather what the specific content of phenomenally conscious states is. In the second half of the talk the various methodological and philosophical implications of NPS shall be outlined:, (i) it leads to a new and special version of structural representationalism about phenomenal content, (ii) it proposes neuroscientific measurement procedures that focus on the relation-ships between different stimuli (as, for instance, similarity ratings or representational geometry methods),, (iii) it leads to holism about phenomenal experiences, and, (iv) serves to reject inverted qualia scenarios.

Implicit/explicit learning across primate species: a process dissociation study

Raphaelle Malassis (Ecole Normale Supérieure), Jerome Sackur (Ecole Normale Supérieure), Dezso Nemeth (Claude Bernard University Lyon 1)

Concurrent Session: Animal and Infant Consciousness, Sunday June 24th, Classroom 220, 11:00am-11:15am

Psychology of human learning distinguishes implicit learning, resulting in nonconscious knowledge, and explicit learning, resulting in conscious knowledge. Despite that a comparative approach is essential to better understand their conditions of emergence, functions and underlying mechanisms, the hypothesis of a similar distinction between implicit and explicit forms of learning in other species has been largely overlooked so far. We will present a study assessing the hypothesis of a dissociation between implicit and explicit sequence learning in four non-human primate species (chimpanzees, Pan troglodytes, n = 4; orangutans, Pongo abelii, n = 4; Guinea baboons, Papio papio, n = 12; capuchin monkeys, Sapajus sp. n = 12), and comparing their performance to humans (n = 32) tested with the same task. We used a reference test for probing conscious sequence knowledge in humans, derived from the Process Dissociation Procedure (PDP; Jacoby, 1991; Destrebecqz & Cleeremans, 2001). Within this procedure, explicit learning is evidenced by successful control over the reproduction of the learned behavior, and implicit learning by its automatic reproduction regardless of the task demands. In the current study, participants first learned visuo-spatial sequences in a target tracking task on a screen. They were then trained to perform a sequence completion task under two conditions: one in which they must reproduce the learned sequences, and another in which they must avoid reproducing these. Humans did not receive verbal instructions and had to learn the PDP conditions based on the same training procedure as the non-human participants. Humans who could verbalize the PDP conditions and the presence of regularities were able to both reproduce and avoid reproducing the learned sequences at ceiling levels, while the others tended to reproduce the sequences in both conditions. Non-human primates applied alternative response strategies but nevertheless tended to reproduce the sequences in both conditions. We will discuss hypotheses regarding the alternative response strategies favored by the non-human primates, as well as the sensitivity of the sequence completion task to implicit and explicit learning in these different species.

Investigating the Role of Cerebral Cortex in Consciousness

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Concurrent Session: Sleep, Dreaming, Anesthesia, Friday June 23rd, Classroom 204, 12:15pm-12:30pm

In humans, the level of consciousness is reliably assessed by quantifying the spatiotemporal complexity of cortical responses using Perturbational Complexity Index (PCI) and related PCIst (st, state transitions). These measures are high in wake and REM sleep, when subjects retrospectively report vivid experiences, and low in NREM sleep and slow wave anesthesia. However, the cellular and network mechanisms responsible for the ability of these measures to reflect the level of consciousness are poorly understood. In NREM sleep and slow wave anesthesia, when PCI/PCIst values are low, cortical neurons fire more or less synchronously. A long-standing hypothesis has been that in those states, the stimulation used to measure PCI/PCIst is more likely to trigger a large OFF period, silencing the cortical network, impairing the communication among areas, and thus resulting in a simple evoked response. However, studies in humans and rodents so far could not provide direct evidence for the cessation of cortical unit firing. Here, we investigated PCIst responses in freely moving rats and mice using electrical and optogenetic stimulation accompanied by unit recording probes with multiple contacts (Neuropixels and NeuroNexus probes). First, we validated PCIst in freely moving rats and mice by showing that it is lower in NREM sleep and slow wave anesthesia than in wake or REM sleep, as in humans. Specifically, we found that in rats (8 males) PCIst values in NREM sleep decreased on average by 50 $\pm$ 20% relative to wake and by 51 $\pm$ 27% compared to REM sleep, resulting in significant changes at the group level (paired ANOVA; $F(1.69, 23.7)= 33.4$; $p< 0.0001$; $\eta2= 0.70$; Tukey correction for multiple comparison). Similarly in mice (8 mice, 4 females; CaMKIIα::ChR2 transgenic line), we found that PCIst values recorded from posterior parietal cortex are higher in wake than in NREM sleep, and almost always higher in REM sleep than in NREM sleep ($F(1.35, 8.14)= 6.23$; $p= 0.0302$; $\eta2= 0.51$). We then showed that low PCIst is associated with the occurrence of a cortical OFF period of neuronal silence. Moreover, we found that stimulation of deep, but not superficial, cortical layers lead to reliable PCIst changes across sleep/wake and anesthesia. Overall, we found that consistent PCIst changes are independent of which single cortical area is being stimulated or recorded, except for recordings in mouse prefrontal cortex. These experiments show that PCIst can reliably measure vigilance states in unresponsive animals and support the hypothesis that it is low when an OFF period disrupts causal interactions in cortical networks. In ongoing experiments in mice, we also find that the selective optogenetic activation of pyramidal neurons in different cortical areas is sufficient for the recovery of the righting reflex after the induction of a coma-like state. Thus, the direct activation of cortical pyramidal neurons is likely sufficient for the recovery of consciousness.

The nature of the readiness potential in conscious, voluntary actions

Uri Maoz (Chapman University / UCLA / Caltech), Jake Gavenas (Chapman University), Aaron Schurger (Chapman University)

Concurrent Session: Action, Decision, Volition, Friday June 23rd, Classroom 202, 11:00am-11:15am

Exactly 40 years ago, Libet and colleagues demonstrated that the onset of brain activity classically associated with voluntary, spontaneous action (the readiness potential, RP) precedes the reported onset of the conscious decision to move (W time). Many took this as evidence that consciousness plays no causal role in decision making and action formation. The Libet results have come under severe methodological and conceptual criticism. Still, they left the neuroscience of volition with two key debates. The first relates to the nature of the RP. Does it reflect preparation to move (classical view)? Or is it a byproduct of an autocorrelated accumulation-to-bound process, backward averaged from movement onset (recent reinterpretation)? The second debate focuses on the best way to measure W time, if it is at all possible. Below we discuss our results, which bear upon both questions. The classical interpretation of the RP was bolstered by a recent probe study of spontaneous action. There participants carried out self paced movements while occasionally interrupted and asked whether they just had an intention to move. Such reported intentions to move were shown to coincide with RP-like EEG deflections. However, we showed that those deflections stem solely from trials where the probe was delivered too close to movement onset for participants to inhibit their movement. In another study, we simulated spiking neural-networks with clustered connectivity and slow synapses. These demonstrated key characteristics of single-neuron recordings in humans, especially spontaneous, concurrent ramping up or down of neurons in a cluster. Furthermore, in aggregate, the network model exhibited RP-like negative deflections before threshold crossings. Both studies thus provide evidence against the RP reflecting specific preparation to move. Another set of studies focused on W time, which was classically measured by asking participants to report the position of a rotating spot on a clock face when they first had the urge to move (Libet clock). But the Libet clock is problematic—e.g. affected by neural activity after movement onset, systematically correlated with delayed action-feedback, dependent on whether it was presented before or after other tasks. So, the probe method was heralded as a better alternative. Yet we show that it also suffers from conceptual and methodological issues, especially related to metacognitive task switching. Instead, we tested whether pupil dilations predicted W time. Interestingly, pupil dilation onset was correlated with Libet-clocks measures of W times (controlling for general expectation, motor execution, and awareness of motor output). Pupillometry may therefore be a more objective method to measure W time. Based on the above, we sketch a model of volition that also explains our earlier finding that the RP is much diminished before meaningful, deliberate decisions.

Investigating the relationship between intrinsic neural activity and temporal resolution

Isabel Maranhao (University of Sussex), Miguel Maravall (University of Sussex), Warrick Roseboom (University of Sussex)

Concurrent Session: Time Perception, Saturday June 24th, Classroom 218, 3:15pm-3:30pm

Discrete perception accounts state that the brain processes continuous information about the world in discrete perceptual snapshots. Previous findings suggest that whether two stimuli are reported as having occurred simultaneously or sequentially is not only dependent on their physical asynchrony, but also on the temporal relationship between stimulus onset and neuronal states. These results are consistent with discrete perception accounts which assert that there is a neural state more likely to integrate sensory information in time, rendering the presented stimuli to be perceived as simultaneous and, conversely, a state more likely to segregate sensory information in time, rendering stimuli to be perceived as successive. Recent studies on this topic have focused on how alpha-band oscillations might mediate temporal organisation of perception, especially in vision. Discrete sampling and robustness of alpha-band properties are often uncritically assumed to be true. Mostly correlational evidence has been reported regarding the speed of one's alpha oscillation and performance in temporal resolution tasks. Sources of changes in participant reports, however, could possibly be explained by changes in decisional criteria, relating more to report bias than changes in perception per se. Here we present the results of a series of pre-registered studies (https://osf.io/u3qbr) wherein we investigated if such a relationship between temporal organisation of perception, indexed through behavioural temporal precision, and neural oscillations in the alpha and beta bands exists, both in the visual and tactile domain. We first tested if performance on a visual duration discrimination task is correlated with one's intrinsic alpha-band (7-13Hz) and beta–band (13-30Hz) peak frequency (using EEG). Our prediction was that people with better behavioural temporal precision should, in theory, have faster intrinsic frequencies. In a further study, we had participants provide ternary choice synchrony judgements about visual or tactile stimulus pairs while we recorded EEG to investigate pre-stimulus phase relationship for integrated and segregated perceptual choices. The ternary choice synchrony and EEG task was repeated over two sessions a ~week apart. The two session design allowed us to test the reliability of intrinsic (peak) alpha and beta frequencies over time. Results showed that intrinsic alpha and beta frequencies are robust over this time period, however, they have a much weaker relationship to visual temporal precision than previously reported. No evidence for an effect of pre-stimulus phase (whether it be alpha or beta) on the visual or tactile synchrony judgements was found. Overall, our results undermine discrete perception frameworks, challenging research on temporal consciousness to reconsider how we sample the world.

The metacognitive hierarchy: bi-directional interactions between local and global confidence

Hélène Van Marcke (KU Leuven), Senne Braem (uGent), Kobe Desender (KU Leuven)

Concurrent Session: Visual Metacognition, Sunday June 24th, Classroom 214, 11:15am-11:30am

A common interest within the field of metacognition is decision confidence: the metacognitive confidence that people attribute to the choices they make. Decision confidence is typically studied on a very localized, choice-specific level, referred to as local confidence. However, humans do not only have metacognition about individual trials, but can also introspect their own performance on a higher-level. This is referred to as global confidence: the general confidence that someone has in their abilities to perform a task, thus situated on a higher level than local confidence. Although theoretical accounts predict recurrent interactions between both types of confidence, so far only the influence of local on global confidence has been empirically established. In the current work, we set out to provide the first empirical evidence for bi-directional interactions between local and global confidence. To this end, we tested participants on simple, perceptual decision-making tasks and queried both local and global confidence ratings. In line with the hypotheses, local confidence strongly depended on the level of prior global confidence – whereas in turn global confidence was well predicted as the weighted sum of recent local confidence judgments. A computational model provided further evidence that, indeed, local and global estimates of confidence interact in recurring and meaningful ways, resulting in a prolonged influence of local confidence via a manipulation of global confidence. Our results provide empirical evidence for the proposed hierarchy in confidence levels, which holds important implications for clinical practice as well.

Does Edge of Chaos Criticality have diagnostic or prognostic value in Disorder of Consciousness?

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Concurrent Session: Disorders of Consciousness 1, Friday June 23rd, Classroom 202, 5:45pm-6:00pm

Introduction: Consciousness is supported by brain dynamics poised between stability and chaos to enable maximally complex patterns – a state known as edge of chaos criticality (EOC). Brain chaoticity has reliably distinguished wakefulness from anesthesia-induced unconsciousness and seizure-induced unconsciousness. This study investigates the diagnostic and prognostic value of criticality, measured with the modified 01Chaos test, for patients in disorders of consciousness (DOC). We hypothesized that a decrease in level of and potential for consciousness will be accompanied by increased distance from the EOC. Methods: We analyzed an existing dataset of 256-channel resting state electroencephalograms from 260 patients in a DOC, recorded at the University Hospital Pitié Salpêtrière, Paris. Patients’ level of consciousness was assessed using the Coma Recovery Scale-Revised. Recovery of consciousness was defined by the patient’s ability to follow commands within 2 years post-recording (Glasgow Outcome Scale-Extended (GOSE) > 2). Signal chaoticity was estimated using the modified 01-Chaos test (Gottwald & Melbourne, 2009) in the 5 Hz low-pass filtered signal on all electrodes and epochs individually. Alternatively, the low-pass frequency was specified independently for every channel and epoch using the FOOOF algorithm. Following Toker et al. (2022), we estimated the closeness to the EOC by performing a nonlinear transformation on the signal chaoticity over a range of possible edge values (alpha). Group comparisons were performed using an independent t-test. Results: The average signal chaoticity did not differentiate patients according to their level of consciousness or their recovery of consciousness. The largest group difference between patients in an unresponsive wakefulness syndrome (UWS) and patients in a minimally conscious state (MCS) was found at alpha equal 0.85, supporting previous findings locating the EOC at 0.85. However, the closeness to the EOC did not significantly distinguish MCS from UWS patients. The variance of the chaoticity over electrodes significantly distinguished patients who later recovered consciousness from those who did not ($t = -2.76$, $p < 0.01$), with a more homogenous dynamic behavior indicating a favorable outcome. Conclusion: Our results suggest that a homogenous cortical dynamic behavior is associated with the eventual emergence of consciousness in brain-injured patients. No diagnostic value of a patient’s current level of consciousness was found in brain chaoticity.

Disorders of Consciousness through Global Neurophysiological Measures: A Meta-Analysis

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Concurrent Session: Disorders of Consciousness 1, Friday June 23rd, Classroom 202, 5:15pm-5:30pm

A known problem in neurophysiological research is the lack of reproducibility. This is especially relevant when the research concerns disorders of consciousness (DoC). Obtaining reliable data is made challenging by the heterogeneity of clinical profiles and brain lesions in DoC patients. As meta-analyses rank among the strongest research designs based on hierarchical levels of evidence, we here use this approach to quantitatively synthesise existing findings based on EEG, MEG and fNIRS in DoC patients. In January 2022, using databases MEDLINE via Ovid, and Scopus and Embase via Elsevier, we conducted a literature search for resting-state EEG, MEG, and fNIRS studies published from 2000 to 2022, involving adults with prolonged DoC and a primary diagnosis of unresponsive wakefulness syndrome (UWS) or minimally conscious state (MCS) based on a validated behavioural scale. Two referees independently screened abstracts and full texts of potentially relevant studies, followed by extraction of useful data. Authors were contacted when statistics were not available in the published materials. Separate random effect meta-analyses were conducted to compare global metrics between UWS and MCS, and healthy controls (HC) using the R package 'meta'. The full protocol, including the search strategy using controlled vocabulary and keyword terms, is available on PROSPERO (CRD42022327151). As of January 2023, from a total of 3563 unique studies, 21 were found eligible for inclusion in the meta-analysis, spanning a total of 499 UWS and 508 MCS patients, and 240 HC. We here report only measures appearing in three or more studies, all of these EEG-based. For comparisons between groups of subjects, differences were found across multiple frequency bands for measures of power, connectivity, and graph theory (i.e. participation coefficient). Large effects were only apparent between HC and DoC (both UWS and MCS), with power and connectivity in δ and α bands consistently showing significant differences, along with power in the β band. Still, heterogeneity between studies was often considerable, and larger for UWS than MCS when compared to HC. Power in δ and α bands, as connectivity in α band also differed between UWS and MCS, with medium effect sizes. Furthermore, UWS and MCS showed different power and participation coefficient in θ and connectivity in β band, all with small effect sizes. Despite heterogeneity, we found major differences in EEG δ and α measures between DoC patients and HC; albeit the effect was smaller, δ and α measures consistently differed also between UWS and MCS, possibly indicating that these measures might be of interest for diagnostic purposes. The relatively larger variability observed in UWS compared to MCS studies supports the notion of heterogeneity of the former group, with part of UWS patients likely presenting covert awareness, i.e. behaviourally unresponsive but with residual brain activity similar to MCS.

Investigating automaticity constraints and cognitive penetrability of multisensory integration illusions.

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Concurrent Session: Perception, Friday June 23rd, Classroom 206, 6:15pm-6:30pm

Multisensory integration is a psychological construct which is related to the neural processes by which unisensory signals are combined to form a new product. Perceptual effects or illusions that rely on cross-modal conflicts, such as the McGurk effect, Sound-Induced Flash Illusion (SIFI) and Temporal Ventriloquism (TV), have historically been considered as outcomes of these neural processes. In these examples, the relevant multisensory integration processes have sometimes been assumed to be automatic, encapsulated and ‘early’, namely as happening thanks to direct interactions between different (uni)sensory areas. These assumptions act to support the presumed ecological validity of these effects, as only fully automatic and encapsulated processes are thought to reflect generalizable multisensory perceptual effects - as distinct from changes in perceptual experience and/or response bias that are only evident in contrived lab-based experiments or attributable to experiment demand characteristics. In a series of experiments, we challenged these assumptions by first probing the demand characteristics of experimental designs used for the McGurk effect and the SIFI. We found that typical control conditions do not exclude that these illusions may result from task demands rather than other processes. We then addressed the cognitive penetrability of these illusions by relating the wide inter-individual variability in the susceptibility to the McGurk effect, SIFI and TV to trait phenomenological control, which is defined as the capacity people have, in various degrees, to change their experience to meet situational goals. Preliminary results on the relationship between phenomenological control and McGurk, SIFI and TV show a negative, a positive and no relationship, respectively. These results suggest that McGurk effect and SIFI are cognitively penetrable and hence not fully automatic nor encapsulated. To examine core assumptions of ‘automaticity’, we challenged models of multisensory integration which propose a hard temporal binding window of integration as the main mechanism underlying SIFI, by manipulating the temporal (a)synchrony between the visual and the auditory streams. In another study, we manipulated the featural similarity between the sounds, including using auditory metamers, building on previous research which showed abolition of the illusion when the inducing sounds are not identical. The results show that (i) illusion reports don't fully depend on a close temporal alignment between the auditory and visual streams and that (ii) featural ‘apparent’ similarity of the inducers constitutes a necessary constraint for the illusion to be reported. These results reveal that higher-level cognitive processes likely play a major role in reports of the SIFI. This research highlights the cognitive penetrability of some putatively multisensory effects (McGurk and SIFI), as well as problems with interpreting the SIFI as an ‘early’ and automatic effect.

Introspective inference counteracts perceptual distortion

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Concurrent Session: Visual Metacognition, Sunday June 24th, Classroom 214, 10:30am-10:45am

Insight is a complex form of introspection and denotes an agent's ability to recognize the extent to which their subjective internal perceptual experiences track with the actual states of the external world. Insight can help discern which conscious experiences will be used to alter our existent beliefs and which will be discounted as ”not real”, such as in the case of dreams, illusions or hallucinations. Insight is characteristically impaired in psychosis. Most frequently until now, insight and its impairments in psychopathology has been measured based on questionnaires, either self-reported or clinician-reported. Indirect or implicit measures of insight and other introspection-related processes such as metacognition hold unique promise to better understand its impairments in psychopathology. Intuitively, compensation for perceptual distortions can be flexible and take into account a model for how the distortion may have been generated, or it could be a more general response bias adjustment. We refer to the first type of compensation as insightful inference. To induce strong perceptual distortions, we created a task based on a variant of the motion after-effect (MAE) illusion. To measure insight in a quantitative manner, we quantified participants' ability to report beliefs in which they demonstrate proper compensation for their perceptual distortions. Even without trial-by-trial feedback, healthy participants compensated for the MAE illusion in the condition in which they were asked to infer the actual direction of motion (“Believe” condition), as opposed to reporting perceived motion (“See” condition). In a second experiment, a parametric choice of the test stimuli allowed us to apply an optimal-observer model to the participants responses and confidence reports which provided a good fit to the data. This model revealed that a possible mechanism for belief compensation is incorporating knowledge of the perceptual distortion into the likelihood and thus the decision. Furthermore, confidence reports, reaction times and pupil dilation patterns shifted in tandem with the psychometric curves, suggesting changes in uncertainty during belief compensation and supporting an interpretation in terms of adjustments at an intermediate inference stage. An application of the drift diffusion model to the reaction times data identified changes in drift rate and the starting point in the “Believe” condition relative to the “See” condition, but no differences in the decision bound, thus ruling out a response-bias mechanism for compensation. In sum, we show that healthy individuals may plausibly perform insightful inference and compensate for internal distortions through adjustments in perceptual-decision variables.

The Meta-Problem of Acquaintance

Jakub Mihálik (Czech Academy of Sciences/NYU)

Concurrent Session: Philosophical Foundations, Friday June 23rd, Classroom 220, 11:45am-12:00pm

Chalmers' meta-problem of consciousness is the problem of accounting for 'problem intuitions' about phenomenal consciousness, including the judgment that subjects enjoy acquaintance with their phenomenal states. This 'acquaintance-intuition' portrays acquaintance as the subject's direct, intimate awareness, something that's hard to account for in physicalist terms, hence yielding 'a problem of acquaintance'. I'll contribute to solving Chalmers' meta-problem by examining the options open to phenomenal realists regarding its crucial dimension, which I call 'the meta-problem of acquaintance' (MPA), the problem of accounting for the acquaintance-intuition. Chalmers' solution to MPA, based on Saad's idea that phenomenal states tend to cause the cognitive states they rationalize, relies on acquaintance having its own 'acquaintance-phenomenology' (APh). I'll argue, however, that the phenomenal construal of acquaintance is controversial. Firstly, APh would arguably prevent acquaintance from being phenomenologically immediate, as the acquaintance-intuition tells us it is. This immediacy arguably entails that acquaintance is 'transparent', which rules out APh. Secondly, the phenomenal construal of acquaintance faces an infinite-regress challenge. If acquaintance involves APh, one must be acquainted with APh, among other phenomenal features. Assuming, however, that acquaintance in general involves APh, one's being acquainted with APh involves further phenomenology, etc. ad infinitum. Insofar as experiences aren't infinitely phenomenologically complex, then, some acquaintance-instances must be non-phenomenal. Given these difficulties, the non-phenomenal construal of acquaintance (Coleman, Lockwood, later Russell) merits examination. Since, however, Chalmers' solution to MPA requires that acquaintance is phenomenal, proponents of non-phenomenal acquaintance must look elsewhere for solutions. I'll propose two solutions compatible with phenomenal realism. On the 'awareness-schema approach', inspired by Graziano (see also Dewhurst & Dolega), the acquaintance-intuition is based on one's brain generating a useful, although inaccurate, description of the complex, representational awareness of experience. While Graziano's theory arguably entails strong illusionism (Frankish), I'll suggest that phenomenal realists can endorse a 'hybrid account', combining mitigated illusionism about acquaintance (which makes acquaintance seem problematic without positing illusory APh), with phenomenal realism. Alternatively, on the 'inferential approach', inspired by Coleman and Rosenthal, one infers judgments about acquaintance from one's judgements that their experience is 'here', and that one isn't aware of any mediating factors (which makes acquaintance seem problematic). I'll argue that considerations of theoretical parsimony, and the worry that the awareness-schema approach undermines phenomenal realism, render the inferential approach preferable for phenomenal realists.

Discovering Emergence in Complex Neural Systems

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Concurrent Session: Neural Correlates of Consciousness, Sunday June 24th, Classroom 210, 11:45am-12:00pm

How phenomenal consciousness emerges from a neurophysiological basis is a fundamental question in consciousness science. Progress in addressing this question may benefit from principled and practical measures of emergence. One way to specify emergence is when a macroscopic property appears to be functionally independent from its microlevel constituents. Building on this intuition, a recently developed data-driven metric–Dynamical Independence (DI)–identifies coarse-grained macroscopic variables as those for which prediction of their evolution is not improved by knowledge of their microlevel constituents. While many alternative measures of emergence rely on discretisation of continuous-valued processes, DI can be applied directly to continuous-valued neurophysiological time-series data. First, we illustrate the characteristics of DI using a multivariate autoregressive system. Then, using The Virtual Brain (TVB) platform we simulate large-scale neural dynamics with basic oscillatory, and biologically realistic, coupled neural mass models. Varying global coupling and noise in the presence of realistic time-delays, DI is optimised across coarse-grainings to identify emergent functionally independent neural dynamics (FINDs) in candidate neural systems. We next propose a statistical approach to determine which regions in the brain network model are significantly implicated in the dynamics of the candidate FINDs. Intriguingly, we find that the macroscopic structure of the dynamics, and the areas that are implicated in their generation, correspond best at a balance between global coupling and noise. This suggests that macroscopic structure is sensitive to integrative and segregative mechanisms–connecting measures of emergence to measures of dynamical complexity that have been implicated in delineating conscious states. Altogether, we provide an illustration, and development of how dynamical independence delivers a measure of emergence that applies to biologically-realistic neural activity. Our results suggest that the emergence of macroscopic FINDs offers a complementary approach to graph-theoretic and information decomposition approaches, and may provide a practically applicable method for identifying the macroscopic structure associated with global conscious states such as anaesthesia, sleep, and psychedelia from neurophysiological time-series data.

Interface between humans and artificial intelligence in conscious judgement processes.

Ken Mogi (Sony Computer Science Laboratories & University of Tokyo)

Concurrent Session: Virtual Reality and Neurotechnology, Friday June 23rd, Classroom 218, 11:45am-12:00pm

One of the salient functions of consciousness is to make appropriate judgements about the environment. Under certain conditions, judgements and choices can be delegated to other agents, both natural and artificial, where efficient sharing of information is essential. Recent advancements in artificial intelligence have highlighted the need to optimize the interface between the machine and the human brain. Here I study the role of explicit and implicit information in a setup simulating self-driving cars, an emerging field of artificial intelligence. 674 subjects (349 females, 329 males, 6 other genders, age 47.2 ±12.2) participated in the experiment. Subjects made responses in a seven-point scale. When asked whether they wanted to know the details of self-driving algorithms, 91.7 % answered in the affirmative (in scales of 5, 6, 7). 9 clips of 4s to 21s (with an average of 10.1s) representing risky situations on the road were extracted from "Dash Cam Owners Australia May 2019 On the Road Compilation". The videos were presented to the subjects in the Original, Evaluation (with risk evaluation explicitly given by the experimenter) and Random (random numbers given in the same range as the Evaluation) conditions, with the fictional suggestion that they were from self-driving cars. Each subject saw videos in one condition only, assigned according to their self-reported birth months. Anxiety was significantly lower when viewing videos in the Random condition compared to the Original condition. In the spectrum of image-based to algorithm-based navigation strategies, 52.9 % of subjects preferred image-based (scales of 1, 2, 3), while 36.9% preferred algorithm-based (scales of 5, 6, 7). Risk evaluations by image-based subjects were significantly lower than algorithm-based subjects in the Original and Random conditions. Anxiety levels in image-based subjects were significantly lower than algorithm-based subjects in all conditions. When asked if one would pull the lever in the 5 vs 1 trolley problem (Thompson 1984), 45.6% answered GO (pull the lever) while 24.1% answered NO GO. NO GO subjects evaluated the risks as significantly higher in all three conditions compared to the GO subjects. NO GO subjects reported significantly higher anxiety in all three conditions. In sum, the subjects' anxiety level was lowest in the Random condition, with intermediate level of explicit information. Individual differences in cognitive traits affected subjects' risk perception and anxiety induced by situations presented. The cognitive effects of artificial intelligence systems replacing computation in the human brain (Frey & Osborne 2013) is likely to be effected by modes of information presentation, and the nature of individual strategies for judgement. Elucidation of the consciously conducted cognitive process of judgement would suggest better designing principles for the interface of artificial intelligence systems such as self-driving cars.

An alternative defense of IIT's Exclusion postulate

Hedda Hassel Mørch (Inland Norway University of Applies Sciences)

Concurrent Session: Theories and Models, Sunday June 24th, Classroom 218, 12:00pm-12:15pm

Among the five postulates of the Integrated Information Theory (IIT), the Exclusion postulate may be the most controversial – at least, it has been widely criticized as redundant or unfounded (see, e.g. Schwitzgebel 2015, Bayne 2018, Merker et al. 2021). The Exclusion postulate claims that consciousness never overlaps (i.e. if a system is conscious, none of its parts can be conscious as well, nor can it itself be a part of larger conscious system). The postulate in turn supports IITs claim that consciousness requires maximal (as opposed to merely some non-zero amount of) phi, since maximal properties cannot overlap. The main basis of the postulate is the corresponding Exclusion axiom, which claims that consciousness is definite, or has determinate borders (Tononi et al. 2014). However, this axiom seems quite different from the postulate and doesn't straightforwardly support it – as nothing obviously prevents things with determinate borders from overlapping. IIT's actual derivation of the postulate also seems to depend on various additional philosophical arguments, according to which existence is equivalent to having causal powers and multiple overlapping causal powers would generate vicious overdetermination (Tononi and Koch 2015), be ruled out by Occam's razor (Tononi et al. 2014) or violate conservation principles (Tononi 2017). I will briefly note some problems with appealing to such philosophical arguments, before outlining an alternative defense, according to which although non-conscious systems may well overlap without problems, conscious systems cannot. This will be based on two main arguments. According to the first, the borders of consciousness seem, introspectively, to have a nature such that overlap would necessarily yield systems that are completely distinct rather than related as parts and wholes. According to the second, the possibility of overlap would enable paradoxical motivational incoherence within conscious agents.

Conscious awareness of multi-attribute choice processes

Adam Morris (Princeton University), Ryan Carlson (Yale University), Hedy Kober (Yale University), M.J. Crockett (Princeton University)

Concurrent Session: Action, Decision, Volition, Friday June 23rd, Classroom 202, 11:45am-12:00pm

How much conscious awareness do people have of the mental process guiding their choices? A long tradition in psychology assumes “choice process awareness” is limited, but this has received surprisingly little objective empirical investigation. Here, we fill this gap with a novel task with two parts. In Part 1, participants made 100 choices between options varying on nine attributes: homes to rent varying on size, kitchen quality, etc. (Study 1), or movies to watch varying on quality of acting, cinematography, etc. (Study 2). Each study recruited 300 nationally-representative participants from Prolific. Prior work has established that multi-attribute choices can be modeled in terms of the weights people assign to attributes and the heuristics people use to integrate those attributes. We used model-fitting to estimate (a) the participant’s best-fitting attribute weights, and (b) the probability that the participant used each heuristic. Then, in Part 2, participants reported (a) the attribute weights they believe they had used when making their choices, and (b) whether they think they had used each heuristic. We compared these self-reports to the model-fitting results to compute two awareness scores: weight-awareness (the correlation between the best-fitting and self-reported weights) and heuristic-awareness (the probability of the self-reported set of heuristics). Finally, accurate task performance could be produced by direct introspection, or by inferring one’s choice processes via observation. To disentangle these accounts, we also collected two additional samples of “observer” participants. Each observer was matched to an original “decider” participant from Studies 1-2, shown all the decider’s choices, and incentivized to accurately to report the decider’s choice process. We predicted that deciders would be more accurate than observers, supporting an awareness account. We found that choice process awareness varied substantially across participants, but was highly accurate on average (far above chance, all $p < 0.001$). The mean weight-awareness was 0.89 (Study 1) and 0.59 (Study 2). ~40% of participants in each study reported the most-probable set of heuristics, which would only happen by chance 17% of the time ($p < .001$). As predicted, observers were less accurate than deciders in reporting deciders’ choice processes (p’s < .001). Our results contradict the popular view that people have little or no conscious awareness of their choice processes.

Investigating the role of sensorimotor spatial dependencies in shaping conscious access to virtual 3D objects

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Concurrent Session: Virtual Reality and Neurotechnology, Friday June 23rd, Classroom 218, 12:00pm-12:15pm

According to sensorimotor accounts of perceptual experience, subjective presence/veridicality of objects builds up gradually as one learns how changes in sensory inputs depend on bodily movements. To investigate how sensorimotor interactions shape visual experience, we designed a virtual reality-based setup allowing us to manipulate the complexity of visuomotor spatial dependencies governing interactions with unfamiliar 3D objects. Across two goal-oriented tasks, participants had to learn to manually control fully visible objects to reach or follow visually cued rotations. In different conditions, virtual objects moved in congruent, opposite, novel (orthogonal), or random directions in response to manual movements. This procedure allowed the assessment of sensorimotor performance and enabled us to associate distinct objects with different coupling rules. The two sensorimotor control tasks occurred alternately with the continuous flash suppression (CFS) task, during which stationary objects underwent perceptual suppression. We hypothesised that virtual objects whose motion was experienced as depending on actions in a lawful, and thus encodable, manner (i.e. according to a congruent, opposite, or novel – but not random – dependency) would be detected faster than objects moving randomly in response to actions (for which there is no world-related statistical structure to learn). We first found that performance in the sensorimotor tasks consistently decreased along with the difficulty of the conditions (i.e. congruent > opposite > novel > random). However, the pre-registered analysis yielded no significant differences in CFS breakthrough times of objects manipulated under different coupling rules. An exploratory analysis assessing whether the acquisition of 'sensorimotor mastery' was associated with reduced detection times also showed no significant effects. Our finding of no difference in the perception of stimuli moving in line with and opposite to lifelong expectations concurs with previous results in this field. We expected this based on the assumption that both congruent and opposite dependencies may be relatively easy to learn. Indeed, the sensorimotor tasks indicated good performance in both these conditions, contrasting with the low performance in the other conditions. Nevertheless, our hypothesis of slower conscious access to randomly responding objects was not confirmed, suggesting the ineffectiveness of sensorimotor spatial manipulations in interocular suppression paradigms. Notably, in all conditions, object movement remained tightly coupled (i.e. contingent) to the participant's actions, and such stimuli have already been shown to break suppression faster than uncoupled/prerecorded visual inputs (Suzuki et al. 2019). Thus, one possible explanation of our results is that mere sensorimotor contingency may be a sufficiently salient factor to override any influences related to the identifiability of specific spatial dependencies.

A Comparative Neuropsychopharmacology of Altered States of Consciousness

Conor Murray (University of California, Los Angeles), Joel Frohlich (University of Tübingen), Royce Lee (University of Chicago), Harriet de Wit (University of Chicago)

Concurrent Session: Altered States of Consciousness, Saturday June 24th, Classroom 210, 2:00pm-2:15pm

Altered states of consciousness (ASC) represent an acute and marked deviation in subjective experience from normal, waking consciousness. ASC arise through diverse induction mechanisms including sensory deprivation, meditative techniques, and psychoactive drugs. Serotonin (5-HT) 2A receptor agonists, also known as psychedelics, are one class of psychoactive drugs that induce ASC. Psychedelics, including psilocybin and lysergic acid diethylamide (LSD), have re-emerged in psychiatry as break-through therapies for a number of indications. Despite recent advances, major questions remain related to their potential therapeutic efficacy, including the therapeutic relevance of the induced ASC and neurobiological mechanisms of action. Comparative neuropsychopharmacology offers an approach to systematically address the neural basis of psychedelics and their corresponding ASC within the context of other psychoactive compounds, including psychostimulants or cannabinoids. This talk will synthesize recent published work with unpublished findings in healthy human participants. Our published work has shown that very low or "microdoses" of LSD, which were not sufficient to induce ASC on the 5-Dimensional Altered states of Consciousness Rating Scale (5D-ASC), were sufficient to reproduce a well-established neurophysiological effect of high doses, specifically broadband cortical desynchronization, assessed by resting-state electroencephalography (EEG). In a separate study, we showed that high doses of the cannabinoid tetrahydrocannabinol (THC), which induced ASC, did not affect broadband cortical synchronization. Together, these data indicate that therapeutic brain states induced by 5-HT2A agonists may not require ASC. In unpublished work, we expanded our analyses, examining microdoses of LSD (0, 13, and 26 micrograms, within-subjects; n = 22), THC (0, 7.5, and 15 mg, within-subjects; n = 24), and methamphetamine (0, 10, and 20 mg, within-subjects; n = 29) on neural complexity or "entropy," using Limpel-Ziv complexity (LZ) and Permutation Entropy (PE). Neural complexity is a neural correlate of consciousness increased by psychedelics that may predict therapeutic outcomes. Our objective was to perform a comparative neuropsychopharmacology across three drug classes from three placebo-controlled studies using resting-state EEG (BioSemi, 128 electrode system). Findings indicate that microdoses of LSD dose-dependently increased entropy measures across scalp electrodes, mimicking effects of larger doses of 5-HT2A agonists. In contrast, THC dose-dependently decreased entropy while methamphetamine had no effect. These findings suggest that 5-HT2A signaling, even when activated by doses that are indistinguishable from placebo, may be sufficient to mediate unique neurotherapeutic benefits in the absence of ASC. Future studies are needed to uncover neural correlates of ASC across induction mechanisms and examine potential therapeutic relevance.

Leveraging neural indexes to track the dynamics of conscious contents in wakefulness

Esteban Munoz Musat (Paris Brain Institute), Lionel Naccache (Paris Brain Institute), Thomas Andrillon (Paris Brain Institute)

Concurrent Session: Imagery and Mind Wandering, Friday June 23rd, Classroom 220, 6:15pm-6:30pm

CONTEXT , Being awake is a highly dynamic state in which individuals switch between different types of conscious contents: for example episodes of on-task attentional focus (ON), mind wandering (MW, the experience of internally generated task-unrelated thoughts), or mind blanking (MB, the experience of an “empty mind” while being awake). Neural indexes have been validated to discriminate or detect states of consciousness but it is unclear if they can also discriminate between different conscious contents within a state. Previous findings suggest that local state modifications within wakefulness, such as fluctuations of arousal, could account for MW and MB. We will leverage validated neurophysiological metrics of consciousness states to explore the dynamics of these conscious contents within wakefulness. METHODS , 23 healthy participants performed a sustained attention task, while we recorded their brain activity using high-density scalp EEG. Every 30 to 70 s, participants were interrupted and instructed to report their subjective experience (probes), including whether they were ON, MW or MB. We extracted complexity (e.g. Kolmogorov, Permutation Entropy), and connectivity indexes (Weighted Symbolic Mutual Information, wSMI) from the EEG signal in the 5 seconds preceding the probes. These markers have been previously used to characterize different conscious states and we examined if they could discriminate between conscious contents. Finally, we trained machine learning classification algorithms on these features to predict the dynamics of participants’ mental states. RESULTS , We observed topographically specific modifications of signal complexity and connectivity according to mental contents. Compared to ON, MW was associated with a reduction of complexity over frontal electrodes and of functional connectivity in the high delta band. MB was however associated with the same changes but over posterior electrodes. Interestingly, functional connectivity computed in the theta, alpha, and beta bands revealed a moderate reduction of long-range connectivity in MW, as well as a more pronounced breakdown of functional connectivity in MB. A Random Forest classifier trained with complexity and connectivity features could predict mental content at the single-trial level, allowing for a dynamic analysis of mental content during the task. CONCLUSION, Neural markers that can distinguish between different states of consciousness can also distinguish between different conscious contents. Furthermore, local fluctuations of cortical dynamics (in space and time) seem to shape the stream of consciousness and the dynamics of its contents. They also provide new and more nuanced insights for the “back vs front” debate about the neural correlates of consciousness: while the apparent lack of a conscious experience (MB) seems more associated with a loss of complexity in posterior regions, it also involves a breakdown of fronto-posterior connectivity.

Knowing what I don’t know: Visual guessing

Caroline Myers (Johns Hopkins University), Chaz Firestone (Johns Hopkins University), Justin Halberda (Johns Hopkins University)

Concurrent Session: Visual Metacognition, Sunday June 24th, Classroom 214, 11:00am-11:15am

When viewing a bright red apple under ideal conditions, perceptual experience closely matches what we see. However, the conditions under which we perceive the visual world are rarely so ideal. A variety of visual factors affect our conscious experience and, when we’re not sure of what we’ve seen, we have to make a guess. Questions of consciousness have examined the relationship between perception and degraded awareness across a variety of paradigms that include backward/forward masking, binocular rivalry, and extremely brief display durations (<100ms). However, the presence of a stimulus signal in each of these cases makes it difficult to discern whether responses in these tasks reflect low-confidence internal representations or guesses. When they consider guesses, current modeling approaches assume such guesses are generated randomly, and can be modeled by sampling from a uniform distribution of possible feature values (e.g. a lapse parameter.) However, humans might maintain rich and nuanced expectations of the visual world, and guessing might not be random. Here, we asked (1) whether observers guess randomly, and if not, (2) whether guessing engages metacognitive processes (e.g. models of one’s own visual abilities). Adult observers performed a working memory task in which colored discs (E1) oriented arrows (E2) or lines of varying length (E3) simultaneously appeared at isoeccentric locations for 0, 16, 33, 66, or 132ms, before being masked by randomly oriented discs, arrows, or lines of varying length. These conditions (i.e. brief display durations and effective masking) allow us to investigate guessing under conditions of degraded, or indeed entirely absent, perception. Observers report the feature value of a single target, indicated by a response cue. We found that observers’ guesses are not random - rather, observers engage in a strategic pattern of guesses appropriate to each visual feature. For example, in Experiment 2, observers were less likely to guess higher-precision (cardinal) orientations relative to lower-precision (oblique) orientations, consistent with a bias to select feature values with low prior probability and low internal precision (as if reasoning “that’s something I would miss”). In Experiment 3, observers’ guesses reflected a combination of metacognitive reasoning and a task-specific strategy: responses were systematically biased to avoid long line lengths and minimize trial-level error volatility, resulting in a Gaussian guess distribution skewed towards smaller lengths. The variety, and consistent non-uniformity, of these strategies across experiments reveals that, rather than sampling randomly over a given feature dimension, guessers enlist metacognitive strategies: observers reason about the likelihood of what they’ve seen, and their likelihood of error, given internal knowledge of their own perceptual capacities.

What do the inattentionally blind see?

Makaela Nartker (Johns Hopkins University), Chaz Firestone (Johns Hopkins University), Howard Egeth (Johns Hopkins University), Ian Phillips (Johns Hopkins University)

Concurrent Session: Richness of Consciousness, Friday June 23rd, Classroom 218, 6:15pm-6:30pm

Inattentional blindness (IB) — the failure to notice highly visible stimuli when attention is otherwise engaged — has fascinated scientists for half a century. A key reason is that IB seemingly illuminates the relationship between attention and awareness, apparently revealing that visual consciousness requires attention. In drawing such conclusions, a crucial assumption is that subjects who report not noticing were truly unaware. In four experiments, testing >10, 000 participants, we found that subjects who report not noticing an unexpected stimulus can still discriminate its features at above-chance levels, casting doubt on this assumption. Exps.1-3 modified Mack & Rock's (1998) classic IB paradigm: On trials 1-3, a cross appeared for 200ms, and subjects reported which arm was longer. On trial 4, some subjects were shown an unexpected colored line on one side of the display; others were shown nothing additional. Exp.4 tested subjects in sustained IB (Wood & Simons 2017): Subjects counted how often squares of one color bounced off the display's perimeter, while ignoring other squares. During this task, some subjects were shown another shape traversing the display for 5s. In all exps. regardless of whether something unexpected appeared, subjects answered the traditional IB question ("Did you notice anything unusual?" yes/no), followed by forced-choice and forced-response questions (e.g. "Was the extra line on the left or the right?" or "Was the shape a circle or a triangle?"). These experiments revealed significant sensitivity to location (Exps.1&3), color (Exps.2&4) and shape (Exp.4), even amongst non-noticing subjects. Subjects who claimed not to have seen the IB stimulus nevertheless demonstrated visual sensitivity to it. Why does this happen? Including absent trials allows us to answer this question by enabling derivation of signal detection statistics that separate sensitivity from bias in yes/no awareness responses. We found that subjects were biased to report not noticing, suggesting greater awareness than yes/no questioning reveals. Furthermore, Exp.3 found that (a) even highly confident non-noticers discriminated location above chance, and (b) yes/no confidence predicted discrimination accuracy, suggesting subjects have graded access to information about unexpected stimuli. Our findings suggest that IB does not provide a sound basis for the "consensus view" (Noah & Mangun 2020) that attention is necessary for awareness (Cohen et al. 2012; Pitts et al. 2018) — a hypothesis central to many theories of consciousness, e.g. global neuronal workspace theory (Dehaene & Naccache 2001) or AIR theory (Prinz 2012). Instead, ironically, IB provides evidence that awareness of certain features survives inattention. These results are consistent with a neglected account of IB: Inattention does not abolish awareness; rather, it degrades it. Demos of these studies, and a reference section, are available at: https://tinyurl.com/ASSC23.

Assessing the Subjective Effort of Working Memory Maintenance in Monkeys

Jad Nasrini (Emory University), Robert R. Hampton (Emory University)

Concurrent Session: Metacognition, Friday June 23rd, Classroom 206, 12:15pm-12:30pm

Holding something in working memory requires active maintenance or information is lost. In contrast, recognition of items as familiar does not depend on an active memory process during the delay interval. We can distinguish these memory processes in monkeys by manipulating the source of stimuli to be remembered in a match-to-sample paradigm. Using a small set of repeating images requires monkeys to hold each sample in working memory, while a large set of initially novel images can be recognized as familiar at test without active maintenance. Six monkeys chose between completing tests of working memory or familiarity. Reward likelihood was made equivalent using false feedback. If monkeys are sensitive to the effort involved in working memory maintenance, then they should prefer to take familiarity tests that can be solved without rehearsal. In Experiment 1, monkeys showed no preference for either type of test when memory delays were fixed ($t(5)=.619, p=.563$), but accuracy was very high on both tasks. In Experiment 2, we determined a memory delay for each monkey that resulted in working memory accuracy below 75%, and monkeys still showed no preference ($t(5)=-1.293, p=.252$). These findings suggest that monkeys are not sensitive to the cognitive effort involved in working memory maintenance.

The ALARM theory of consciousness: an evolutionary perspective

Albert Newen (Institut für Philosophie II, Ruhr-Universität Bochum), Carlos Montemayor (San Francisco State University)

Concurrent Session: Theories and Models, Sunday June 24th, Classroom 218, 11:00am-11:15am

Consciousness is still one of the biggest riddles in philosophy and science. The aim is to characterize the core functional roles of consciousness and to outline a two-level theory of consciousness to account for the relation between evolutionary old and more recently developed types of consciousness. The conceptual thesis is that we should distinguish two levels of consciousness, namely bodily arousal and general alertness. This conceptual distinction is proven to be empirically adequate and epistemically fruitful from a variety of perspectives including an evolutionary, a neurophysiological, a behavioral, a functional, and a phenomenological perspective. Let me highlight some central considerations: 1. The evolutionary perspective: bodily awareness is available in an evolutionary old system to trigger a state of alarm of the system which enables it to activate an immediate survival reaction, e.g. if homeostatic regulations of temperature or breath can no longer automatically adjust because it is too hot or not enough oxygen is available, then this leads to bodily awareness in form of pain to activate the being to leave and search for a cool area resp. a fresh air environment. Evolutionary younger biological system with a developed prefrontal cortex enjoy general alertness. The main function is to enable new types of learning: This includes one-case learning in the context of a system of conscious attention designed to monitor and respond to important signals, e.g. a biological system hurts by fire and then never touches fire again. Here we are also inclined to accept the thesis of Jablonka that consciousness enables unlimited associative learning (Ginsburg & Jablonka 2019). 2. Neural correlates: The twofold distinction fits nicely to recent empirical observations of the role of deep cortical and thalamic brain activities for human visual consciousness as described in recent anaesthesia studies with monkeys (Central lateral thalamus is plausible underlying basic arousal: Redinbaugh et al. 2020) as well as by Halassa (Thalamic reticular nucleus is plausibly enabling general alertness: Nakajima et al. 2019) 3. The two-level theory allows us to account for phenomenological distinction of phenomenal consciousness when just waking up and being not yet fully alert and when the later (usually quickly) sets in. Finally, we can describe animal consciousness as unfolded in two versions. Thus, we can systematically investigate for each species which type of consciousness is implemented and how this is realized. Furthermore, this enables us to describe differences and similarities between human and animal consciousness. 4. We can clarify the theoretical embedding: This account is developed as a processing account of consciousness and can be understood as an important addendum to global workspace theory which underestimates the evolutionary perspective and the role of thalamic processes.

None so blind: meaningful changes are more detectable across saccade-induced blindness

Brian Odegaard (University of Florida), Alan L.F. Lee (Lingnan University), Isaac Lee (Lingnan University), Addison Sans (University of Florida), Ryan Faulkner (University of Florida), Leo Ng (Lingnan University), Andrew Haun (University of Wisconsin), Dana Chesney (St. John's University), David Rosenthal (City University of New York), Francis Fallon (St. John's University)

Concurrent Session: Richness of Consciousness, Friday June 23rd, Classroom 218, 5:45pm-6:00pm

If a visual image is changed at the exact moment someone moves their eyes, surprisingly salient changes to visual scenes are often unnoticed (Grimes, 1996). Previous results show that observers frequently fail to notice changes in the identity, color, size, rotation, position, and presence of altered objects in scenes. The likelihood of change detection can be explained in part by the type and magnitude of changes in these “low-level” visual features. However, evidence from other change-blindness paradigms indicates that “high-level” semantic, meaning-based changes also influence detection: changes that are semantically inconsistent with a scene may be easier to detect (e.g. Hollingworth & Henderson, 2000). This raises two interesting questions: (1) Do semantic and scene-congruence factors influence awareness of such visual changes? (2) If changes are missed, do observers demonstrate awareness of pre-change attributes of the changed content, post-change attributes, or neither? Across two laboratories (the University of Florida and Lingnan University), we have developed a saccade-induced change blindness paradigm where on each trial, an image is flipped on a pseudorandomly-determined saccade. We sought to investigate if “semantic” changes that alter the meaning of a visual scene or changes which include the appearance of “incongruent” items are more noticeable than other types of changes. We created novel image-pairs that were defined by one of four features: 25 image-pairs with mostly semantic changes, 25 image-pairs with mostly incongruent changes, 25 image-pairs with minimally semantic or incongruent changes (change-present controls), and 25 image-pairs that did not change. In our experiment, 40 total participants (20 each at the two locations) completed a 100-trial change-detection task. On each trial, they viewed images for up to 20 seconds and pressed a spacebar as soon as they experienced a change. Changes were triggered by a saccade during the viewing. Our results showed that change detection rates positively correlated with image ratings about the degree of semantic or scene-congruence change in an image pair. Change detection rates were lower when images were more complex. Additionally, when changes were missed, participants were equally likely to indicate that the changed item possessed the pre- or post-change attribute. This likelihood was modulated by the participants’ gaze strategy during the trial. We note that these results have interesting implications for the Higher-Order Theory of consciousness: the finding that subjects select the pre-change attribute at all in miss trials provides evidence that higher-order awareness can misrepresent first-order content, at least in some circumstances. We will discuss these findings within the greater context of existing empirical support for Higher Order Theory, and conclude with a discussion of how to further pursue paradigms to test predictions made by versions of this theory.

Plant "consciousness" after Darwin: a proposal

Pecere Paolo (University of Roma Tre)

Concurrent Session: Animal and Infant Consciousness, Sunday June 24th, Classroom 220, 11:30am-11:45am

Plant “sensation” and “consciousness” are controversial issues in contemporary botany. Scientists such as Peter Trewavas, Stefano Mancuso and Monica Gagliano that sensory awareness, learning, memory, communication, and possibly a kind of consciousness should be ascribed to plants (e.g. Trewavas 2003; Baluska, Mancuso, et al 2009; Gagliano 2018). A substantial part of the scientific community has dismissed such claims because of poor evidence and the lack of neural systems in plants (for an overview of this criticism and a defense see Calvo and Lawrence 2022). In this talk, I will examine this issue in historical and epistemological perspective, and make a modest proposal for its settlement. First, I will go back to the source of these debates, i.e. Darwin’s remarks on plant “sensation” and “behavior”, and the analogy between roots and brains in the 1880 book “The Power of Movement in Plants”. Although these passages have been recently celebrated as a revolutionary “breakthrough” concerning plant consciousness, I will point out that the issue was already well-known and controversial in the 19th century, as scientists debated whether plant tissues are just “irritable”, i.e. endowed with a non-conscious disposition to react to stimuli, or properly endowed with a capacity to sense. Before Darwin’s investigations, the capacity to have feelings and a rich inner experience had been ascribed to plants by Gustav Fechner, the founder of psychophysics, notably in the remarkable 1848 book “Nanna, or the Soul of Plants”. The Darwinian biologist Ernst Haeckel would eventually accept these claims and even talk of “cell-souls”. With respect to this panpsychism, Darwin’ stance was much more cautious, and was accompanied by the recognition that plants “do not of course possess nerves or a central nervous system”. Indeed, I will argue that any post-Darwinian talk of sensation and behavior is grounded on two principles: the postulate of biological continuity among living beings, according to which “numberless gradations” of states fill the gap between the mental states of different species; and analogy, as the basic Newtonian epistemic rule of scientific investigation concerning properties that we cannot directly experience. In this perspective, the contemporary debate on plant consciousness appears to be grounded on this classical question: how far can we legitimately stretch our analogies concerning the “mental” life of plants? I will argue that we should deal with our ignorance by means of a nominalist approach, using specific notions such as P-sensation and P-consciousness, in order to avoid any ungrounded anthropomorphic projection while at the same time leaving open the possibility that kinds of mental states exist in plants.

Insula cortex structural connectivity gradients guide functional responses to an interoceptive task

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Concurrent Session: Neural Correlates of Consciousness, Sunday June 24th, Classroom 210, 10:45am-11:00am

One of the fundamental questions in neurosciences is an association between the structural organization of the brain and its functionality. Partition of the brain can be done according to different properties, including functional or structural connectivity or anatomical features. An area of particular interest is the insula cortex, associated with interoception – the ability to perceive signals from visceral organs. The insula cortex has a complex anatomical structure, with debate as to how it should be parcellated. Functional connectivity has been used to parcellate it into variable numbers of subdivisions but more recent studies suggested that connectivity diversity in the region is better characterised as a continuum with a gradual change. Such a gradient approach has not been applied to insula structural connectivity and so it is not known if the same organisational principle applies in the structural domain. Furthermore, it is unclear how such a structural gradient would relate to functional responses to interoceptive and exteroceptive tasks. Sixteen healthy participants underwent functional magnetic resonance imaging (fMRI) and diffusion weighted imaging (DWI) sessions. The functional had two conditions: interoceptive, when participants counted their heartbeats (CHB); and exteroceptive, when they counted the number of tones (CTO) presented through headphones. Diffusion data was used for tractography using probabilistic tracking from each insula voxel to a set of target regions. Gradients based on resulting probability matrices were computed using a "diffusion mapping" dimensionality reduction technique. Relationships between functional response and diffusion scores were tested at the voxel level through linear mixed-models with the condition (CHB vs CTO) as a fixed effect and subjects as a random effect. The first gradient was retained as it explained most data variability. This aligned with the anterior-posterior insula axis in both hemispheres. fMRI data analysis revealed a higher positive BOLD response in the superior-anterior insula during the interoceptive condition and in the anterior insula for the exteroceptive condition. A voxel's position on the gradient predicted its functional responses in both hemispheres ($F = 72.9$, $p < 0.001$, $\eta p2 = 0.8$ for the left; $F = 39.8$, $p < 0.001$, $\eta p2 = 0.7$ for the right). A significant interaction between functional condition and gradient position was found for both hemispheres ($F = 1470.5$, $p < 0.001$, $\eta p2 = 0.04$ for the left; $F = 669.9$, $p < 0.001$, $\eta p2 = 0.02$ for the right). The primary gradient of structural connectivity diversity in the insula cortex follows the anterior-posterior axis of the region. This gradient predicts differential insula activity in interoceptive against the exteroceptive condition. These results suggest that the difference in brain responses to internal and external stimuli is guided by specific structural connectivity patterns between insula areas and the rest of the brain.

Metacognitive judgments: direct readout or causal inference? The case of introspective reaction times.

Nathalie PAVAILLER (Laboratoire de Neurosciences Cognitives, Marseille, France), Boris BURLE (Laboratoire de Neurosciences Cognitives, Marseille, France)

Concurrent Session: Time Perception, Saturday June 24th, Classroom 218, 2:00pm-2:15pm

In the last few years, metacognition research has been revived by focusing on more tractable forms of judgments such as performance monitoring, as performance can be directly accessed from observable behaviors. Studies on performance monitoring largely focused on actions accuracy via confidence judgments or error monitoring. In many cases, these second-order judgments turn out to be accurate and correlate with first-order measures, revealing good metacognitive abilities. It does not imply, however, that these subjective evaluations reflect a real read-out of the evaluated parameter. Participants may instead rely on inferences based on other salient cues. In the present study, we focused on the subjective evaluation of a continuous parameter, namely action timing. More precisely, we measured introspective reaction times (iRT), that is the estimation of the time it took to provide a response to a stimulus. In a visual choice reaction time task, participants were asked to report their reaction times (RT) on a visual analog scale after each trial. Perceptual difficulty and response force were manipulated. Besides already reported correlation on means, RT and iRT were also strongly correlated trial-by-trial, indicating a fairly good direct read-out of RT duration. Furthermore, these metacognitive skills were related to participants timing abilities in a duration estimation task. However, the linear association between the two measures presented some biases. RT were overestimated in high response force condition and for right responses, and underestimated in case of errors, which suggests that iRT was, at least partly, inferred from non-temporal cues and hence reflects a mental construct rather than a direct estimation of RT. To better elucidate which processes contributing to RT (decisional and motor ones) are accessible to metacognitive evaluation, we used electromyographic recordings to fractionate RTs into premotor and motor components, giving an objective measure of decision and motor execution times, respectively. Results indicate that both processes durations contribute to the subjective reports. In addition, EEG data are currently being processed and will bring insights on the cerebral activities underlying the observed temporal metacognitive abilities. Overall, these findings highlight the building blocks of introspective reaction times and dissociate what is directly readout from the temporal content of RT and what is inferred from other sources of information.

Intermittent beta bursts in the subthalamic nucleus are modulated by stimulus detection and associated confidence

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Concurrent Session: Neural Correlates of Consciousness, Sunday June 24th, Classroom 210, 11:00am-11:15am

Local field potentials recorded in the subthalamic nucleus of human individuals undergoing deep-brain stimulation have provided a unique window to understand its role in decisions requiring the inhibition of motor responses. However, it is still unclear whether the subthalamic nucleus merely inhibits motor output or whether it could also play a role in conscious perception. Here, we recorded local field potentials in the subthalamic nucleus of seven individuals with obsessive-compulsive disorder detecting faces embedded in noise and reporting confidence in their response. The presence of a temporal delay between stimulus onset and response allowed us to disentangle motor and perceptual activity. We found that reported faces were associated with a post-stimulus increase in theta-band and a decrease in beta-band oscillatory power, suggesting that the subthalamic nucleus activity encodes perceptual information dissociated from motor output. We then characterized time segments corresponding to bursts in beta activity. When stimuli were detected, burst probability increased prior to the stimulus and decreased around 500 ms post-stimulus. The post-stimulus decrease was mainly driven by stimulus intensity for hits, and by confidence for misses. Together, our findings suggest that bursts of oscillatory activity in the basal ganglia carry perception-relevant information that differs between seen and unseen stimuli and supports a role of subcortical structures in perceptual consciousness.

Computational rationality approaches to arbitrating models of cognition: a case study using perceptual metacognition

Megan Peters (University of California Irvine), Yingqi Rong (University of California Irvine)

Concurrent Session: Visual Metacognition, Sunday June 24th, Classroom 214, 11:30am-11:45am

Perceptual confidence results from a metacognitive process which evaluates how likely our percepts are to be correct. Many competing models of perceptual metacognition enjoy strong empirical support. Arbitrating these models traditionally proceeds via researchers conducting experiments and then fitting several models to the data collected. However, such a process often includes conditions or paradigms that may not best arbitrate competing models: Many models make similar predictions under typical experimental conditions. Consequently, many experiments are needed, collectively (sub-optimally) sampling the space of conditions to compare models. Here, instead, we introduce a variant of optimal experimental design which we call a computational rationality approach to generative models of cognition, using perceptual metacognition as a case study. Instead of designing experiments and post-hoc specifying models, we began with comprehensive model comparison among four competing generative models for perceptual metacognition, drawn from literature. By simulating a simple experiment under each model, we identified conditions where these models made maximally diverging predictions for confidence. We then presented these conditions to human observers, and compared the models' capacity to predict choices and confidence. Results revealed two surprising findings: (1) two models previously reported to differently predict confidence to different degrees, with one predicting better than the other, turned out to predict confidence in a direction opposite to previous findings; and (2) two other models previously reported to equivalently predict confidence showed stark differences. Our findings reveal the promise of this computational rationality approach to maximizing experimental utility in model arbitration while minimizing the number of experiments necessary to reveal the winning model, both for perceptual metacognition and in many other domains.

Measuring metacognition: A comprehensive empirical assessment of current methods

Dobromir Rahnev (School of Psychology, Georgia Institute of Technology, Atlanta, GA, USA)

Concurrent Session: Metacognition, Friday June 23rd, Classroom 206, 10:45am-11:00am

INTRODUCTION, One of the most important aspects of research on metacognition is the measurement of metacognitive ability. However, the properties of existing measures of metacognition have mostly been assumed rather than empirically established. Here I perform a comprehensive empirical assessment of all common measures using the best available open datasets. MEASURES OF METACOGNITION, I examine the properties of the measures meta-d', M-Ratio, M-Diff (Maniscalco & Lau, 2012), the area under the Type-2 ROC curve (AUC2), the Goodman–Kruskall Gamma coefficient (Gamma), the correlation between confidence and accuracy (Phi), and the difference between confidence for correct and error trials (ΔConf). Using the logic of M-Ratio and M-Diff, I also develop the novel measures AUC2-Ratio, Gamma-Ratio, Phi-Ratio, and ΔConf-Ratio, as well as AUC2-Diff, Gamma-Diff, Phi-Diff, and ΔConf-Diff. Finally, I also examine the model-based measures meta-noise (Shekhar & Rahnev, 2021) and meta-uncertainty (Boundy-Singer et al. 2023). In total, I analyze 17 measures of metacognition and apply them to 7 large datasets from the Confidence Database. PROPERTIES EXAMINED, Prior work focused primarily on the relationship between measures of metacognition and Type-1 performance. Here, I take a more comprehensive approach. I start by examining the measures' validity and precision (i.e. the sensitivity of a measure to the variable of interest relative to its natural fluctuation). Because no established methods exist to assess validity and precision, I develop a new method. In addition, I examine each measure's dependence on Type-1 accuracy, response bias, and metacognitive bias, as well as each measure's split-half and test-retest reliabilities. RESULTS, Reassuringly, I find that all measures of metacognition investigated here are valid. The measures show similar levels of precision except for meta-uncertainty, which appears to be slightly noisier than the remaining measures. Another reassuring finding is that all measures have very high split-half reliabilities as long as they are computed based on 100 or more trials. However, the test-retest reliabilities are extremely low for all of the Ratio, Diff, and model-based measures ($r < .3$ when computed using up to 200 trials) and higher but still low for the remaining measures ($r < .6$ when computed from up to 200 trials). In addition, the results show that most measures show only weak dependence on response and metacognitive bias. Finally, all traditional and Diff measures show dependence on Type-1 accuracy, but this dependence is strongly diminished for all Ratio and model-based measures. CONCLUSION, This comprehensive assessment paints a complex picture: no measure of metacognition is perfect and depending on the details of the experiment, different measures may be preferable. Based on these results, I make specific recommendations about the use of different measures.

Signatures of efficient coding in perceptual metacognition

Samuel Recht (Department of Experimental Psychology, University of Oxford), Nick Yeung (Department of Experimental Psychology, University of Oxford)

Concurrent Session: Visual Metacognition, Sunday June 24th, Classroom 214, 12:15pm-12:30pm

Bayesian inferences has been extensively used as a normative framework to understand perceptual decisions and subjective confidence. As a form of metacognition, confidence is thought to play a functional role in adaptive behaviour, modulating information-seeking, task prioritisation and goal-setting. One significant question pertains to the source of signal in metacognitive computations. Does metacognition rely on estimates of external, environmental factors, or rather track the fluctuations in internal states like attention or vigilance? Ideally, metacognition should prioritise the most informative source of evidence, a source which varies with tasks and contexts. In a stable, uncluttered environment, performance mainly fluctuates because of internal states, but the opposite is true when environmental uncertainty increases. Does metacognition adequately arbitrate between external and internal evidence across tasks and context? We propose that an answer to this question can be found in the paradoxical effect prior expectations have on confidence evaluations. Perception has been shown to preferentially encode the most likely features in the environment, a process coined 'efficient coding' and shown to induce non-linear interactions between perception and prior expectations (Wei & Stocker 2015). In the present study, we show that efficient coding not only makes counter-intuitive predictions about how prior expectations bias confidence judgments, but could also provide a diagnostic tool to probe the source of signal in metacognition. Across the analysis of 6 datasets involving perceptual decisions and confidence ratings (+70K trials), we found that depending on the task characteristics, confidence judgments can either be biased towards – or, less intuitively and more often, against - prior expectations. A pattern in stark contrast with the classical Bayesian approach to perception which only predicts a positive bias of prior expectations on confidence. We propose these non-linear patterns to reflect a strategic allocation of resources that maximises coding efficiency. These results suggest that systematic metacognitive distortions in prior integration could naturally emerge from an efficient Bayesian encoding-decoding process. We show how this new prior-confidence relation can be potentially used to probe the nature of the evidence used in confidence judgments.

Mental Imagery and the Experience of Volition

Paulius Rimkevičius (Chapman University & Kaunas University of Technology), Aaron Schurger (Chapman University), Tillmann Vierkant (University of Edinburgh)

Concurrent Session: Action, Decision, Volition, Friday June 23rd, Classroom 202, 12:00pm-12:15pm

Preliminary evidence suggests that imagery plays a role in the experience of volition: anecdotally, participants report relying on imagery in reporting their intentions brain areas linked to imagery are linked to volition; and models of volition that take into account imagery fit the data well. We wanted to explore this role further. We had two main questions. First, how much do people rely on imagery in reporting their intentions? Do they rely on it more when they perceive no external behavior? Second, can frequency and vividness of imagery explain variability in EEG signals associated with volition? Does it explain variability in the readiness potential? To answer these questions, we conducted two studies. In the first study, participants performed three tasks. First, they spontaneously moved and reported when they became aware of intending to move (Movement task). Second, they filled out questionnaires: an adapted version of the Nevada Inner Experience Questionnaire and the third version of the Movement Imagery Questionnaire (Questionnaire task). Third, they spontaneously imagined moving and reported when they became aware of imagining (Imagination task). EEG recordings were made during the first and third tasks. In the second study, a separate group of participants performed two tasks. First, they performed either the Movement task or a task where, if they heard a signal when intending to move, they had to refrain from moving (Interruption task). Second, they performed the Questionnaire task, as in the first study. We had four main predictions. First, participants will report imagery in both the Movement task and the Interruption task (since people rely on imagery in reporting intentions). Second, participants will report more frequent imagery in the Interruption task (since they will not be able to rely on perceived external behavior on interrupted trials). Third, the EEG signal in the Movement task, locked to time of movement, will correlate with the signal in the Imagination task, locked to time of imagining (since execution and imagination partly rely on the same mechanisms). Fourth, participants with more frequent and vivid imagery will have a larger readiness potential amplitude (since the readiness potential at least partly represents imagery generation). The evidence we have so far confirms the first and third predictions. We discuss the implications of our results for the debate about the existence of conscious will. If the predictions are confirmed, it will suggest that at least one of the ways in which people become aware of their decisions is through imagery that is present before action. What that implies for the existence of conscious will shall depend on what exactly is the relation between generating imagery related to an action (such as saying “now” in inner speech) and deciding to perform that action (such as deciding to act now). That relation currently remains a subject of debate.

Active inference and conscious content: A psychophysical study of re-emergence in motion induced blindness

Jonathan E Robinson (Monash Centre for Consciousness and Contemplative Studies (M3CS), Monash University), Andrew Corcoran (Monash Centre for Consciousness and Contemplative Studies (M3CS), Monash University), Gyula Kovács (Fredrich-Schiller University, Jena, Germany), Karl J Friston (University College London, London, UK), Jakob Hohwy

Concurrent Session: Perception and Attention, Saturday June 24th, Classroom 204, 3:15pm-3:30pm

Motion induced blindness paradigms have long been employed to investigate the neural and psychological mechanisms associated with reappearance and disappearance of conscious content. An influential framework for modelling self-organising systems known as Active Inference, under which organisms adopt policies of action expected to reduce free energy over time, is now beginning to expand into the realm of consciousness. Under Active Inference, actions (including eye gaze, attention, motor action etc.) are hypothesised to be necessary for the appearance of content in consciousness. Here we empirically test this theory using a carefully controlled adaptation of the classic motion induced blindness paradigm. In an 'active' condition participants were asked to look towards a target stimulus following its disappearance from consciousness, and to report its reappearance in awareness. Eye-tracking acquired during these 'active' trials was then replayed to precisely emulate the dynamic retinal stimulation during 'passive' trials in which the eyes remained fixated at the centre of the screen. In this way we compare active and passive conditions for reappearance rates to empirically test the contribution of action in conscious reappearance. We find differences in both reports of reappearance and stimulus recognition. We discuss these findings in the context of Active Inference as an account of conscious content, and consider directions for future research.

A large-scale investigation of structural brain correlates of metacognition.

Renate Rutiku (Jagiellonian University), Luka Juras (University of Zagreb), Matan Mazor (University of London), Monika Derda (Jagiellonian University), Elisa Filevich, Humboldt-Universtität zu Berlin; Steve Fleming, University College London; Michał Wierzchoń, Jagiellonian University; Kristian Sandberg, Aarhus University

Concurrent Session: Visual Metacognition, Sunday June 24th, Classroom 214, 11:45am-12:00pm

Despite the central role of metacognition in many theories of consciousness, we still know relatively little about its internal structure and its neural underpinnings. Previous attempts to extract domain-general behavioral indices of metacognition and map them to common neural sources have yielded mixed results. Thus it is not clear yet whether metacognition is a general trait-like ability or whether it applies differentially to specific tasks. We hypothesize that the previous mixed results are in large part due to small sample sizes and a lack of attention to the stability of the behavioral indices of metacognition (or indeed the metacognitive processes themselves). We aimed to address these shortcomings in a large-scale collaborative effort as part of the SkuldNet consortium/EU COST Action CA18106. Metacognitive ability was assessed in two independent samples (N1=301; N2=246), along with a comprehensive mapping of participants' brain structure. Participants in the first cohort completed visual and auditory versions of a simple 2AFC discrimination task and a 2AFC detection task (4 tasks in total) and rated their confidence in response accuracy on every trial. A subsample of 54 participants also repeated the experiment on a separate day in order to determine the stability of metacognition over time. First, various common measures of metacognition were compared in terms of their stability within tasks and testing sessions, and between tasks and testing sessions. We will present the results of these comparisons and discuss potential reasons why some measures are more stable than others. For example, response bias is a strikingly stable behavioral marker of interindividual differences across tasks and time. Other measures of metacognition such as meta-d' are significantly less stable. Second, we tested the relation between various behavioral indices and multimodal metrics of individual brain structure in order to explore the neural architecture underlying metacognition. Specifically, we used quantitative multi-parameter mapping (MPM) and diffusion-weighted imaging (DWI) to conduct a brain-wide association analysis and ROI analysis based on previously published findings. The results highlight how important it is to attempt replication of brain-behavior associations in larger cohorts because many of the findings cannot be verified. Yet accounting for the stability of the behavioral measures in the analysis may increase the robustness of the results. We will summarize which of the previous findings were replicated in our first cohort. We will also present results from an out-of-sample replication of our findings in our second cohort. Together, these findings highlight the complex multidimensional nature of metacognition and demonstrate how interindividual differences in behavior can be exploited to reveal its underlying neural architecture.

A predictive coding theory of subjective time

Saeedeh Sadeghi (Cornell University), Adam Anderson (Cornell University), Marc Wittmann (Institute for Frontier Areas of Psychology and Mental Health), Shimon Edelman (Cornell University)

Concurrent Session: Time Perception, Saturday June 24th, Classroom 218, 3:00pm-3:15pm

According to Aristotle, time does not exist without change. This view has been debated by philosophers and physicists with respect to physical time, but it may also be relevant to the subjective experience of time. Here, we propose that a subjective representation of time is tied to the amount of change in the observer's internal model of the world. Within the predictive processing theoretical framework, the human brain maintains an internal probabilistic generative model of the world. We suggest that each of the factors empirically demonstrated to lengthen perceived duration is associated with a need for a more extensive update of the predictive model (i.e. larger divergence between prior and posterior). In the predictive processing model of the brain, mismatches between bottom-up, sensory-driven signals and top-down predictions constitute prediction errors (PE). The internal model is constantly updated to include hitherto unaccounted-for external factors that may have led to a PE, in an attempt to decrease it. A more extensive change in the internal model during perceptual inference might be driven by a larger PE, a larger weight on PE, or both. Novelty, unpredictability, and intensity of sensory intake — factors known to dilate subjective duration of stimuli — can be seen as resulting in a larger PE. Attention, another major factor robustly associated with the lengthening of subjective time, is formulated within the predictive processing theory as a selective increase in the weight of stimulus-driven PE. The present proposal extends to autonomic factors including interoceptive focus (increasing weight of interoceptive PE during physiologically arousing events) and cardiac orienting (facilitating sensory intake, that is, larger sensory PE), both known to dilate subjective time. The predictive processing perspective further enables framing alterations of time as a by-product of an active process embedded within perception. Moving beyond the passive and artificial "stimulus to perceived duration" paradigms in laboratory tasks, in the real world we proactively control our sensory organs and whole body, selecting the stimuli they are exposed to, and the duration of exposure. Subjective duration thus becomes a by-product of actions aimed at minimizing free energy in the brain. A physical action, such as directing a sensory organ, modulates stimulus exposure duration, while a mental action, such as attention, modulates the amount of stimulus-driven updating of the internal model. In conclusion, our theoretical perspective provides an empirically supported explanation for the experience of subjective duration, grounded in a biologically supported computational model of the brain as an active predictive machine. Further questions, however, remain. In particular, the connection between valence, which has been previously equated with the rate of change of PE, and time perception needs to be clarified.

Tonic and phasic dopamine fluctuations in striatum differentially relate to variations in human time perception

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Concurrent Session: Time Perception, Saturday June 24th, Classroom 218, 2:45pm-3:00pm

Our perception of time shapes nearly all aspects of our conscious experience but human time perception is notoriously variable and prone to biases. Converging lines of evidence suggest a role for striatal dopamine in interval timing but this relationship remains unclear. Here we investigated how striatal dopamine relates to interval timing in patients with Parkinson's disease undergoing deep brain stimulation. Using fast scan cyclic voltammetry (FSCV), we recorded the in-vivo electrochemical signal (at 10 Hz) during completion of a visual temporal bisection task (500-1100 ms). On each trial, patients classified the duration of a stimulus based on its similarity to short or long reference intervals which they learnt prior to the testing phase. Compared to controls, patients showed poorer temporal precision although both groups showed comparable accuracy. In patients, poorer temporal precision was associated with lower tonic dopamine levels and the phasic bursts of dopaminergic activity were associated with a tendency to underestimate temporal intervals. Our results demonstrate the significance of the striatal dopamine system in human time perception, showing that the steady-state tonic dopamine levels and the transient bursts of dopaminergic activity may play differential role in time perception. Altogether, these results help to advance current understanding of the neurochemical basis of how we perceive the passage of time.

Neural correlates of consciousness: a coordinate-based meta-analysis of brain alterations in disorders of consciousness

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Concurrent Session: Disorders of Consciousness 1, Friday June 23rd, Classroom 202, 6:00pm-6:15pm

The neural correlates of consciousness (NCC) are currently a matter of debate. Insights into NCC can be obtained by studying patients with disorders of consciousness (DoC). The present meta-analysis aims to shed light on the NCC, by quantitatively synthesizing existing evidence on brain structural, functional and molecular alterations in DoC. In January 2022, we used MEDLINE via Ovid, and Scopus and Embase via Elsevier databases to search for resting-state MRI and PET studies, published from 2000 to 2022, and involving adults with prolonged DoC and a clinical diagnosis of unresponsive wakefulness syndrome (UWS) or minimally conscious state (MCS) based on a validated behavioural scale. Two referees (among AS, BK, NA, SA, JA) independently screened abstracts and full texts of selected studies and extracted coordinates of whole-brain, voxel-based comparisons involving DoC patients. Coordinate-based meta-analysis was performed via activation likelihood estimation (ALE) with a cluster-level $p<0.05$ FWE-corrected statistical threshold and an uncorrected $p<0.001$ cluster-forming threshold. Distribution of brain alterations was compared to the topography of resting-state networks, based on the FINDlab atlas. The full protocol, including search strategy using controlled vocabulary and keyword terms, is available on PROSPERO (CRD42022327151). As of January 2023, of the resulting 2045 MRI and 753 PET studies, 15 MRI and 18 PET studies met criteria for inclusion, for a total of 1026 patients (454 UWS; 572 MCS) and 277 controls. The primary analysis, including studies comparing DoC patients vs. controls , revealed brain alterations in cortical regions, medially (precuneus, posterior/middle cingulate gyrus) and laterally (angular gyri, inferior parietal lobules), and in subcortical regions (dorsomedial thalami and head of caudate nuclei). Distribution of brain alterations was predominant in the default mode (42%), executive control (28%), and basal ganglia/thalamus (23%) networks. Contrast analysis of UWS and MCS results revealed stronger brain alterations in UWS in the precuneus, posterior/middle cingulate gyrus, right angular gyrus and inferior parietal lobule, and dorsomedial thalami. This meta-analysis provides the most extensive evidence to date on brain alterations in DoC, pointing at a specific set of regions, at cortical and subcortical level, as anatomical basis for the NCC. Our findings are only in partial agreement with current candidate theories of consciousness: differently from the global neural workspace's predictions, we do not find evidence that frontal regions are necessary for consciousness and, differently from integrated information theory's prediction, we find the 'posterior hot zone' to be substantially limited, without involvement of occipital and temporal regions. We also report DoC to be characterized by brain alterations in subcortical structures, a finding that can be understood in the framework of the mesocircuit hypothesis.

A behavioural marker to dissociate subjective experience from perceptual decisions in a detection experiment

Nicolás Sánchez-Fuenzalida (Universiteit van Amsterdam), Simon van Gaal (Universiteit van Amsterdam), Stephen Fleming (University College London), Johannes Jacobus Fahrenfort (Vrije Universiteit Amsterdam)

Concurrent Session: Methods and Measures, Saturday June 24th, Classroom 220, 3:15pm-3:30pm

A central goal in consciousness research is to determine what is consciously experienced and what is not. Unfortunately, objective and subjective behavioural measures are known to be sensitive to biases that are unrelated to changes in conscious experience. To tackle this problem, in previous experiments, we have introduced a novel measure that selectively tracks changes in subjective experience by asking participants to reproduce that experience in a controlled fashion. We have shown that this reproduction measure accurately tracks conscious experience, and is immune to the same biases that typical objective and subjective measures are sensitive to (Sánchez-Fuenzalida et al. PsyArXiv 2022). However, these experiments have only used categorical judgments, while another key feature of consciousness is subjective detection (visible vs invisible, seen vs unseen etc). Here we present a new experiment in which we asked observers to detect dim Gabor patches and to reproduce their experience of the stimuli (patch contrast), to determine how well reproduction tracks conscious experience in a detection context. We then used three bias conditions: an attentional cue (Carrasco et al. Nature Neuroscience 2004), a pay-off scheme and an asymmetrical base-rate to manipulate their relative proportion of ‘seen’ and ‘not-seen’ responses. While the relative frequency of ‘seen’ trials increased under all manipulations, only the attentional cue manipulation had an effect on observers’ reproduced experience of stimulus present trials. When the attentional cue preceded the stimuli the overall reproduced strength of the stimuli increased, whereas in the base-rate and payoff condition observers reproduced present-patches more often without a concomitant change in the reproduced strength of the stimuli. These results suggest that there are two distinct phenomena that operate in a detection context: (1) a signal reflecting the subjectively perceived strength of a stimulus (2) a threshold process that is used to make present-absent decisions. We propose that (1), but not (2) reflects changes in conscious experience, and that reproduction can help to isolate this signal.

Towards a micro-phenomenology of the intravenous DMT state

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Concurrent Session: Altered States of Consciousness, Saturday June 24th, Classroom 210, 2:00pm-2:15pm

Introduction: When administered in the lab, the 5-HT2A receptor agonist N, N-Dimethyltryptamine (DMT) radically alters the subjective character of experience. However, scientific understanding of DMT experiences in a lab setting is limited by the shortcomings of commonly used phenomenological methods. Specifically, phenomenological models based on self-report questionnaire methods typically do not typically capture the temporal dynamics of experience, instead averaging subjective properties over the entire experience. Qualitative methods, such as thematic or content analysis, suffer this same limitation. The micro-phenomenology (MP) interview and analysis method is well suited to address this lack of granularity in psychedelic phenomenology, modelling experience richly on both the synchronic (within-moment) and diachronic (between-moments) dimensions. Methods: This qualitative study is the first to apply both the MP interview and analysis method to psychedelic data. 25 participants were intravenously dosed with 20 mg of DMT fumarate in a lab setting while undergoing combined EEG and fMRI. MP interviews about the experience were performed upon return to a baseline state. A micro-phenomenological analysis protocol was applied, including novel adaptations developed to accommodate the particularities of non-ordinary experience. Synchronic and diachronic categories were extracted and used to compare and cluster similar experiences. Results: A hierarchical taxonomy of categories on both the synchronic and diachronic dimensions is proposed, along with descriptions and observed frequencies of the phenomenological clusters that emerged. Discussion: In line with Varela's 'neurophenomenological' research programme, further work on this project will statistically validate the phenomenological clusters identified here against the corresponding fMRI and EEG data. Additionally, the present study can be seen as the first step in a micro-phenomenological pipeline, starting here with a comprehensive look at entire DMT experiences, before narrowing down in further work to study component experiences (e.g.: the experience of presences that seem to have their own minds, colloquially referred to as 'DMT entities') at the micro-phenomenological level.

Presenting a Sham Intervention as Personalised Increases Its Perceived Effectiveness in a Randomised Controlled Trial

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Concurrent Session: Ethics, Value, Valence, Pain, Saturday June 24th, Classroom 206, 2:45pm-3:00pm

Personalised health approach, where individuals receive interventions targeted to their genetic and physiological characteristics, can drastically improve treatment outcomes. However, it is yet unclear how much of this improvement is due to the pharmacological personalisation itself versus the placebo effect from the contextual factors involved in the tailoring process, such as the personalisation process. Here, we tested whether presenting a placebo machine as personalised analgesic would improve its perceived effectiveness. Across two samples ($N1 = 17$, $N2 = 85$), 102 adults participated in a pain study where they could use a (sham) machine described as an analgesic while receiving painful heat stimulations to their arm. The participants were either told that the machine was to be personalised to their genetics and physiology, or that it was effective in reducing pain generally. Those in the personalised condition then completed an elaborate procedure including several sham tests, that they believed was used to personalise the machine to their characteristics. Participants in the control condition went through the same procedure but believed it necessary for study eligibility. Participants receiving the sham personalisation reported stronger reductions in pain intensity than the control group in the feasibility study (standardised $b = -0.50$ [-1.08, 0.08]) and the pre-registered double-blind confirmatory study ($b = -0.20$, [-0.36, -0.04]). We found similar effects on pain unpleasantness ($b = -0.52$ and $b = -0.24$, respectively). This study presents some of the first evidence that the process of personalising an intervention may increase its perceived effectiveness. It may have implications for various current and future attempts to tailor health and well-being interventions.

What's wrong with GOTHic hallucinations?

Kranti Saran (Ashoka University)

Concurrent Session: Philosophical Foundations, Friday June 23rd, Classroom 220, 11:30am-11:45am

Byrne and Manzotti (2022; henceforth B&M) have argued in favour of the GOTHic theory of hallucination, according to which there is always an object of hallucination and it is always a physical object, sometimes of the ordinary kind, sometimes of the (numerous) gerrymandered kind (p. 341, 345). Their theory assimilates hallucination to perception, because, as in perception, hallucinations have a “palpable particularity” (p. 334) and they share with perception a “felt perceptual nature” (p. 349). Their theory accords a central role to episodic memory, which “provides a basic inventory of familiar objects” that “under certain conditions” enable our visual system to “present gerrymandered objects composed from the inventory” (p. 350). According to B&M, sensory imagination is a “degenerate kind of hallucination” that may be “subject to voluntary control” (ibid). Thus according to B&M, sensory imagination is assimilated to a kind of hallucination (that crucially relies on episodic memory), which is in turn assimilated to perception. I present three objections to GOTHic hallucination: an empirical objection, a conceptual objection, and a phenomenological objection. The Empirical Objection: Late-stage Alzheimer’s disease is marked by a simultaneous impairment of episodic memory and accentuation of visual hallucinations (El Haj et al. 2017; El Haj et al. 2019). While not a decisive objection to GOTHic hallucination, I show that the evidence counts against it. I also construct an ideal case to settle the matter empirically. The Conceptual Objection: It is a well established empirical result that we easily and often confabulate our episodic memories. Consider a hallucination H of an object O based on the materials supplied by a confabulated episodic memory of O that (presumably) inherits its presentational phenomenological character from it. But, as per hypothesis, there never was any presentation of O, though it is represented in episodic memory. How do we account for the hallucination of O? Because the GOTHic account assimilate sensory imagination, hallucination, and perception, it seems to lack the resources to account for this case. The Phenomenological Objection: Drawing on M.G.F. Martin’s “Out of the Past: Episodic Recall as Regained Acquaintance” (2001), I argue that the GOTHic account of hallucination fails to account for the phenomenological distinctiveness of sensory imagination, episodic memory, hallucination, and perception. On a more concessive note, the GOTHic account’s phenomenological inadequacy invites development and specification of the view to meet the standards of phenomenological adequacy.

Can Predictive Processing teach us anything about Consciousness?

Tobias Schlicht (Ruhr-Universität Bochum)

Concurrent Session: Theories and Models, Sunday June 24th, Classroom 218, 11:45am-12:00pm

Recently, the popular predictive processing framework (PP) has been used to address consciousness (e.g. Hohwy & Seth 2020, Clark 2019). Here, I critically examine two claims made about the progress that PP can make in the neuroscientific and philosophical investigation of consciousness. Firstly, I argue that PP is unlikely to yield significant breakthroughs in the search for the neural correlates of consciousness (NCCs, as Hohwy & Seth 2020 claim). It is too vague to individuate neural mechanisms at a fine enough scale, and its predictions for NCCs are too divergent to guide a systematic search (Solms 2020). Despite its unifying ambitions, the framework comprises competing computational models which rely on different assumptions and are underconstrained by neurological data. Secondly, I argue that the framework is also ill suited to provide a unifying theory of consciousness. There is a tension between the claim that PP is compatible with all of the leading neuroscientific models of consciousness (global workspace, recurrent processing, information integration), as stated by Clark (2019), and the facts that (1) most attempts explaining consciousness within PP rely heavily on external assumptions, and that (2) the competing theories propose different criteria for consciousness and take different stances on important problems such as "overflow" (Block 2011). External assumptions, not PP per se do the heavy-lifting in explaining phenomena; PP does not make any testable predictions by itself to rule out any of the competing theories. Finally, I turn to Clark's (2019) and Clark, Friston and Wilkinson's (2020) strategy of solving the hard problem by addressing the meta-problem of consciousness. Here again, it is the - conceptually independent - theoretical illusionism as a cognitive theory of consciousness that does most of the work (Frankish 2016, Kammerer 2016). Clark et al. liken qualia to inferred contents, on a par with our projections of other internal and external causes of our sensory inputs. They appeal to the level of certainty associated particularly with mid-level hypotheses within the complex hierarchy of top-down and bottom-up processing in the brain. That is, particular qualia are inferred causes “that are also represented as especially certain” (Clark et al. 2020, 21). By likening qualia to inferred contents and rejecting any position on which they would be admitted as data to be explained (Chalmers, 2013), Clark in effect sides with Dehaene (2014) and Dennett (1991) in rejecting a notion of phenomenal consciousness that asks for explanation in addition to cognitive access to information. But the appeal to mid-level predictions in the processing hierarchy fails since it is never independently justified and makes false predictions: The Müller-Lyer illusion, for example, persists, i.e. two lines phenomenally appear to be different in length even though the most certain hypothesis is that they are equal in length (after measuring, say).

A Theory of Visibility Measures in the Dissociation Paradigm

Thomas Schmidt (University of Kaiserslautern-Landau), Melanie Biafora (University of Kaiserslautern-Landau)

Concurrent Session: Methods and Measures, Saturday June 24th, Classroom 220, 2:45pm-3:00pm

Research on perception without awareness , primarily relies on the dissociation paradigm which compares a measure of awareness of a , critical stimulus (direct measure) with a , measure indicating that the stimulus has been , processed at all (indirect measure). We argue , that dissociations between direct and indirect , measures can only be demonstrated with , respect to the critical stimulus feature that , generates the indirect effect, and the obser-, ver's awareness of that feature, the critical cue. We expand Kahneman's (1968) concept of , criterion content to comprise the set of all cues , that an observer actually uses to perform the , direct task. Different direct measures can then , be compared by studying the overlap of their , criterion contents and their containment of the , critical cue. Because objective and subjective , measures may integrate different sets of cues one measure generally cannot replace the , other without sacrificing important infor-, mation. Using a simple mathematical for-, malization, we redefine and clarify the , concepts of validity, exclusiveness, and ex-, haustiveness in the dissociation paradigm show how dissociations among different , awareness measures falsify simple theories of , "consciousness", and formulate the demand , that theories of visual awareness should be , sufficiently specific to explain dissociations , among different facets of awareness.

Is There Evidence for Unconscious Semantic Processing? a Systematic Review and Meta Analysis

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Concurrent Session: Methods and Measures, Saturday June 24th, Classroom 220, 3:00pm-3:15pm

The extent and scope of unconscious semantic processing is yet to be agreed upon. Studies have yielded conflicting findings, leading some researchers to argue in favor of such processing, and others to doubt its existence. A possible cause for this mixed pattern of result is the variety of methods used in the field, pertaining mainly to the way stimuli are suppressed from consciousness, and the way subjects' awareness of the stimuli is assessed. The influence of this heterogeneity has not been quantitatively assessed in a comprehensive manner yet. Here, we conducted a wide-scale systematic review and meta-analysis (with 136 papers in which 741 effects were reported) in an attempt to determine whether unconscious semantic processing is a robust phenomenon, and assess how it might be modulated by researchers' methodological choices. Our work is based on searches on PubMed and PsycInfo conducted in December 2020. Our analysis involved an initial meta-analysis on all effects using a random effects model, and then a series of meta-regression models for the moderator analysis. The results provide evidence for unconscious semantic processing and for large true heterogeneity between studies, though strong indications of potential publication bias were also found. In addition, some methodological factors relating to the suppressed stimulus, to the type of the awareness measure and to the experimental task were found to moderate the effects. These results call for further examination of semantic processing without awareness in future experiments and of the influence of these moderators on it.

You can't go wrong with Integrated Information Theory

Aaron Schurger (Chapman University)

Concurrent Session: Theories and Models, Sunday June 24th, Classroom 218, 12:15pm-12:30pm

According to chat-GPT, Integrated Information Theory (IIT) is the most promising current neuroscientific theory of consciousness. Part of the reason given for this are its rigorous mathematical foundations. As is common in mathematics, IIT is grounded in a set of “axioms”: incontrovertible truths about the nature of the first-person perspective on information processed by the brain – what the “what it is like”, is like. These five axioms are directly accessible to each of us through introspection, and they include things like “intrinsic existence” and “integration”. The axioms are considered self-evident, meaning that they do not require evidence or proof. From these five axioms, five postulates are logically derived, assuming a certain isomorphism between the phenomenology (embodied in the axioms) and the physics of brain activity (or activity in any appropriately interconnected system). The postulates can then be used to directly derive a mathematical formula that yields a value known as phi, that indexes consciousness in a system. I will argue that, because IIT’s axioms are self-evident, and its postulates are derived logically from the axioms, and the mathematics of phi are a directly translated from the postulates, then there is a very real sense it which, a-priori, IIT cannot be wrong. While this is a highly desirable property of mathematical proofs, it is undesirable in science because any explanation that, a-priori, cannot be wrong, is unscientific. This problem should rear its head any time IIT is ostensibly proven wrong empirically – it can only mean that somewhere there’s been a mistake in deriving the postulates or the math from the postulates. Otherwise, the logic of IIT is guaranteed to point the way. Examples of failed predictions derived from IIT are, undeniably, few and far between: IIT has, thus far, fared quite well in the arena of empirical validation, notably in predicting states of consciousness based on brain activity. I will argue that this is due to sleight of mind that rests on two enablers: (1) the labels in such studies, like “unresponsive wakefulness” or “minimally conscious” are derived clinically based on third-person observations, and (2) brain damage is not and has never been selective for “subjective experience”. A good method for detecting a healthy functioning brain would work just as well. I will conclude by arguing that it is impossible to tell IIT apart from a theory of perception, and that if consciousness and perception are identical, then there is no need for a theory of consciousness. In light of this, I offer the following prediction: you can replace the word “consciousness” with the word “perception” in anything that has ever been written about IIT without any loss of meaning or validity. If the prediction holds, then consciousness (as in “subjective experience”) is identical with perception under IIT, in which case, there is no need for a theory of consciousness.

Perspectival Information in Multisensory Integration

Miguel Ángel Sebastián (Universidad Nacional Autónoma de México)

Concurrent Session: Philosophical Foundations, Friday June 23rd, Classroom 220, 11:15am-11:30am

The representational theory of mind, according to which cognitive processing depends on the transformation and storage of information-bearing structures (representations) is widely accepted and the mainstream approach in cognitive science. Representations that carry information relative to a particular point are called `egocentric'. In tune with this idea, weak forms of representationalism maintain that experiences with the same phenomenal character convey some common information. It has been argued that such phenomenal information is egocentric and that it has a special kind of semantic content that we can call 'perspectival'. If a sentence is used to capture such a content, an indexical expression is (at least implicitly) deployed—e.g. 'I am phi-ing', 'from here'. However, the alleged reference of the indexical expression is not part of the phenomenal content, and this explains that the same information is, within a world, true in some cases but not in others. Centered world semantics, for example, adequately capture such a content. This paper researches the role such phenomenal information might play in cognition, focusing on the particular case of multisensory integration. In perception, this sort of observer- or effector-relative information is typically conceptualized by appeal to different frames of reference. The standard theory for multisensory spatial integration and sensorimotor transformations maintains then that sensory modalities encode the location of objects in frames of reference that are specific to each modality. As a consequence, in order to use information relative to different locations, our cognitive systems need to be able to translate information relative to one location into another. I present some empirical and computational challenges that this standard approach faces, and focus on what I take to be the major problem: In our conscious experience information from different modalities seems to be perfectly integrated; consciousness offers semantically unified information. To address these concerns, I propose an intermediate layer that integrates information by abstracting away from the different frames of reference involved in different modalities, and sketch a computational model that will illustrate the kind of mental architecture that can support it. I offer reasons to think that the informational content attributed to this layer corresponds to the perspectival content attributed to our conscious experience.

The development of consciousness-state complexity of brain responses: Perturbation Complexity Index in newborns and young infants

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Concurrent Session: Animal and Infant Consciousness, Sunday June 24th, Classroom 220, 12:15pm-12:30pm

The difference between sleeping and awake newborns is self-evident to their parents. However, it remains unclear when and how the complexity of brain responses starts to discriminate between consciousness states early in life. Here, we addressed this issue, employing a recently devised approach, based on the computation of the Perturbational Complexity Index (PCIst) on the EEG responses elicited by peripheral stimulations. PCIst quantifies the responses to an EEG signal perturbation, indexing whether the responses remain segregated or if they spread in large networks. The more responses spread, the greater the complexity is. Coherently, in adults, PCIst values are known to discriminate between consciousness states. To investigate the development of consciousness-state related complexity, we recruited 18 full-term newborns (age=12-72 hours) and 18 full-term infants (age=3-4 months) and recorded EEG during wakefulness and sleep while electrical stimuli were peripherally applied to the median nerve. From the resulting somatosensory evoked potentials, we calculated the PCIst values in wakefulness and sleep and compared them within each sample. Then, we ran Pearson correlations between age (in hours for newborns, in days for infants) and the delta between the PCIst values in wakefulness and sleep. By comparing PCIst values, a diametrical pattern was found between the two samples: infants showed higher PCIst values in wakefulness than in sleep ($t=3.39$; $p=0.0035$), newborns showed significantly higher PCIst values in sleep than in wakefulness ($t=3.27$; $p=0.0045$). Moreover, while the age correlated with the difference between wakefulness and sleep in infants ($r=0.669$; $p=0.002$), it did not in newborns. Overall, our results show that, if applied to newborns and infants, the perturbational approach provides a diametrical picture of signal spread. 3-month-olds, like adults, show greater complexity in wakefulness than in sleep and the correlational analyses suggest that postnatal experience may foster the development of an adult-like pattern in infancy. Conversely, newborns show opposite results, with greater complexity in sleep as compared to wakefulness. These findings are in line with physiological studies suggesting a different developmental function of neonatal and infant sleep. It has been proposed that the function of neonatal sleep is to foster the emergence of cortical large-scale functional connectivity. Conversely, sleep waves promoting responses segregation to preserve sleep from environmental stimuli are developed from the second month of age. Hence, it seems that functional connectivity maturation is mainly promoted by sleep in newborns, while in infants, like in adults, it may be mainly promoted by environmental stimuli experience during wakefulness. To conclude, our results suggest that, in the developing brain, complexity may not depend on consciousness states per se, but rather reflects how consciousness states drive brain maturation.

Voluntary actions and problem-solving

Silvia Seghezzi (University College London), Stefan Bode (University of Melbourne), Steve Fleming (University College London), Patrick Haggard (University College London)

Concurrent Session: Action, Decision, Volition, Friday June 23rd, Classroom 202, 10:30am-10:45am

Volition refers to a capacity to initiate actions through one's autonomous conscious decisions. Voluntary actions are often made for a reason, which is typically a representation of a desirable goal state. However, existing paradigms for studying volition focus on arbitrary, meaningless actions, favouring the stimulus-independency aspect of volition rather than goal-directedness (Haggard, 2019). The aim of this study was to develop a new view of volition as goal-directedness. We investigated the neurocognitive processes of goal-directed actions, their overlap with the brain areas/processes traditionally associated with voluntary actions, and their interaction with other neurocognitive systems during a problem-solving task. We used a computerised version of the "Tower of London" (TOL, Shallice 1982) problem-solving task in a series of fMRI and EEG experiments. We compared a condition in which participants solved ToL problems with an instructed condition in which they performed individual actions that constituted the solution as a simple response task without any goal to be achieved. In the fMRI experiment, this comparison revealed a significant activation of the medial frontal cortex, which overlapped – although not exclusively – with the areas classically associated with voluntary actions (Seghezzi & Haggard, 2023). The same comparison yielded a greater EEG Readiness Potential associated with ToL actions. fMRI gPPI revealed a distinctive pattern of connectivity between the pre-SMA and the prefrontal cortex before the first action of the ToL sequence, and increased parietal connectivity later in the sequence. EEG WPLI measure of connectivity confirmed the latter, but not the former result. These results provide the first experimental testing of the distinctive goal-directedness aspect of voluntary actions. Defining volition as goal-directedness has clear implications for the conceptualization of its underlying cognitive mechanisms. In particular, these cognitive processes imply a degree of consciousness, since the agent must have a representation of a goal, attribute value to the goal, and must realize that they are not currently in the goal state. Also, by embedding voluntary actions in a goal-directed context, this project goes beyond a conceptualisation of volition as an isolated cognitive function, revealing how volition and its neurocognitive processes are linked to other cognitive areas in a distributed network for problem-solving.

Does global paralysis come with attentional impairment?

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Concurrent Session: Body and Embodiment, Sunday June 24th, Classroom 206, 1:15am-11:30am

Despite recent improvements in the assessment of non responding patients, detecting covert cognition behind total paralysis is a critical ethical issue. Active EEG paradigms have shown that up to 20% of persons with disorders of consciousness (DOC) are in cognitive-motor dissociation (CMD), that is to say capable of modulating their brain activity according to an instruction given by the experimenter, but without any voluntary motor capacity. However, current electrophysiological assessment tools have been poorly validated in conscious patients with severe motor impairment, as in locked-in syndrome or due to an advanced stage of amyotrophic lateral sclerosis (ALS). Our expertise in the field of brain-computer interfaces (BCI) led us to note that several electrophysiological markers conventionally used to predict recovery from disorders of consciousness, such as the P300, are hardly observed in conscious but almost totally paralyzed patients. This raises important concerns about the sensitivity of active EEG paradigms to detect a response to command. In line with several theories in cognitive and computational neuroscience, we hypothesize that impaired (oculo-)motor skills are associated with perceptual disorders and altered attentional control. A related hypothesis is that severe motor disability is associated with an alteration of the peripersonal space. We set-up a multicentric study to recruit these rare patients in 6 hospitals in France. We realized experimentations at home or at hospital. We assessed so far 19 conscious patients with a severe paralysis (brainstem injury or amyotrophic lateral sclerosis or spinal cord injury), 3 DOC, and 10 healthy subjects with three active EEG paradigms: motor imagery (Claassen et al, 2019), selective attention (Seguin et al, 2023, preprint) and sustained auditory attention (Morlet, 2023). We also assessed a well-established measure of the defensive peripersonal space, the hand-blink reflex. We quantified the quality of oculomotor control thanks to a range of neuro-ophtalmological assessments. These overt oculomotor tasks were designed to be as close as possible to the covert attentional tasks realized during the EEG active protocols. For the main analysis, we divided the clinical group in two categories: those who present a normal or subnormal oculomotor control and those who don’t. We test the hypotheses that those who fail to show overt attention should also be impaired in covert attentional tasks. We demonstrated the feasibility of such multimodal explorations of these patients. The preliminary analysis of eye-tracking data reveal that oculomotor impairments seem to be very prevalent in this population of patients (nystagmus, unstable fixation or saccadic intrusion during smooth pursuit). Electrophysiological analyses are in progress. This battery represents an unprecedented access to the cognitive abilities of these patients that are barely accessible to classical neuropsychological assessment.

Multisensory integration in Peripersonal Space as a neurophysiological marker of self-consciousness

Andrea Serino (University Hospital Lausanne)

Concurrent Session: Disorders of Consciousness 2, Saturday June 24th, Classroom 214, 3:15pm-3:30pm

The experience of our embodied Self is not limited to the physical constraints of our body, but it extends into the space where the body interacts with the environment, i.e. peripersonal space (PPS). PPS is represented via the integration of multisensory-motor signals related to the body and to external stimuli in space. Studies have shown that this multisensory integration mechanism is implied in "embodying" artificial or virtual bodies and body parts, and accordingly, PPS representation shapes as a function of changes in bodily self-experience. We developed a neurophysiological marker to measure the multisensory integration mechanism underlying PPS. Here I will show how such mechanism: a) varies as a function of the level of consciousness in patients with disorders of consciousness (DOC), b) emerges in newborns as a function of their hours of life, c) distinguishes wakefulness from sleep, and sleep with or without dreams; d) contributes to predicting the final recovery outcome in patients with DOC. I will discuss these results within the general framework of Bodily Self Consciousness and its underlying neural mechanisms.

Conscious and Unconscious Memory and Eye Movements in Context-Guided Visual Search

David R. Shanks (University College London), Daryl Y. H. Lee (University College London)

Concurrent Session: Unconscious Processes, Sunday June 24th, Classroom 204, 11:45am-12:00pm

What is the role of consciousness in the guidance of eye movements towards target locations in familiar scenes? In a recent eyetracking study, Ramey, Yonelinas, and Henderson (2019) measured eye-movement efficiency (scanpath ratio) and memory judgments when participants searched for targets in repeated and novel scenes. When trials judged new with high confidence were selected, scanpath ratio was lower for old scenes (misses) than for new scenes (correct rejections). In addition, familiarity as measured by recognition confidence did not significantly predict scanpath ratio. Ramey et al. attributed these results to unconscious learning guiding eye movements. In a re-assessment of Ramey et al.'s data, we show that their findings can be accounted for by a single-system computational model in which eye movements and memory judgments are driven by a common latent source that is accessible to consciousness. In particular, (a) the scanpath ratio difference between high-confidence misses and correct rejections is a consequence of regression to the mean, while (b) the low correlation between familiarity and scanpath ratio is a natural consequence of the low reliability of the scanpath ratio measure. A preregistered experiment confirms a novel prediction of the alternative single-system model. This work offers a parsimonious account of Ramey et al.'s findings without recourse to unconscious guidance of eye movements.

Prospects and pitfalls for a science of artificial consciousness: the case of Large Language Models

Henry Shevlin (University of Cambridge)

Concurrent Session: Artificial Intelligence, Friday June 23rd, Classroom 204, 5:45pm-6:00pm

The last three years have witnessed a rapid period of progress and development in Large Language Models such as OpenAI's GPT series, DeepMind's Chincilla, and Google's LaMDA. In one sense these systems are quite simple, functioning primarily to predict the next sequence of tokens from an input, but their performance across a range of natural language processing tasks has dramatically exceeded expectations of most within the machine learning community. Most strikingly for cognitive science, the conversational abilities of these systems make it easy to unreflectively attribute mental states to them, as demonstrated by the already-famous incident when Google engineer Blake Lemoine claimed that the LaMDA model was sentient. While his claim was largely repudiated by the wider consciousness community, it invigorated debate concerning whether and how we could make confident assessments of the presence or absence of consciousness in language models. In this talk, I consider three challenges that the science of consciousness needs to grapple with in order to make such assessments. The first is what I term the metaphysical controversy problem, and concerns the persistent sharp disagreements among different theorists concerning the metaphysical nature of consciousness. While such disagreements are common in science, they are especially pernicious for attributing consciousness to non-human systems insofar as (i) they are questionably amenable to empirical resolution; (ii) in some cases (such as debates between panpsychists and illusionists) they make radically different predictions about distributions of consciousness; (iii) it is unclear whether consciousness science is moving towards greater consensus. The second challenge is what I term the Specificity Problem. Even confining ourselves to 'mainstream' cognitive theories of consciousness such as higher-order thought theory and global workspace theory (GWT), we face a serious challenge applying them outside of canonical cases of human consciousness. Thus when assessing ascriptions of consciousness to beings with very different cognitive architectures, there is no clear rationale for determining the appropriate level of specificity with which to calibrate them. For example, by the lights of GWT, is it sufficient for an AI system to instantiate some process of system-wide information exchange, or are more specialised capacities such as working memory required? The third challenge for applying consciousness science to LLMs stems from the persistent role played by contested intuitions in assessment of theories. Intuitions concerning consciousness vary considerably, and vary even more wildly in for AI consciousness. This would not be a problem if intuitions played a minimal role in the science of consciousness, they play a central role in assessing the plausibility of theories of consciousness as a whole. I conclude with some brief reflections for how the field can best overcome these challenges.

LSD Disrupts the Encoding of the Arrow of Time in the Brain

Kenneth Shinozuka (Centre for Eudaimonia and Human Flourishing, University of Oxford), Prejaas Tewarie (Department of Clinical Neurophysiology, University of Twente), Marco Fabus (Oxford Centre for Human Brain Activity, University of Oxford), Pedro Mediano (Department of Computing, Imperial College London), Christopher Lynn, Robin Carhart-Harris, Morten Kringelbach, Gustavo Deco

Concurrent Session: Altered States of Consciousness, Saturday June 24th, Classroom 210, 2:45pm-3:00pm

LSD is a psychedelic drug that induces altered states of consciousness, but its effects on the brain are poorly understood. Past research has broadly shown that psychedelics affect functional connectivity in the brain, but most studies use undirected measures, which do not capture the temporal order of connectivity: when the timeseries of two regions become causally connected, which one precedes or follows the other? Furthermore, does the timeseries of one region *depend* on the temporal order - that is, the local arrow of time - of the other? In other words, if one were to reverse a timeseries, would its connectivity with the other timeseries in the pair change significantly? While existing measures like Granger Causality can be used to answer the first question, they cannot shed light on the latter two questions. In this paper, we provide insights on both questions by applying the recently-developed INSIDEOUT framework to quantify the irreversibility of brain signals on LSD. Irreversibility is defined as the difference between the cross-correlations of brain signals and their time-reversed counterparts. We find that LSD makes the brain more reversible, both in the broadband signal and in the alpha and beta frequency bands. Additionally, LSD scrambles the temporal order of functional connectivity; the activity in a brain region is more likely to both precede and follow, rather than either precede or follow, the activity of other regions. LSD also reduces the *dependence* of each timeseries on the temporal order of other timeseries. We propose that alterations in cross-frequency coupling may be a plausible mechanism for this phenomenon; using empirical mean decomposition, we show that, under LSD, the amplitude modulation of one timeseries depends less on the sequence of different instantaneous frequencies in other timeseries. Taken together, all of these results demonstrate that LSD disrupts the local arrow of time in the brain. In general, irreversibility is also closely related to the amount of entropy production in a system, or how far away the system is from (thermodynamic) equilibrium. It is worth noting that entropy production is not the same as entropy, which is a measure of uncertainty or disorder. As our findings imply that LSD decreases entropy production, they may add nuance to existing theories (i.e. the Entropic Brain Hypothesis) claiming that psychedelics alter consciousness by increasing entropy in the brain. We hope that future research will explore the relationship between the neural arrow of time and the subjective arrow of time, which might serve as a backbone for the stream of conscious experience.

Identifying the neural network dynamics underlying one-shot perceptual learning with intracranial EEG

Jonathan Shor (Vilcek Institute of Graduate Biomedical Sciences and Neuroscience Institute, New York University Grossman School of Medicine), Thomas J. Baumgarten (Neuroscience Institute, New York University Grossman School of Medicine), Daniel Hasegan (Vilcek Institute of Graduate Biomedical Sciences, New York University Grossman School of Medicine), Sasha Devore (Department of Neurology, New York University Grossman School of Medicine), Daniel Friedman; Patricia Dugan; Ignacio Saez; Fedor Panov; Werner K. Doyle; Orrin Devinsky; Eric K. Oermann; Biyu J. He

Concurrent Session: Perception, Friday June 23rd, Classroom 206, 6:00pm-6:15pm

Conscious perception of ambiguous sensory input requires integrating sensory information with prior knowledge. Individuals vary in how strongly prior knowledge influences perception, and disturbances of this process may lead to perceptual disorders such as hallucination. Distinct sources of prior knowledge have been shown to influence recognition, including past experiences and top-down expectation. Here, we investigate brain network dynamics underlying past experiences' influence on conscious perception using intracranial EEG (iEEG). Using a dramatic one-shot perceptual learning task, prior studies from our laboratory have shown that multiple large-scale cortical networks are involved in prior-knowledge-guided perception. Recently, a study in brain-lesioned amnesiac patients showed that the hippocampus and related medial temporal lobe structures are not needed for successful one-shot perceptual learning. This established that cortical networks implement prior-knowledge-guided perceptual recognition. However, the neural dynamics and network-level interactions supporting one-shot perceptual learning remain largely unknown. In this study, we leveraged the high spatial and temporal resolution of iEEG to track neural dynamics across large-scale brain networks during prior-guided visual recognition. Patients undergoing presurgical evaluation with iEEG monitoring performed a one-shot perceptual learning task. First, patients were shown degraded black-and-white images that are difficult to recognize. They were then presented with the original greyscale images which reliably disambiguated the degraded version, such that degraded images presented afterwards were typically recognized. We assessed neural activation by calculating broadband gamma power. As expected, neural activation time courses were distinct and separable between pre- and post-disambiguation images in ventral stream regions. Interestingly, this separation also occurred in several prefrontal regions including the anterior cingulate cortex and lateral prefrontal cortex. We next compared the tuning profiles of single electrodes in response to grayscale images to their tuning profiles triggered by pre/post-disambiguation images. A more similar tuning profile between post-disambiguation and grayscale images than between pre- and grayscale images would suggest a shift of neural representation toward the image-specific prior knowledge as a result of disambiguation. We observed a distinct temporal evolution of this effect across brain regions. The first appearance of a shift towards prior knowledge occurs in high-level visual cortex as early as 200ms after image presentation, before being observed in early visual cortex and frontal regions, suggesting a potentially unique role for high-level visual cortex in storing perceptual priors. Together, these results reveal sequential involvement of visual and frontal cortices in prior-guided visual recognition following one-shot perceptual learning.

Non-REM parasomnia experiences are associated with EEG signatures of dreaming

Francesca Siclari (Netherlands Institute for Neuroscience, The Netherlands), Jacinthe Cataldi (Centre Hospitalier Universitaire Vaudois, Switzerland), Aurélie Stephan (Netherlands Institute for Neuroscience, The Netherlands), José Haba Rubio (Centre Hospitalier Universitaire Vaudois, Switzerland)

Concurrent Session: Sleep, Dreaming, Anesthesia, Friday June 23rd, Classroom 204, 10:45am-11:00am

Sleepwalking and related parasomnias result from sudden, incomplete awakenings out of Non-rapid eye movement sleep. Intriguingly, behaviour during parasomnia episodes can occur with no or minimal consciousness and recollection, or in relation to vivid, dream-like experiences. To understand what accounts for these differences in consciousness and amnesia, we recorded 102 parasomnia episodes with high-density EEG and interviewed participants about their experiences immediately afterwards. Compared to reports of no experience, reports of experience were preceded, during sleep, by a previously documented signature of dreaming, which persisted into the episode when patients displayed elaborate behaviours in relation to dream-like scenarios. Amnesia for the content of the experience was modulated by the degree of right hippocampal activation during prior sleep and the persistence of fronto-parietal slow wave activity during the episode. Our findings suggest that parasomnia experiences share the same neural correlates as dreams, and that arousal systems may play a role in the generation of dream contents.

The Conscious Theory of Higher-Orderness

Nicholas Silins (Cornell University)

Concurrent Session: Theories and Models, Sunday June 24th, Classroom 218, 10:45am-11:00am

The massive debate in philosophy and psychology and neuroscience about higher-order theories of consciousness has not adequately distinguished between the following two claims: (Necessary Awareness): For any conscious mental state M and subject S, if S is in M, then S is aware of M. (The Higher-Order Theory): For any conscious mental state M and subject S, if S is in M, then M is conscious because S is aware of M. While I will assume that the first claim is true, I will argue that we should reject higher-order theories of consciousness. We should turn them on their head to go with the following theory: (The Ascending Road): For any conscious mental state M and subject S, if S is in M, then S is aware of M because M is conscious.

Finding Consciousness in an Attractor Landscape: Overflow For Global Workspace Theorists

Jonathan Simon (Université de Montréal), George Deane (Université de Montréal), Axel Constant (University of Sussex)

Concurrent Session: Artificial Intelligence, Friday June 23rd, Classroom 204, 6:15pm-6:30pm

In this talk we outline a new conception of how to delineate conscious from non-conscious states (i.e. the aspects of neural activity that directly or constitutively contribute to the character of conscious states, from aspects that do not). Our conception allows for a reconciliation between those who hold that the functions of consciousness center on activity in the neocortex (e.g. the activity of a global workspace or metacognitive systems) and those who hold that the contents of consciousness are rich, and overflow what is explicitly represented by global workspace or metacognition. The key to our approach is to suggest that the relevant delineation should be given at the level of dynamic systems theory. Working memory states can be understood as attractors in a dynamic neural state space. Increasingly, work in neuroscience and artificial intelligence exploits this insight. In "Sources of Richness and Ineffability of Phenomenally Conscious States" (Ji et. al. 2023) we show that if conscious states are trajectories or moments of trajectories in a dynamic attractor landscape, then in a standard range of conditions they are provably richer (in a strict information-theoretic sense) than attractor states themselves. Here, we consider how to approach the delineation question within this framework. If indeed conscious states are trajectories or moments of trajectories in a dynamic attractor landscape, we confront two principal questions: first, what exactly is the projection from the total neural (or neuro-chemical) state space to the state space in which working memory, global workspace and so on may be understood as an attractor landscape? Second, what is the temporal window over trajectories in this space that we associate with conscious states? We will suggest some in-framework tools to help address this question. Ji, X. Elmoznino, E. Deane, G. Constant, A. Dumas, G. Lajoie, G. Simon, J. and Bengio, Y. "Sources of Richness and Ineffability for Phenomenally Conscious States." arXiv preprint arXiv:2302.06403 (2023).

Processing of the same narrative stimuli elicits common functional connectivity dynamics between individuals

Jacobo D Sitt (Paris Brain Institute, France), Basak Turker (Paris Brain Institute, France), Laouen Belloli (Paris Brain Institute, France), Adrian M Owen (Western University, Canada), Lorina Naci, Trinity College, Ireland

Concurrent Session: Perception, Friday June 23rd, Classroom 206, 5:45pm-6:00pm

The brain's continuous processing of incoming information and production of appropriate responses is a complex and dynamic systemthat remains challenging to investigate. To better understand the interplay between ongoing brain activity and neural responses to external stimuli, new tools and methods are needed. In this study, we utilized two different levels of representation of brain connectivity states to investigate how sensory information processing influences ongoing brain activity. 15 participants underwent fMRI recordings during movie watching and rest. A second group of 12 participants watched the same movie but in a scrambled order, preventing them from understanding the plot while still viewing every scene. Phase synchronies between 42 brain regions were computed for each fMRI volume during all three conditions. Brain connectivity state at each time-point was therefore represented in a 861-dimensional space. First, we focused on this high-dimensional space by clustering these connectivity states into 4 prototypical connectivity maps using k-means algorithm. Our analyses revealed that certain brain connectivity states were predominantly manifested in the movie condition, while others were mainly present in the non-movie conditions. Furthermore, we hypothesized that functional connectivity dynamics would be similar across participants during movie watching when brain activity is driven by the same narrative. As expected, we found a higher synchronization across participants during movie watching compared to resting state and scrambled movie conditions. We then tested whether this synchronization effect could be observed in a lower-dimensional representation. To achieve this, we used an autoencoder to represent the computed connectivity states in a 32-dimensional space, followed by k-medoids clustering in this latent space. Despite the substantial dimension reduction (from 861 to 32), the original results were successfully replicated: the occurrence probability of brain states varied with different conditions and participants exhibited synchronization during movie watching. Importantly, the synchronization effect was found to be greater in the latent space compared to the original space. These results suggest that (i) processing of the same high-level information elicits common neural dynamics among individuals and (ii) autoencoder-based dimension reduction could enhance measurement sensitivity by enhancing the representation of the sequence of subjective processes into a sequence of latent brain states.

Access and Consciousness

Michael Snodgrass (Department of Psychology, University of Michigan), N/A ()

Concurrent Session: Richness of Consciousness, Friday June 23rd, Classroom 218, 6:00pm-6:15pm

What is the relationship between access and consciousness? The answer has profound implications for whether consciousness is unitary or occurs in fundamentally distinct forms. For example, in Block's (e.g. 2007) framework, phenomenal consciousness (i.e. experience) and access consciousness (i.e. globally broadcast mental contents freely available for use in thinking, reasoning, etc.) are distinct kinds of consciousness. Snodgrass' (e.g. Snodgrass & Shevrin, 2006) framework resembles Block's, but distinguishes first-order phenomenal consciousness and second-order reflective consciousness (wherein the latter utilizes globally broadcast, freely available phenomenal contents in thinking, reasoning, etc.). In contrast, global workspace theory (GWT; e.g. Naccache, 2018) holds that phenomenal consciousness intrinsically involves access, and hence that twofold typologies are mistaken. Here, I argue that GWT-style unitary conceptions of consciousness (wherein experience and access are inextricably linked) are mistaken, and that instead at least some twofold typologies (e.g. first-order/phenomenal vs. second-order/reflective) are correct--and hence that access is not constitutively related to experience, but rather is a function of reflective consciousness. To demonstrate this, I critique different versions of the "constitutive intuition," distinguishing two forms of access: 1) Global broadcasting/the global workspace; and 2) Utilization of phenomenal contents by second-order reflective processes--that is, first-order vs. second-order access. Regarding the former, I argue that global broadcasting does not itself involve access at all, but is rather a necessary precondition for second-order access by reflective consciousness. Regarding the latter, I argue that experience can occur alone, without being accessed by reflective processes. In both scenarios, I argue that forms of a critical error occur--namely, logically invalid assertions that, since all phenomenally conscious contents can (again, optionally) be accessed by second-order reflective processes, this implies that phenomenal experience constitutively depends on such processes (cf. Philips, 2018). Instead, the opposite is true: Second-order reflective consciousness constitutively depends on first-order phenomenal contents. To clarify, second-order reflective awareness is hierarchically related to phenomenal awareness, so that the former requires the latter but not vice-versa. By analogy, everyone agrees that episodic memory hierarchically depends on semantic memory (and that all semantic contents are available for use in episodic processes), but no one thinks that this implies that semantic memory is constitutively dependent on episodic memory (indeed, the reverse holds). Finally, common constitutive intuitions that to experience something implies that we "know" we're experiencing it are false; "knowing" is a function of second-order reflective awareness, not experience itself.

Decision formation in parietal cortex transcends a fixed frame of reference

NaYoung So (Columbia University / HHMI), Michael N. Shadlen (Columbia University / HHMI)

Concurrent Session: Action, Decision, Volition, Friday June 23rd, Classroom 202, 12:15pm-12:30pm

Neurons in the lateral intraparietal cortex (area LIP) represent the formation of a decision when it is linked to a specific action, such as an eye movement to a choice target. However, these neurons should be unable to represent a decision that transpires across actions that would disrupt this linkage. We investigated this limitation by simultaneously recording many neurons in the LIP of two rhesus monkeys while the monkeys reported a perceived direction of the motion in the two brief motion pulses they saw before and after intervening eye movements. Although intervening actions disrupt the representation by single neurons, the ensemble achieves continuity of the decision process by passing information from currently active neurons to neurons that will become active after the action. In this way, the representation of an evolving decision can be generalized across actions and transcends the frame of reference that specifies the neural response fields. We speculate that even some mental operations involving abstract concepts that are free from any spatial frame of reference, such as mental arithmetic, might involve operations similar to the information transfer studied here. Just as it does for more general frames of reference, the transfer of information might eliminate the need for direct representations of some concepts (e.g. the subtraction equality, 12 - 7 = 5, as a fact). Instead, such representations may exist at the operational level (i.e. the transfer), and therefore, as noted by Zipser and Andersen (1988), ‘‘exist only in the behavior [or intention] of the animal.’’

Manipulating semantic representations without awareness by using fMRI-based decoded neurofeedback.

David Soto (Basque Center on Cognition, Brain and Language), Pedro Margollés (Basque Center on Cognition, Brain and Language), Patxi Elosegi (Basque Center on Cognition, Brain and Language), Ning Mei (Basque Center on Cognition, Brain and Language)

Concurrent Session: Virtual Reality and Neurotechnology, Friday June 23rd, Classroom 218, 12:15pm-12:30pm

Learning a word, involves the mapping of perceptual referents to high-level semantic representations. It is widely held that, conscious access to the perceptual referents is needed to learn the meaning of concrete words. Nonetheless, a few studies on evaluative , conditioning provided intriguing data suggesting that concepts may be implicitly modified via associative learning. These studies, however were criticised due to demand characteristics of the experiments and the reliability of the awareness measures (Field, 2000), including failures, to replicate (Stahl et al. 2016). Here we resolve these issues by conditioning a high-dimensional multivariate pattern of brain activity , for which we lack conscious access (Watanabe et al. 2017). Specifically, we used fMRI-based decoded neurofeedback (DecNef) to , incept perceptual meaning into the brain representations of meaningless symbols, thereby by-passing the conscious mapping between words and , perceptual referents. First, a decoder was trained to classify living from non-living images in the fusiform cortex. During the DecNef , sessions, participants were exposed to a meaningless symbol while they self-regulated their brain activity to increase monetary reward. Unbeknownst to them, the reward was determined by the decoder's probability of the living class in the fusiform. We observed significant, learning effects in the induction of the living category across training sessions, despite participants were unaware of the nature of , the intervention. We then evaluated the behavioural impact of DecNef training in a visual search task including living and non-living , pictures that were pre-cued by the incepted or by a novel symbol. We did not observe any cuing effect of the incepted (vs. non-incepted) symbol , on search performance. However, there was a main effect of DecNef training: relative to a control group, selection of the target category, (living) was impaired during search compared to the non-incepted category. Conscious awareness therefore may be necessary for associative, learning of words and perceptual referents, however, visual representations can be reprogrammed without awareness to affect search , behaviour. Our Python pipeline for real time fMRI -PyDecNef- is open-access for the use of the scientific community. References:, Field, A.P. (2000). I like it, but I'm not sure why: Can evaluative conditioning occur without conscious awareness? Consciousness and Cognition, 9, 13–36. Stahl, C. Haaf, J. & Corneille, O. (2016). Subliminal evaluative conditioning? Above-chance CS identification may be necessary and insufficient for attitude learning. Journal of Experimental Psychology: General, 145(9), 1107–1131, Watanabe, T. Sasaki, Y. Shibata, K. & Kawato, M. (2017). Advances in fMRI real-time neurofeedback. Trends in cognitive sciences, 21(12), 997-1010.

A new neurocognitive model of visual mental imagery: domain-specific and domain-general visual mechanisms

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Concurrent Session: Imagery and Mind Wandering, Friday June 23rd, Classroom 220, 5:45pm-6:00pm

Visual Mental Imagery (VMI) enables the creation of a mental image of an object by retrieving, modifying, and recombining sensory information from long-term memory. The literature in this field has grown significantly, covering five domains of VMI: visuospatial, colors, shapes, letters, and face imagery. Nevertheless, the degree of overlap between the behavioral and neural correlates linked with VMI domains remains undefined, and the debate about the similarities between imagined and perceived conscious representations within each domain has yet to be resolved. In this talk, we begin by reviewing findings from these five VMI domains and delineate the many aspects and features at which VMI has been studied in humans. We draw four main conclusions: first, at the methodological level, over 50 different experimental designs are used by VMI researchers, allowing for the study of various facets of this construct. Second, performing mental imagery tasks is more difficult compared to perceptual tasks, as shown by slower response time and reduced accuracy, regardless of stimulus domains. Third, the fronto-parietal network and the fusiform gyrus of the left hemisphere show increased activation for VMI, across multiple domains. Fourth, domain-specific activation is also found in regions of the ventral and dorsal pathways supporting visual perception, such as the fusiform face area for VMI of faces, the lingual gyrus for color imagery, and MT for imagined and perceived trajectories. We then discuss how this knowledge relates to the original findings we obtained from behavioral and 7T fMRI studies that used the online version of the French-language Batterie Imagination-Perception (eBIP) to assess participants' abilities in both visual imagery and visual perception tasks. Our behavioral findings indicate that individuals with aphantasia, defined as the subjective experience of a lack of or nearly absent visual imagery, are slower in processing visual information in both imagery and perception, while the precision of their processing seems unaffected. Neuroimaging findings show that typical imagers and individuals with aphantasia differ in the connectivity within brain regions associated with mental imagery, due to the Fusiform Imagery Node (FIN) being functionally isolated from frontoparietal regions, a pattern observed for both in visual mental imagery and perception. We conclude by extrapolating a model that describes how VMI is implemented by means of a neurocognitive architecture that combines domain-general and domain-specific mechanisms. We also discuss hemispheric laterality patterns that have not been described previously and how these patterns change based on the imagery domain under investigation. Additionally, we draw a path forward for the study of human visual mental imagery by laying out five testable hypotheses regarding the neurocognitive architecture underlying this function and its spatiotemporal dynamics.

Performance Confounds and Nagel's Notion of the Subjective

James Stazicker (King's College London, Department of Philosophy)

Concurrent Session: Methods and Measures, Saturday June 24th, Classroom 220, 2:15pm-2:30pm

The problem of performance confounds (PCs) is a central problem in the search for neural correlates of consciousness (NCCs). This short talk argues that current attempts to eliminate PCs fail because they ignore the fact that the problem of PCs is, fundamentally, a problem about the subjective and objective in Nagel's sense (1974 / 1986). A remedy is suggested. The problem of PCs is roughly this: behavioral measures of consciousness suffer from a confound between mechanisms of consciousness and the 'effective information processing' involved in performance of a task (Lau 2008). Current attempts to eliminate PCs proceed independently of concerns about the explanatory gap (e.g. Lau 2008; Morales et al 2015). The assumption that work on NCCs should set aside such concerns (Crick and Koch 1998) is sustained by a pair of ideas: (i) we can identify NCCs by identifying neural conditions that share conscious experiences' causal roles; (ii) the explanatory gap does not make identifying conscious experiences' causal roles especially problematic (Chalmers 1996; Shea 2012). Against (ii), this talk argues that the explanatory gap concerns conscious experiences' causal roles as much as their intrinsic character. In particular, the psychological roles distinctive of consciousness are subjective in Nagel's sense: they are understood only by taking up the subject's point of view, so we cannot identify them with neural mechanisms' objective causal roles. For example, it may be distinctive of conscious perception that the subject is put in a position to have certain perception-based thoughts expressible by saying "that object" (Campbell 2002). The thought so expressed can be understood only by someone with relevantly similar conscious perception—i.e. only by someone who shares the subject's point of view in relevant respects. Similarly, the relevant notion of being *put in a position* is defined in subjective, normative terms, not in a way identifiable with a causal, neurofunctional role. This makes it uncertain whether the effective information processing involved in performance of a behavioural task, or any other neurofunctional role associated with consciousness, is a mechanism of consciousness itself or a confound for such mechanisms. Current attempts to eliminate PCs do not face up to this problem. They hold fixed the effective information processing involved in performance of a behavioural task, while measuring consciousness through other neurofunctional roles associated with consciousness (e.g. Lau and Passingham 2006; Morales et al 2017). For the reasons above, it is uncertain whether this method successfully controls for a confound for consciousness, or instead holds consciousness fixed while measuring another neurofunctional confound for consciousness. A more promising, interdisciplinary methodology identifies causal constraints imposed by subjective, normative psychological roles, and assesses which neurofunctional roles fulfil these constraints.

‘Eye am sure but I don’t know it’: gaze reflects implicit sensorimotor confidence in explicit beliefs

Yonatan (Yoni) Stern (University of Haifa), Ophir Netzer (University of Haifa), Oz Mashiah (Bar Ilan University), Asaf Appelbaum (Bar Ilan University), Danny Koren, University of Haifa; Roy Salomon, University of Haifa

Concurrent Session: Visual Metacognition, Sunday June 24th, Classroom 214, 10:45am-11:00am

We constantly strive to create models that capture the fundamental principles and patterns governing our incoming sensory input. Some of these learning processes result in conscious knowledge such as explicit beliefs. However, much of our learning is driven by implicit processes, such as sensorimotor adaptation, that operate outside of our conscious awareness. The interplay between these explicit and implicit processes and their underlying computational mechanisms in health and psychopathology remains unclear. To address these questions, we developed an associative learning task in virtual reality. A cue, that was probabilistically associated with the upcoming target’s location, was presented to participants that predicted the upcoming target’s location. Then participants entered a virtual environment in which the target appeared after a delay. Focusing on participants eye movements and gaze direction prior to the target’s appearance, we assessed participants’ implicit ocular expectation of the target’s location and its relation to their explicit response. In an exploratory (N = 30) and pre-registered replication (N = 40) study we first found that participants successfully learn the underlying probabilistic relation between the cue and target and their explicit performance was above chance. Second, implicit ocular expectations, measured by gaze direction before the target’s appearance, were closely aligned with participant’s explicit predictions. To further characterize this relation, we found that gaze duration fulfills the computational hallmarks of statistical confidence as previously defined (Sanders et al. 2016): (i) a monotonic relation with accuracy, (ii) the relation between gaze and evidence strength was markedly distinguished for trials in which the explicit prediction was correct and incorrect. (iii) trials with increased gaze towards the prediction showed a stronger relation between evidence and accuracy, in comparison to low gaze trials. Thus, ocular expectations reflect implicit sensorimotor confidence in one’s explicit belief. Third, exploring how implicit confidence influences subsequent explicit decisions, we found that gaze acts as an implicit wager of one’s confidence modulating the likelihood of retaining one’s belief. Specifically, errors on trials with high implicit confidence, were more likely to result in a rule switch as opposed to low confidence trials. Thus, implicit expectations and explicit predictions mutually influence each other, demonstrating a unique reciprocal relationship between conscious and unconscious oculomotor learning processes. Furthermore, gaze offers unique insight of the latent cognitive processes underlying explicit predictions. Ongoing data is being collected from individuals on the psychotic spectrum to further identify the implicit and explicit aberrant process that contribute to their impaired learning of the environment.

Meditation Altered Psilocybin-Induced Effective Connectivity

Devon Stoliker (Turner Institute for Brain and Mental Health, Monash University), Leonardo Novelli (Turner Institute for Brain and Mental Health, Monash University), Adeel Razi (Turner Institute for Brain and Mental Health, Monash University)

Concurrent Session: Altered States of Consciousness, Saturday June 24th, Classroom 210, 2:15pm-2:30pm

The interplay between meditation and psychedelics has emerged as a topic of significance for the disciplines of neuroscience and psychiatry. Both can advance applied and basic knowledge. However, their synergy is not well understood. To investigate the combined effect of meditation and psychedelics on neural mechanisms, 60 healthy adults without prior experience in either meditation or psychedelics were administered a 19mg dose of psilocybin. Half of the participants participated in an 8-week mindfulness meditation program before psilocybin was administered. Resting state functional MRI (8 min, TR = 910ms) was performed prior to psilocybin administration as an unblinded baseline (No-drug condition) and on the day of psilocybin administration (Drug condition), 80 minutes after administration. Following the standard resting state scan, we performed an fMRI session with a pre-recorded guided meditation (6min 30 sec, TR = 910ms), which we analyzed here. Dynamic causal modelling was used to model the default mode network effective connectivity differences 1) between all participants at in No-drug and Drug conditions (N = 60 in each group), and 2) between participants in Drug condition who received the 8-week mindfulness meditation program and those who did not (n=30 in each group). The default mode network was modelled using 10 aggregated regions of the Schaefer parcellation including the right dorsal medial prefrontal cortex (R-dmPFC), right ventral prefrontal cortex (R-vPFC), left prefrontal cortex (L-PFC), left parahippocampus (L-PHC), bilateral precuneus and posterior cingulate cortex (L/R-PCC), bilateral temporal lobe (L/R-Temp) and bilateral parietal lobe (L/R-Par). In our first effective connectivity analysis of Drug vs No-drug, results demonstrated increased self-inhibition of all PFC regions, the R-Temp, and the PCC in all participants under psilocybin, indicating decreased sensitivity of these regions to inputs. Decreased inhibition was also observed under psilocybin in the self-inhibition of the L-Par and from the L-PCC to the R-vPFC. In our second effective connectivity analysis of the Drug condition, meditators showed greater changes in the connectivity altered by psilocybin compared to non-meditators, in the greater increase of vPFC and L-PCC self-inhibition and greater decrease of L-Par self-inhibition and inhibition from the L-PCC to the R-vPFC. In contrast, meditators showed lesser changes in the connectivity altered by psilocybin compared to non-meditators, in the decreased self-inhibition of the R-Temp and R-dmPFC. These results suggest experience with meditation may modulate the effective connectivity altered by psilocybin. In addition to identifying the neural mechanisms underlying the psychedelic state and meditation, our findings contribute to understanding the influence of mindset on psychedelic neural dynamics and may have clinical relevance for the combined use of meditation and psychedelics in therapeutic applications.

Situating Machines within Normative Practices: Agency, Moral Responsibility and the AI Stance

Anna Strasser (Ludwig Maximilians Universität München), Michael Wilby (Anglia Ruskin University)

Concurrent Session: Artificial Intelligence, Friday June 23rd, Classroom 204, 5:15pm-5:30pm

Artificial learning systems increasingly seem to occupy a middle ground between genuine personhood on the one hand, and mere causally describable machine on the other (Nyholm 2018; Coecklebergh 2020; Strasser 2022). Such systems are neither wholly lacking mentality, nor wholly possessing it; neither wholly lacking agency, nor wholly possessing it; neither wholly lacking moral responsibility nor wholly possessing it. This lends itself to a host of problems: psychological, ethical, and legal. Under what circumstances, and in what ways, should we treat artificial systems as thinking things, with agency and forms of legal and moral responsibility, which cannot be off-loaded elsewhere? In this paper, we argue for what we call the 'AI Stance' (Strasser & Wilby 2023) that is applicable to artificial systems when engaged in interactions with human partners. The AI Stance involves an integrated suite of interpretative and predictive devices that allow us to understand not just the intentional and rational aspects of human-machine interaction but also the normative, value-laden aspects of those interactions too. On this view, artificial systems can be thought of as genuine agents when their behaviour is autonomously geared towards finding novel means to an end that is specified by a human partner. They can be thought to adopt a goal – specified and scaffolded by a human partner – and hence be seen to be acting intentionally with regards to that goal. Further, they can be held morally responsible for negative outcomes where the responsibility for any outcomes that occur within that interaction cannot be off-loaded to anyone outside of the interaction, nor wholly attributable to the human partner. In such cases, rather than generating a 'responsibility gap' (Sparrow 2007), the AI Stance is able to identify fault with the means used by the artificial system. From within the AI Stance such fault should be understood as moral rather than merely causal: drawing on an influential account of moral blame (Scanlon 2008), we argue that taking the AI stance allows for artificial system to be judged blameworthy for their action, and for future interactants with the system to modify their relations with that system in ways that are appropriate to that judgement.

Modelling Phenomenological Differences in Aetiologically Distinct Visual Hallucinations Using Deep Neural Networks

Keisuke Suzuki (Hokkaido University), Anil K. Seth (University of Sussex), David J. Schwartzman (University of Sussex)

Concurrent Session: Artificial Intelligence, Friday June 23rd, Classroom 204, 6:00pm-6:15pm

Visual hallucinations (VHs) are perceptions of objects or events that occur without corresponding sensory stimulation. These unusual experiences provide intriguing insights into the mechanisms underlying perceptual experience, especially since VHs arising from different aetiologies can have very different phenomenological characteristics. Notably, VHs stemming from neurological conditions (e.g. Lewy body dementia, Parkinson's disease), visual impairment (e.g.Charles Bonnet syndrome (CBS)), and psychedelic substances all exhibit significant differences in phenomenology. To better understand the nature of these differences, and what they can tell us about normal non-hallucinatory perceptual experience, we apply a method based on computational neurophenomenology: the application of computational models, interpretable in terms of neural mechanisms, to account for the phenomenological properties of perceptual experience. We first identify three dimensions that are pertinent to distinguish VHs due to neurological disease, visual loss, and psychedelics: veridicality, spontaneity (dependence on sensory input), and complexity. We next explore the potential computational basis of these differences by utilising recent advancements in visualising the learned representations of a coupled classifier and generative deep neural network (Nguyen et al. 2016). Adapting this architecture, we were able to generate synthetic VHs that varied along these three dimensions. We used objective measures applied to the synthesised images to validate variation in these dimensions (e.g, the Inception Score to validate veridicality). Finally, we experimentally verified the representativeness of our synthesised hallucinatory images in two studies that surveyed the phenomenology of VHs in neurological and CBS patients, as well as individuals with recent psychedelic experience. In both studies, after initially confirming that the three phenomenological dimensions served as useful indicators to distinguish between the various types of naturally-occurring VHs, we investigated whether the corresponding synthetic VHs captured the distinctive aspects of hallucinatory phenomenology for each aetiology. In both studies, we found that the synthetic VHs designed to model a specific type of VH were indeed deemed as the most representative of the lived experience of VHs for the corresponding group, as compared to other synthetic VHs generated by the model. Our results highlight the phenomenological diversity of VHs associated with distinct causal factors and demonstrate how a neural network model of visual phenomenology can successfully capture the distinctive visual characteristics of hallucinatory experience. The novel combination of deep neural network architectures and a computational neurophenomenological approach provides a powerful approach towards closing the loop between hallucinatory experiences and their underlying neurocomputational mechanisms.

Beyond the cerebral cortex - the striatum's unique contributions to consciousness

Joanna Szczotka (Center for Sleep and Consciousness, University of Wisconsin-Madison)

Concurrent Session: Neural Correlates of Consciousness, Sunday June 24th, Classroom 210, 12:15pm-12:30pm

In the last decade, consciousness science has largely focused on systematic comparisons of some of the most prominent theories in the field, such as Integrated Information Theory, Predictive Processing or Global Workspace Theory. A big part of the ongoing debate is establishing whether it is the frontoparietal or posterior cortices that are optimally wired for a substrate of consciousness, or NCCs. An implicit agreement among the theories is that it is the 'cortex' that generates subjective experience; the subcortical areas being its mere 'enabling factors' (with a controversial exception of the thalamus). Here, we attempt to show the incompleteness of this cortico-centric view. One brain structure that has been largely dismissed in consciousness science – the striatum – might turn out to bring a lot of explanatory power into fundamental questions, such as why consciousness 'flows the way it does'. Due to very conspicuous deficits in motor control upon lesions of striatum, its function has long been associated with motor sequencing, implicit learning, and habit formation, all claimed to be operating unconsciously. However, while that appears true for the dorsolateral striatum (or putamen in primates), it is untenable for the dorsomedial striatum (or caudate in primates). Here, we present human and animal data to conclude that the caudate provides unique contributions to contents and structure of subjective experience. A closer investigation of almost 100 first-person reports of patients with various striatal lesions reveals that these patients experience an "an empty and idle mind", a striking loss of spontaneous thoughts or mind-wandering and an extremely flat affect. Although that peculiar phenomenology is often dismissed as a 'motor deficit' in its nature, we argue that the motor symptoms only secondarily derive from a profoundly altered quality of consciousness. Consistently, animal data show that specifically caudal lesions yield sensory neglect, attentional deficits and dramatically distorted time perception. All these non-motor symptoms following striatal lesions call for an explanation that contemporary theories of consciousness in their current form do not provide. Synthesizing insights from most recognized frameworks in the field (IIT, GWN, PP) with developments in reinforcement learning, we present a model extending the NCCs beyond the cerebral cortex. By closely resembling a chaotic oscillator, the globus pallidus in orchestra with subthalamic nucleus appear perfectly situated to contribute to the overall signal diversity (a core signature of consciousness according to some theories) and parallel an 'exploration engine', as in RL systems. Leaving aside whether NCCs reside in the front or the back of the cerebral cortex, we argue that the cortex on its own, without the striatum, would not be able to explain some of the most ubiquitous, but often taken for granted aspects of conscious experience.

Knowledge organization under the hood: the benefits of unconscious memory reactivation

Amir Tal (Columbia University), Eitan Schechtman (University of California Irvine), Bruce Caughran (Northwestern University), Ken Paller (Northwestern University), Lila Davachi

Concurrent Session: Unconscious Processes, Sunday June 24th, Classroom 204, 12:15pm-12:30pm

Transforming experience into knowledge requires internal rehearsal. During sleep or idle wake, recently experienced episodes are replayed, which increases the probability of their long-term maintenance. But what is special about these "offline" states that make them well suited for consolidating knowledge into long-term memory? We propose that knowledge formation and restructuring is optimal when conscious control over memory reactivation is alleviated. It is the unconscious brain, we propose, that enables wide-spread reactivation and restructuring of memories, and is hence well-suited for forming novel long-term knowledge. In the current study we therefore examined the effect that unconscious reactivation has on associative memories. After learning associations between words, objects, and locations, participants were presented with a subset of the learned words in a supraliminal manner, and another subset of these words in a subliminal manner. Later, memory for consciously reactivated and for unconsciously reactivated items was compared, as well as for items that were not reactivated but shared category membership with reactivated items. Post-reactivation memory tests revealed that while conscious reactivations strengthened direct associations and weakened related memories, unconscious reactivations benefited weak memories and seemed to facilitate integration with related memories. Results align with our hypothesis that associative spread is higher for unconscious as compared to conscious reactivation. They provide insight into the mechanisms underlying memory structuring during offline reactivation, and offer a new hypothesis for a unique role of unconscious processing in memory.

Modulating the subjective experience of pain using decoded fMRI neurofeedback

Vincent Taschereau-Dumouchel (Université de Montréal), Taryn Berman (McGill University), Cody Cushing (University of California, Los Angeles), Hakwan Lau (RIKEN center for brain science), Mathieu Roy

Concurrent Session: Ethics, Value, Valence, Pain, Saturday June 24th, Classroom 206, 3:00pm-3:15pm

The precise brain mechanisms involved in generating the subjective experience of pain are still quite elusive. Brain decoders such as the neurological pain signature (NPS) can be trained to accurately predict pain reports, but such decoders may primarily reflect unconscious nociceptive mechanisms in the brain. In fact, it was previously shown that another brain decoder, the stimulus intensity independant pain signature (SIIPS), can predict the subjective experience of pain beyond what can be explained by the NPS and the level of nociceptive input alone. In order to devise new targeted interventions for pain, we need to better understand the link between the modulation of such patterns of brain activity and the subjective experience. To address this question, we devised a new approach to conduct real-time decoding of functional magnetic resonance imaging (fMRI) data in the standard Montreal Neurological Institute (MNI) space. Using this approach, we showed that both the SIIPS and NPS can predict subjective pain ratings in real time in out-of-sample participants. Furthermore, in a double-blind placebo-controlled decoded neurofeedback experiment, we trained participants to up- or down-regulate the SIIPS and measured the effect of the intervention on pain ratings. Our results indicate that participants can be trained to down-regulate the expression of the SIIPS decoder independently from the NPS. Importantly, the success of this training was associated with the perceived intensity of painful stimulations after the intervention. Taken together, these results indicate that closed-loop brain imaging interventions can be conducted using MNI-space decoders, potentially opening up a range of new applications for the study of consciousness.

An adversarial collaboration to test predictions of first-order and higher-order theories of consciousness using subjective inflation

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Concurrent Session: Comparing Theories of Consciousness, Friday June 23rd, Classroom 210, 6:00pm-6:15pm

Goal: “Phenomenal awareness” in vision is our subjective experience of seeing something. First-order (FO) and higher-order (HO) theories posit that either FO (sensory) or HO (re-representations of or pointers to FO) representations are critical for phenomenal awareness. A key motivation for HO theories is subjective inflation: for peripheral, unattended stimuli phenomenal experience can be stronger than the accuracy of sensory (presumably FO) processes would suggest. Previous studies of subjective inflation generally used one pair of stimulus strengths–weaker for attended and stronger for unattended–to yield performance-matched conditions, which has limited interpretation of the results. Here, in a preregistered adversarial collaboration of opposing theorists and two neutral experimental labs, we tested whether attention dissociates subjective reports and objective performance across a range of stimulus strengths, consistent with HO predictions of subjective inflation. Methods: Human observers (n=30 across sites) performed a spatial attentional cueing task. On each trial, observers viewed four texture backgrounds of ±45° oriented lines in which texture-defined oval figures appeared peripherally half the time. We manipulated the discriminability of the figures using 7 individually-calibrated texture line lengths. A response cue instructed observers to simultaneously make 1) a subjective report: whether they saw the oval and/or its orientation and 2) an objective report: the vertical/horizontal orientation of the oval. Before the textures, a central precue (60% valid, 20% neutral, 20% invalid) instructed observers to attend to one or all stimulus locations. Online fixation monitoring ensured peripheral stimulus presentation. Results: We confirmed that, in figure-present trials, objective performance and subjective awareness increased with stimulus strength and attention. To assess subjective inflation, we developed a new area-under-the-curve approach to relate objective and subjective reports across stimulus strengths for matched levels of orientation discrimination performance. We found that subjective awareness was higher under inattention across a range of matched discriminabilities. Analyzing figure-present and -absent trials together revealed that not only were signal detection criteria more liberal but also detection sensitivity was lower under inattention at matched discriminabilities. Conclusion: Attention can dissociate objective performance and subjective awareness reports across a range of stimulus strengths in the visual periphery. This experiment is the first of a series testing the robustness of subjective inflation across stimuli and tasks. The results will help adjudicate between FO and HO theories. Supported by the Templeton World Charity Foundation Accelerating Research on Consciousness initiative (to BJH, JWB, NB, DC, RND, MAKP).

Can we learn information non-consciously? - Exploring the relationship between non-conscious working memory and statistical sequence learning

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Concurrent Session: Unconscious Processes, Sunday June 24th, Classroom 204, 12:00pm-12:15pm

Recent reports have provided converging behavioral, computational, and neural evidence in favor of ‘working-memory like’ non-conscious maintenance of information. However, whether this long-lasting non-conscious maintenance constitutes evidence for a genuine non-conscious working memory system, with similar characteristics and capabilities as conscious working memory, is still contested. Here, we approach this question by introducing statistical regularities in consciously and non-consciously presented stimulus sequences: In a spatial delayed-response task, two independent samples of participants (total N = 60) reported the location of two subsequently presented target locations. Critically, the position of the first target fully predicted the position of the second target. For seen target sequences, we observed the expected benefit of stimulus predictability: Over the course of three experimental blocks, localization accuracy for target 2 diverged from that of target 1, with objective performance for the second target being higher than that for the first target. Moreover, while participants’ localization responses were ~uniformly distributed in position space on trials, in which the first target was replaced by a blank screen (ie. target-absent control), they were systematically biased towards the expected predicted position on trials, in which the second target was omitted. Together, these findings suggest that, in conscious conditions, participants were able to extract the statistical structure of stimulus sequences and learn them over the course of the experiment. By contrast, a different picture emerged for unseen target sequences. While participants consistently guessed unseen target locations much better than would have been predicted by chance alone, there was no clearly detectable benefit for target 2. Instead, localization performance for unseen trials remained stable throughout the entire duration of the experiment. This suggests that, while non-conscious information can be maintained for several seconds, it either takes much longer than in a conscious situation to extract and learn longer-term statistical dependencies, or may be impossible. In ongoing analyses, we are exploiting additional behavioral and eyetracking data to arbitrate between these two competing hypotheses and refine the pool of candidate neural mechanisms. Overall, these preliminary results point towards several novel insights: On one hand, they further strengthen the reported dissociation between conscious and non-conscious maintenance of information, and highlight the need for future investigations into the exact nature and neural substrates of this non-conscious ‘working memory.’ On the other hand, they also give us the opportunity to assess the lower bounds of statistical learning and speak to the question as to how automatic such learning processes really might be.

The heart as a subjective pacemaker: how experienced time expands and contracts within each heartbeat

Manos Tsakiris (Royal Holloway University of London), Irena Arslanova (Royal Holloway University of London), Vassilis Kotsaris (University of Kent)

Concurrent Session: Time Perception, Saturday June 24th, Classroom 218, 2:15pm-2:30pm

Our experience of time passing, one of the most fundamental aspects of human consciousness, is highly subjective and often highly distorted. Current models suggest that perceived duration is constructed from accumulation processes and is encoded from temporally evolving neural dynamics. Yet, all neural dynamics and information processing ensue at the backdrop of continuous interoceptive signals originating from within the body. Even though growing evidence suggests that bodily interoceptive signals are crucial elements of deeper layers within the brain's hierarchical perceptual networks, the causal role that such interoceptive signals may play in shaping our time perception and its biases has not been investigated. We capitalized on recent research showing that phasic fluctuations within the cardiac cycle impact neural and information processing across a range of cognitive domains. To study the causal influence of cardiac signals on time perception, we presented temporal stimuli either during the systolic phase of the cardiac cycle, when baroreceptors are firing signals to the brain, or during the diastolic phase, when baroreceptors are quiescent. Across two experiments , participants performed a temporal bisection task, and stimulus presentation was time-locked to systole, or to diastole, when the heart relaxes, and baroreceptors are quiescent. When participants judged the duration of emotionally neural visual or auditory stimuli (Experiment 1), systole led to temporal contraction, while diastole led to temporal expansion. Such cardiac-led distortions were further modulated by the arousal ratings of the perceived facial expressions (Experiment 2). At low arousal, systole contracted while diastole expanded time, but as arousal increased, this cardiac-led time distortion disappeared, shifting duration perception towards contraction. Taken together, our studies illustrate how the two phases of the heartbeat – systole and diastole – pull temporal representations in opposite directions; at systole, time contracts, whereas at diastole, it expands, a balance that is disrupted under heightened arousal. These findings document how time perception is distorted in specific directions in tandem with the spontaneous physiological fluctuations of our cardiac activity. Or, to put it in the words of the novelist Haruki Murakami, "time expands, then contracts, all in tune with the stirring of the heart" ('Kafka on the shore').

Complex brain states with high connectivity enhance conscious perception of threshold stimuli

Basak Turker (Paris Brain Institute), Dragana Manasova (Paris Brain Institute), Claire Sergent (Paris Brain Institute), Jacobo Sitt (Paris Brain Institute)

Concurrent Session: Neural Correlates of Consciousness, Sunday June 24th, Classroom 210, 10:30am-10:45am

It has been suggested that the richness of conscious experience can be directly linked to the richness of brain state repertories. Indeed, studies investigating anesthetized monkeys, patients with Disorders of Consciousness (DoC), and healthy participants have shown that brain states characterized by long-range interactions and anticorrelations diminish with the loss of consciousness. Furthermore, active interventions (i.e. deep brain stimulation) aimed at inducing recovery from a state of unconsciousness also increase the richness of brain state repertories and the occurrence of these highly connected brain states. In this study, we go beyond this correlation and assess the functional role of these brain states in the formation of conscious experience by altering the capacity to process external information. Participants underwent simultaneous fMRI and EEG recordings while performing an auditory detection task, with stimuli presented either at the detection threshold, sub-threshold, or supra-threshold in a randomized fashion. The task consisted of 6 blocks, and after each block, participants reported a subjective evaluation of their level of (i) tiredness, (ii) success, and (iii) focus (on task versus mind-wandering) during the task. Using phase-coherence-based functional connectivity and k-means clustering, we were able to identify five recurrent brain states that matched those found in previous studies, with one being the highly connected state (high-state). We hypothesized that participants would have higher detection rates for threshold stimuli presented during the occurrence of a high-state. As expected, we found a significant increase in detection rates only for threshold stimuli when participants were exhibiting a high-state. Interestingly, threshold stimuli were more likely to be detected if the previous stimulus was detected, regardless of brain state. Moreover, the occurrence of the high-state increased following detection, with participants being more likely to transition to a high-state after a stimulus detection. Finally, the occurrence of the high-state in a block was correlated with subjective and objective success and was not associated with tiredness or attentional focus. These results show that certain ongoing, complex brain configurations facilitate conscious perception and that the increase in performance does not seem to be linked to subjective fatigue or attentional state. Furthermore, conscious access in turn alters ongoing brain activity by increasing the occurrence of highly connected states. Our results underline the importance of these complex brain states for conscious access and conscious states. In the future targeting these moments of high-connectivity states in DoC patients could help us detect windows of higher permeability to the external world and pave the way for individualized patient-care protocols.

Who is that, behind me? Investigating the identity of induced presence hallucinations by merging face morphing, robotics and virtual reality systems

Neza Vehar (Laboratory of Cognitive Neuroscience, Ecole Polytechnique Fédérale de Lausanne (EPFL)), Louis Philippe Albert (Laboratory of Cognitive Neuroscience, Ecole Polytechnique Fédérale de Lausanne (EPFL)), Arthur Trivier (Laboratory of Cognitive Neuroscience, Ecole Polytechnique Fédérale de Lausanne (EPFL)), Fosco Bernasconi (Laboratory of Cognitive Neuroscience, Ecole Polytechnique Fédérale de Lausanne (EPFL)), Olaf Blanke

Concurrent Session: Virtual Reality and Neurotechnology, Friday June 23rd, Classroom 218, 10:45am-11:00am

Among the uncanny feats of our conscious mind, is the experience of someone's presence in the close vicinity of our body without anyone actually present. Such Presence hallucinations (PH) can occur in patients with neurodegenerative, psychiatric and neurological diseases, but also in healthy individuals, particularly during bereavement (Kamp et al. 2020). PH has been associated with alterations in self-monitoring of sensorimotor signals (Blanke et al. 2014; Bernasconi et al. 2021). These phenomenologically varied hallucinations are most commonly described as anthropomorphic, where the identity of PH (iPH) can be perceived as that of a significant other (e.g. partner) or as an unidentified stranger. Despite its significance for people who regularly experience them as comforting or disturbing, iPH remains poorly understood. This is primarily due to the paucity of methods to investigate and induce these hallucinations in real-time, as well as the absence of implicit quantitative measures, hampering the unravelling of this complex conscious experience. Here we investigated the mechanisms of iPH in healthy subjects, by merging a robotic sensorimotor method that has been shown to induce PH (Bernasconi et al. 2022), with a 2AFC (partner or stranger) face identity detection task implemented inside immersive virtual reality, as an implicit measure of the experienced identity of iPH. Nineteen healthy participants in romantic relationships performed the PH-inducing sensorimotor robotic task, followed on each trial by a brief exposure to morphs between their partner's and a stranger's photograph. We successfully replicated PH induction with this set-up, as participants reported feeling someone was around them significantly more in the asynchronous sensorimotor robotic stimulation rather than the synchronous condition ($p=0.036$). Furthermore, we observed that the sensorimotor robotic significantly modulates the face perception. That is, in the PH-inducing asynchronous condition participants perceived more Partner, when compared to the same morphing level in the synchronous condition ($p= 0.005$). This interaction was particularly evident for older participants ($p<0.001$), those with longer relationships ($p=0.042$) and participants that generally report experiencing more spontaneous PH in their daily lives (trait-PH, as measured by a questionnaire ($p=0.02$). We interpret these findings as the result of altered self-monitoring, where PH-inducing conflicting sensorimotor stimulation activates a closely related neural and functional representation to the self in the brain – that of our partners.

Fearful faces guide the eyes before reaching visual awareness

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Concurrent Session: Unconscious Processes, Sunday June 24th, Classroom 204, 10:45am-11:00am

Threat-related stimuli like fearful faces are preferentially processed by the brain, even in the absence of visual awareness. Previously, we demonstrated that the eyes move towards fearful faces and away from angry faces in the absence of visual awareness (Vetter, Badde, Phelps & Carrasco, 2020, eLife). In the current study, we investigated the processing stages during which fearful faces gain visual awareness. We addressed two questions: 1) which eye movement patterns accompany the breaking-through of fearful faces into visual awareness and 2) whether fearful voices could have an effect on break-through or eye movements. We suppressed intact and scrambled fearful faces from visual awareness using continuous flash suppression and paired them with fearful, neutral or spectrally inverted voices. As indicators of visual processing levels, we tracked eye movements as well as objective and subjective behavioural measures of visual awareness. We found that fearful faces broke through to visual awareness more often than scrambled faces, in line with earlier findings (e.g. Yang et al. 2007), and confirming the preferential processing of fearful faces. In those trials where participants subjectively reported having seen at least a brief glimpse of the visual stimulus, we found that the eyes move towards the stimulus even when participants are yet unable to localise the stimulus correctly. Critically, the eyes moved towards fearful faces earlier than towards scrambled faces. Voices showed no interaction effects with visual stimuli in neither eye movement nor behavioural data. Our findings demonstrate that during the process of visual stimuli gaining awareness, the eyes detect visual stimuli first even when they cannot be localised yet, and this effect is particularly pronounced for fearful faces. The absence of an effect of voices suggests that multisensory integration may not easily occur in the absence of visual awareness. Overall, we conclude that the eyes are early detectors of fearful faces, both in the absence of awareness, and during the process of gaining visual awareness.

Representation of sustained passive visual experience across different frequency ranges

Gal Vishne (The Hebrew University, Jerusalem, Israel), Edden M. Gerber (The Hebrew University, Jerusalem, Israel), Robert T. Knight (University of California, Berkeley, United States), Leon Y. Deouell (The Hebrew University, Jerusalem, Israel)

Concurrent Session: Neural Correlates of Conscious Vision, Friday June 23rd, Classroom 210, 11:45am-12:00pm

Everyday vision is rife with instances of (brief, 1-2sec) unchanging visual input, yet these common periods of input stability have been largely neglected by previous work, which focused on onset or change-related responses. Introspectively, experience during these periods seems to reflect the external stability, and therefore this question also has important implications for the study of consciousness in general, and for arbitrating between specific theories of consciousness (COGITATE consortium; Melloni et al. 2021). Whether we are indeed continuously conscious is still debated, however, even extreme theories of discrete perception do not suggest gaps of more than ~500ms (Herzog et al. 2020), highlighting the importance of characterizing neural coding during these periods. Thus, we reanalyzed intracranial recordings from ten patients undergoing surgery for epilepsy, viewing diverse images from multiple categories in multiple durations (300-1500ms; Gerber et al. 2017). Focusing on high-frequency activity (HFA, 70-150Hz), we recently showed that sensory regions (occipital and ventral-temporal cortex) manifest rich and highly dynamic population responses, yet we identified a stable representational subspace, which affords a temporally invariant readout of visual category and exemplar-level information continuously throughout stimulus presentation (Vishne et al. 2022). In addition to this continuous representation, we also identified transient onset-related stimulus information in fronto-parietal regions (including PFC). We now extend this finding by examining multivariate responses in other frequencies, focusing on ranges accessible with non-invasive physiology, including broadband activity in low frequencies (<30Hz), and amplitude in the alpha (8-14Hz) and theta (2-8Hz) ranges. In sensory regions, we find that all frequency ranges contain information about stimulus content, some for more than a second after the onset. However, in contrast to the HFA response, category information in lower frequencies was dynamic in time, and did not track the entire duration of the stimulus, implying a prolonged onset response rather than a sustained representation which can account for the perceptual experience of (brief) stability. Thus, these results argue that to the extent consciousness is continuous, the HFA response in sensory regions is more suitable as a neural correlate of perceptual experience compared to the lower frequencies. Frontoparietal regions showed only faint category information in the lower frequencies. Category information was completely missing from prefrontal cortex, despite the suggested role of PFC oscillatory dynamics in shaping perception and cognition (Helfrich & Knight, 2016). Future research will investigate the possibility of oscillatory control signals that are not content specific.

Augmenting the dimensions of consciousness

Karina Vold (University of Toronto)

Concurrent Session: Virtual Reality and Neurotechnology, Friday June 23rd, Classroom 218, 11:15am-11:30am

Birch, Schnell and Clayton (2020) present a multidimensional framework for understanding interspecies variation in states of consciousness. Their framework distinguishes five key dimensions of variation: perceptual richness, evaluative richness, integration at a time, integration across time, and self-consciousness. For them, the framework is useful for constructing a consciousness profile for each species by assessing a given species against each of the five dimensions. They further argue that each species has its own distinctive consciousness profile, such that there is no single scale along which species can be ranked as more or less conscious. In my proposed talk, I will make use of this new influential multidimensional framework for understanding interspecies variation in states of consciousness (Birch, Schnell, Clayton 2020) to analyze the potential augmentative impacts of emerging neurotechnologies on human consciousness profiles. I argue that certain technologies have the potential to influence where an individual human ranks along each of the five different dimensions of conscious. Emerging neurotechnology and other new forms of cognitive enhancements will allow humans to experience more or less perceptual richness, more or less evaluative richness, more or less integration at a time and across time, and more or less self-consciousness. Hence these technologies can augment (or reshape and alter) human consciousness profiles in interesting and worthwhile ways. To support this claim, I will review each of the five dimensions and the existing neurotechnologies that bear on them. To end, I suggest some potential implications of these possibilities, including what philosophical insights we might derive from the implication that the structure of our conscious experiences can be shaped by technology.

Can minimal models help understanding consciousness?

Wanja Wiese (Ruhr University Bochum, Germany)

Concurrent Session: Theories and Models, Sunday June 24th, Classroom 218, 11:15am-11:30am

Should models of consciousness be mechanistic models of particular types of systems (Fahrenfort & van Gaal, 2021)? Such models might provide a complete explanation of consciousness in human beings and other, physiologically similar mammals (Northoff & Lamme, 2020). But they may not provide a good model of consciousness in other animals, such as non-vertebrates (Birch, 2022), let alone artificial systems. More general models, which abstract away from the underlying mechanistic details, may be applicable to a wide range of different conscious systems. However, this raises two questions:, Q1: To what extent are minimal models of consciousness (Metzinger, 2020; Wiese, 2020) genuinely distinct from abstract mechanistic models (Craver & Kaplan, 2020)?, Q2: Can such minimal models of consciousness provide justified explanations?, Using the recently proposed Conscious Turing Machine (CTM) (Blum & Blum, 2021) as an example, I highlight 3 ways in which minimal models of consciousness can differ from abstract mechanistic models and can help explain and understand consciousness (addressing Q1 & Q2). Minimal models ... (1)... may focus on non-causal factors and provide mathematical non-causal explanations. (2)... may focus on non-causal factors and provide non-explanatory understanding. (3)... may focus on necessary (but not sufficient) conditions for consciousness to help clarify some constitutive factors of consciousness. (1): Some minimal models provide mathematical proofs of, e.g. algorithmic properties. For instance, the CTM, which is inspired by global workspace theory, specifies an algorithm that resolves the competition for access to the global workspace; furthermore, (Blum & Blum, 2021, p. 23) show that a chunk's chances of entering the workspace is independent of its location. Although one would need empirical support to justify that the brain implements an algorithm that indeed has this property, the mathematical explanation why the algorithm has these properties is independent of the underlying mechanistic details. (2) A further way in which minimal models like the CTM differ from abstract mechanistic model is that certain details of the computational architecture and the algorithms specified by the model are arbitrary. This shows that the non-arbitrary, invariant features of the algorithm and architecture are robust (if not necessary), because they are compatible with a variety of versions of the CTM. We gain a deeper understanding by learning that some of its properties are not contingent on a particular version of the model. (3): Models that only focus on necessary (but still informative) conditions for consciousness can be regarded as minimal. For instance, the global workspace architecture proposed by the CTM may be necessary, but not sufficient for consciousness (as suggested, e.g. by Graziano et al. 2020). Hence, minimal models can differ from abstract mechanistic models and still make a contribution to understanding consciousness.

Distinct sources of spontaneous activity influencing perceptual sensitivity and criterion

Yuan-hao Wu (NYU Grossman School of Medicine), Ella Podvalny (NYU Grossman School of Medicine), Biyu J. He (NYU Grossman School of Medicine)

Concurrent Session: Neural Correlates of Conscious Vision, Friday June 23rd, Classroom 210, 10:45am-11:00am

Fluctuation in spontaneous brain activity is known to play an important role in shaping conscious perception in humans and animals. Previous studies have shown that human conscious perception of threshold-level stimuli is influenced by prestimulus spontaneous activity across distributed brain networks. Yet, the precise contributions of individual brain areas and networks to perception remain largely elusive. For example, prestimulus spontaneous activity may influence observer's propensity towards having a particular perceptual outcome or may influence observer's discrimination or detection sensitivity. , To address this question, we recorded brain activity in 25 subjects (17 females) using whole-brain 7T fMRI while they performed an object recognition task with a long prestimulus interval. Subjects were instructed to view images of objects presented at individually titrated recognition threshold and report the object category and their recognition experience on each trial. Using the Signal Detection Theory framework applied to the recognition responses, we sought to identify brain regions whose prestimulus spontaneous activity influences observers' perceptual sensitivity and criterion, respectively. To better understand the mechanisms that link prestimulus spontaneous activity and perceptual behavior, we also assessed the relation between prestimulus activity in the identified brain areas and stimulus-evoked responses. We found that recognition criterion was influenced by prestimulus activity distributed across multiple regions: Higher prestimulus activity in the cingulo-opercular salience network resulted in a more liberal criterion, while higher prestimulus activity in the medial prefrontal cortex (mPFC) and occipitotemporal visual areas led to a more conservative criterion. In contrast to criterion, perceptual sensitivity only correlated with prestimulus activity in the mPFC. In addition, high prestimulus mPFC activity resulted in reduced trial-to-trial variability in the stimulus-evoked responses across widely distributed brain regions. In contrast, lower prestimulus activity in the visual network resulted in reduce trial-to-trial variability and enhanced encoding of object category in the evoked responses within visual regions. , In sum, the present work identified the cortical sources of prestimulus activity that exert influences on perceptual sensitivity and criterion during threshold-level object recognition. Moreover, our results revealed how prestimulus activity from these brain regions impacts the trial-to-trial variability and stimulus encoding in evoked responses, providing novel insights into how spontaneous brain activity influences conscious perception in humans. ,

Early and late changes in intracranial EEG activity in tactile conscious perception

Taruna Yadav (Yale School of Medicine), Shweta Majumder (Yale School of Medicine), Tuan Bui (Yale School of Medicine), Kate L. Christison-Lagay (Yale School of Medicine), David Jin, Julia Ding, Noah Freedman, Mariana M. Gusso, Sharif I. Kronemer, Shanae. L. Aerts, Isaac Freedman, Kun Wu, Imran H. Quraishi, Adithya Sivaraju, Eyiyemisi Damisah, Hal Blumenfeld

Concurrent Session: Neural Correlates of Consciousness, Sunday June 24th, Classroom 210, 11:15am-11:30am

Understanding the mechanisms of conscious perception is a major goal of current neuroscience research, with significant headway being made in recent years. Our previous work in the perception of visual and auditory stimuli showed that intracranial EEG (icEEG) power in Not Perceived trials is limited to early sensory areas, while for Perceived trials icEEG activity increased in the sensory areas and widespread cortical association networks. To further investigate whether different sensory modalities share similar patterns of activity, a tactile perceptual threshold task was used with icEEG recordings. In the task, patients were presented with a vibration (40ms) at their perceptual threshold to one of their non-thumb fingers via vibrating tactors in a randomized fashion. The perceptual threshold of each participant was adjusted from trial to trial using a minimized expected entropy staircase method such that the vibration was detected in only ~50% of the trials. No vibration was delivered in 14% of the total trials (blanks). After each trial, participants were asked two questions, i) whether a vibration was felt and ii) which finger was stimulated. Behavioral findings indicate that participants (n=7) perceived a vibration in 53.2% (SEM 5.2%) of vibration-present trials. The false positive rate was 9.5% (SEM 5.2%) for blank trials. When participants reported perception of the stimulus, they correctly indicated its location in 81.6% (SEM 3.4%) of trials; when they reported no perception, finger localization accuracy was 26.5% (SEM 1.6%; chance level 25%). As a proxy for local neural processing, icEEG power in the broadband gamma frequency range (40-115 Hz) was compared for Not Perceived and Perceived trials. During early stimulus processing (<300ms), gamma power increased above baseline in the somatosensory, frontal, and insular cortices in perceived trials. During later processing of perceived stimulus, bilateral gamma power increases were observed in frontal cortices and temporal pole which spread to the frontal and parietal association cortex. These prominent changes outside the somatosensory cortex were not observed in Not Perceived trials. These findings are consistent with our previous results in visual and auditory paradigms, indicating that there are shared mechanisms of conscious perception involving a broad network of cortical regions across sensory modalities.

Ancient origins of the global workspace- are all vertebrates conscious?

Oryan Zacks (Tel Aviv University)

Concurrent Session: Animal and Infant Consciousness, Sunday June 24th, Classroom 220, 10:45am-11:00am

The Global Neuronal Workspace (GNW) theory of consciousness offers an explicit functional architecture that relates phenomenal consciousness to cognitive abilities such as perception, motor control, attention, memory, and evaluation. The theory does not directly address how such an architecture evolved and which animals (if any) can be considered to posses the basic neuronal mechanisms necessary for conscious processing. In this talk I will propose an evolutionary history of the GNW architecture in the vertebrate lineage, focusing on the basic GNW functional architecture that is present in all jawed vertebrates, indicating that jawed fish and all descendant vertebrates should be considered as minimally conscious beings. I will focus on two significant differences in GNW brain structures between basal vertebrates and mammals that have implication for conscious experiencing. First, the fish brain contains two primary sensory processors, the telencephalon for olfactory processing and the midbrain tectum for all other sensory modalities. This suggests that consciousness in these animals is less unified compared to mammals, especially humans, in which all senses are integrated in the cerebral cortex. More importantly, the ancestral global workspace itself is instantiated by the event-memory system that is implemented by the hippocampal homologue. Only in mammals (and perhaps other lineages, such as birds), dedicated structures evolved, and the memory and workspace functions became anatomically and functionally separated. The hippocampus became specialized for faster and more flexible memory encoding, while the neocortex provided additional layers of integration and higher-order representation. These suggestions have implications for our understanding of current and past hippocampal and cortical functions, for the conceptualizations of memory and consciousness and for the elucidation of the evolutionary relations between memory, learning and consciousness.

Simulation-Based Explanation of Intelligent Behaviour in Portia spiders: A Marker of Consciousness?

Daria Zakharova (London School of Economics and Political Science, Department of Philosophy, Logic and Scientific Method)

Concurrent Session: Animal and Infant Consciousness, Sunday June 24th, Classroom 220, 10:30am-10:45am

This paper evaluates the evidence for mental representations in the jumping spiders of the Portia genus. It compares two existing explanations of Portia's sophisticated 'detour' behaviour, one simulation-based (Cross et al. 2020), the other based on embodied cognition (Barrett, 2011). I argue that while Barrett's explanation in partially correct, it does not sufficiently explain the empirical findings, and a minimal simulation capacity can be plausibly postulated. At the same time, Cross et al. underestimate the role the spider's eyes play in guiding its behaviour. They thus posit mental capacities that would, if present, put serious strain on a very small neural processing system. This leaves the account open to significant challenges. I argue that a version of an embodied-cognitive account can accommodate these challenges, without contradicting the claim for mental simulation capacity. I then develop a positive case for positing a capacity for representation which incorporates features of both embodied cognition and computational accounts of intelligence. I agree that the sensorimotor system partially takes over the type of work done by neural processing in other intelligent species. However, the fact that Portia's eyes work by literally scanning the environment, may suggest that it necessarily creates a minimal model of its surroundings. My account leads to the question: does the relevant type of "minimal model" suffice for either (a) understanding of the structure of the environment, or (b) consciousness? Regarding (a), I argue that it does not: this is purely "competence without comprehension", in Dennett's (2017) sense. Regarding (b), I argue that the relevant type of internal modelling may be a marker of consciousness, according to some, relatively controversial background theories. I call this a "weak marker" of consciousness. The paper thus proposes a hybrid explanation of Portia's behaviour that incorporates elements from embodied cognition theory and computational theory of mind, arguing that Portia may have a capacity for mental representation without requiring high-level cognition or "human-level" conscious experiences. References Barrett, L 2011: Beyond the Brain. How Body and Environment Shape Animal and Human , Minds. Princeton: Princeton University Press. Cross, F et al. 2020: Arthropod Intelligence? The Case for Portia. Front. Psychol. 11:568049. Dennett, DC 2017: From bacteria to Bach and back. New York, NY: W. W. Norton.

Propofol induced burst suppression evokes neuronal firing and local field potential traveling waves in the human brain

Veronica M. Zarr (University of Utah), Michael Allee (University of Utah), Tyler Davis (University of Utah), Paul House (University of Utah), Bradley Gregor, University of Arizona; Elliot H. Smith, University of Utah

Concurrent Session: Sleep, Dreaming, Anesthesia, Friday June 23rd, Classroom 204, 11:45am-12:00pm

230 million people each year undergo general anesthesia. Despite substantial work, the spatiotemporal neural dynamics underlying medically induced loss of consciousness (mLOC) remain a mystery. Neural traveling waves are electrical perturbations that propagate across the brain with systematic phase delays. Recent work has characterized traveling wave propagation mechanisms in non-human primates (NHP) during mLOC and showed that they change directions. Prior work has shown the presence of burst suppression firing during mLOC. However, ours is the first study to characterize the spatiotemporal dynamics of traveling waves in human action potential and local field potential (LFP) activity during mLOC. We hypothesized that burst suppression evokes brain oscillations that propagate as traveling waves. We examined direct brain recordings during propofol induced loss of consciousness, from Utah-style microelectrode arrays from two adult patients with intractable epilepsy who were undergoing monitoring for surgical treatment for medically resistant seizures. Upon identification of burst suppression, we then regressed the timing of LFP and neuronal firing against the two spatial dimensions of the microelectrode array. We operationally defined traveling waves as regression models with slopes that significantly differed from zero, assessed via an F-test against a permutation distribution of N spatially shuffled LFP or firing times. We fit these models with both L1 and L2 regularization for both signals, and controlled for false positives with permutation testing. We recorded a total of 96 LFPs and 71 single unit recordings for patient one. Out of 93 total bursts in patient one, traveling waves were identified from 30% of LFPs and from 54% of single unit recordings, using the L1 regularization regression model, respectively. Using the L2 regularization regression model, traveling waves were identified from 52% of LFPs and from 29% of single unit recordings, respectively. We recorded a total of 71 local LFPs and 96 single unit recordings for patient two. Of the channels recorded, traveling waves were identified from 14% of LFPs and from 27% of single unit recordings, using the L1 regularization regression model, respectively. Using the L2 regularization regression model, traveling waves were identified from 25% of LFPs and from 33% of single unit recordings. We therefore showed that neural activity during burst suppression propagated as traveling waves. Our observations suggest that subsequent research into anesthesia burst suppression evoked traveling waves may identify spatiotemporal signatures of traveling waves that can differentiate among consciousness states at the level of local neuronal populations.

Poster Presentations

Opposite effects of observational learning on performance and confidence

David Aguilar-Lleyda (Riken Center for Brain Science), Wojciech Zajkowski (Riken Center for Brain Science), Rei Akaishi (Riken Center for Brain Science)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Choices between alternatives rely upon evaluating their value, with such evaluations being made with different levels of confidence. As we learn the value of the alternatives, we should both become more confident in which option has the highest value, and choose it more. Such relationship among value learning, choices and confidence has been mainly studied when learning follows our own choices. However, much less attention has been given to learning by observing our peers' choices. The present study aimed at investigating the different impact these two types of learning may have on later choices and confidence. In particular, we focused on whether any difference in performance (choices and identification of the highest value alternative) derived from introducing observation would affect confidence. We designed a two-armed bandit task where each trial involved drawing a card from one of two decks. Both decks gave points drawn from Gaussian distributions, with one deck having higher mean reward. At the start of each trial, participants decided between choosing themselves or observing another agent choosing. After some trials, participants made a confidence rating where they simultaneously judged which deck gave higher mean reward and to what extent they were confident in that judgment. In order to modulate engagement in observation, we factorially manipulated two variables across blocks. The first variable was observee experience: in some blocks, participant and observee started choosing at the same time, while in others the observee had already completed 10 trials. Experienced observees were more likely to pick the best alternative, thus characterizing observation as a way to speed up learning. The second variable was the mean reward for both decks, which could be high or low. In low reward blocks, choosing the lower mean reward deck incurred a high risk of receiving negative reward, capturing observation as a way to avoid aversive outcomes. We found more observation choices in low reward blocks, as well as in experienced observee blocks, particularly on early trials. More observation in low reward blocks was associated with more own choices of the best deck, as well as with better judgments on which deck was best. Despite such better performance, absolute confidence in low reward blocks was lower than in high reward blocks. This dissociation could potentially be explained by an agency effect where confidence increases (decreases) when making our own choices (observing), but also by a reward effect where confidence increases (decreases) in the presence of negative (positive) reward. To disentangle these options, we ran a follow-up experiment where high/low reward blocks were dissociated by design from frequent/no observation blocks. There we found independent effects of both reward and agency on confidence. Overall, our results show that factors fostering observational learning may have opposite effects on performance and confidence.

Consciousness is learning: predictive processing systems that learn by binding may perceive themselves as conscious

Vladimir A. Aksyuk (National Institute of Standards and Technology, Gaithersburg, MD 20899, USA)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Predictive processing (PP) is a framework for understanding cortical function as deep generative modeling for sensory data prediction and action control. Here we advance a conceptual proposal that introduces a mechanism for learning new categorical PP causes by binding, enabling fast single-example compositional learning. Generation of new perceptual hypotheses via attributing common hidden causes to sets of PP inferences with persistent and time-correlated prediction errors enables efficient and flexible generalization. We argue that these unpredicted inferences bound by this system are its conscious contents. The categorical PP system learns by adding new causes to directly predict those specific features which are near-simultaneously inferred with prediction errors persisting longer than about 100ms to 500ms. The process implements Bayesian learning of the new categorical causes by decaying their predictions over time unless they are refreshed and fine-tuned by being inferred repeatedly to reduce the prediction errors. Learning by binding is hierarchical: the newly added causes are not predictable and, whenever inferred with a sufficient likelihood and duration, are themselves bound with other coincident unpredicted inferences. The resulting shallow-tree structures of new causes encode all perceptions uniquely distinguishing the present moment. These structures manifest as working memories formed from single perceptual examples and turn into short- and long-term memories retrievable by associative recall. We argue that these bound feature structures are perceived by the system as its conscious contents. These contents are unified yet differentiated, explain timing effects in postdictive perceptual integration, and are consistent with both empirical observations in paradigm cases such as masking and first-person reports of conscious experience. Once bound, features can immediately cross-predict each other via their common cause, allowing both associative recall and modulation of a large variety of previously unconnected perceptions and active-inference actions. These bound features become globally available, a hallmark of the global workspace theory (GWT). Thus, our proposal bridges GWT, PP, and feature binding, which is a central component of the recurrent processing. Please see arXiv:2301.07016 for details, the meta-hard problem, action learning, higher cognitive functions, and categorization following the hard criteria of Doerig, Shurger, Herzog,2021.

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Hierarchical markov blanket consciousness

Mahault Albarracin (Universite du Quebec A Montreal), Maxwell Ramstead (UCL), Karl Friston (UCL)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

The field of consciousness is undergoing a new revival. The field has known several eras of popularity, often stopped when coming into complex if impregnable questions. Recently, researchers and philosophers such as Anil Seth, David Chalmers and Daniel Dennett have reignited the field, and reformulated the main questions of consciousness. While Chalmers focuses on issues of qualia, Seth reformulates the problem in terms of the structure of consciousness. However, to answer these questions, we need to operate under a model of consciousness which can help us deduce the possible answers. Many models have been proposed, such as higher-order theories, global-workspace theories, integrated information theories, and predictive processing theories. Under such headings, there is a proliferation of models but very few attempts to integrate or unify such approaches and none can fully integrate phenomenal and access consciousness, or unify all of these models. , The aim of this paper is to present a minimal unifying model of consciousness that integrates several current proposals based on the variational free-energy principle (FEP). We propose that the current content of consciousness corresponds to the information encoded in this Markov blanket between interoception (the perception of internal bodily states) and exteroception (the perception of external stimuli). This information is encoded on the equivalent of a holographic screen. Policy selection mediates the information which becomes the focus of attention for the individual. The model that we propose is unifying, in that we show how current models of consciousness premised on the FEP fit together in a nontrivial way, and can be derived from some basic principles. Indeed, all the approaches to consciousness carry a specific focus which includes some precisions necessary to carry out a useful map of a specific process. Our approach offers the tools not only to connect each of the models, but also to offer building blocks to retrieve them formally.

Narrative Selfhood and Animals: Identifying Desiderata of a Theory of the Self

Marriah Alcantara (York University)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

In ordinary conversation, we regularly refer to selves – myself, yourself, themselves – to attribute something (e.g. actions, traits, dispositions, beliefs, etc.) to someone. One way that we can understand the self is as a narrative – that the self is constructed by the stories one tells about themselves, and these narratives allow us to persist over time and serve as a mechanism for understanding ourselves. However, narrative theories tend to struggle when we try to expand the views to creatures without language. I diagnose three central issues with expanding accounts of narrative selfhood to animals, and in doing so identifies desiderata for any theory of the self. First, narrative theories tend to hold that an individual must be able to literally tell stories about themselves to engage in self-construction, meaning that all non-linguistic animals would be excluded. Second, narrative views struggle to determine when an animal is acting authentically – if we cannot attribute a self, then it doesn't make sense to say that a particular action is 'out of character' for an individual. But, many human-animal and animal-animal interactions rely on knowing who an individual is, allowing us to notice when something is awry with the animal we are engaging with. Finally, there are at least some animals to whom we would like to attribute actions to – to say they chose the action or were responsible in some sense. While one might think these problems only arise from misguidedly trying to expand the view to animals, I argue that each of these problems also shows up when discussing narrative selfhood in humans. We tend to think that nonverbal adult humans and prelinguistic children have selves, and a view that requires language has difficulty accounting for this intuition. The problems of authenticity and attributability are somewhat different for human selves than for animals who may not have selves on this view, but are related: Much of the utility we get out of having selves and ascribing selves to others is being able to predict our own as well as others' actions. Part of doing this at least for humans involves being able to pick out when a particular action is out of character for an actor. If who you are is constituted by the stories you tell about yourself, then it might seem that you are trivially always 'yourself' in terms of being 'in character.' These considerations might make abandoning narrative theory somewhat attractive, but I will conclude with a different suggestion: any satisfactory theory of narrative selfhood needs to be able to account for non-linguistic selves, (in)authenticity, and the problem of attributability. While certainly not the only desiderata of a theory of the self, paying attention to these three areas offer a way to shape our theory construction.

Reconceptualising creativity: the paradoxical interplay between conscious control and unconscious processing

Dr Stephanie Alcock (University of the Witwatersrand), Dr Aline Ferreira-Correia (University of the Witwatersrand), Prof Kate Cockcroft (University of the Witwatersrand)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Creativity is a defining aspect of the human experience. This ability to generate ideas that are both novel and effective is not only a crucial operator that drives social progress and entrepreneurship but also functions as a vehicle of self-expression and higher-order self-awareness. Given its importance, creativity is understudied in cognitive neuroscience. Consequently, there are diverse understandings of and contradicting empirical findings on its cognitive underpinnings, its relationship to other cognitive functions, such as intelligence, and exterior factors acting on it. This study aimed to develop a novel theoretical model of creativity using structural equation modelling (SEM), empirically investigate its relationship to intelligence and assess the contextual factors that influence its subprocesses using an understudied population cohort in creativity research of elderly participants (n = 125). Results of the structural equation analysis showed that, contrary to traditional conceptualisations, creativity relies on the paradoxical interplay between higher-order, effortful processes characteristic of conscious control, and automatic, associative processes characteristic of unconscious processing. We also observed interesting associative relationships between intelligence and aspects of creativity that are either moderated or mediated by contextual factors, such as socio-economic status and level of education. Our findings call for a new framing and reconceptualisation of traditional theoretical models of creative cognition.

Can patients with Disorders of Consciousness encode and recover new memories? A high-density EEG feasibility study

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

If the last few years have seen an improvement in neuroimaging and electrophysiology techniques, allowing a reduction of misdiagnoses between the different Disorders of Consciousness (DoC), little is known regarding the kind of consciousness that these different states entail: How it is to be in an Unresponsive Wakefulness Syndrome or a Minimally Conscious State? While some studies have looked at DoC patients' residual perception of the environment or emotional processing of information, memory, this essential cognitive function that shapes everyone's waking life, has been largely overlooked. Hence, we sought to develop a robust no-report paradigm to test DoC patients' ability to form and recover perceptual memories in the short and long term. To this aim, we designed a two-day protocol, with an exposure phase on Day 1 (perceptual learning/short-term memory) and a replay phase on Day 2 (long-term perceptual memory), both involving auditory stimulations and high-density EEG recordings. This new protocol was validated on 20 healthy volunteers. In the exposure phase, participants were exposed to continuous acoustic white noise for 150s (total duration: 20 minutes). In these noise sequences, we hid repeating noise-sequences (0.3s noise snippets repeated 10 times every 0.5s). Participants were asked to listen attentively to the sound but were not aware of the presence of these repeated sequences. The repetition of the exact same white noise snippet, even when seemingly embedded in running white noise, has been shown to induce a phenomenon of perceptual learning for those snippets. This perceptual learning was tested the following day in the replay phase, in which participants were presented with isolated sequences of 5s of white noise containing either no repetition (control), repeating noise snippets identical to the learning phase (old items) or repeating noise snippets which were never heard before by participants (new items). First, we found an EEG marker (event related potential, ERP) of the rapid formation of short-term perceptual memories to acoustic noise in the exposure phase. Importantly, since noise snippets are hidden in white noise, there are no perceptual landmark that can explain the emergence of an ERP except through a phenomenon of perceptual learning. Second, we found EEG evidence for the reactivation of long-term perceptual mnesic traces by comparing the cerebral responses between old and new items in the replay phase. We thus obtained reliable cerebral markers of perceptual memory encoding and retrieval that can be looked for in DoC patients and we are implementing our paradigm in clinical settings, in the neuro-intensive care unit. Preliminary results obtained in DoC patients will be presented as well. Beyond the clinical interest of assessing putative memory abilities in patients presenting an impairment of consciousness, this project also addresses the fundamental question of the relationship between memory and consciousness.

A Spike in Entropy Precedes the Mismatch Negativity ERP, Providing A Direct Link Between Computational Prediction Error and Neural Activity Associated with Prediction Error

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Lempel-Ziv complexity (LZC) has been used to reliably distinguish between conscious states using brain imaging data from electroencephalography (EEG). At its information theoretical basis, LZC is an estimator of Shannon's entropy rate, which is a measure of predictability or surprise. Additionally, a corollary of the entropic brain hypothesis is that the unpredictability of neural activity is reflective of the brains inability to predict — and therefore suppress — bottom-up stimuli. This leads to the following conjecture: that an increase in 'richness' of conscious content is at least partly facilitated by a disruption in the prediction updating systems at the sensory level. This conjecture could be tested using the mismatch negativity (MMN) paradigm, which has been used to investigate model updating in the auditory system via an event related potential associated with a mismatch between expectation and stimuli. To our knowledge, research has not attempted to directly relate any measures of entropy to this neural adaptation process. A recently developed algorithm for estimating signal complexity via state space entropy rate (CSER) allows for entropy measurements at a high enough temporal resolution for the analysis of event related EEG data, enabling us to test the hypothesis that prediction error has an associated spike in complexity that is resolved by updating the predictive model. Our analyses reveal a significant spike in entropy occurring 40ms prior to the onset of the MMN, providing a first direct link between computational prediction error and neural activity associated with prediction error. To see if entropy of larger spatial and temporal data segments were associated with characteristics of the MMN, we tested for linear relationships between baseline entropies and changes in MMN amplitude and MMN latency. We found that baseline entropy was widely varied between subjects but stable within subjects across trials. We did not find any significant relationships between subject baseline entropies and subject MMN amplitude or latency, suggesting that baseline entropy is not directly related to this measure of auditory prediction error. The prediction error associated with the MMN has been related to attentional shift, suggesting that the brain uses accurate predictions to prevent sensory stimuli from taking up phenomenological space. The spike in entropy preceding the MMN therefore implies a mechanistic link between entropy and consciousness.

Proactive action control is associated with theta activity in the mid-frontal and right lateral-prefrontal areas

Dariusz Asanowicz (Jagiellonian University), Ilona Kotlewska (Jagiellonian University), Bartłomiej Panek (Jagiellonian University)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Self-control is an ability needed for overcoming our reflexive, impulsive, or habitual conflicting action tendencies. If one wants to strategically prepare for encountering an action conflict, then self-control regulations must be deployed proactively, ahead of time. This EEG study aimed to investigate the neural basis of such proactive adjustments of action control, and their modulatory effects on the online processing of response conflict. In two experiments, participants (N 59) performed the flanker task, in which action conflict stems from simultaneous activation of two competing response programs entailed by target and flanker stimuli. To involve proactive control, trials with response conflict were signaled by predictive cues. The EEG was recorded in both experiments. The following questions were addressed: Does conflict-cueing improve performance? We observed improved behavioral performance in the predictive condition, suggesting that participants proactively utilized the cues to prepare for the upcoming demands. How is conflict processing affected by predictive cueing? Conflict-related modulations of midfrontal N2, theta power, and theta phase synchrony were smaller in the predictive than in the neutral condition. This suggests that proactive control suppressed the impact of incongruent flankers, so that the conflict was reduced, and so was the online control involvement. Is proactive control implemented through pre-activation of online control? Conflict-cueing also increased midfrontal theta power and theta inter-regional connectivity before target onset, suggesting pre-activation of the control processes beforehand. Do proactive and reactive control depend on common or unique processes? Unlike online control, proactive control triggered a burst of theta power in the right hemisphere's dorsal and ventral lateral prefrontal cortices. In other words, the prospective deployment of executive control entailed involvement of two separate sources of frontal theta activity. The results therefore suggest that the two modes of action control rely on partially distinct neural mechanisms.

Does the neurobiology of language mediate LSD-induced changes in higher-order consciousness?

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Introduction, Consciousness can be grossly differentiated into primary, e.g. sensory awareness, and higher-order consciousness, involving self-awareness. A recent review of anecdotal, behavioural, and neurobiological evidence suggests a model by which the neurobiology of language plays a fundamental role in producing and sustaining the ‘self’ and self-awareness (Skipper, 2022). Because psychedelic drugs profoundly affect consciousness and states of self, e. g. through ‘ego dissolution’, they constitute a unique tool to test this model by temporarily ‘lesioning’ selfhood, without eliminating sensory awareness. The model predicts that individual differences in regions of the brain associated with auditory and language processing will be associated with participants’ conscious experience of ego-dissolution. Methods, To test this hypothesis, we employed ‘Spatial Inter-Subject Representational Similarity Analysis’ (SIS-RSA) on a subset of fMRI data obtained from Carhart-Harris et al. (2016). Twelve psychedelic-experienced healthy participants were given 75 micrograms of intravenous LSD and listened to one of two lyricless songs in the scanner (N=6 per song). After listening, participants were asked to rate their subjective experience of ego-dissolution. We constructed intersubject similarity matrices for 260 regions of interest at each timepoint of the musical stimulus (Pearson's R). We also construct a behavioural similarity matrix by calculating the pairwise mean rank of participants' ego-dissolution scores obtained after musical scans. We then calculate its distance from the intersubject similarity matrices of participants' ego dissolution scores at each timepoint (Spearman’s Rho). Significance was determined using 5000 permutations of participants’ behavioural scores, and thresholded at $p<0.01$. Results, Across both musical scans, individual differences in the spatial patterns of activity in the right superior and middle temporal gyri were associated with individual differences in ‘ego dissolution’ scores. There were no other significant results. Discussion, These results show that a set of brain regions involved in language processing, including those more typically associated with semantic processing, predict individual differences in ‘ego dissolution’. This suggests that the self and self-awareness, i.e. higher-order consciousness, is at least partially mediated by the neurobiology of language. Prior empirical and theoretical work has posited that disruption of the ‘default mode network’ as the neurobiological origin of the effects of psychedelics on the ‘ego’. However, it is more parsimonious that the self is a linguistic construct and that a more complete picture likely involves the interaction between ‘default mode’ and regions supporting language processing (Skipper, 2022). This would also account for other phenomenological features of the psychedelic experience, e.g. ‘oneness’ as a result of impairing the categorical nature of language.

Evaluative conditioning under limited cognitive resources: a tDCS study

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Evaluative conditioning (EC) is a phenomenon that describes a change in an object's evaluation due to its repeated pairing with an affective stimulus. Two dominant theoretical accounts have been proposed to explain the mechanisms underlying EC, namely, the associative account and the propositional account. The associative account suggests that EC arises from memory associations between the conditioned stimulus (CS) and the unconditioned stimulus (US). According to the associative account, the repeated pairing of the CS with the US strengthens the association between the two stimuli, leading to an automatic change in the evaluation of the CS. On the other hand, the propositional account posits that EC is the result of the formation of propositions or statements that describe the relationship between the CS and the US. These propositions have truth value and describe the relational qualities of the CS and US, which can then be used to guide behavior. The propositional account suggests that EC may be diminished under limited cognitive resources during learning, as the formation and processing of propositions requires cognitive resources such as working memory and abstract processing. To test this prediction, we applied transcranial direct-current stimulation (tDCS) to the left dorsolateral prefrontal cortex (dlPFC), an area of the brain that has been shown to be involved in reasoning, cognitive control, working memory, and abstract processing. The tDCS application was intended to modulate the activity of the dlPFC, which in turn would affect cognitive resources during EC learning. The study used direct ratings as well as an indirect affective priming task to measure the effect of dlPFC modulation on EC. The results of the study suggest that the dlPFC plays a crucial role in EC, and that the propositional account may be more accurate than the associative account in explaining the underlying mechanisms of EC. Specifically, the study found that tDCS modulation of the dlPFC led to diminished EC effects, as measured by both direct ratings and the affective priming task. These findings suggest that the formation and processing of propositions are indeed crucial for EC, and that cognitive resources such as working memory and abstract processing are necessary for this process.

Brain-stomach biomarkers of psychiatric symptoms, interoceptive awareness and bodily attention.

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Objectives, Psychiatric symptoms are traditionally associated with neurological dysfunction. However, emerging evidence suggests mental health is not only a consequence of dysfunctional brain dynamics, but also arises from neuronal interactions with interoceptive bodily signals. Furthermore, deficits in interoceptive consciousness may have consequences for mental health. The contribution of embodied mechanisms to psychopathology has been demonstrated in broad mental health conditions including anxiety, depression, and ADHD. However, previous research has focused on brain-cardiac and brain-respiratory domains, less is known of the contribution of brain-stomach mechanisms on cognition. We expect individual differences in the gastric network (resting-state network phase-synchronized to the stomach) to demonstrate variations in psychiatric symptoms, interoceptive performance and bodily attention. Research questions, What characterizes brain-stomach fingerprints of interoceptive cognition and psychiatric symptom dimensions? Materials and methods, ~250 participants completed a comprehensive battery of psychiatric symptom and lifestyle inventories, interoceptive performance tasks (i.e. heart rate discrimination task and respiratory resistance task), multidimensional interoceptive experience sampling, as well as resting-state fMRI and physiological recordings (i.e. electrogastrography). First, we conducted exploratory factor analysis on psychiatric inventory responses to identify concrete symptom dimensions. We characterized the gastric network as resting-state regions synchronized to the phase of the gastric rhythm (~0.05 Hz). Finally, we assessed individual differences in the gastric network with variations in psychiatric symptoms, interoceptive performance, as well as awareness and attention to various bodily signals. Results, We found evidence for correlates of brain-stomach patterns with specific psychiatric symptom dimensions, as well as with interoceptive awareness and bodily attention measures. This included distinct brain-stomach profiles for each latent psychiatric and interoceptive performance construct. Conclusion, We present findings of brain-stomach fingerprints of psychopathology, interoceptive awareness and bodily attention. These brain-body fingerprints may be utilised as biomarkers for broad psychiatric and interoceptive dimensions.

UnЯeal? Kinematic responses to deviations from Sense of Reality

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Our consciousness represents to us a facsimile of the environment around us. We typically take this representation at face value and believe it to authentically represent the world. This connection is referred to as "reality" and our evaluation of its authenticity is known as the Sense of Reality. Distortions in Sense of Reality are diagnostic criteria for numerous neuropsychiatric and neurological disorders. In this study, we aim to understand the physiological responses and kinematic characteristics when the Sense of Reality is challenged (i.e. when we experience strange experiences diverging from our typical world experience, consciously or unconsciously). To achieve this, we have created a novel virtual reality paradigm that mimics the phenomenology of hallucinations found in psychedelic, psychotic, and mystical states, and explore their effects on physiology. By methodologically altering various aspects of visual perception in the virtual environment, we can manipulate participants' experiences and analyze their reactions to these “Virtual Hallucinations” through phenomenological responses, kinematic, interoceptive, and neural signals. The study is divided into two parts. In the first part, we determine each participant's Just Noticeable Difference (JND) by a staircase procedure for each virtual hallucination, creating a common scale for comparison. With the JND, we can tailor the experience intensity to each participant, ensuring a similar experience for all despite individual perception differences. In the second part, we compare the subjective effects of different virtual hallucinations based on each participant's threshold sensitivity. The two parts of the study were conducted with a 1-10 days interval and the duration of each part was approximately 2 hours. In one exploratory experiment (N=32) and another ongoing preregistered replication (N=32), we investigated whether movement kinematics during virtual hallucinations can inform us of participants’ subjective experiences. Our results from experiment 1 show that the experience of virtual hallucinations can be decoded from implicit bodily motion kinematics. Our results suggest that experiences of altered reality, such as those found during hallucinations, may manifest in bodily kinematics. This may in turn offer a new implicit measure of the Sense of Reality.

Exploring the neural basis of time perception: an fMRI study on the effects of pause duration in temporal reproduction task

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

The ability to perceive and produce temporal intervals is called time perception. This can be investigated via a temporal reproduction task, where subjects reproduce previously experienced durations. Pause duration (PD) between the target stimulus (standard) and reproduction period affects subject responses. More specifically, as the PD increases across the period from one second to three, the reported duration also increases. In contrast, the reported duration remains quite constant for PDs over three seconds. The process during the first three seconds (transition zone) has been described as the processing stage, while after three seconds has been described as storage (plateau). Our question is whether distinct activation during the first three seconds of the PD compared to after three seconds can be observed via functional magnetic resonance imaging (fMRI). Nine healthy participants (5 females, mean age = 25) underwent an fMRI scan during which they did a visual temporal reproduction task. They were asked to pay attention to the duration of the first stimulus and press the button when they felt that the duration of the second stimulus reached the duration of the former. The stimuli (white disc of 1°) lasted for two seconds and were repeated at either 7° or 18° 40 times each in an interleaved design. The PD was randomized between six and seven seconds. fMRI data were preprocessed with fMRIPrep and analyzed with the FMRIB Software Library. The PD was split into the transition zone (until three seconds) and the plateau (after the three seconds), and used as two contrasts. Transition zone related activity was observed in the following areas: occipital pole and lateral occipital cortex, precuneous cortex, middle and superior frontal gyri, bilateral amygdala, and cerebellum. Activation during the plateau event was seen in the areas: supplementary motor cortex, superior frontal, right postcentral and paracingulate gyri, bilateral insular and opercular cortex, and left thalamus. An additional model showed that the activation related to the transition zone is not the same as in standard duration. Thus, the processes during the pause duration are not the same as in the encoding stage. These preliminary data suggest that activation patterns in the transition zone and plateau are different. The transition zone is associated with visual processing and allows for adjustments of the encoded duration. The plateau process occurs before the response event and is associated with activation in motor areas. The postcentral gyrus and insular cortex are also activated during the plateau and may reflect the further processing of time intervals as a stimulus related to interception.

The social role of sleep, dreams and visions in the Koryak village of Tymlat (Kamchatka, Russian Far East)

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Ethnographic literature has described the central role of dreams in Siberian societies. North Asian shamanic traditions place imagination at the heart of their social organization and relationship to the environment: the shamans, figures of mediators between the visible and the invisible, have developed techniques aimed at stimulating and transmitting culturally determined mental imagery. Dreams and visions are seen as ways of accessing virtual environments, non-human subjectivities, invisible entities (animals, spirits, the deceased, etc.). Daydreaming and mind wandering also enable them to become receptive to uncontrolled imagery. In some societies, these techniques are not limited to "experts": every person is believed to have the ability to experience meaningful dreams for the community. While anthropological studies have been conducted among Siberian populations, there is little recent data regarding their contemporary conceptions of dreams and their sleep practices, or the impact of multiple upheavals (Russian colonization, Christianization, globalization, climate change,…) on these phenomena. Here, we present data collected on a ten-week ethnographic fieldwork in the Koryak village of Tymlat (Kamchatka, Russia) in 2019. Ethnographic participant observation and extensive interviews with the population constitute the methodological framework of this study. We collected a corpus of dream narratives and, through daytime and nighttime observations, were able to document contemporary theories and practices of sleeping and dreaming. We studied local forms of sleep pathologies, especially sleep paralysis with hypnagogic hallucinations, a widespread phenomenon among every generation in the village. We also followed the process of picking and preparing fly-agaric, a mushroom used by the Koryak for its hallucinogenic and medicinal properties, and known to induce vivid dreams and increased creativity. Although this practice has been mentioned since the 18th century, it had previously never been studied extensively. Our data shows that these experiences have an impact on everyday life, especially social relations, local art (songs, dances) and subsistence activities (hunting, fishing…). The phenomenological narratives collected in Tymlat demonstrate that dreams shape local notions of the self, and of the environment: the invisible is conceptualized as a collective space accessible through dreams and visions, in which every person can learn to navigate. Dream-sharing and the interpretation of visions appear as local ways of transmitting collective images, stories and worldviews, and educating younger generations in a context of multiple socio-economic and environmental transformations. By presenting empirical data collected in a specific social, geographical and cultural context, this ethnographic study allows us to better understand the diverse ways in which human societies explore consciousness, and produce knowledge based on dreams and visions.

Neural Representations of Sensory and Numerical Absence

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

An overlooked aspect of human consciousness is a capacity to actively encode the absence of stimulation or sensory input. Intriguingly, sensory absences may in turn ground conceptual absences, such as the notion of zero on a number line. A link between numerical zero and sensory absence is suggested by the fact that in both sensory and numerical domains, representing absence is associated with unique properties, such as increased processing times and delayed developmental trajectories. In addition, graded tuning curves have been observed for both numerical (Nieder, 2016) and phenomenal magnitude (Barnett et al. 2022). How the brain encodes sensory and conceptual absences, and the relationship between them, remains poorly understood. We characterised neural responses to conceptual (symbolic) and sensory (non-symbolic) representations of absence in humans in an MEG experiment. Using cross-decoding techniques we found that a distance effect typical of magnitude codes was found when participants viewed both numerical dot stimuli or Arabic numerals. Importantly, explicit absences (either the absence of dots, or the number zero) were represented within each of these magnitude codes. We also confirmed the existence of notation-independent representations of zero, with cross-decoding between sensory and numerical absences. Moreover, representations of absence were source-localised to parietal and prefrontal regions previously shown to house zero-coding neurons in non-human primates and corvids. The finding that the number zero is incorporated into a mental number line alongside other numerosities mirrors recent single-neuron findings in animal models, and provides a first characterisation of a neural basis for zero representation in humans. Our results lend weight to the hypothesis that sensory absences ground conceptual representations of absence such as the number zero. This approach opens up new possibilities in understanding the neural mechanisms that give rise to the active encoding of the absence of experience – a key property of human conscious awareness.

High-frequency rTMS over right inferior parietal cortex alters sense of agency: an rTMS/EEG study

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Sense of agency (SoA) is the feeling that one's action is the cause of an external sensory event. Earlier neurostimulation and brain-imaging studies suggest that the area broadly identified with right inferior parietal lobe (IPL) or temporo-parietal junction (TPJ) acts as a key comparator of action representations with action outcomes. A positive correspondence of this comparison is linked with increased gamma coupling between inferior parietal-preSMA circuitry. Moreover, excitatory 10 Hz rTMS over this area has been shown to result in increased reporting of own actions as externally manipulated. Effect of 20 Hz rTMS on SoA has not been tested yet, however this frequency reportedly induces gamma band oscillations in the target region. In the present study, we explored the effect of low- and high-frequency rTMS stimulation over right IPL on the sense of agency and the potential role of gamma oscilations in this process. Participants (n=16) completed four visits in which they received a TMS protocol (1 Hz, 10 Hz, 20 Hz, placebo) followed by a simple sensorimotor SoA task and resting-state EEG recording. In the SoA task, participant controlled the movement of a cursor on a screen and indicated by a button whenever they experienced the movement as being externally manipulated by a researcher. Following the 20 Hz rTMS stimulation subjects showed significantly decreased accuracy in the agency reports. This effect drawed most strongly from decrease in successfull rejection of manipulated action outcomes. Besides that, subjects also showed a weak trend to more likely experience self-controlled movements as being externally manipulated.

Studying latent representations of Disorder of Consciousness using VAEs on EEG-to-Marker translations

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Patients with disorder of consciousness (DoC) present a challenge for clinical diagnosis as subjective reports are not possible due to their inability to communicate with the external world. Furthermore, inter-patients and inter-etiologies variability make it hard to capture DoC general properties. Different studies have shown evidence that the brain is a large-scale complex system where collective behavior emerges from nonlinear dynamics of all neuron interactions. This activity self-organizes into a much lower number of states, suggesting that a low-dimensional manifold could explain the diverse states of consciousness. Currently, the DoC diagnosis is obtained using the coma recovery scale - revised (CRS-R) and patients are diagnosed as Unresponsive Wakefulness Syndrome (VS/UWS), Minimally Conscious State (subcategorized into MCS+ and MCS-) and Emergent Minimally Conscious State (EMCS). Such scales are sensitive to subjectivity of the physician and rely on the patient's behavioral responses. Also, electroencephalogram (EEG) protocols are used to compute markers (e.g. connectivity, complexity or spectral) which are derived from predictions of current theories of consciousness, then classic machine learning algorithms are trained to predict the patients' state from those markers. In this work, we propose a novel variational autoencoder (VAE) architecture that we called Variational Translator Encoder (VTE) to obtain a low-dimensional latent representation of the raw EEG data where the decoder learns to reconstruct the previously proposed biomarkers. We tested three encoder architectures (linear, LSTM and CNN) depending on the EEG data representation (time series or time-frequencies). Using such VTE architecture, we are able to first study the dynamics of the markers and the amount of shared and mutual information between them, and second, from the topology of the latent space, we can study the existent synergy in the EEG-to-biomarkers dynamics. Ultimately from the discrepancies between the latent space and the CRS-R diagnosis and the aforementioned study of the latent space topologies we can hint toward miss-diagnosis. Our preliminary results show that encoding from epochs of 800 milliseconds with 64 channels at 100Hz we are able to obtain a 3 dimensional latent space that reconstructs almost all the markers. This latent space separates the DoC categories (VS/UWS, MCS-, MCS+ and EMCS) according to the CRS-R diagnosis even though this information is never given to the model. The obtained gradient in the latent space shows a linearity from VS/UWS to MCS+/EMCS and generalices to separated cohorts of Healthy Controls (HC) and DoC patients from other centers. In order to quantify the latent space properties, we used Random Forest classifiers trained in the original cohort and tested in unseen cohorts. While current classifiers are not coherent regarding unseen classes, using our latent representation, the HC were coherently classified as EMCS.

Ketamine effects on consciousness in healthy controls, an electroencephalography study

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Ketamine is a NMDA receptor antagonist that is used in medicine as an anesthetic agent. When administered at low doses, it can also induce reversible psychotic-like symptoms such as delusional ideas (Krystal & al. 1994). Several studies revealed that conscious access and conscious processing were impaired in schizophrenia (Berkovitch & al. 2017), and other psychiatric conditions with psychotic features (Berkovitch & al. 2021). Therefore, ketamine may trigger psychotomimetic effects through a disruption of conscious access. To explore ketamine effects on consciousness, we intravenously administered ketamine (0.5mg/kg/h) or placebo to 22 healthy volunteers (2 sessions, cross-over, random order) and recorded their brain activity during a perceptual task using electroencephalography. In this task, we manipulated conscious access through bottom-up and top-down parameters. A sound was played and followed after a variable delay by a masked digit. Participants had (1) to identify the sound and/or (2) to compare the digit to 5 and report its visibility (simple or dual task). Sound- digit and digit-mask delays (stimulus onset asynchrony, SOA) parametrically varied to study the interaction between attentional availability (top-down) and visual masking (bottom-up). Under ketamine, participants were less able to consciously perceive the digit (report it as "seen" and correctly compare it to 5). This impairment was maximal in the dual task at the intermediate SOA (50ms): 49.2% of trials were conscious under ketamine vs. 67.9% under placebo ($p<0.001$). Importantly, no impairment was observed at the longest SOA (183ms, $p=0.51$) and in the simple task for the shortest SOA (33ms, $p=0.29$). Participants were faster but had a decreased conscious access for the longest sound- digit delay (500ms) and there was a significant increase of the psychological refractory period under ketamine ($p<0.001$). We observed a modulation of brain activity according to the SOA, the pharmacological condition and the behavioral measures. N2 and P3 both increased as a function of SOAs ($p<0.001$). The N2 component was significantly reduced under ketamine across SOA ($p=0.025$). Interestingly, at SOA 50ms, both P3 and N2 tracked conscious access across the placebo and the ketamine conditions (conscious vs. unconscious: $p=0.004$ for the N2 and $p=0.034$ for the P3). There was also an interaction between conscious access and pharmacological condition only for the N2 component ($p=0.038$). Finally, conscious access numerically decreases as a function of psychotomimetic effects, as assessed by the Clinician-Administered Dissociative States Scale (CADSS), but the correlation did not reach significance ($p=0.2$). Overall, our results suggest that ketamine disrupts conscious access through alterations of both bottom-up and top-down processing, and leads to a reduction of the N2 component. Contrary to what is found in schizophrenia, processing of conscious information (SOA 183ms) is not impaired by ketamine

Decrease in perceptual suppression correlates with increased heart rate

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Neural mechanisms of conscious perception are not only shaped by processing of external stimuli but are also influenced by intrinsic signals arriving from the body, such as cardiac signals. Yet, the physiological mechanism by which cardiac activity affects neural activity and ensuing perception remains poorly understood. We aimed to investigate the causal relationship between cardiac activity, neural activity, and visual perception. To do this, we combined a perceptual suppression task with an autonomic challenge. This allowed us to examine how altered heart rates might influence perceptual suppression. Twenty-nine subjects reported subjective target visibility in a bistable flash suppression task while at rest or while cycling using a desk ergometer at two different resistance levels. ECG and EEG data were collected and correlated with perceptual suppression rates. Cycling resulted in an average heart rate increase of 15% during low resistance cycling and 44% during high resistance cycling. Compared to rest, alpha power (9-13 Hz) was reduced during the cycling challenge. Importantly, we found a significant decrease in perceptual suppression rates during cycling compared to rest, with a 14% decrease during low resistance cycling and a 12% decrease during high resistance cycling. Our findings indicate a relationship between cardiac activity and conscious visual perception. Since cycling did not change perceptual performance in catch trials with physical target removal, this result cannot be attributed to impaired task performance during the cycling condition. Whether these autonomic challenge-induced perceptual effects are caused by changes in general arousal and accompanying changes in neural excitability or can be attributed to the neural processing of cardiac signals remains to be seen.

Investigation of the gamma-range auditory steady-state responses as a biomarker of awareness in disorders of consciousness

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The acurate diagnosis of disorders of concsiounsess (DOC), including unresponsive wakefulness state (UWS) and minimally conscious state (MCS), could be a challenging issue when it is based only on behavioral indices. Approaches based on neuroimaging or measuring electrophysiological brain activity may help to overcome this by providing objective biomarkers of the neurocognitive status of the patient. We present the results of an approach based on measuring EEG responses to auditory stimulation, called auditory steady-state responses (ASSR). ASSRs are oscillatory responses to periodic acoustic stimulation visible in frequency-domain of the EEG signal. These responses, especially around the 40-Hz part of the spectrum (gamma-range), seem to reflect changes in the functional integrity of the thalamocortical system at various levels of awareness. In this study we investigated three protocols of eliciting ASSRs in the group of 71 DOC patients with varying diagnoses (UWS/MCS plus/minus, eMCS) and etiology. The protocols involved constant frequency 40-Hz stimulation (CFS), narrow-band chirp modulated stimulation in the range of 25-55 Hz (NBS), and wide-band chirp modulated stimulation in the range 30-100 Hz (WBS). Chirp modulated auditory stimuli consist a gradual decrease of stimulation frequency over time. Depending on condition each subject received 100-300 stimulus repetitions. Diagnosis of DOC patient was established on the basis of repeated CRS-R administration (5 times per subject within week time, the best obtained diagnosis treated as the final diagnosis). Additionally, the integrity of auditory pathways was screened with otoacoustic emissions and auditory brainstem responses (ABR). ASSR response measure was the averaged intertrial phase clustering / phase-locking index (ITPC/PLI) from the 9 frontocentral channels. In the constant 40-Hz stimulation condition we observed higher ITPC responses in the group of aware patients (with diagnosis of MCS+/- and eMCS) than in the UWS group. Similar effects were also observed in NBS and WBS conditions within the range of stimulation frequency around 40 Hz. The integrity of auditory pathway was an important constraining factor of the observed responses. In patients who obtained negative ABR screening test results (with positive otoacoustic emissions test results), the ITPC scores were markedly decreased across all patient groups, thus influencing group differences. In patients who had positive ABR results, the significantly higher response was observed only for the constant 40-Hz stimulation. Our study demonstrated that ASSR gamma-range responses are sensitive to the DOC diagnosis. The possible reason of that effect is the impaired activity of thalamocortical system indexed by gamma-range responsitivity to auditory stimulation. However this effect constrained by the impaired integrity of the auditory pathways, and one method of testing this integrity is with the use of ABR screening tools.

The effect of guided Bilateral Eye Movements and Changing Visual Input on the detection of gradual changes in emotional faces

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Bilateral Eye Movements (BEM) performed concurrently with subjective reports about ongoing imagery, memory, and recollection of emotional visual material affect their accuracy and vividness. It has been suggested that visual representations are degraded because bilateral eye movements during perception and subjective reports tax working memory capacities and attention. It needs to be clarified, however, if these effects are attributable to the eye movement (BEM), to a change in the viewpoint of the visual input (CVI), or a change in the contents of the display (CVC). This study investigated the effects of three different visual manipulations on a subsequent change detection task. We used a pre-post-treatment design and assigned participants to one of three computer-guided manipulations. One group was asked to follow a moving dot from left to right (BEM); a second group was asked to keep eyes stationary at fixation while the background switched viewpoint from left to right (CVI); and a third group was asked to keep eyes stationary at fixation while the fixation dot changed colour (CVC). All changes happened at a frequency of 1.2Hz, and all treatments lasted for 16 minutes. , Before and after the manipulations, participants saw videos with naturalistic scenes. Either an actor's face morphed from neutral to angry or happy, or an object changed colour (and back). Changes were subtle and restricted to a small part of the display. Participants had to press a button as soon as they detected a change, followed by a confidence rating. Because all manipulations entail changes in either display or content, we hypothesised that change detection and subjective reports would be affected in all three groups. However, because of the added visual and motoric effort of the bilateral Eye Movements, we expected this group to be affected the most, followed by the CVI. Preliminary results from a pilot study suggest that participants in the CVI group became slower in detecting facial changes of anger at the post-test. Moreover, the CVI and the CVC groups showed higher confidence levels and were faster in their confidence decision times at the post-test. These effects were not observed in the BEM group. Final results will be presented, and further analyses will be discussed, particularly the evaluation of the moment of an emotional detection to assess the effects of the manipulations on the specific contents of the detected change,

Representing Relations Perceptually

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Is perception limited to representing basic perceptual qualities and their spatial layout, or can it represent “richer” properties, such as categories and relations? If it can represent richer properties, how does it do so? In debates about perceptual experience and perceptual representation, one important question is whether the world is represented conceptually or non-conceptually. In this talk, I will focus on perception of relations. Relations include simple spatial relations like being to the left of, or being farther away than. They can also extend to more complicated properties like fitting into, chasing, being a part of, or even punching or kicking. There is an intuitive assumption, shared by philosophers and psychologists alike, that the more “abstract” a relation is, the more concepts are required to represent it. On this view, if perception represents relations, then perception employs concepts. I resist this view, and argue for non-conceptual perceptual representation of relations. The intuition that relations must be represented conceptually can be cashed out in terms of two properties: role-filler independence and discreteness. Role filler independence is the property of relations where distinct items can equally instantiate the relation – any two items might instantiate the relation being on top of, in either direction. Discreteness is the idea that there are clear divisions between situations where the relations is represented and ones where it isn’t. Together, these produce the intuition of abstractness – that there is some distinct representation used equally in every case where the relation is represented – and conceptual representations are thought to exhibit this property. I argue that a non-conceptualist can capture these properties. Three ingredients are needed: extended perceptual spaces, space boundaries, and vehicle independence. Extended perceptual spaces capture higher-order covariation between values on lower-level dimensions, and are established in the literature on both categorical perception and motor control. Space boundaries correspond to areas in the space that mark of category distinctions. Both of these aspects are well-established in the categorical perception and motor control literatures. Vehicle independence entails that two objects or properties have distinct representations within an extended space. This accounts for role-filler independence because multiple distinct objects, for instance, may bear the same higher-level relationship to each other in a perceptual or body-posture space. It accounts for discreteness with space boundaries. The finding that there is a ”threshold,” for instance, beyond which two circles are seen as touching or in which one is seen as containing, is easily captured by this view. Hence, perception represents relations, but needn’t do so conceptually.

Inducing Deep Meditation with Focused Ultrasound

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

, If it were possible to reliably induce successful states of mindfulness—more quickly, consistently, or with less effort—the barrier for individuals to reap the many apparent benefits of mindfulness would be effectively lowered. Moreover, mindfulness is a low-risk altered state of consciousness ripe for the study of subjective experience; such a procedure would provide much-needed causal conclusions concerning its neural correlates. We aim to study the possibility of inducing mindfulness via direct neuromodulation of theory-driven brain regions using focused ultrasound (FUS). Specifically, targets include the posterior cingulate cortex, bilateral head of the caudate, and the bilateral insula. FUS is applied to one of these targets (guided using structural MRI, outside the scanner) for 12 minutes to 36 expert (arm 1) and 36 novice (arm 2) meditators participating in a 1-hour meditation. During each session, meditative depth is probed—through self-report—roughly every 4 minutes before, during, and after FUS application. Concurrently, a range of physiological measures are also recorded (heart rate, EMG, respiration, GSR). Moreover, extensive questionnaires are given before and after meditation to assess, along many dimensions, the precise subjective state of individuals during each meditation session (e.g. “how loud or quiet was your internal dialogue?”). This procedure is repeated in 4 counterbalanced sessions per subject—corresponding to 3 target regions and 1 sham condition, such that all results may be compared within subjects between stimulation and sham conditions, revealing any changes in subjectivity specifically induced by neuromodulation of each target region as well as a time course of any induced changes in meditative depth/physiology during the 1-hour meditation. These methods are designed to not-only provide evidence for or against a plausible mechanism for lowering the barrier to achieving successful mindfulness, but also constitute a novel and particularly discriminating battery of measures adapted to study the subjective experience of mindfulness meditation. Specifically, this battery can provide rich online (physiology, reported depth) and offline (high-dimensional subjective report) measures of both body and mind.

Tripsitter or guide? A second-person perspective on psychedelic-assisted therapy

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Tripsitter or guide? A second-person perspective on psychedelic-assisted therapy , Psychedelic-assisted therapy is a new experimental paradigm that yields promising results in the treatment of disorders such as depression and addiction. However, there is still a lot of resistance and skepticism as to whether psychedelic-assisted therapy can ever become regulated and accepted as a standard practice in psychiatry. I will focus here on one aspect that seems to differ in important ways from traditional therapy: the relationship between patient and therapist. According to Gupta et al. (2019), a necessary part of psychiatrists' work is participatory sense-making (Gallagher, 2009): the therapist has an active role in guiding the patient through their own experiences. A central idea behind this suggestion is that this second-person perspective allows the patient and the therapist to meet halfway. Power imbalances between patient and therapist are a known issue in traditional psychotherapy - however, they are exacerbated by the use of psychotropic drugs, inducing powerful changes in conscious experience that render the patient more vulnerable to external influences than in regular therapy. This is not only true for the more obvious cases of ethical misconduct, such as sexual abuse, where the risk is increased with psychedelics but not new; more subtle forms of influence might be specific to this paradigm. Due to the high suggestibility of subjects under the influence of psychedelics, ideas or personal beliefs of someone perceived as a guiding figure can disproportionately influence their interpretation of the external world or their own self-model or life events. For this reason, therapists need to strike a difficult balance between soberly guiding someone through their trip and navigating a second-person interaction, while avoiding putting too much of themselves and their own ideas or interpretations into the therapeutic process. This is a new ethical territory to navigate, and assuming that this risk can be controlled, it might need additional or different ethical guidelines that are not currently considered in traditional therapy.

Is predictive processing involved in priming of visual awareness across the visual field?

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The predictive processing framework suggests that our experience of the visual world is determined by a precision-weighted combination of prior expectations with available sensory data. There is a lot of evidence for the effects of expectation on perception, but few studies have directly investigated the role of precision weighting. Here, we tested whether the influence of priors on awareness of ambiguously rotating spheres could be modulated by sensory precision. In our first experiment we induced priors for rotation direction by presenting an unambiguously rotating sphere, and measured the prior's influence on awareness once the sphere transitioned to ambiguous rotation. Consistent with precision weighting, we found that observers' perception of ambiguous rotation was less biased towards the prime when spheres were presented to peripheral vision, where sensory precision is low, compared to foveal vision. In a second experiment, we aimed to verify that this effect was driven by top-down expectations, by moving spheres between foveal and peripheral locations as they transitioned from unambiguous to ambiguous rotation. However, under these new conditions the effect disappeared, suggesting that contrary to precision-weighting, other factors specific to each visual field location were responsible for the original effect. In a third experiment we replicated the original effect and investigated whether spatial differences in visual motion adaptation might explain it. We indeed found stronger adaptation to visual motion for peripheral compared to fixated stimuli. However, this effect was not predictive of the effect of visual eccentricity on primed awareness, suggesting that a different mechanism must be at work. We consider the implications of these results for predictive processing theories of awareness and propose how future work may isolate the mechanism/s behind this novel effect.

On the neural basis of the sense of agency in a civilian and a military population

Emilie Caspar (Ghent University), Salvatore Lo Bue (Royal Military Academy of Belgium), Antonin Rovai (Université libre de Bruxelles), Xavier de Tiège (Université libre de Bruxelles), Axel Cleeremans - Université libre de Bruxelles

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Previous studies showed that the sense of agency is altered by coercive instructions and in military populations receiving commands on a daily basis. The neural basis of the sense of agency are still not fully revealed yet. One of the major flow is that MRI studies conducted to investigate the neural basis of the sense of agency are conducted in neutral contexts, with actions producing neutral consequences (e.g. a keypress leads to a beep). In this presentation, I will show two MRI studies aiming at investigating the neural basis of the sense of agency in a civilian and in a military population, for which agency can be altered. Participants have to decide freely, or are instructed, to press a button sending a real painful shock to another individual in exchange for €0.05 or not. Compared to previous MRI studies observing activity in the pre-SMA, our socially-relevant paradigm showed that temporal binding rather correlate with activation in the Medial Frontal Gyrus (MFG). Results are discussed regarding the relevance to study the sense of agency in more socially relevant settings.

Active self-touch restores bodily self-awareness altered by the rubber hand illusion

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Bodily self-awareness relies on a constant integration of visual, tactile, proprioceptive, and motor signals. Conflicting visuo-tactile stimuli can induce temporary alterations of self-awareness, as shown by the classical rubber hand illusion (RHI). It remains unclear whether non-visual signals could compensate for visuo-tactile conflict's effects on self-awareness. Here, we used the RHI in combination with a robot-mediated self-touch paradigm to systematically investigate the role of tactile, proprioceptive, and motor signals in protecting and restoring bodily self-awareness. Participants moved the handle of a leader robot with their right hand and simultaneously received corresponding tactile feedback on their left hand from a follower robot. This self-touch stimulation was performed either before or after the induction of a classical RHI. Across three experiments, active self-touch delivered after – but not before– the RHI, significantly mitigated the proprioceptive drift caused by RHI, supporting a restorative role of active self-touch on bodily self-awareness. The effect was not present during involuntary self-touch, where the participants' hand was passively moved, ruling out an effect of proprioception. Unimodal control conditions confirmed that the coordination of both tactile and motor components of self-touch WAS necessary to restore bodily self-awareness. These results suggest that voluntary self-touch can restore an intrinsic representation of the body following visual capture during RHI.

Continuous Organismic Sentience: a Challenge for Artificial Consciousness

Ignacio Cea (Center for Research, Innovation and Creation; Universidad Católica de Temuco, Chile)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

In consciousness studies there is a growing tendency to consider affective experience as a fundamental form of consciousness that arises from interoceptive processes that inform the organism about the changing states of its body's internal milieu in order to maintain homeostasis (Parvizi and Damasio, 2001; Thompson and Varela, 2001; Merker, 2007; Thompson, 2007, 2015, 2022; Barrett and Bliss-Moreau, 2009; Solms, 2013, 2019, 2021a, 2021b; Barrett and Simmons, 2015; Seth and Tsakiris, 2018; Solms and Friston, 2018; Carvalho and Damasio, 2021; Damasio, 2021; Pereira Jr, 2021; Seth, 2021). I call this the "affective-homeostatic view" of consciousness (AHV for short), which is very close to what has recently been called "affect-based theories" of consciousness (Seth and Bayne, 2022). Crucially, if this view is on the right track, a case can be made against the possibility of artificial consciousness. Simply put, if i) consciousness is fundamentally affective (i.e. no consciousness without affect); and ii) affect is inseparable from homeostatic/allostatic regulation in living bodies; then, iii) it would not be possible for a system to instantiate consciousness if it does not possess a living body demanding homeostatic/allostatic regulation, which is exactly the case for standard (super)computers and robots. In others words, if the affective-homeostatic view of consciousness (AHV) is correct, then, subjective, qualitative experience in artificial systems lacking living bodies to regulate would be impossible. However, the AHV still needs further development for this case to be made. In particular, for affect to be the fundamental form of consciousness and inseparable from the regulation of a living body, then some experientially ubiquitous homeostatically-rooted form of affect should be identified and precisely characterized. Hence, to advance in this direction, in the present contribution we ask: 1) is there any form of affective experience that is always present in consciousness? 2) is it related to interoception and homeostasis? and, 3) what are its properties? As a theoretical step forward in addressing these questions, in this paper we analyze in detail Damasio's notion of "primordial feelings", and compare it with my concept of "Continuous Organismic Sentience", which was recently proposed as a theoretical synthesis of Jim Russell's "core affect" and Thomas Fuchs' "vitality" (Cea & Martínez-Pernía 2023). I try to show that Damasio's "primordial feelings" can be subsumed under the notion of "Continuous Organismic Sentience", which provides affirmative answers to questions 1) and 2), and, regarding question 3), a set of thirteen properties divided into ontological, phenomenological and functional categories. These results provide another step forward to achieve a unified concept of a ubiquitous and fundamental, homeostatically-rooted affective layer, that may signify an important challenge for artificial consciousness.

The role of tactile information on metacognitive representations of agency

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

When we intentionally move our body, our brain compares the sensory predictions to the sensory consequences accompanying our actions. Only if these two match, then we feel that we are the agent of our actions. Empirical studies often investigate this sense of agency (SoA) by manipulating primarily visual representations of either the movement or the consequences of that movement on the environment. While most experimental manipulations focus on the visual consequences of movement, tactile information can, and does, also guide our movements by encoding properties of the external world. To investigate the contributions of tactile information to representations of our own movements, we compared the contributions of visuo-tactile and visuo-proprioceptive information. We asked participants to complete two tasks — one where we measured subjective ratings of agency and one where we measured their metacognition of agency when different aspects of the movement displayed (spatial, temporal, tactile) were manipulated. On the first task, participants move their right hand towards one of two targets (circular ridged plates). We tracked the hand movements precisely with movement sensors and we used this information to control a virtual hand moving on a computer screen. We included trials where the visual feedback was manipulated in one of three possible ways. In three conditions, either the timing of the movement, the location of the hand in the virtual space, or the direction of the ridges on the physical plate was incongruent with the real movement or tactile sensation. Participants completed the movement and then rated how much agency they felt they had. With this task, we verified that the novel tactile manipulation employed in our study affected the subjective ratings of agency similar to the temporal and spatial manipulations. That is, the magnitude of the tactile discrepancy was inversely related to agency ratings. On the second task, we integrated the agency task into a metacognitive framework which allowed us to evaluate the role of tactile information on the precision of agency representations, devoid of the confounds and report biases that are intrinsic to the subjective ratings used in the former task. In this metacognitive agency task, participants perform the same movement toward the target two consecutive times. Participants first discriminated in which of the two intervals they felt more control over and then rated their confidence in their own decision. Given the ubiquitous tactile sensation that results from our movements, this study sheds light on a crucial, but neglected aspect of our interaction with the world, whilst maintaining tight experimental control. It also complements the recent work/approach that we and other groups have started to develop, aiming to investigate agency in relation to, and using tools borrowed from metacognition research,

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Cost of changing one’s mind reflects conscious intent in free and instructed selections

Emma Chen (Chapman University), Jake Gavenas (Chapman University), Aaron Schurger (Chapman University), Uri Maoz (Chapman University)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The capacity to manifest conscious intentions is a critical characteristic of morally responsible agents. Thus, neuroscientific findings related to conscious intentions have the potential to contribute to judgments of an agent’s moral and legal culpability (Aharoni et al. 2008). Attempts to study the neural basis of conscious intent, however, have often confounded intentions with other cognitive functions, such as urges to move (Libet, 1983; Lau et al. 2004), thinking or planning (Matsuhashi & Hallett, 2008), decodability of brain activity (Soon et al. 2008), and mere motor preparation (Salvaris & Haggard, 2014). Additionally, previous studies primarily focused on proximal motor decisions, which often carry less relevance to human agency than abstract decisions and may also rely on different neural mechanisms (Maoz et al. 2019). We sought to address these shortcomings by designing a new neuropsychological paradigm that minimizes confounds with other cognitive functions to focus on abstract intentions. If one intends and thereby commits to bringing about an outcome, straying from that commitment—i.e. changing one’s mind—entails an energetic and temporal cost (Ruselaj et al. 2009). Such a cost could be used as a proxy for intention, with greater cost indicative of a more robust intention (Löffler et al. 2020). Here, we index this cost using reaction times. To experimentally produce this type of change-of-mind situation, we had participants complete a variant of a delayed match-to-sample task for abstract decisions. In response to a pre-cue, they formed an intention to select one of two abstract options (blue or green colors) that were mapped onto an action (button press) only during the subsequent go-cue. The go-cue further instructed them to either follow through on their intention (regular trials) or forced them to select a specific color, thereby leading to a congruent or incongruent choice (change-of-mind trials). We further compared instructed and free selections by either instructing the participants which color to select or letting them freely choose, respectively, via the pre-cue. Behavioral analyses revealed that participants showed larger reaction time differences between regular and change-of-mind trials for instructed selections compared to free ones. This finding suggests that intentions generated during instructed selections may be more robust than those generated during free decisions, at least for arbitrary choices. Future analyses aim to correlate reaction time costs to EEG features, which should reflect intentional commitment to a plan of action and ultimately provide information about the neural basis of conscious intentions. By using the cost associated with changing one’s mind to study intentions, our paradigm offers a new avenue for neurocognitive investigations of intentionality that may come to bear on matters of moral and legal significance.

Dissociating the effects of attention and expectation on threshold-level object perception

Brandon Chen (New York University), Biyu J. He (New York University)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Attention and expectation are known to influence perception. Attention is thought to improve an observer's sensitivity in detecting or categorizing a stimulus, whereas expectation is thought to influence an observer's bias in stimulus judgment. There is mixed evidence, however, on the extent to which the effects of expectation and attention are independent or interactive. We collected data from subjects (N=21) performing a threshold-level perception task in which spatial attention and content expectation were orthogonally manipulated. Stimuli consisted of images from four categories (faces, objects, animals, and houses). On each trial, two stimuli were presented equidistant (4 d.v.a from central fixation; 4x4 d.v.a in size) from central fixation along the horizontal meridian. Subjects were probed on one of the images to report image category, their subjective recognition status and confidence in their recognition report. As in prior studies, we operationalized attention as the relevance of the stimulus to the task and expectation as the probability that the stimulus will have a particular content. Attention towards one stimulus location was directed by a pre-stimulus attention cue corresponding with a post-stimulus probe cue with 70% validity. Expectation of the stimulus content was manipulated using stimulus placeholders that predicted (with 70% validity) if the stimulus would be a meaningful image (regardless of category) or a scrambled noise image. We analyzed the subject's recognition reports using signal detection theory and generalized linear regression models. Consistent with prior studies, we found attention predominantly modulated sensitivity (d'). Expectation modulated criterion, but only in unattended trials. Surprisingly, the direction of expectation's effect was opposite to previous reports: when the stimulus was expected to have meaningful content, subjects were more conservative in reporting that they recognized a meaningful stimulus. Further analysis showed that in unattended trials, the subjects' categorization and recognition responses were influenced by the non-probed image. We interpret these effects as reflecting a "bleed-through" effect of the non-probed (originally attended) image in invalidly cued trials. We additionally conducted a control task (N=6), in which attention and expectation were manipulated in separate blocks. Interestingly, when manipulated in isolation, the effects of attention and expectation on perception were similar: both enhanced sensitivity with no effect on criterion. Thus, when expectation is manipulated in isolation, it is likely confounded with attention. These findings reveal subtle yet complex effects of attention and expectation on threshold-level object perception. When manipulated orthogonally and concurrently, attention and expectation interact to influence perceptual recognition. These results add to the evolving story of attention and expectation's influence on conscious perception.

An fMRI replication study using a subjective colour preference task to probe self-related networks

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Self-related brain networks have been mapped to the cortical midline structures through the use of different self-oriented paradigms. Among these paradigms, a design by Johnson and colleagues (2005) used subjective choices (i.e. self-related) based on simple color stimuli to probe for such self-related networks. In this task, participants must report what combination of presented colours they find the most subjectively pleasing, compared to which are objectively most similar (i.e. non-self-related) in the control condition. Using fMRI, Johnson et al. found that anterior (ACC) and posterior cingulate cortex (PCC) activity was higher during subjective decisions than objective ones. Although additional converging evidence supports these specific regions being part of self-related networks, this initial study had low statistical power due to the small sample size. This means that the results may not be reliable, which could preclude the wider use of this task in self research. As such, we aimed to replicate and expand upon this initial study to ensure the validity of the paradigm. To this end, 60 healthy participants were recruited for an fMRI study using an adapted version of Johnson et al.'s paradigm. Data were preprocessed with fMRIPrep and analysed according to a standard GLM approach implemented in the FSL FEAT toolbox. Group statistical maps were generated through permutation testing with FSL Randomise. Resulting maps were thresholded with an FWE-corrected voxel-wise threshold of $p < 0.01$. In line with the original study, self-related responses were identified in the ACC and PCC. Furthermore, we found that the left inferior and orbital frontal cortex also played a role in self-related responses. These results support the validity of the colour preference judgment task as a tool to probe for self-related networks in the brain.

Boosting conscious perception through attention and neuromodulation

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Attention boosts perception of near-threshold stimuli thanks to the influence of fronto-parietal networks over sensory regions. Previous functional Magnetic Resonance studies in our group have demonstrated that phasic alerting and spatial attention improve perception through partially overlapping fronto-parietal regions, including the left Frontal Eye Field (FEF). In the present study, we exploit the power of Transcranial Magnetic Stimulation (TMS) to probe the causal role of the left FEF in the interactions between attention and conscious perception. Participants (N=50) detected near-threshold targets preceded by either auditory cues (to manipulate phasic alerting), or spatially predictive visual cues (to manipulate spatial attention). The behavioral task was performed after theta-burst stimulation to either the left FEF or the vertex (in separate sessions). Results demonstrated the expected attentional effects on reaction times and on the percentage of consciously detected targets (i.e. faster responses and better conscious detection for tone present vs. tone absent trials, and spatially valid vs. invalid trials). Moreover, response criterion was modulated by the stimulated region. TMS over the left FEF (as compared to vertex stimulation) altered response criterion for contralateral targets in the alerting task and for ipsilateral targets in the orienting task. Furthermore, previous studies in our lab have shown that white matter microstructural variability correlates with TMS effects. We hypothesize that TMS effects will correlate with the indexes of microstructural white matter properties of relevant tracts, such as the Superior Longitudinal Fasciculus and the Inferior Fronto-Occipital Fasciculus. Other data-driven approaches are envisioned (such as Tract-Based Spatial Statistics) to explore the role of additional tracts in the correlation between white matter integrity and TMS effects. Positive results would confirm the role of white matter variability in neuromodulation effects in the healthy brain.

Searching for domain-general and domain-specific neural correlates of auditory and visual consciousness - behavioral and ERP findings

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The vast majority of studies investigating neural correlates of consciousness to date come from vision, raising the question of their results' generalizability. Similarly to VAN in visual modality, an Auditory Awareness Negativity (AAN)has been proposed as an NCC in hearing. This component is observed in temporal and parietal electrodes and, similarly to VAN, peaks around 200 ms after stimulus onset. Comparisons of the experimental results between studies reveal at least partial similarities between auditory and visual modalities, such as the presence of both early negativity and late positivity waves. However, there are few studies where both modalities were investigated. We conducted two experiments to investigate the relationship between electrophysiological correlates of visual and auditory awareness. In a visual experiment, a Gabor patch was presented in the center of the visual field. In an auditory experiment, a simple tone was presented binaurally. In both experiments, there were three types of trials: (1) critical (at individual threshold, staircased), (2) control (containing a stimulus presented above the calibrated threshold level) and (3) catch trials (no tone or Gabor patch). After presentation of a given trial participants performed an objective detection task (stimulus present/absent) and rated their subjective perception using the Perceptual Awareness Scale. Results show differences in conscious perception and its neural correlates between modalities. Analyses of sensitivity (d') and the response bias (c) demonstrated that detection task performance in auditory experiments was more accurate with moderate response variance and higher sensitivity. ERPs analysis revealed that the early AAN and VAN components are modality-specific NCCs i.e. both components have different effects on behavior, separate activity topographies as well as appear in different time windows (in the visual experiment VAN appears earlier). On the contrary, LPP includes both modality-dependent and modality-general features. The LPP topography for both auditory and visual experiments contains the general features of the modality (i.e. similar activity in both experiments), while the time window was more modality-specific - LPP in the visual task appears earlier and the time window is wider.

The Dyadic Relationship between Consciousness and Meaning

Joshua Clingo (University of California - Merced)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Phenomenal consciousness is ubiquitous in humans–this indicates that it likely serves a function that exerts evolutionary selection pressure. If so, we should then ask how and in what way the what-it-is-like aspect of consciousness serves a special function that wasn't already available before its emergence. We propose that answering this question is best done by discarding the anthropocentric assumptions held my many theorists. To do so, we examine cellular life and its history, both across evolutionary history and across individual lifetimes. Here we find that the functions of phenomenal consciousness are ubiquitous. Agents distinguish between objects and background, switch attentional focus, create and maintain memories, and reference/self-reference their perceptions, actions, and memories. These functions are found in life at all scales. To fail to perform these functions is to fail to survive and replicate. Following others, we call this process 'basal meaning'. Basal meaning structures the behavior of cells and collections of cells, scaling behavioral complexity as novel arrangements of these increase in size and capability (e.g. senses). This process began with the origin of life and has continued today. Though this story accounts for the functions associated with consciousness (e.g. attention, memory, self and other awareness), it says nothing of the phenomenal aspect of being that accompanies our human-scale consciousness and the felt meaningfulness that it entails. To address this, we examine and compare basal meaning to human meaning. In doing so, we consider how meaning in human life echoes that of cellular life, finding that the functions of each fit neatly along a continuum. Humans and cells pursue meaningful goals in the same way–humans simply navigate a much more complex and diverse state space. This raises the question: given functional isomorphism, is there any reason to suppose that cellular life is devoid of the phenomenal aspect of meaning-making? We examine this question in detail, concluding that phenomenal consciousness likely follows a continuum where what-it-is-like-ness scales and changes with meaning-making. That is, as our goals expand in complexity and scale across space and time, so too does phenomenal consciousness expand–and this holds true for contraction as well, where agents with simple goals have simple phenomenal consciousness. This is not to say that meaning and consciousness are identical but that they form a dyadic relationship that can be explored. If this is true, then studying meaning in experimental ways can also serve to study and better understand phenomenal consciousness.

Inferring metacognition in humans and machines

Clara Colombatto (University College London), Steve Fleming (University College London)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Artificial intelligence is increasingly pervasive in our daily lives. A key challenge is understanding how humans think about machines, and how these attitudes might influence trust and collaboration in human-machine interactions. While we are able to observe and assess machines’ objective performance (e.g. a self-driving car stopping at a red light), assessing their metacognition is equally important (e.g. how sure the car is that it should stop vs. continue). This type of metacognitive inference is especially challenging given that internal states manifest differently for humans vs. machines: for example, when making decisions humans are typically less confident when their performance is low, while algorithms’ confidence may be at ceiling and/or unrelated to their performance. Here we ask how humans form estimates of machines’ metacognition, and which variables might influence these impressions. To investigate these questions, we designed a novel task where participants observed another agent make a series of perceptual choices of varying difficulty (namely, which of two noise patches contained a gabor stimulus with varying opacity) and later reported how confident they thought the observed agent was in that choice. The agent was either another person or a robot, and each participant watched both agents in a randomized order. The observed choice behavior (i.e. accuracy and response time) was based on the actual behavior of one of 20 “counterpart participants” who had previously participated in the experiment. Crucially, the same generative functions determined the choice behavior of both the other person and the robot – such that for each participant, the behavior was equated across these two observed agents, and any differences in inferred confidence were solely due to the human vs. robotic nature of the agent. Inferences of confidence were sensitive to variables such as task difficulty (with higher confidence estimates on easier trials), observed accuracy (with higher confidence estimates when the agent responded accurately), and observed response time (with higher confidence estimates when the agent responded faster). Strikingly, inferred confidence was significantly higher for robots vs. other people, even though their performance was in fact identical. This boost in inferred confidence for machines was strongest at the beginning of the relevant experimental blocks, suggesting that it might originate from a prior belief about how machines work, but may later be attenuated via observation and learning of machines’ behavior. Participants also reported trusting the robot more than the other person, suggesting that inferences of metacognition might support overall character judgments and social impressions, above and beyond performance. Overall, these results are a first step towards characterizing how humans infer metacognition in each other and in machines and begin to uncover the cognitive mechanisms at play in human-machine interactions.

Subjective confidence judgments promote stronger use of prior information than in decisions, even when accounting for differences in processing time

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

According to Bayesian models of decisions and confidence, both our perceptual decisions as well as the sense of confidence that accompanies them are based on the precision-weighted integration of prior information ("priors") and new incoming sensory input ("likelihoods"). It is, however, unclear how optimally priors and likelihoods are really weighted in decisions and confidence, and whether they are used in the same way at these two levels of processing. In a previous experiment, we quantified how priors are used in confidence, compared to their use in decisions. In a gamified dual-decision task, we varied the precision of priors and new sensory evidence to create pairs of conditions that were matched on posterior precision level, but differed on which source of information was more informative. We found that prior information was underweighted in discrimination decisions, but then used to a greater extent in confidence judgments. This was supported by fitting a Bayesian model with a weighting parameter for the prior at both the decision and confidence level. These results can lead to two different interpretations. One possibility is that making explicit confidence judgments leads people to consider prior information that was dismissed in the decision. Alternatively, it is possible that the stronger use of the priors in confidence is due to continued post-decisional evidence accumulation. To arbitrate between these two options, in a second experiment we used the same dual-decision task, but with an added delay before the second decision response. In this way, the time post stimulus-onset of the first-order decision was forced to match the timing of the confidence report in the first experiment. This allowed us to assess whether added evidence accumulation time would change the pattern of results. We found that it did not, and we replicated the findings of the first experiment, suggesting that there is something in the nature of explicit, subjective confidence that leads to stronger use of prior information, compared to decisions.

A pattern completion account of contextual and semantic influences on source (false) memory.

Laura Convertino (UCL), Daniel Bush (UCL), Neil Burgess (UCL)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Rather than being a stable act of perception's replay, memory is fallacious and imperfect, constructive and dynamic, deeply embedded in our present experience. More recently, both philosophical understanding and experimental evidence are revisiting the traditional idea of a series of stored engrams, proving its communalities with functions such as imagining and dreaming. In this context, a growing body of literature challenges the traditional dichotomy between episodic and semantic memory. The study of false memory, and the impossibility to differentiate the conscious phenomenological experience of experienced vs not inferred stimuli, helps to highlight the constructive nature of memory and the interaction between semantic and episodic memory. We used both mathematical models and behavioural tasks to test how possible hippocampus-dependent adaptive neuronal mechanisms might be responsible for these events. In hippocampus research, memory has been studied as the result of neuronal pattern completion via multiple learnt associations. In the first part of this work, we used a modified version of the DRM (Rodiger and McDermott, 1995) task, dependency analysis and an auto-associative Hopfield network model to challenge the traditional separation of episodic and semantic memory. In an online task, 30 healthy participants were asked to encode, recognise and recollect (memory of word pairs within a list) words from sixteen 4-word lists. Words in each list could be semantically related or randomly grouped. Participants were tested with words from the lists and new words, and with 'lure' words semantically related to the lists but not presented at encoding. In our behavioural study, we successfully reproduced the DRM recognition results, using lists of only 4 words, with 70% of false recognition for lures and longer reaction time for false memories ($p<0.01$). In pair recollection, we asked the participant to remember whether different pairs of words belonged to the same list; we found a significant interaction between temporal context (list) and semantic contexts ($p<0.001$). Moreover, retrieval for pairs with lure words (false memory) was not significantly different from retrieval of correct pairs, and confidence ratings did not find any difference between true and false positive responses. Our dependency model and the simulated Hopfield network results succeeded in reproducing our findings, with an auto-associative biologically plausible mechanism based on encoded temporal and semantic associations. These results bring new insights into the shared mechanisms responsible for semantic and episodic memory, their optimal interaction and interference, and the continuous spectrum of declarative memory.

tCFS: A new ‘CFS tracking’ paradigm reveals uniform suppression depth regardless of target complexity or salience

Jacob Coorey (The University of Sydney), David Alais (The University of Sydney), Matthew J. Davidson (The University of Sydney), Randolph Blake (Vanderbilt University)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

When the eyes view separate and incompatible images, the brain suppresses one image and the other is perceived. This interocular suppression can be prolonged by presenting a dynamic stimulus to one eye, resulting in continuous flash suppression (CFS) of the static image. Measuring the time needed for a suppressed image to breakthrough from CFS (bCFS) has been widely used to investigate unconscious processing and has led to controversial claims regarding the scope of visual processing without awareness. Advocates interpret faster bCFS times to salient stimuli as evidence for unconscious high-level processing, while opponents claim differences in low-level stimulus features determine breakthrough times. Here, we address this controversy with a new ‘CFS tracking’ paradigm (tCFS) in which the suppressed image steadily increases in contrast until breakthrough (as in bCFS) but upon a keypress indicating breakthrough its contrast then decreases until suppressed again (at which point it increases again until breakthrough, then decreases again until suppressed, etc). Unlike bCFS, tCFS tracks the cycle of breakthrough and suppression, with the difference between these contrast thresholds providing a measure of CFS suppression depth. Our new tCFS paradigm confirms that: (i) breakthrough thresholds differ across target type (e.g. grating vs face) – as bCFS has shown – but (ii) suppression depth does not vary across target type. Once the breakthrough contrast is reached for a given stimulus (which varies over stimulus category, likely explained by low-level stimulus factors), all stimuli show a strikingly uniform reduction in the corresponding suppression threshold and thus a constant suppression depth. Our finding of uniform suppression depth indicates a single mechanism of CFS suppression, one that likely occurs early in visual processing where it is not modulated by target salience or complexity. Results from our new tCFS method show that variations in breakthrough thresholds alone do not provide sufficient basis for inferring unconscious processing and that corresponding suppression thresholds are required to prevent misleading conclusions being drawn

Exploring the dynamics of conscious experiences in narcolepsy

Arthur LE COZ (Paris Brain Institute), Delphine Oudiette (Paris Brain Institute), Isabelle Arnulf (Sleep Pathology Unit - Pitié Salpêtrière Hospital), Thomas Andrillon (Paris Brain Institute)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

We spend a large proportion of our waking lives not focused on our direct environment or task at hand, a tendency that includes episodes of mind wandering or mind blanking. These phenomena have been linked with the occurrence of sleep-like activity in healthy non-sleep deprived individuals. Could these so-called local sleep intrusions be even more prevalent in patients with hypersomnia who spend much more time at the borderland between wakefulness and sleep? Here we explored the fluctuation of spontaneous conscious experiences in patients with narcolepsy type I (NT1). NT1 patients are characterized by fragmented nights of sleep, rapid transition toward sleep and especially rapid eye movement sleep even during the day and hallucination during waking. We relied on two different sustained attention tasks: an online paradigm and an EEG protocol. In the online experiment, NT1 patients and controls were instructed to detect the presence or absence of faces in Mooney stimuli. These stimuli included upward and inverted faces to manipulate task difficulty. Our goal here was to test if NT1 patients have the tendency to report more faces when none are present than controls (which could be associated with the prevalence of hallucinations in NT1). In the EEG experiment, NT1 patients and controls underwent a Sustained Attention to Response Task (SART). In the SART, participants are presented with sequences of random digits and are instructed to respond to all digits except the digit 3 (go/nogo). The SART allows us to determine the impact of attention on responsiveness and executive controls. We leveraged EEG recordings in this task to detect the occurrence of sleep-like slow waves during the SART. The SART was performed twice by each participant, at the start and end of the day to capture the effect of the time spent awake. Consequently, in both tasks, we sampled subjective experience through random probes to assess participants' mind state (task-focused, mind-wandering (MW) or mind-blanking (MB)), vigilance, or motivation. Preliminary Results : We replicated previously reported levels of MW and MB in both tasks (32.6% and 7.6% respectively, n=30 individuals). In the SART, we observed a tendency in NT1 patients to MB more than controls only at the beginning of the day compared to the afternoon (15.8% vs 7.7% and 2.5% vs 4.2% resp.). We are performing additional analyses, which will be completed by June. We expect to observe more MW in NT1 patients than controls in both tasks. We also expect more sleep-like slow waves in NT1 than controls. Finally, we hypothesize that we will confirm the tendency of NT1 patients to "hallucinate" faces when absent in link with the occurrence of sleep-like slow waves. Consciousness is highly dynamic but inter-individual differences in this dynamic are still poorly understood. By focusing on individuals with hypersomnia, we can explore how the hybrid states between wakefulness and sleep shape the stream of consciousness.

Exploring the dynamics of conscious experiences in narcolepsy

Arthur LE COZ (Paris Brain Institute), Delphine Oudiette (Paris Brain Institute), Isabelle Arnulf (Sleep Pathology Unit - Pitié Salpêtrière Hospital), Thomas Andrillon (Paris Brain Institute)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

We spend a large proportion of our waking lives not focused on our direct environment or task at hand, a tendency that includes episodes of mind wandering or mind blanking. These phenomena have been linked with the occurrence of sleep-like activity in healthy non-sleep deprived individuals. Could these so-called local sleep intrusions be even more prevalent in patients with hypersomnia who spend much more time at the borderland between wakefulness and sleep? Here we explored the fluctuation of spontaneous conscious experiences in patients with narcolepsy type I (NT1). NT1 patients are characterized by fragmented nights of sleep, rapid transition toward sleep and especially rapid eye movement sleep even during the day and hallucination during waking. We relied on two different sustained attention tasks: an online paradigm and an EEG protocol. In the online experiment, NT1 patients and controls were instructed to detect the presence or absence of faces in Mooney stimuli. These stimuli included upward and inverted faces to manipulate task difficulty. Our goal here was to test if NT1 patients have the tendency to report more faces when none are present than controls (which could be associated with the prevalence of hallucinations in NT1). In the EEG experiment, NT1 patients and controls underwent a Sustained Attention to Response Task (SART). In the SART, participants are presented with sequences of random digits and are instructed to respond to all digits except the digit 3 (go/nogo). The SART allows us to determine the impact of attention on responsiveness and executive controls. We leveraged EEG recordings in this task to detect the occurrence of sleep-like slow waves during the SART. The SART was performed twice by each participant, at the start and end of the day to capture the effect of the time spent awake. Consequently, in both tasks, we sampled subjective experience through random probes to assess participants' mind state (task-focused, mind-wandering (MW) or mind-blanking (MB)), vigilance, or motivation. Preliminary Results : We replicated previously reported levels of MW and MB in both tasks (32.6% and 7.6% respectively, n=30 individuals). In the SART, we observed a tendency in NT1 patients to MB more than controls only at the beginning of the day compared to the afternoon (15.8% vs 7.7% and 2.5% vs 4.2% resp.). We are performing additional analyses, which will be completed by June. We expect to observe more MW in NT1 patients than controls in both tasks. We also expect more sleep-like slow waves in NT1 than controls. Finally, we hypothesize that we will confirm the tendency of NT1 patients to “hallucinate” faces when absent in link with the occurrence of sleep-like slow waves. Consciousness is highly dynamic but inter-individual differences in this dynamic are still poorly understood. By focusing on individuals with hypersomnia, we can explore how the hybrid states between wakefulness and sleep shape the stream of consciousness.

Describing different critical points in conscious and unconscious states using TMS-EEG

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The critical brain hypothesis posits that the brain self-organizes to a critical point, or a point when a system is at a phase transition. The hypothesis evolved in part due to the findings of computational benefits, maximization of information processing, in systems poised at one particular critical point called the edge-of-chaos. However, neuroscientific evidence of criticality in the brain uses a different measure of criticality: the presence of scale-free avalanches (bursts of distributed neuronal activity)) which is associated with a different critical point, directed percolation. Recent evidence has suggested a close relationship between conscious state and critical dynamics using both avalanche phenomena and measures of chaos, but it is unclear if both or only one of the two proposed critical points support consciousness. The edge-of-chaos critical point is relevant for consciousness as the maximization of information processing (i.e. complexity) aligns well with current theories of consciousness (Integrated Information Theory and Global Neuronal Workspace). A new measure in the literature has been proposed to evaluate complexity in the brain, called the perturbational complexity index (PCI). PCI quantifies the algorithmic complexity of the EEG response to transcranial magnetic stimulation (TMS-EEG) and suggests that the complexity of the brain’s response is higher during states of consciousness compared to deep sleep, anesthesia, and impaired consciousness following severe brain injuries. We propose that TMS-EEG data can be used to also study scale-free avalanches as the TMS pulse can be used to induce various avalanches in the brain at a defined start time and location. Thus, this perturbational approach could represent an ideal methodology to measure both critical points in conscious and unconscious brains. For this study, we use retrospective TMS-EEG data collected from healthy controls at UCLA and a subset of the original PCI benchmark population collected at UNIMI (NREM sleep, anesthesia, and vegetative state [VS]). The aim of the current study is to compare two measures of criticality across different conscious states and see if scale-free avalanches are present for patients suspected of covert consciousness (diagnosed as unconscious but who were found to have an above-threshold PCI). We predict scale-free avalanches to not be present in some unconscious states, e.g. VS, even when PCI is suggestive of consciousness. Preliminary data from healthy controls (N=13) suggests that while scale-free avalanches are present in the brain response to TMS, they are not consistent with directed percolation criticality. These findings suggest that either the waking brain is closer to a different critical point than previously found or scale-free activity may be supported by a different generative process. Findings from unconscious states will further clarify the relationship between this scale-free activity and conscious state.

Trajectories of consciousness and functional recovery: A longitudinal case series of five brain-injured patients

Beatrice P. De Koninck (University of Montreal), Charlotte Maschke (McGill University), Daphnee Brazeau (University of Montreal), Amelie Apinis-Dehais (Hôpital du Sacré-Coeur de Montréal, CIUSSS du Nord-de-l'Île-de-Montréal Research Center (CRHSCM)), Briand, Marie-Michèle; Arbour, Caroline; Williamson, David; Duclos, Catherine; Bernard, Francis; Blain-Moraes, Stefanie; De Beaumont, Louis

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

After a severe brain injury, many patients remain in an altered state of consciousness with an unclear prognosis. Most longitudinal studies on severe brain injury assess patient functional recovery via a single measure of recovery several months post-injury. Repeated measures can monitor subtle changes in injured brains and their abilities to regain consciousness as early as the subacute stage of injury. Such endeavours are necessary to identify determinants of consciousness recovery and how it translates to long-term functional outcomes. The present case series illustrates trajectories of consciousness and functional recovery in five brain-injured patients based on multimodal measurements from the subacute stage up to 6 months post-injury. This subset of patients was part of a larger intervention-based study in which participants received a five-day 20-minute transcranial alternating current stimulation protocol. Five medically stable adults with brain injuries were recruited at Hôpital Sacré-Coeur de Montréal. Patients were recruited if, upon withdrawal from all continuous sedation, they did not regain responsiveness. Measures of behavioural consciousness [Coma Recovery Scale-Revised (CRS-R)] were acquired over 7 days, and one-week post protocol. Five-minute resting-state HD-EEG recordings were also acquired daily. At 3 and 6 months post-ICU admission, phone assessments were conducted to measure long-term functional recovery using the following tools: Glasgow Outcome Scale-Extended, Disability Rating Scale, Functional Independence Measure and Burden Scale for Family Caregivers. The EEG signal was analyzed using power spectrum analyses as well as their aperiodic component defined by the spectral slope and offset of the power spectral density [1-45 Hz]. Five patients were recruited over a 6-month recruitment period [4 severe traumatic brain injury (sTBI), 1 anoxia; mean age = 32.6, SD = 9.5; 1 female, 4 males]. Four patients showed shifts in power spectrum peaks towards higher frequencies as their CRS-R scores improved. The 1-45 Hz spectral slope showed distinct trends between etiologies when compared to improvements based on CRS-R scores. Behaviorally, the 4 sTBI patients emerged from their disorder of consciousness by the end of the 2-week study period. Long-term functional outcome measurements at 3 and 6-month time points showed linear improvements for all sTBI patients. These initial results demonstrate the relevance of repeated multimodal assessment in subacute brain-damaged patients in the ICU when consciousness levels are fluctuating. Repeated resting-state EEG measures could be key to identifying covert recovery trends and emergent brain dynamic patterns inaccessible with regular behavioural measurements. Such measurements paired with long-term functional recovery may help predict recovery trajectories based on specific endotypes of subacute brain-damaged patients with disorders of consciousness.

Detecting sensory-evoked changes in conscious contents using the perturbational complexity index

Sergio Ponce de Leon (University of California, Merced), Kristina Backer (University of California, Merced), Jeff Yoshimi (University of California, Merced)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The perturbational complexity index (PCI) is a measure of consciousness that was motivated by the integrated information theory's (IIT) claim that consciousness is phenomenologically integrated and differentiated. In brief, PCI can be computed by 1) recording the brain's spatiotemporal response to a transcranial magnetic stimulation (TMS)-induced cortical perturbation using high-density electroencephalography (EEG), and then 2) compressing the resulting activation matrix using the Lempel-Ziv (LZ) complexity algorithm. Although PCI has been shown to discriminate between consciousness and unconsciousness within healthy subjects, as well as across levels of consciousness in brain-injured patients, it's not clear whether PCI can discriminate between conscious contents, or if it can be computed from sensory stimuli (vs. TMS-evoked perturbations). Demonstrating this could lend support to the claim that PCI is a practical proxy for IIT's theoretical measure of consciousness (Phi), which in principle can discriminate between conscious contents. Demonstrating this could also enable opportunities for corroborating differences in subjective experience neurophysiologically, for computing PCI on existing data, and for computing PCI in cases where TMS can't be used. In this preliminary study, we computed LZ complexity and PCI(st), the latest method for computing PCI based on principal component decomposition and state-transition quantification, which is just as accurate as PCI(lz) and can be measured using standard TMS/EEG hardware. For this study, we used an existing EEG dataset where 40 participants reported experiences of meaningful and non-meaningful visual stimuli. Analysis is underway, and the results will be presented at the conference.

The unconscious mins in the predictive brain

George Deane (University of Montreal)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Concepts of the unconscious, repression, and avoidance have played central roles in our understanding of the mind for over a century, being central concepts in psychoanalytic theory and psychotherapeutic practice. On this view, repression and other forms of defence provide for an avoidance of unpleasure or painful experience, driving mental contents outside of awareness into the unconscious. This conceptualisation has been key in various forms of psychotherapeutic practice, but has been almost entirely absent from the increasingly predominant field of computational psychiatry, and concepts from psychoanalysis have not been brought into contemporary cognitive science largely due to difficulty to test them empirically. A much narrower conception of the unconscious features quite prominently in consciousness science, the central question being what kind of processing requires consciousness and what kind of processing can proceed unconsciously, and the role of the (dynamic) unconscious is largely if not completely ignored. In this talk, I argue that predictive processing, particularly the active inference framework, naturally accommodates an expanded view of the unconscious in which unconscious contents drive avoidant mental actions that 'repress' certain contents from awareness. This is a computational reanimation of concept of the unconscious mind and mechanisms of the unconscious such as repression. On this view, repression and other forms of defence provide for an avoidance of unpleasure or painful experience, driving mental contents outside of awareness into the unconscious. The active inference framework provides the computational machinery to formalize the concept of the unconscious and to finally generate means of testing the concept empirically. Drawing on a wealth of computational work in the active inference framework, I propose repression occurs when agents perform mental actions (self-generated actions over attentional states) that attenuate (painful) observations that are likely to shake their confidence in their ability to control outcomes via action - formally articulated as the 'precision' on the action model. These actions, once habitualized, mean that painful observations are ‘held out’ of awareness, but continue to be a source of stress on the system and shape mental contents. I then outline how this mechanism also shapes the contents of consciousness, through biasing the selection of sensory evidence the system incorporates into its posterior predictions. I argue that not only does this conceptualization expand our notion of the unconscious within consciousness science, it also makes the dynamic unconscious a target for empirical investigation. Finally, i touch on implications of this picture for developing a theory of consciousness.

Can thoughts be read from the brain? A defense for Wittgenstein

Xueqian Deng (The Johns Hopkins University School of Medicine)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The idea of brain-reading could be traced all the way back to Richard Caton's observation of the electrical activity of brains in rabbits and monkeys in 1875. Efforts in this light have come to form the field of "brain-computer interface"(Vidal, 1973), and recently significant progress has been made in the field (Anumanchipalli et al. 2019; Willett et al. 2021; Metzger et al. 2022; Chaudhary et al. 2022). While brain-computer interface research has incredible pragmatic implications in areas such as medical care and neuroprosthetics, this paper aims to discuss an epistemic question about brain-computer interface. Namely, could thoughts be read from the brain at all? The stated epistemological problem has been famously remarked by Wittgenstein: "No supposition seems to me more natural than that there is no process in the brain correlated with associating or with thinking; so that it would be impossible to read off thought-processes from brain processes" (Wittgenstein, 1980). However, blinded by recent impressive advances, several philosophers argue for "neuroscience contra Wittgenstein". They argue that modern neuroscientific findings could show that the Wittgensteinian epistemological position on brain-reading is wrong: namely, with advances in neurotechnology, thoughts could be read from the brain (Wenzel, 2022). I will argue such arguments are unwarranted because of a miscommunication between the philosophers and the scientists. Some philosophers take the experiment-based claims in scientific papers as ground truths for their philosophical arguments; in such case, they fail to heed the epistemological position of the enquiry and behavioral details of the experiments. Here is an explication to make clear why Wittgenstein would make such claims. While big titles are on the cover page of scientific journals, the meaningful conclusion from neuroscientific research generally take the following form: neural activities A have correlation with behavioral activities B. If causal manipulations such as lesions or optogenetics have been done, the claims could be extended: neural activities A have a causal relationship with behavioral activities B. Fundamentally, brain-computer interface seeks to establish a relation R between neural activities A and behavioral activities B, which is only intelligible given behavioral activities B. Therefore, such correlation results from neuroscience research could never support an out-of-context general reading, which is necessary for the philosophical possibility of reading thoughts from brain.Thus, it is impossible that we could read our brains like "a book even though there is only ink and paper" (Wenzel 2022). I will expound my arguments in a thorough manner with examples from both philosophy and science in this work.

How do we learn to be accurately confident ?

Pierre Le Denmat (KU Leuven), Tom Verguts (Ghent University), Kobe Desender (KU Leuven)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

When making a decision, individuals usually experience a sense of confidence. According to Bayesian decision theories, confidence reflects the learned probability of making a correct response, given a certain amount of accumulated evidence and response time. Although optimal, independently learning this probability for each point in the evidence X time space would be computationally intractable. We developed and validated a novel model of decision confidence that proposes a low-dimensional approximation of this optimal yet intractable solution. Importantly, this model can be reframed as a single-layer neural network, offering a principled method to explore how humans learn to map incoming data into a sense of confidence that closely resembles their objective probability of being correct. In this work, we describe this new implementation of our model and present novel empirical data investigating the dynamics throughout an experiment of the evidence – confidence mapping.

Do Biological Cells Perceive? Applying Perceptual Information Processing Metrics to Single Cells

Sebastian Dohnany (The Francis Crick Institute), Kelvin Van-Vuuren (The Francis Crick Institute), Pedro A. M. Mediano (Imperial College London), Katie Bentley (The Francis Crick Institute)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Using metrics developed to track perceptual information processing in humans and taking inspiration from frameworks like active inference, we investigate to what extent they can be applied to single biological cells. It is well-known that cells extend a variety of protrusions into their environment, currently thought to help cells explore their environment to guide cell migration in reaction to environmental cues. However, recent studies suggest that they might instead play an active role in enhancing adaptive cell decision-making, as a form of "active perception" due to sensorimotor feedback that, we propose, drives their formation. In other words, the more they protrude, the more they sense and the more they sense, the more they protrude. Here, we extend signatures of sensorimotor feedback established in other systems to detect the relationship between sensory activation and morphological changes of the cell. If they can be shown to be coupled, it would represent an important step in our understanding of how cells interact with their environment. Currently, the hypothesis is tested in biologically realistic computational simulations, whilst in tandem we are developing experiments to apply the framework to real cells once established in the simulations. By unifying the language and measures used to study perception across different biological scales, we hope this work will contribute towards a unified theory of perception.

Assessing the Diagnostic and Prognostic Value of Three-Node Network Motifs in Coma Using General Anesthesia

Kira Dolhan (McGill University), Adrian Owen (Western University), Stefanie Blain-Moraes (McGill University)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Introduction: Network motifs are connection patterns within a network that occur at a greater frequency than in random networks. In our previous work, we demonstrated that three-node motifs calculated from high-density EEG topologically reorganized during loss and recovery of consciousness due to general anesthesia (Duclos et al. 2021). We also conducted a case study on three patients with disorders of consciousness (DOCs) exposed to propofol anesthesia while hd-EEG was recorded, and showed that the topological reorganization of motifs was predictive of recovery of consciousness and favorable DOC outcome (Nadin et al. 2020). In this study, we assessed the diagnostic and prognostic value of three-node motifs on brain-injured coma patients. We hypothesized that the magnitude of motif reconfiguration during withdrawal from anesthesia would have prognostic and diagnostic value for coma. Methods: We recruited 23 coma patients with severe brain injury during the first seven days of admission to the intensive care unit. We collected 128-channel EEG for 10 minutes while patients received a clinically relevant infusion of propofol anesthesia, and for a 10-minute propofol cessation during a routine clinical assessment. Directed functional connectivity was estimated using the directed phase lag index and the frequency, topology and distance of 5 three-node motifs were calculated. Patient diagnosis was assessed using Glasgow Coma Scale (GCS) when patients were off sedation, and prognostic outcome was assessed via Glasgow Outcome Scale Extended-Revised (GOSE) scores measured 6-months post-EEG recording. Reconfiguration of motif topology when patients were on versus off anesthesia was quantified via cosine similarity. Spearman's correlations were conducted between motif cosine similarity and GCS/GOSE scores. Results: Two motifs were significant in coma patients: a motif with long-range chain-like connections ("motif 1") and another with short-range loop-like connections ("motif 7"). Motif 1 weakly reconfigured, shifting from central to frontal dominance during anesthesia cessation ($s = 0.63$), while motif 7 strongly reconfigured from central dominance to a dispersed pattern ($s = 0.29$). The distance between connected nodes in motif 7 decreased during anesthesia withdrawal ($t = 2.37$, $p = 0.027$), but was not significant for motif 1 ($t = 1.75$, $p = .093$). Neither motif 1 nor 7 correlated with GCS ($r_s = .19$, $p = 0.500$ and $r_s = 0.18$, $p = 0.488$, respectively) or GOSE ($r_s = 0.13$, $p = 0.637$ and $r_s = 0.21$, $p = 0.415$, respectively) scores. When binarizing patient outcome into favorable (GOSE > 2) versus unfavourable, the reconfiguration of motifs 1 and 7 did not significantly differ as a function of patient outcome ($t = -0.53$, $p = 0.608$ and $t = -0.80$, $p = 0.434$, respectively). Conclusions: During a clinically relevant cessation of sedation in coma patients, differences in EEG network motif properties are not correlated with prognostic or diagnostic outcomes.

The neuroscience of volition: a newcomer's guide

Tomáš Dominik (Institute for Interdisciplinary Brain and Behavioral Sciences, Chapman University, CA, USA), Alfred Mele (Department of Philosophy, Florida State University, FL, USA), Aaron Schurger (Institute for Interdisciplinary Brain and Behavioral Sciences, Chapman University, CA, USA), Uri Maoz (Institute for Interdisciplinary Brain and Behavioral Sciences, Chapman University, CA, USA)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

You are reading a book in your favorite armchair and, at some point, you reach for a cup of tea. You probably do not pause and ponder why you decided to reach for the cup of tea at that particular moment. However, a series of neural events occurred leading to your action, in a fashion that tells us something important about how the brain produces voluntary movements. In 1965, Kornhuber and Deecke asked participants to spontaneously move at irregular intervals. They found that the movement seems to be preceded by a negative deflection in the averaged EEG signal—the readiness potential (RP). In the 1980s, Benjamin Libet and colleagues explored when in the course of movement preparation, the participants become aware of their intention to move (W). Based on their results, they argued that W emerged only after the RP onset. Many took this to mean that the actions in Libet's experiment were initiated unconsciously. There are many issues with Libet's experiment, and today its results are interpreted much more cautiously. Despite that, Libet's experiment laid the groundwork for a field now termed the neuroscience of volition. Here we aim to comprehensively summarize the history and empirical findings of the neuroscience of volition. From the original set of approximately 2000 publications, we selected over 400 papers and books constituting the core knowledge base of the neuroscience of volition. In doing so, we summarized previous research on delays in conscious experience production that directly inspired Libet's 1980s study. We provide a comprehensive overview of Libet's experiment, including its lesser known but important features, such as trials with movements occurring non-spontaneously. We show that Libet's results were replicated in many follow-up studies. However, we also point to objections to Libet's experiment, such as caveats in his method of obtaining introspective reports, problematic points in his interpretation of the RP, and conceptual issues such as Libet's dualistic assumptions. Additionally, we show that the literature contains many suggestions for overcoming these issues. Advances in the neuroscience of volition naturally go beyond criticism of Libet's experiment. New methods for recording volition-related brain activity were proposed: machine-learning-based EEG and fMRI decoding, frequency-domain EEG methods, intracranial recordings, and many others. Contemporary methodologies study meaningful actions instead of arbitrary ones, explore genuinely spontaneous behavior independent of experimental instructions, or use neuroscientific knowledge to predict which choice the participant makes when presented with various alternatives. We conclude with some of the contemporary open questions in the field. Are intentions discrete states or are they dynamical processes? Is consciousness itself causal in volitional processes? How early can we predict a self-initiated action, and which of its aspects are or are not predictable?

Stream of Consciousness as a Markov Chain

Van den Driessche Charlotte (LSCP ENS-PSL, Paris), Jérôme Sackur (LSCP - EHESS, Paris), Mahiko Konishi (LSCP - ENS-PSL, Paris)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

The dynamical nature of consciousness has long been recognized, from the early Buddhist scriptures to the foundations of modern consciousness research. Indeed, in an oft-quoted passage of his Principles of Psychology (1890), William James notes: “Consciousness then, does not appear to itself chopped up in bits [...]; it flows. A 'river' or a 'stream' are the metaphors by which it is most naturally described. In talking of it hereafter let us call it the stream of thought, of consciousness, or of subjective life.” However, the vast majority of current consciousness research studies the phenomenon of consciousness as a series of conscious moments or snapshots. Indeed, observing the dynamics of this private phenomenon is a challenge. While the meandering and spontaneous nature of thought has been argued to be central to definitions of stream of thoughts (Christoff et al. 2016; Zanesco, 2020) only a handful of studies have directly characterised dynamic patterns in self-reported ratings of attentional focus or mind wandering with methods that can account for the temporal ordering of probe reports over time. One interesting approach is to employ Markov-chain modelling. A Markov chain is a stochastic model describing a sequence of possible events in which the probability of each state depends only on the previous one (Gagniuc, 2017). In this study, we ask whether the sequence of mental states can be described as a Markov chain, or whether simpler models (where the probability of each state is independent of the previous ones) are sufficient. We engaged participants in a visual metronome task, with random thought probes (30~90 seconds). At each probe, participants had to verbally report the complete sequence of thoughts that they experienced since the previous probe – a task that differs from the standard thought probing method, where participants are instructed to report their very last thought before the probe. Five external raters applied a classification of the mental states in five tiers (Focus, Distraction, Mind-Wandering, Task Related Interference, Blank, (Van den Driessche et al. 2017, Van den Driessche et al. in prep) so as to obtain a sequence of states for each report. We then used simulations to fit our data to models and found that stochastic models of order 1 (Markov chains) better accounted for the sequence of reported mental states. We discuss the limitation of our conclusions, notably with respect to the reliability of our access to inner states.

When the philosophical zombie smiles at you – Believing a face to be computer-generated affects perception and emotional processing

Anna Eiserbeck (Humboldt-Universität zu Berlin), Martin Maier (Humboldt-Universität zu Berlin), Julia Baum (Humboldt-Universität zu Berlin), Rasha Abdel Rahman (Humboldt-Universität zu Berlin)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Advances in technology have recently led to the rise of high-quality computer-generated portraits of people who do not exist in real life, often indistinguishable from photographs of existing people by the naked eye. These "fake" faces can display emotional expressions just like real faces. Yet, similar to the idea of a philosophical zombie, the depicted behavior does not originate from a conscious mind and is not connected to actual emotional experience. Does the belief about whether a depicted person is real or computer-generated affect how we process their emotional expression? In the present EEG study, participants viewed faces showing different expressions (neutral, angry, happy) after receiving information about the respective face being real or (allegedly) fake. When marked as fake, smiling faces appeared less positive, as reflected in valence ratings and early brain activity related to visual perception (P1 and N170 component), were emotionally less arousing (indicated by a reduced early posterior negativity [EPN] effect), and were evaluated more slowly and effortfully (late positive potential [LPP]). None of these modulations were observed for negative expressions. These findings demonstrate that smiles, but not angry expressions, of presumed fake faces dampen perceptual, emotional, and evaluative face processing. Overall, the results indicate that – given the same visual input – beliefs about the existence or nonexistence of a person (as a conscious agent) can influence our perceptual and emotional experience.

Artificial Consciousness and Chatbots

Aïda Elamrani (Institut Jean Nicod - ENS-PSL)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

In a famous paper, in 1980, John Searle introduced a distinction between weak and strong artificial intelligence (A.I.). He argued computer programs would always lack natural understanding. To support his claim, he designed the Chinese room thought experiment which is now a classic. Since then, much progress has been made to understand minds, brains and programs. Currently, the predominant approach in the scientific community to tackle the (easy) problem of consciousness is to regard the brain as a natural information processing device (e.g. Baars, Seth, Tononi, Graziano, Dehaene, …). Meanwhile, state-of-the-art artificial information processing devices achieve impressive performance in several domains, and strikingly in the field of conversational agents (LaMDA, ChatGTP, …). First, I show why and how Searle’s arguments, although still very relevant, are outdated. I build an updated account of the Chinese Room thought experiment in light of the past 30 years of scientific progress. This leads me to argue the weak vs. strong goals Searle set for AI need to be extended to artificial consciousness (A.C.): weak A.C. relates to the functional aspects of consciousness, while strong A.C. relates to the phenomenal aspects of consciousness - which I illustrate by the special case of chatbots.

Think twice: Re-assessing confidence improves metacognitive sensitivity

Patxi Elosegi (Basque center on Cognition Brain and Language, Donostia, Spain), Dobromir Rahnev (School of Psychology, Georgia Institute of Technology, Atlanta, GA, USA), David Soto (Basque center on Cognition Brain and Language, Donostia, Spain)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Metacognition is a fundamental feature of human behaviour but, currently, we lack protocols to improve it. Finding such protocols would improve our understanding of the mechanisms supporting metacognition. Here, we introduce a two-step confidence choice paradigm to test whether metacognitive performance may improve by asking subjects to reassess their initial confidence estimates. Previous work on perceptual and mnemonic decision-making has shown that type-1 sensitivity benefits from reassessing the primary choice (McLean, Ouyang, & Ditterich, 2020; Parks and Yonelinas, 2009), however, it is not clear whether such an effect occurs for type-2 confidence choices as well. To test this hypothesis, we ran two separate online experiments in which participants completed a type-1 task followed by two consecutive confidence choices. Under these circumstances, the second confidence choice can be regarded as a discrimination task in which observers can only improve or worsen their initial confidence estimates, hence allowing the computation of second-step meta-d' on top of the first-step meta-d'. The results showed that observers' metacognitive sensitivity in the second step was higher than in the first-step, and overall well above chance. That is, metacognitive sensitivity improved after re-examination. This was further confirmed by two additional observations. First, we found that averaging the first and second confidence responses yielded better metacognitive sensitivity than considering the first confidence judgement alone. Additionally, we also observed that type-1 sensitivity was better when participants increased their confidence in the second choice, compared to when they decreased their confidence. These results indicate that metacognitive noise may be filtered out by additional post-decisional processing, thereby improving metacognitive sensitivity. We discuss the ramifications of these findings for models of metacognition and for developing protocols to train and manipulate metacognitive processes. McLean, C. S. Ouyang, B. & Ditterich, J. (2020). Second guessing in perceptual decision-making. Journal of Neuroscience, 40(26), 5078-5089. Parks, C. M. & Yonelinas, A. P. (2009). Evidence for a memory threshold in second-choice recognition memory responses. Proceedings of the National Academy of Sciences, 106(28), 11515-11519,

Predictability of haptic feedback affects awareness of intentions and actions: evidence from the Libet clock

George Evangelou (Goldsmiths, University of London), James Moore (Goldsmiths, University of London)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Our conscious intentions to act typically feel internally generated. However, it has also been argued that external sensory feedback related to the action can modulate our intentions. Indeed, previous research has shown judgements of intention are drawn toward delays in the apparent time of action, suggesting intentions might be inferred retrospectively. Here we address a similar question in two novel ways. First, we modulate haptic feedback, a sensory modality that has been little studied in the context of volition research. Second, we examine the impact of predictability of this sensory feedback on intentions. In the current study, we use the Libet clock method to examine the effect of haptic feedback and its predictability on intention awareness. Participants made a button press movement using a touchless system with mid-air haptics. We manipulated feedback in three conditions so that they either received a) haptic feedback, b) no haptic feedback, or c) randomised haptic feedback. Using the Libet clock task, participants reported either the time they experienced the intention to act (W) or the actual time they made the button press movement (M). To examine whether the effect of feedback differs as per its predictability, the randomised condition was split by feedback for the analysis. Results showed a main effect of predictability on W judgements such that they were reported as closer to the action when feedback was unpredictable compared to predictable. With M judgements on the other hand, there was a significant interaction, showing a difference in the predictable conditions such that they were reported after the actual action with haptics and before without. Furthermore, M judgements were generally reported after action when feedback was unpredictable. These findings suggest that conscious intentions are formulated earlier when feedback for actions is predictable. On the other hand, motor awareness is earlier when there is no external action feedback expected, perhaps suggesting that motor awareness in these instances is tied more to preparatory motor signals.

Neuropsychological profiles of top-down modulation of conscious experiences in hypnosis

Afik Faerman (Stanford University), David Spiegel ()

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

The capacity to experience perceptual, cognitive, emotional, and behavioral phenomena and alterations in agency following verbal suggestions in hypnosis (i.e. hypnotizability) likely represents a set of inherent cognitive processes. Recent findings link hypnotizability with executive functions and information processing, supported by neuroimaging evidence of network connectivity and activation profiles of specific structures. Investigating the neurocognitive mechanisms of individual differences in the ability to use top-down modulation of conscious experience can help us understand how conscious experiences are constructed and identify points of intervention to form and test relevant hypotheses. Using a neuropsychological approach, we review and integrate current evidence to provide a framework of neurocognitive profiles across the spectrum of hypnotizability. First, we identify methodological limitations, highlight inconsistent findings, and acknowledge risks of bias. We then present profile differences between individuals with high and low hypnotizability, including simple attention, varying cognitive burden from increasing task complexity and time constraints, and aspects of executive functioning such as cognitive flexibility and some forms of inhibition. We discuss theoretical implications, clinical considerations, limitations of the current literature, and proposed directions for further research.

Toward the Systematic Study of Attribution of Consciousness to Artificial Conversational Agents

Juan Carlos Farah (École Polytechnique Fédérale de Lausanne), Pedro A. M. Mediano (Imperial College London), Enrico Amico (École Polytechnique Fédérale de Lausanne), Denis Gillet (École Polytechnique Fédérale de Lausanne)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

As robots and intelligent systems become more commonplace, understanding the nature and effect of their interactions with human beings is of paramount importance. A crucial part of this challenge is studying how and why humans tend to attribute human-like consciousness to intelligent agents. While a few neuroimaging studies have investigated how human beings interact with artificial conversational agents (Chaminade et al. 2012; Özdem et al. 2017; Rauchbauer et al. 2019), the experimental setups, artificial agents, types of interactions, and analysis methods used in these studies vary widely. In this work, we propose a new experimental design to systematically study how humans attribute consciousness to artificial conversational agents—as well as the neural correlates underpinning this attribution—using methods from computational social science, social neuroscience, and information theory. Our work builds on a framework for designing and implementing task-oriented conversational agents (Farah et al. 2022; Farah et al. 2023), allowing researchers to control the different social cues (e.g. eye movement, photorealism, small talk) often harnessed by conversational agents, as classified by Feine et al. (2019). We use this framework to design an experimental approach compatible with neuroimaging acquisition methods in order to produce data that can shed light on the mechanisms through which consciousness attribution could be mediated. Our results could serve to inform the design of artificial agents, help define the ethical implications of the deployment of more human-like agents, and better understand how human-agent interactions change when artificial agents exhibit human-like social competencies.

Reaching for ourselves: Decoupling movement and touch to explore the adaptability of self-touch

Anne Felsenheimer (Max Planck School of Cognition, Max Planck Institut for Human Cognitive and Brain Sciences , Leipzig, Germany), Antonio Cataldo (Institute of Cognitive Neuroscience, University College London, Alexandra House 17 Queen Square, London, WC1N 3AZ, UK), Barnabás Béres (Institute of Cognitive Neuroscience, University College London, Alexandra House 17 Queen Square, London, WC1N 3AZ, UK), Patrick Haggard (Institute of Cognitive Neuroscience, University College London, Alexandra House 17 Queen Square, London, WC1N 3AZ, UK)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

When we touch our arm with our finger, movements and touch sensations merge on our body, creating a congruent multisensory perception that may play a fundamental role self-consciousness. Body shape and muscle strength can change, so even simple actions self-touch actions may require adaptation in our sensory and motor responses. While visuomotor adaptation has been extensively studied, the processes of sensorimotor adaptation in self-touch remains relatively unexplored. In this study, two interconnected robots were used to elicit a self-touch-like sensation. Participants moved one robot with their right hand, resulting in a corresponding touch on their left forearm. Initially, the length of touch was matched to the movement that caused it (baseline). Participants then performed trials where their movements were either shorter or longer than the touch thereby caused (adaptation), followed by another phase where movements were equal to tactile sensations (post-adaptation). Participants judged the length of either the movement or the touch, and then received feedback on the correct spatial extent of the stimulus. In everyday self-touch, movement and touch sensations are inherently interconnected. In this study, we aimed to explore the time course of adaptation, possible after-effects in each domain, and the impact of visual feedback. By decoupling touch and movement, we were able to implement implicit sensorimotor adaptation of touch or of movement respectively, within a single experimental design. The results are taken as evidence for the integration of sensory and motor signals, and for the adaptability of this integration in creating a coherent conscious experience of a bodily self.

Decoding facial information without awareness under dis-continuous flash suppression

Yen-Ju Feng (National Taiwan University), Po-Jang Hsieh (National Taiwan University)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Abstract, Whether facial information can be accessed without awareness remains controversial from a neurophysiological perspective, likely due to non-optimal parameters used in previous paradigms. Three improvements were made in this study to explore optimal measurements for unconscious processing of facial information. First, dis-continuous flashing suppression (dCFS) allowing for longer suppression duration was applied. Second, in addition to univariate analysis, multivoxel pattern analysis was used to determine whether face-driven activations were present in both lower and higher visual areas. Lastly, to meet ecological validity as well as to increase the signal-to-noise ratio of the stimuli, we utilized dynamic video clips in addition to commonly used static images. With these improvements, two neuroimaging (fMRI) experiments were conducted: Exp. 1 using faces and objects as stimuli while Exp. 2 using faces and scenes. In Exp. 1, we demonstrated that conscious faces elicited more widespread univariate activations than conscious objects, whereas no differential activation was found when stimuli (faces/objects) were suppressed as invisible. Multivariate classification coupled with ROI analysis showed that dynamic invisible faces can be successfully distinguished from dynamic invisible objects in occipital-temporal regions (left CAL, right MOG, and bilateral FFA), suggesting that interocularly suppressed faces/objects are still processed and decodable without awareness. Similarly, in Exp. 2, conscious faces also elicited more widespread univariate activations than conscious scenes. Multivariate classification coupled with searchlight algorithm showed that static faces can be differentiated from static scenes in the conscious condition in right CAL and right SMA, and that dynamic faces can be differentiated from dynamic scenes in left MOG, right CAL, right IFGtriangle, right PreCUN, and right SMA. While collapsing static and dynamic trials, conscious faces can be differentiated from conscious scenes in right FFA and right STG. With regard to the unconscious condition, we found that the right CAL can differentiate suppressed static faces from suppressed static scenes. In additional, several regions including the left LING, left PCL, right STG and right MCC can differentiate suppressed dynamic faces from suppressed dynamic scenes. Finally, while collapsing static and dynamic trials, we found that left LING can differentiate suppressed faces from suppressed scenes. Overall, in both experiments we demonstrated that conscious faces elicited more widespread univariate activations than conscious objects or scenes, whereas no differential activation was found when stimuli (faces/objects and faces/scenes) were suppressed as invisible. A finer-grain analysis, however, enabled the decoding of visual cortex and face-related areas even in an unconscious state, indicating that facial information could be processed without awareness.

Testing Global Neuronal Workspace and Integrated Information Theory with Magnetoencephalography: Analyzing Activation and Synchronization in the Brain

Oscar Ferrante (University of Birmingham, Birmingham, United Kingdom), Ling Liu (Peking University, Beijing, China), Huan Luo (Peking University, Beijing, China), Ole Jensen (University of Birmingham, Birmingham, United Kingdom), Cogitate Consortium

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Understanding the mechanisms in the human brain supporting consciousness is a fundamental question in neuroscience. Several competing theories have been proposed to explain how a conscious experience emerges from neuronal activity. To accelerate research on consciousness, the predictions of these theories should be tested using a common experimental framework. This is the aim of COGITATE, an adversarial collaboration testing predictions from Global Neuronal Workspace (GNW) and Integrated Information Theory (IIT). Here, we present the magnetoencephalography (MEG) results of one of the experiments. During the experiment, participants were presented with visual stimuli that were undoubtedly consciously perceived, while also manipulating their task-relevance and duration. Specifically, we tested predictions proposed by the two theories regarding activation and inter-regional connectivity measured by phase-synchronization. GNW predicts a phasic activation in prefrontal cortex (PFC) at both stimulus onset and offset for task-irrelevant stimuli, while IIT predicts content-specific sustained activation in posterior cortex when task-irrelevant stimuli are presented. Additionally, GNW predicts stronger content-specific synchronization between PFC and category-selective areas in the “ignition” time window, whereas IIT predicts sustained synchronization between early visual cortex (V1/V2) and category-selective areas. The results of the time-frequency representations of power and phase-synchronization in gamma band activity will be presented. The integration of our results with other neuroscientific techniques and testing additional theoretical predictions will provide more conclusive evidence supporting or refuting the two theories and will help clarify how consciousness arises in the human brain.

The Influence of Feature-Based Attention and Response Requirements on ERP Correlates of Auditory Awareness

Dmitri Filimonov (University of Turku)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

In search for the neural correlates of consciousness (NCCs), it is important to isolate the true NCCs from their prerequisites, consequences, and co-occurring processes. To date, little is known about how attention affects the event-related potential (ERP) correlates of auditory awareness and there is contradictory evidence on whether one of them, the late positivity (LP), is affected by response requirements. By implementing a GO-NOGO design we controlled for feature-based attention and response requirements in the same experiment. The results show a prolonged auditory awareness negativity (AAN) for aware trials, which was influenced neither by attention, nor by response requirement. The LP was affected by both attention and response requirement. Consistent with the levels of processing hypothesis, the LP was related to consciousness as a correlate of the processing of higher-level stimulus features, likely requiring access to a "global workspace". Our findings further suggest that AAN is an ERP correlate of auditory consciousness proper and thus a true NCC in the auditory modality.

What drives intersubject correlation during passive listening?

Emilia Flo (Paris Brain Institute), Alvaro Cabana (CIBPsi - UdelaR), Juan Valle-Lisboa (CIBPsi - UdelaR), Damian Cruse (School of Psychology - University of Birmingham), Jacobo Sitt

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

When participants are exposed to common narrative stimuli, physiological signals such as pupil size, heart rate, and brain activity synchronize across subjects. Attended stimuli elicit higher intersubject correlation (ISC) suggesting that the source of covariation in brain and bodily signals arises from similar processing of sensory information. Passive listening to narrative stimuli allows probing of the brain in a naturalistic way and can be used with individuals for which following instructions or providing overt responses are not possible. In this line, it has been shown that non-communicative patients exposed to narrative stimuli can present brain activity patterns correlated to healthy controls. Understanding which are the speech properties that elicit these common brain responses is crucial to determine whether ISC can be used to infer awareness. In this work, we aim at disentangling which are the speech representations that drive the ISC seen in EEG recordings. 27 subjects passively listened to 16 minutes of an audiobook while EEG activity was recorded. ISC was obtained using correlated component analysis and the component showing the highest correlation was studied. Encoding models for speech features (envelope (E), spectrogram (S), word onset (WO), and word unpredictability (WU)) were built by fitting temporal response functions (TRF) using linear regression for each subject and feature, with a leave-one-out nested cross-validation procedure for hyper parametrization. Individual significance of the ISC and the prediction accuracy of the TRF models were assessed with circular shuffle statistics. Predicted responses were subtracted from the EEG and, ISC and TRFs were recomputed on the residuals. TRFs obtained for acoustic features resulted in higher predicted accuracy values than higher-level representations ($E=0.043\pm0.017$; $S=0.044\pm0.018$; $WO=0.0280\pm0.012$; $WU=0.029\pm0.012$, $F(3,78)=49.47$, $p<0.001$). Preliminary results show a correlation between ISC and the predicted accuracy of the TRFs. The correlation was stronger for TRFs for word onset ($r=0.81$, $p<0.001$) and word unpredictability ($r=0.81$, $p<0.001$) in comparison to the envelope ($r=0.64$, $p<0.001$) and the spectrogram ($r=0.46$, $p<0.001$). When the predicted responses for each feature were removed the ISC significantly diminished, and the decline was greater for acoustic features (diffE=3.7e-3 diffS=4.1e-3 diffWU=2.7e-3 diffWO=2.6e-3, $F(4,64)=60.09$, $p<0.001$). After the removal of acoustic features, ISC was still significant for all subjects and was significantly correlated with the predicted accuracy obtained for WU ($r=0.59$,$p=0.001$) and WO ($r=0.60$,$p<0.001$) TRFs. The subtraction of all TRF' EEG predictions did not abolish ISC. Overall, our results suggest that ISC arises from the integration of multiple levels of information present in speech. Future work refining the semantic representation used and how attention affects the weight of this feature on the ISC will be conducted.

Replicating the unconscious working memory effect: A multisite preregistered study.

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

One of the biggest challenges in modern science is disentangling the mechanisms of consciousness. In recent years, an especially provocative assertion states that working memory (WM) can operate unconsciously, namely, for items reported as unseen. In its first formulations, WM was assumed to operate consciously, but with Soto et al. (2011)'s work this issue began to be empirically tested. Soto et al. (2011) devised a simple discrimination experiment, where participants were presented with a Gabor grating and retained its orientation across a 2 s delay period, after which they were asked to report whether a test grating was rotated to the left or right with respect to the initial grating stimulus. Participants were also asked to report the visibility of the memory stimulus on each trial using a Perceptual Awareness Scale. Soto et al. (2011) found that in those trials where participants reported absence of awareness (unseen trials), they performed above chance in the orientation test, suggesting that these stimuli had been successfully stored and retrieved from WM. Also, Soto et al. failed to find any correlation between performance in the WM task and perceptual awareness of the memory cue, and furthermore, a regression of performance on awareness returned a significant positive intercept, suggesting that performance in the WM task is predicted to be positive even for participants who show no evidence of awareness. These results lead logically to the conclusion that WM can operate on stimuli that have not been consciously experienced. Recently, a meta-analysis by Gambarota et al. (2022), collating data from all the empirical studies that have addressed this question so far, concluded that there is a medium-sized unconscious WM effect. In this poster we present our registered report, whose goal is to test whether WM can operate unconsciously, by replicating the original study of Soto et al. (2011) with a high-powered multi-site sample. This responds to the need for more systematic and larger-scale studies in research on unconscious WM, as urged by Gambarota et al. (2022) in their meta-analysis. Moreover, the empirical evidence gathered so far poses concerns that we will attempt to address and overcome, following recent methodological recommendations, across three major aspects: research biases and statistical power, the minimal baseline requirements, and potential hazards with data analyses.

A dissociation between EEG entropy at slow and fast timescales in non-pharmacological altered states of consciousness

Joel Frohlich (Institute for Advanced Consciousness Studies), Ninette Simonian (Institute for Advanced Consciousness Studies), Nicco Reggente (Institute for Advanced Consciousness Studies)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

The entropy or “complexity” of electroencephalography (EEG) signals decreases during states of unconsciousness and increases during psychedelic states relative to ordinary wakefulness (Sarasso et al. 2021). However, it is uncertain how EEG entropy changes during non-pharmacological altered states of consciousness (npASC). We explored this by inducing npASC using both stroboscopic stimulation (N = 136) and focused breathing meditation (N = 73) while recording spontaneous 64-channel EEG at pre-experience baseline, during the experience, and post-experience. The stroboscopic stimulation contained four distinct sequences with different visual frequencies and often induced geometric perceptions similar to those experienced under psychedelics. After artifact reduction, we computed the permutation entropy (Bandt and Pompe, 2002) of EEG signals at fast timescales (8 - 20 Hz) using a 16 ms lag (PermEn16) and slow timescales (4 - 10 Hz) using a 32 ms lag (PermEn32). Both timescales were chosen to encompass the alpha band, given the visual nature of the stroboscopic stimulation. We analyzed results using linear mixed models. After using a Bonferroni correction to adjust our alpha level, a main effect of timepoint was significant for all channels, lags, and stimulation parts ($P < 0.0001$). As expected, PermEn16 significantly increased during npASC. Puzzlingly, however, PermEn32 significantly decreased during npASC. Our results show a dissociation between EEG entropy at fast and slow timescales during npASC. In particular, our finding of diminished 4 - 10 Hz entropy during npASC, including the visually rich experience of stroboscopic stimulation, is surprising given that neural entropy generally scales with the richness of conscious content (Carhart-Harris, 2018).

The Thick Present: Matter as Memory

Rami Gabriel (Columbia College Chicago)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

How can our understanding of the evolution of the mind illuminate our experience of time? In this paper, I put forward a monist model of the extent to which mnemonic capacities shape conscious experience. According to the affective turn in the neurosciences, sentience originates in the valence of intero- and extero-ception. The function of basic phenomenal experience is to allow creatures to monitor and control allostatic regulation in relation to their ecological and cultural niche. These sensory affects generated in upper brain stem and midbrain structures are coordinated through relations between the body and the world and thus owned by the self-organized system of the organism. Creature consciousness is subsequently thickened when mnemonic capacities expand an organism's management of internal and external signals. A naturalist approach to the mind-body problem in which affective sentience is the phenomenal expression of an organism's multiple levels of allostatic regulation directs us to a secure delineation of how consciousness results from the integration of time, memory, and meaning. Replacing dualism with monism, this paper parallels Henri Bergson's Matière et Mémoire in pursuing a fundamental connection between consciousness and memory. I explore how the study of memory helps explains how conscious experience is contoured by affect and buttressed with meaning. My thesis is that the rich nature of the thick present can be analyzed through delineating how memory, the trace of time, furnishes perception and cognition with epistemic context. Intentional content is framed by our mnemonic capacities to maintain, integrate, and project through time. Memory is thus how consciousness encapsulates the affective sentience of interoceptive and exteroceptive motivations in agential experience. I develop a deep history of sentience which evolves from traces to reflexes, associations, symbols, and ultimately reflexivity. At the most basic level, I describe matter as memory in the record of genetic and developmental time. For sentient creatures, memory orients consciousness with predispositions and interpretative schemas that enable recognition, exploratory behaviors, and dialogical processes. The present is felt as the mnemonic content of embodied habits, norms, associations, concepts, and dispositions. To elucidate this teleological function of content, I analyze spatial memory and proto-representations (PPRs). Next, I integrate the phenomenology of subjective time in state-dependent recall and nostalgia with empirical research on the cognitive structure of memory. Finally, autonoetic consciousness is depicted as arising from the interaction between consciousness moving through time and higher-level cognitive faculties. This is illustrated by philosophical and empirical research on self-identity.

A combined binocular rivalry-fast periodic visual stimulation protocol reveals a preferential processing in visual awareness for male faces

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The human face is one of the most salient and rich stimuli in the environment. When we encounter people, we rapidly evaluate their age, identity, emotional expression but also gender. Although these judgements are based on visual information, also perceptual and cognitive factors are involved in face evaluation. For instance, faces of the same age and ethnicity faces are prioritized in visual awareness (Stein et al. 2014). Yet, how visual awareness is modulated by the perception of different gender faces is still unclear. In this study, we investigated whether the categorization of the gender of faces affects visual awareness and whether this is modulated by one's gender identity or sexual orientation, by exploiting a paradigm that combined binocular rivalry (BR) and fast periodic visual stimulation (FPVS). BR involves the presentation of two different images to the two eyes, and given our brain's inability to process both stimuli simultaneously, the conscious perception dynamically shifts between the two percepts. FPVS is an electrophysiological protocol that relies on the fact that brain oscillations synchronize (‘tag’) with the periodic presentation of a visual stimulus. In our combined paradigm, we recruited 34 heterosexual cisgender participants (females=17) who were presented with images of male and female faces at different frequencies (6 and 7.5 Hz) to the two eyes. We entered the time of perceptual dominance and the amplitude of electrophysiological responses at the frequencies of interest in two separated 2*2 ANOVAs with Face Gender (male/female) as within subject-factor and Participant Gender (male/female) as between subject-factor. We did not observe any significant effect in behavioral data, but crucially the analysis of electrophysiological activity in response to faces showed a main effect of Face Gender ($F=14.275$; $p=0.005$) that reveals that both women and men had significant higher responses to the male than female face over a bilateral temporo-occipital cluster. Neither the main effect of Participant Gender ($F=0.719$; $p=0.403$) nor the Face Gender*Face Perception interaction were significant ($F=0.119$; $p=0.914$). Our results revealed an implicit visual dominance for male faces. Indeed, the greater tagged responses to male than female faces shows that the brain, under conditions of perceptual ambiguity, tends to privilege male faces. Although this result does not reflect an effect driven by gender identity or sexual preference, it is in line with previous evidence that described a 'male bias' when determining the gender of vague or illusory faces (Wardle et al. 2022). This ‘male bias' could be interpreted from an evolutionary perspective; since a threat is more likely to be associated with a man than a woman, and since evolutionary-threatening stimuli are prioritized in visual awareness (Gomes et al. 2017), it might be safer for the brain to categorize a face as male in ambiguous perceptual conditions as in binocular rivalry.

MEG MARKERS OF AROUSAL AND CONSCIOUSNESS IN EARLY ALZHEIMER'S DISEASE

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Electroencephalography (EEG) has been a significant neurophysiological marker for the diagnosis of Alzheimer's disease (AD) for many years. The spatiotemporal complexity of the EEG signal can be analysed to provide an in-depth analysis of the EEG signal, e.g. people with AD exhibit lower Lempel Ziv (LZ) complexity values compared to healthy controls. While this evidence has been demonstrated using analytic approaches such as sample entropy, it remains an important clinical question as to how this relates to the clinical features or phenomenology of AD, specifically deterioration in general cognitive function. To address this question, this study analysed MEG/EEG data to investigate markers of arousal and consciousness level in AD. The MEG recordings were collected at a 1 kHz sample, eyes closed resting state. The duration varied from 2 to 13.35 minutes. To assess the level of consciousness, the LZ complexity was calculated, which estimates the diversity of patterns of a given signal, acting as a marker for the richness of content of consciousness. Arousal was measured using a ratio of the whole brain alpha-theta bands. A total of 166 participants were included, 83 with AD and 83 age-matched healthy controls. Results showed that the mean LZ sum value was significantly greater in the control group compared to the AD group (0.590 vs 0.581, $W = 4171$, $p = 0.025$). The mean alpha-theta ratio was significantly less in the control group compared to the AD group (1.041 vs 1.372, $W = 2728$, $p = 0.021$). Regression analyses were conducted to investigate the association between the Mini-Mental State Examination (MMSE) and LZ/alpha-theta. MMSE was associated with a significant increase in LZ sum (0.003, $t = 3.033$, $p = 0.003$), indicating an increase in complexity/consciousness, and with a significant decrease in the alpha-theta ratio (-0.102, $t = -2.595$, $p = 0.011$), indicating reduced drowsiness. In conclusion, this study found that patients with AD had reduced consciousness level and arousal compared to age-matched healthy controls. Additionally, consciousness level and arousal in AD patients correlated with the severity of the disease, as measured by the MMSE. This information provides further insight into the neurophysiological changes associated with the disease. While more research is needed to better understand the relationship between EEG signals and the clinical features of AD, this study represents an important step in the development of new diagnostic tools.

Investigating the neural circuit underlying subjective perception through a novel speech illusion

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

It is now widely accepted that conscious perception is not merely constructed from incoming sensory information, but also shaped by our expectations. Indeed, predictive processing theories describe perception as an inferential process that integrates bottom-up sensory input with top-down predictions. However, the neural circuitry responsible for this remains unclear. This study employed 7T functional magnetic resonance imaging (fMRI) to examine layer-specific activity in the auditory cortex during a speech illusion. The fMRI protocol used sparse imaging, including silent inter-scan intervals during which stimulus presentation occurred (Hall et al. 1999; Perrachione & Ghosh, 2013). Participants (N = 11) were presented with a novel illusion on 60% of trials, where auditory input remained constant, yet speech perception was strikingly different. On these trials, an ambiguous degraded speech sound was presented in combination with written text saying either ‘brainstorm’ or ‘green needle’. The text strongly influenced participants subjective experience of the ambiguous speech sounds. Another 20% of trials were aimed to evoke veridical percepts by disambiguating the ambiguous stimulus by adding a clearly spoken voice saying “green needle” or “brainstorm”. The remaining 20% of trials consisted of auditory omission trials where only the text was presented. This paradigm aimed to disambiguate between top-down predictions and sensory input, by contrasting illusory and veridical percepts. We found that both illusory and veridical percepts evoked stimulus-specific activity in the superior temporal gyrus, a region which is particularly attuned to processing speech-related auditory information (Yi et al. 2019). The text cues also evoked activity in this same auditory cortical region, even in the absence of auditory input, suggesting a possible mechanism through which the text might modulate sensory processing in this region. These findings shed light on the neural circuit underlying conscious perception in the human auditory cortex. References Hall, D. A. Haggard, M. P. Akeroyd, M. A. Palmer, A. R. Summerfield, A. Q. Elliott, M. R. Gurney, E. M. & Bowtell, R. W. (1999). “Sparse” temporal sampling in auditory fMRI. Human brain mapping, 7(3), 213-223. Perrachione, T. K. & Ghosh, S. S. (2013). Optimized design and analysis of sparse-sampling fMRI experiments. Frontiers in neuroscience, 7, 55. Yi, H. G. Leonard, M. K. & Chang, E. F. (2019). The encoding of speech sounds in the superior temporal gyrus. Neuron, 102(6), 1096-1110.

Pupil size as a real-time marker of arousal and perception state

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Arousal state has a major influence on the state of consciousness, including normal (e.g. alert, drowsy, and asleep) and abnormal (e.g. disorders of consciousness and seizure) changes in conscious perception. Arousal state is driven by subcortical loci, such as the brainstem and thalamus. Due to their deep location and proximity to large vasculature, arousal-mediating brain regions have been difficult to image using traditional methods. Therefore, an easily accessible measure of arousal state and, by proxy, perceptual state, would benefit the field. Previous literature shows that pupil size corresponds with cognition, behavior, arousal, and perception, independent from changes in environmental lighting. Building on these findings, we aim to use pupil size as a real time marker of arousal and perceptual state. Healthy, adult participants completed an at-perceptual threshold paradigm. The target stimulus was a face image that appeared either to the left or right of a central fixation point. In an initial task phase, the threshold opacity of the target stimulus was found for each participant so that in subsequent presentations it would only be seen 50% of the time. In the main task phase, pupil size (right eye) changes were recorded in real time using with EyeLink 1000 Plus (1000Hz, SR Research, Inc.). A custom algorithm detected in real time pupil peak and trough events. A stimulus was shown on screen during one of three task conditions, each a unique phase in pupil size: (1) pupil peak, (2) pupil trough, and (3) a control, non-peak/non-trough. Preliminary results show that our custom algorithm successfully finds in real time extrema in pupil size. Behaviorally, extrema times coincided with changes in the perception rate of the target stimulus. This result may correspond with the arousal state of neurophysiology associated with different phases of the pupil. In summary, these results demonstrate that extrema can be accurately detected in real-time in pupil size and correspond with intrinsic changes to perceptual state. Our findings have implications for understanding the relationship between arousal and perceptual state. Moreover, this real-time approach in measuring intrinsic changes in pupil size may have translational applications in patient groups with aberrant conscious states.

The analgesic and dissociative properties of ketamine are separate and correspond to distinct neural mechanisms

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Background, Ketamine is a dissociative anesthetic that produces analgesia and psychedelic effects. It has been suggested that the dissociative properties of ketamine support its analgesic effects through modifications of aversive subjective perception. However, while some studies support this hypothesis, others indicate that these effects are independent. These opposing claims may result from the fact that these effects are correlated in time, making them hard to disentangle using behavioral observations or pharmacokinetic models. In the current study, we tested if ketamine's analgetic and dissociative effects correspond to distinct neural mechanisms. Methods , 35 healthy volunteers participated in a within-subject, single-blind placebo-controlled study. During two separate day sessions, they received ketamine (0.4 mg/kg blouse and continuous drip of 0.4mg/kg/h) or a saline placebo while undergoing a pain-inducing manipulation during an fMRI scan. Same-day pain threshold calibration was performed before each session. Pain ratings were documented after each trial. Ratings of dissociation were taken before and after drug/placebo administration and 40 minutes after intervention. Results, Ketamine reduced ratings of thermal pain ($t=5.2;p<0.001$) and a cased strong dissociative effect ($f=142.97;p<0.001$). These effects were not correlated (bayesian estimated correlation coefficient;0.006). During placebo administration, painful vs non-painful stimulus resulted in activation across a range of brain regions including the insula, anterior cingulate cortex, and dorsolateral prefrontal cortex ($pFDR<0.001$). These neural effects were attenuated under ketamine. In both sessions, pain ratings were correlated with a previously developed multivoxel signature of physical pain (bayesian estimated correlation coefficient: 0.39 (placebo session) and 0.57 (ketamine session), indicating that this multi-voxel pattern maintained its relation to subjective pain perception. This multivoxel pattern demonstrated reduced expression following ketamine administration ($t=2.1;p<0.05$), resonating with decreased subjective pain. , Default mode network connectivity, an index previously related to the subjective effects of psychedelics, was reduced under ketamine ($t=5.4;p<0.001$). The degree of default mode network disintegration was correlated with the intensity of dissociation (bayesian estimated correlation coefficient;0.49). The neural correlates of pain did not correspond to dissociation indices and vice versa. Conclusion and limitations, Our data resonate with previous studies showing that the analgesic and dissociative effects of ketamine are behaviorally independent. In addition, we show that distinct neural mechanisms mediate ketamine-induced analgesia and dissociation. However, our results can not rule out a common upstream mechanism producing both effects.

Sighs during sleep: an early sign of brainstem neurodegeneration?

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The REM sleep behavior disorder (RBD) is a sleep disorders where affected patients kick, punch and shout during REM sleep. These emotional displays are aligned with subsequent dream reports and can have real consequences such as injures for themselves or bed partners. Thus, RBD patients represent an intriguing dissociation between conscious contents and behavior. Identifying these dissociative states is also critical for these patients as they represent good predictors of an evolution toward Parkinson's disease (PD) or multiple system atrophy (MSA). However, these behaviors can be infrequent and difficult to record in lab settings. Our aim was here to study more subtle but also more frequent markers of emotions, sighs, and their link with neurogenerative diseases. Here, we studied a large cohort of individuals including 115 controls, 112 RBD, 256 PD and 73 MSA. We recorded each individual in one full-night recording with natural non REM sleep and REM sleep. We use video-monitoring and polysomnography (EEG, EOG, ECG, EMG and respiratory sensors) to monitor participants' brain activity and breathing. There were more participants with sighs in deep NREM sleep in the MSA than in the PD, RBD and control groups. Even when focusing only on patients with sighs in deep NREM sleep, the number of sighs (sigh index) was again greater in the MSA group compared to PD and RBD. In REM sleep, the presence of sighs significantly differed between groups but pairwise comparisons did not reach statistical significance. However, the sigh index in REM sleep was higher in MSA and PD compared to the RBD and control groups, whether participants without sigh were included or not. These results indicate that the observation of subtle emotional displays is characteristic of neurodegenerative diseases such as PD and MSA and could be used as an early biomarker in prodromal RBD. They also provide another window onto the contents of dreams, which has key advantages. Indeed, sighs are more frequent than more complex movements such as kicking or shouting. They also induce less artefacts on the EEG signals. Consequently, they represent a better target to identify the neural correlates of emotions during dream in healthy and clinical populations.

Low gamma auditory steady-state response is sensitive to the level of arousal and awareness during natural sleep.

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Every night when we fall into deep sleep, we appear to lose ability to consciously detect incoming acoustic stimuli, while further during light sleep, we can experience sounds coming from both dreams and external environment. Auditory steady-state responses (ASSRs) are oscillatory responses evoked by periodic auditory stimulation. ASSRs around 40 Hz (low gamma) have been shown to be sensitive to fluctuations in the level of arousal both during sleep and anesthesia, but it remains unclear whether this effect is related to variations in the level of consciousness. In this work, we investigated the specificity of changes in ASSR in the low gamma range to varying levels of arousal by comparing wakefulness, N2 NREM, N3 NREM and REM sleep, and varying levels of awareness by comparing no-dreaming vs dreaming reports of subjects that either had auditory experiences in their dreams or not. We analyzed EEG responses to narrow-band chirp modulated stimulation (25-55Hz range) in the group of 22 healthy volunteers, 14 of whom were participating in serial awakenings study (42 reports). Specifically, we evaluated intertrial phase clustering (ITPC) response from the 9 frontocentral channels. Off-line sleep scoring was based on polysomnography data. We found significant effects ($p<0.05$) of reduced ITPC values in the 37-43 Hz band from wakefulness to both N2 and N3 NREM sleep, but not to REM sleep, and from REM sleep to both N2 and N3 NREM sleep. Moreover, the comparison of subjective reports from serial awakenings paradigm reveals significant difference ($p<0.05$) of ITPC in 37-43 Hz band between no-dreaming vs dreaming reports in which auditory experience was present, but not when it was absent. Note however that wakefulness vs dreaming with no auditory experience was close to significance level. Taken together, these results suggest that low gamma range ASSR are both sensitive to changes in the level of arousal (dropping in NREM sleep), and in the level of consciousness (decreasing during no-dreaming unconsciousness). The latter seems related to the functionality of the auditory pathway. Further research should investigate topographies of these changes and determine whether the observed effects are caused by disruption in the thalamocortical system, and/or result from cortical down states. The current findings strengthen the notion of low gamma range ASSRs as a tool for reliable discrimination between levels of consciousness, suitable for clinical applications.

Intracranial markers of evidence accumulation subserve confidence judgments and changes of mind

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

All decisions one makes are accompanied by a feeling of confidence. This feeling is crucial in a world where decisions are rarely followed by immediate external feedback and may have to be adjusted based on internal signals only. In recent years, evidence accumulation (EA) models have been successful in integrating confidence judgements as part of the decision-making process. In this context, confidence is generally computed from the amount of accumulated evidence at decision time or during a post-decisional period. Despite the success of EA as a generative model of confidence, its neural implementation remains a matter of debate and has rarely been explored using invasive techniques in humans. In the present work, we address these limitations by investigating EA and confidence judgments in 16 individuals with drug-resistant epilepsy implanted with stereotactic electroencephalography (sEEG) electrodes, who performed a two-alternative motion discrimination task followed by a confidence rating task. Importantly, participants responded by moving a computer mouse towards a right or left onscreen target, allowing us to analyze mouse trajectories and identify trials where changes of mind occurred. We analyzed high-gamma activity – a proxy for local neuronal activity – over 796 contacts and isolated electrodes in the visual, parietal and prefrontal cortex whose ramp-like activity was predictive of reaction times, a hallmark of EA. Using optimal feature weights recovered from decoders trained to predict reaction times from high-gamma activity, we could also separate neural activity depending on confidence levels in the same cortical regions. This result strongly supports the idea that confidence judgements derive from evidence accumulation. Finally, we found that the neural activity preceding changes of mind closely resembled the EA-like activity leading to the initial decision in the prefrontal cortex, and notably in the dlPFC and the IFG. Our results show that EA is instantiated across different cortical areas simultaneously, including notably the parietal, prefrontal, and more surprisingly, the occipital cortices. Importantly, we show that EA-like neuronal activity in these cortices not only subserves decisions, but also confidence judgements and changes of mind. Taken together, these results hint that evidence accumulation may be a fundamental computational and neuronal mechanism whose role extends beyond decision-making into the domain of metacognition.

How arbitrary and deliberate decisions differ when studying the neuroscience of volition.

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Volition refers to the capacity of humans to initiate actions based on internal decisions (i.e. intentions) and motivation, rather than only on external stimulation. Studying its mechanisms would be of importance to better understand pathologies associated with a deficit in volitional processes (e.g. obsessive-compulsive disorder, Gilles de la Tourette syndrome, schizophrenia, Parkinson’s disease). So far, the neuroscience of volition has focused on arbitrary (meaningless) decisions and generalize these findings on deliberate (meaningful) decisions. This study investigates the difference between arbitrary and deliberate decisions on different measures related to volition, the readiness potential, the sense of agency, willpower, and the subjective sense of volition. We recruited 50 participants, that had to decide between two options which one would lead to the highest monetary reward. We designed three conditions varying from arbitrary, to easy deliberate and to hard deliberate conditions. Participants could increase their remuneration in deliberate conditions but not in the arbitrary condition, thus varying from meaningful to meaningless decisions. In the easy deliberate condition, one dimension of the two options must be compared to select the best option while in the hard deliberate decision, two dimensions must be compared to select the best option, thus requiring more deliberation. Our results indicate that both the readiness potential and the sense of agency, measured using temporal binding effect, are similar in the three conditions. We observed both higher efforts exerted, as a measure of willpower using handgrips dynamometer, and higher subjective sense of volition, reported on the scales, in the two deliberate conditions compared to the arbitrary condition. Together, our findings seem to indicate that meaningful decisions increased the willpower and subjective experience of volition while the readiness potential and the sense of agency are not impacted in comparison to meaningless decisions. This study shows that care must be taken before generalizing the results of arbitrary decisions to deliberate decisions when studying volition.

Chatbots that are perceived as conscious and human-like can give social and emotional benefits to frequent users

Rose Guingrich (Princeton University), Michael S. A. Graziano (Princeton University)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

How does perceiving consciousness in artificial intelligence (AI) impact our social interactions? Findings based on a survey of companion chatbot users suggest that consciousness-perception and human-likeness moderate positive outcomes in terms of users' social interactions, relationships with family and friends, and self-esteem. Social actor AI such as chatbots, digital voice assistants, and robots has advanced to a point at which people can speculate whether it is conscious. From a psychological point of view, the mere fact that people can perceive AI as conscious makes its impacts on people's social lives worth investigating. People have developed relationships with popular companion chatbots such as Replika, "the AI companion who cares," that can act as a friend, mentor, or romantic partner. We surveyed Replika users on Reddit to investigate this chatbot's impact on users' social interactions and to evaluate whether consciousness-perception moderates these impacts. Preliminary analyses suggest that there is a positive, moderate correlation between perceiving consciousness in the chatbot and favorable social outcomes including better relationships with family and friends and higher self-esteem. When human-likeness is added to the model, this correlation doubles. Overall, these findings suggest that perceiving a chatbot as having a humanlike mind induces carry-over effects on human-human interaction. Making social actor AI more humanlike, therefore, does not simply facilitate people's interactions with AI, but also it can improve people's interactions with other humans according to self-reports by Replika users.

On the neural dynamics underlying high confidence false percepts

Joost Haarsma (UCL, Wellcome Centre for Human Neuroimaging), Peter kok (UCL, Wellcome Centre for Human Neuroimaging)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

False percepts play an important role in various psychiatric and neurological conditions, yet the neural mechanisms underlying these phenomena remain poorly understood. Here, we used magnetoencephalography (MEG) to interrogate the neural dynamics underlying such high confidence false percepts during a visual discrimination task (N=23). Participants were asked to report the orientation of a visual grating embedded in noise, while an auditory cue predicted the most likely orientation. Unbeknownst to participants, 50% of the trials contained only noise. Interestingly, on a sub-set of noise trials participants still reported to perceive a grating with high confidence. We next interrogated the neural dynamics that underlie these high confidence false percepts. We found that on trials where high confidence false percepts were reported, there was an increase in posterior pre-stimulus beta activity. This beta increase was not present prior to high confidence veridical percepts. Conversely, when we used multivariate analyses to decode the perceptual confidence indicated by the participants, we found neural confidence signals that emerged around 200-300ms post-stimulus, which were similar for false and veridical percepts. Finally, a stimulus-specific sensory signal reflecting the orientation of the reported stimulus only emerged later (2100ms-2400ms post-stimulus), around the time participants reported their decision. Taken together, these findings suggest that pre-stimulus beta power is an important contributor to high confidence false, but not veridical, percepts, whereas early post-stimulus confidence signals are similar for false and veridical percepts. We speculate that changes in pre-stimulus beta power might reflect a top-down expectation signal about stimulus presence.

Dementia as a Disorder of Consciousness

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Budson et al. (2022) recently proposed the memory theory of consciousness, i.e. that consciousness can be viewed as an intrinsic part of the explicit memory systems (sensory, working, episodic, and semantic). Because consciousness is a memory of unconscious brain processes, conscious awareness occurs after perceptions, decisions, and action have been completed. Because all cortical regions can be considered part of explicit memory, all areas of the cerebral cortex contribute to conscious awareness. Cortical dementias, including Alzheimer's disease (AD), can therefore be considered disorders of consciousness. Lastly, dysfunction of different cortical regions will impair different domains of consciousness. Here, we outline a series of possible experiments to evaluate various aspects of these hypotheses. The first experiments will examine the neural correlates of consciousness in AD using EEG. Prior research has captured differences in frequency bands during resting-state EEG in healthy individuals compared to patient populations. Of the frequency bands derived during resting-state, gamma band oscillations (30-100Hz) are fundamental for healthy brain activity, including memory, intra-brain communication, and potentially consciousness. Specifically, consciousness has been associated with continuous gamma wave activity, while disrupted consciousness has been associated with an interrupted pattern of gamma waves. While a reduction in the power of gamma oscillations has been observed in AD patients, our experiment will evaluate whether gamma power correlates with various aspects of consciousness, such as visual awareness and mental imagery. The second experiment will evaluate whether a classic event-related potential (ERP) component, P3, correlates with conscious awareness in AD patients. While the P3 may reflect a host of different processes, we will focus on the difference between an early P3 window (300-400 ms) and late P3 window (380-440 ms) and how the early P3 may reflect the decision-making alone while the late window includes the awareness associated with being conscious. The increased P3 latency may reflect the after-the-fact nature of consciousness. The P3 latency in both normal aging and AD patient will be evaluated in relation to various aspects of consciousness. The third experiment will continue prior work with task-based fMRI by exploring differences in brain activity while participants participate in a conscious versus unconscious visual awareness paradigm. Combining EEG, ERP, and fMRI with patient populations is a promising method to evaluate the neural correlates of consciousness. These experiments we will test the overall hypothesis that consciousness deteriorates in individuals with dementia both globally and in relation to the specific cortical regions where pathology is greatest. Lastly, we suggest that considering dementia as a disorder of consciousness will aid our understanding of both consciousness and dementia.

Between self-interest and social preferences – A neuromodulation approach to establish the role of cognitive-control

Eliran Halali (Bar-Ilan University, Israel), Jonathan Slater (Maastricht University, Netherlands), Haim Assor (Bar-Ilan University, Israel), Michal Lavidor (Bar-Ilan University, Israel)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

In many daily social situations, a conflict exists between selfish motives and social considerations. Classical economic theories assume that humans are exclusively self-interested. However, behavioral findings show that people have other-regarding preferences, such as fairness and reciprocity. In recent years, there is an ongoing debate about whether the nature of social preferences is automatically driven (and thus deliberate actions are necessary to ensure economic self-interest) or whether it requires cognitive control (suggesting that self-interest is the primary motive, which needs to be constrained by inhibition). Interestingly, two different inhibitory brain regions with different and unique inhibitory functions were found to be involved in resolving the conflict between social preferences and self-interest in social interactions, the right dorsolateral prefrontal cortex (rDLPFC), which is associated with executive control and the inhibition of reward seeking behavior, and the right ventrolateral prefrontal cortex (rVLPFC), which is associated with emotion regulation. In the present work, we examined the causal roles of the rDLPFC and the rVLPFC in managing such conflicts. Adopting a neuromodulation approach, we applied anodal transcranial-direct-current-stimulation (tDCS) over the rDLPFC (Study 1) and rVLPFC (Study 2) to enhance the cortical activities of these regions among responders in the ultimatum game, a customarily used paradigm for examining the conflict between self-interest motives and social considerations such as fairness and reciprocity. In response to unfair offers, in Study 1 we found that anodal tDCS over the rDLPFC, compared to control (sham stimulation), increased reciprocal behavior at the expense of economic self-interest. In contrast, in Study 2 anodal tDCS over the rVLPFC increased self-interested behavior at the expense of fairness considerations. Taken together, these findings support the notion of distinct regulatory roles for the rDLPFC and the rVLPFC in managing the often-existing conflict between self-interest motives and social preferences. Accordingly, whereas the rDLPFC inhibits self-interested behavior, the rVLPFC regulates emotional-driven social preferences. Interestingly, these findings might reconcile the two contradictory perspectives regarding social preferences as automatically driven versus deliberate. Specifically, considering that self-interest and social preferences have distinguished cognitive control systems, implies that both motivations are automatic processes. This proposition is in line with findings and a theoretical model in the neuro-affective field, and with a broader recent approach for dual reasoning suggesting that competitions between dual processes that traditionally were conceptualized as reflecting competition between an automatic "system 1" process and a deliberative "system 2" process may in fact be competitions between two or more competing automatic "system 1" processes.

Coma Prognostication Using EEG Responses to a Clinically Relevant Propofol Infusion

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Rationale: Prognosticating outcome in coma patients is a clinical challenge. Our previous preliminary work has shown that EEG responses to a target-controlled infusion of propofol at 2 µg/mL was able to distinguish patients in disorders of consciousness who recover from those who do not with 100% accuracy. In this study, we test the prognostic capacity of EEG responses to a clinically relevant propofol infusion in severely brain-injured coma patients in the intensive care unit. Methods: We recorded 128-channel high-density electroencephalograms (EEG) of 10 coma patients (6 stroke; 3 traumatic brain injury; 1 anoxic brain injury) during a brief withdrawal of propofol sedation for clinical assessment and upon propofol re-infusion at a rate determined according to clinical practice. Propofol infusion rates ranged from 20 to 50 mcg/kg/min. EEG was characterized using 1) the direction of functional connectivity measured with directed phase lag index (dPLI) across all electrode pairs; and 2) the degree of each network node, using a network constructed with binarized, weighted phase lag index (wPLI), thresholded at 5% in the alpha frequency band. The differences of both measures between sedation-interruption and anesthesia epochs were calculated for each participant. The hemisphere with the highest EEG reconfiguration between states were selected for each participant. Patient outcome was measured by the highest Glasgow Outcome Scale – Extended (GOS-E) score achieved by the 6-month follow up. The patients with the GOS-E score of 3 and above were defined as recovered, and those below as non-recovered. A logistic regression was performed on the EEG reconfiguration values to separate the recovered and non-recovered patients. Results: Our preliminary dataset of the recovered and non-recovered patients were separable with 80% accuracy using a logistic regression model. A t-test showed that the mean EEG reconfiguration for the recovered patients was higher than the mean for the non-recovered patients, with the result approaching significance ($t(10) = -1.752$, $p = 0.059$, one-tailed). Conclusion: Our study demonstrates the feasibility of using EEG responses to a clinically relevant propofol protocol to identify coma patient who will recover consciousness. This measure can be obtained within the first seven days of ICU admission and has the potential to provide useful information to support caregiver decision making during acute coma.

Ownership for the body presented in third-person perspective investigated by VR experimental psychology

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Virtual reality (VR) apparatus and contents are attracting attention in experimental psychology of self-concept. It has been difficult to experimentally examine the mind-body connection because these two cannot be separated, but in VR it is possible. People can view their own avatar's body from out of the body as a third-person perspective. The use of avatar and paradigms that modulate embodiment (e.g. full-body illusion) in VR allows for new research on the self-concept and embodiment. However, it is under debate whether ownership (self-attribution to one's body) could be elicited for the body presented in third-person perspective. Some studies show that ownership could be elicited for the body presented in third-person perspective (e.g. Lenggenhager et al. 2007; Debarba et al. 2015, 2017), other studies show not (e.g Petkova et al., 2011; Maselli & Slater, 2014). In addition, what factors could affect ownership for the body presented in third-person perspective is unclear. We developed VR experimental platform "Xperigrapher" (Ohyama, 2021) and investigated the factor of similarity for actual body, multimodal synchronization, and gender identity for elicit body ownership presented in third-person perspective. We firstly investigated ownership of simple geometric figure avatar in third-person perspective. We secondly investigated the effect of tactile feedback for ownership of male avatar in third-person perspective. We thirdly investigated the effect of gender identity for ownership of male and female avatars in third-person perspective. The results show that the similarity with actual body, more multimodal synchronization (visuo-motor synchronization plus tactile feedback) enhanced ownership and relation of implicit gender identity and ownership. Bayesian causal inference model for ownership (Kilteni et al. 2015) could be applied to ownership of the body presented in third-person perspective, because of the communality of the model and our experimental data: the influence of the similarity with actual body from comparison of simple geometric shape and photo-realistic human shape avatar can be rephrased as the function of semantic information of perceived object in the model, the effect of visuo-tactile synchronization can be rephrased as the function of multimodal stimulation congruence in the model, gender identity effect can be explained as one of the prior expectations. Our study showed that similarity with actual body and visuo-motor synchronization plus tactile feedback enhanced ownership. These results support previous reports about peri-personal space (e.g. visuo-motor synchronization (D' angelo et al. 2018), similarity with actual body (Salomon et al. 2012). These studies imply that the peri-personal space may be expanded when the avatar body in which ownership is elicited is viewed from a third-person perspective. Future research of relation of perspective and ownership would be also discussed.

The neurobiology of language mediates alterations in conscious experience induced by psychedelic drugs

Regan Harle (University College London), Marcus Glennon (University College London), Jeremy Skipper (University College London)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Psychedelic drugs profoundly affect conscious experience. This often involves ‘ego-dissolution’ or the loss of self and a sense of ‘oneness with the universe’, purportedly correlated with changes in the ‘default mode network’ (DMN). However, the ‘self’ is largely a narrative construct mediated by language. Language is also a general tool for categorisation whose absence might make perceptual experiences seem more connected. Thus, we hypothesized that a parsimonious explanation of the psychological effects of psychedelics has to do with their relative impact on the neurobiology of language. Firstly, we tested this in a subset of classic (or serotonergic) psychedelics, i.e. DMT, psilocybin, as these seem to have the most profound effects on consciousness, in general, through a neuroimaging meta-analysis of all rest and tasked-based fMRI studies in 310 healthy participants. We quantified which terms were most associated with resulting clusters and whole-brain patterns based on thousands of other meta-analyses. Results indicate that psychedelics produced more activity than placebo in a large distributed set of brain regions with the largest cluster in the dorsal medial prefrontal cortex (not typically associated with the DMN). Other clusters included the left posterior inferior frontal gyrus and superior temporal regions associated with language related meta-analytic terms. Placebo produced greater activity in superior temporal regions and related terms, e.g. ‘speech’. Unthresholded whole-brain maps were most positively correlated with task and memory terms and negatively correlated with ‘auditory’, ‘listening’, and ‘sounds’. Rather than the DMN, results suggest that psychedelic drugs increase memory and higher-level semantic while decreasing lower-level sound and speech processing. Thus, loss of ‘self’ and feelings of ‘oneness’ are parsimoniously explained by changes to the neurobiology of language. Thus, loss of ‘self’ and feelings of ‘oneness’ are parsimoniously explained by changes to the neurobiology of language during psychedelic use. Psychedelic induced neuroplasticity in these networks, in concert with changes in self narrative centered around alterations in conscious experience, likely underlie the positive changes in mental health and wellbeing associated with psychedelic drugs. Secondly, we addressed whether ketamine should be considered a 'classic' psychedelic due to its similar effect on consciousness. Extracting data from over 300 further participants, we discovered similar brain associations and results as classic psychedelics, so this opens up a route into using ketamine in similar ways, and allowing for more therapeutic options and further research.

Prediction of the metacognitive abilities across sensory modalities from resting-state fMRI

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Metacognition is the ability to evaluate one's own cognitive processes. As it manifests in the variety of cognitive domains, the question emerges whether it relies on domain-general or domain-specific resources., Behavioural research gives inconclusive answers, most often showing some level of correlations between domains or modalities, which is usually interpreted as a presence of a general metacognitive component. However, mere correlations cannot be interpreted in causal terms, thus, although behavioural research has provided the crucial background for further investigation, the domain generality question needs to face the extended search for their neural substrates. Moreover, given the complexity of human hardware, we cannot limit nor simplify this search to one of the aspects of neural architecture., Here, we examine what functional connectivity can tell us about metacognition across sensory modalities. A large group of participants (n=300) underwent a resting-state fMRI acquisition (eyes open, fixation cross; acquisition time = 18min, TR=801ms), followed by a behavioural examination of metacognition with two-alternative forced choice tasks across four sensory modalities: vision, audition, touch and pain. The behavioural paradigms were matched as closely as possible with respect to the sensory input. The behavioural data were analysed with the bhsdtr2 package, and standard metacognitive measures were derived (dprim, metad, mratio). The resting-state data were preprocessed with fMRIPrep pipeline, further denoised, and connectivity matrices with 400 cortical parcels were built using Schaefer parcellation. This connectivity data is currently analysed using a predictive framework. We will present the results of these analyses, and investigate which resting-state networks are more involved in the prediction of the metacognitive scores for different sensory modalities. Finally, we will discuss these results in the context of domain-general and domain-specific metacognition.,

Decoding the content of consciousness in iEEG

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Understanding how consciousness arises from neural activity in the human brain remains one of the greatest scientific challenges of modern times. Several theories have been proposed to explain how the brain enables conscious experience. Among those, Integrated Information Theory (IIT) and Global Neuronal Workspace Theory (GNWT) have received much attention in recent years. IIT posits that consciousness arises from the integrated information generated by a specific set of neural elements that can exert causal influence on itself, while GNWT proposes that consciousness emerges from the global availability of information in the brain. Though these theories have gained some empirical support, with few exceptions, they have been mostly tested separately, using different experiments and methods. To adjudicate between these two theories of consciousness, we tested specific hypotheses about where and when in the brain the contents of consciousness should be decodable. Specifically, GNWT predicts that the content of consciousness should be decodable from prefrontal areas, whereas IIT predicts that they should be maximally decodable from posterior areas. Here, we present the results of decoding analyses using invasive neurophysiological recordings of intracranial field potentials from both subdural surface and depth electrodes, testing the specific hypotheses of the IIT and GNWT theories using the same experimental paradigm. Using suprathreshold visual stimuli across several image categories (faces, objects, letters, false fonts), we quantitatively assessed the decodability of visual categories under distinct task demands as well as the time course of this decoding considering the IIT and GNWT theory predictions.

Naturalistic use of psychedelics is related to emotional reactivity and self-consciousness: The mediating role of ego-dissolution and mystical experiences

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Background:, Psychedelics are able to acutely alter emotional reactivity and self-consciousness. However, whether the regular naturalistic use of psychedelics can be linked to more persistent trait-level changes in these domains remains an open question. Aim:, To test the hypotheses that (1) using psychedelics is related to higher positive and lower negative emotional reactivity; and (2) an adaptive pattern of self-consciousness, including diminished public self-consciousness and rumination, and increased reflection and self-awareness; and (3) these relations are mediated by the intensity of past ego-dissolution and mystical experiences. Method:, An online survey including questions about the history of psychoactive substance use; questionnaires measuring trait levels of emotional reactivity and self-consciousness; questionnaires for retrospective assessment of ego-dissolution and mystical experiences. Data collected from 2516 participants (1661 psychedelics users) were analyzed using robust linear regression and mediation analysis. Results:, A higher number of lifetime uses of psychedelics predicted greater positive and lower negative emotional reactivity; also, in the domain of self-consciousness, it predicted greater reflection and internal state awareness, and reduced rumination tendency and public self-consciousness. Finally, the intensity of past mystical and ego-dissolution experiences mediated almost all the observed relationships between the lifetime number of psychedelics uses and psychological variables. Conclusions:, Lifetime psychedelics use predicts an adaptive pattern of trait-level emotional reactivity and self-consciousness. Ego-dissolution and mystical experiences are essential in understanding the long-lasting psychological effects of psychedelics use. Our findings might potentially explain previous observations of increased well-being in psychedelics users.

Individual differences in metacognition and anterior prefrontal cortex functional connectivity

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Metacognition, the process of evaluating our own cognition, is fundamental to many aspects of daily life such as problem-solving, decision-making, and learning. Investigating individual differences in metacognition is essential to understanding this process across different domains and tasks, as well as across gender and age. Some attributes of metacognition span multiple domains and contribute to a larger sense of cognitive ability (domain-generality), while other attributes are specific to their respective modalities (domain-specificity). Previous research on metacognition has mainly focused on vision and recognition memory domains, identifying brain structures and networks involved in this process. The anterior prefrontal cortex (aPFC) and associated networks have been consistently found to play a key role across multiple domains. The current study used a novel cognitive task measuring the less-explored semantic memory domain, in addition to visual metacognition. 368 participants completed a metacognition task that covered both visual and non-visual domains, including general knowledge questions related to nutrition and socioeconomics. Additionally, all participants completed a resting-state fMRI. Intraindividual variability in metacognitive insight, the correspondence of cognitive task performance versus the subject's estimation of their performance, was quantified using a computational model based on signal detection theory. This measure was directly compared to seed-based connectivity of relevant brain areas associated with metacognition. Our results present correlates of individual differences in metacognitive insight and resting state connectivity. These findings highlight neural mechanisms underlying both domain-specific and domain-general metacognition, and their potential impact on the development of interventions to improve cognitive functioning in neurodevelopmental disorders or brain injuries.

Differences in metacognitive functioning between obsessive - compulsive disorder patients and highly compulsive individuals from the general population

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Metacognition is the ability to monitor our own thoughts and decisions. Our sense of confidence guides our behavior, and when confidence does not reflect reality, this can result in pathological behavior. For example, low confidence in one's actions could lead to checking behavior in obsessive-compulsive disorder (OCD). Indeed, most case-control studies in OCD have shown under-confidence compared to healthy controls (HCs). Contrarily, studies in general-population samples showed that obsessive-compulsive (OC) symptoms related positively or not at all to confidence. Importantly, it is unclear if findings in individuals with severe OC symptoms are generalizable to actual OCD patients. Most studies have focused on studying local confidence. Metacognition, however, exists on various hierarchical levels, e.g. local confidence in a single decision and global confidence about general performance on a task, which could be more directly relevant to subjective clinical experiences. Studying whether alterations in local confidence extend and relate to alterations in global confidence in OCD is essential for obtaining a more inclusive picture of metacognitive abilities. Our aims were to (1) study alterations in local and global confidence and their relation in OCD patients compared with HCs, and (2) to compare metacognition between OCD patients and a population sample with similar OC symptom scores. A total of 40 HCs, 40 OCD patients (medication-free, no comorbid disorders) and 40 high-compulsive subjects from the general population matched in terms of OC symptom scores and demographics were included. All subjects performed a confidence task in which they indicated local confidence in specific trials and global confidence in their task performance. We compared local and global confidence and their relation between (1) HCs and OCD patients and (2) OCD patients and high-compulsive population subjects. Results showed that OCD patients showed local and global under-confidence compared with HCs, even when controlling for anxiety and depression symptoms. Interestingly, high-compulsive subjects showed significantly more local and global over-confidence than OCD patients. A trend-level interaction effect was found between OC symptom strength and local confidence, with a negative relationship in OCD patients and a positive relationship in high-compulsive subjects. No evidence was found for group differences in the relationship between local and global confidence. Overall, we replicated local underconfidence in OCD patients, which extended to global underconfidence. Importantly, high-compulsive subjects with similar OC symptoms to OCD patients showed diametrically different results, showing overconfidence. The generalizability of findings relating psychiatric symptomatology to (meta)cognitive measures to patient samples is thus not straightforward.

Guidance of eye movements by animate versus inanimate object images in the absence of visual awareness

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

It has long been recognised that images suppressed from visual awareness nevertheless have perceptual and behavioural effects. Complementary eye gaze data demonstrated that in the absence of visual awareness, content-specific images, e.g. emotional faces can guide oculomotor responses differentially according to emotional expression (Vetter, Badde, Phelps & Carrasco, 2020, eLife). Here we investigated whether images along the animate/inanimate distinction would differentially guide oculomotor responses in the absence of visual awareness, too. Since sensory information occurs mostly multimodally in the natural environment, we also tested whether naturalistic sounds congruent or incongruent to the suppressed image affected threshold-level visual processing and its contingent oculomotor responses. Using continuous flash suppression, we suppressed static images of human hand clapping and inanimate motorcycles from observers' awareness while simultaneously presenting image-congruent or -incongruent sounds or no sound. We thresholded image contrast level individually. Participants completed 2AFC tasks on image position and image category (objective measures of awareness) and rated the image's visibility (subjective measure of awareness). Meanwhile, we tracked observer's eye movements, and analysed the changes in gaze position during image presentation. Under successful visual suppression, as indicated by the behavioural measures, preliminary results showed that eye gaze rested more on animate human hand images than on inanimate motorbike images. Sounds did not show a specific effect on this oculomotor behaviour. Our findings reveal that human hand images attracted gaze more so than images of inanimate motorbikes despite being suppressed from awareness, suggesting that animate/human visual information may be better at guiding oculomotor responses in the absence of awareness than inanimate visual information. This suggests that animacy is a potentially powerful feature that guides eye movements even in the absence of visual awareness.

Talk-To-Me: is it possible to communicate with sleepwalkers during an episode ?

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

We have recently shown that lucid dreamers can respond to stimuli during REM sleep via muscular codes. Does this ability to communicate with the outside world extend to sleepwalkers (SW), who exhibit complex behaviors in slow-wave sleep? Method: In a first step, we contacted 62 SWs who were interviewed about their ability to recall their episodes, frequency of different behaviors during an episode (e.g. shouting, fighting, laughing, opening doors, etc.), and relationship between these behaviors, mental activity, and the environment. In a second step, we recruited 14 sleepwalking patients and tried to trigger episodes during Slow-Wave Sleep with sounds. The aim was to interact verbally with them by asking questions in order to test their live mental functions and consciousness aspects (memory, perception-action, etc.). Results: for the interview, 81.97% of SWs reported having at least one conversation with a loved one during an episode. While 81.25% of the interlocutor's words were perceived as if they were spoken, his or her identity was 47.92% of the time interpreted as a character in the dream. Similarly, responses of the SWs were 72.92% of the time related to the dream scenario (e.g. 'there is a monster') rather than to reality. Exchanges and responses of the SWs were generally related to the dream scenery; 91.07% of the time distressing. The SWs have few memories of their nightly discussions (no memory: 34.48%; feeling of having discussed without content: 52.63%; fragmented memories: 39.47%; memory of the complete discussion 7.89%). In the laboratory, sounds triggered a sleepwalking episode in 7% of cases. During these episodes, we managed to interact once indirectly with a patient. His results suggest that SWs can perceive cues from their environment and converse with a person during an episode. In the laboratory, we have promising initial exploratory results that could lead us to experimentally validate the questionnaire and better understand the functions and brain correlates of a sleeper's dreams. Furthermore, results we obtained allow us to consider several experimental approaches to capture this phenomenon. One of the possibilities would be to study this phenomenon in ecological conditions directly at the home of the SW subjects. The sleepwalking model could in the future prove to be a completely new model of access to the mental contents of the human sleeper and give a better understanding of the different conscious experiences during sleep.

Congruent sounds boost dynamic biological motion stimuli into visual awareness

Stefano Ioannucci (University of Fribourg), Petra Vetter (University of Fribourg)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Several examples in the literature indicate how audio-visual integration may arise during the transition from unconscious to conscious visual perception. Moreover, the spatial, temporal, and semantic congruency between sensory modalities has been shown to shape the resulting perceptual experience. Here we investigated how semantic congruency between action sounds and visual biological motion stimuli influence the transition of visual stimuli from unconscious to conscious states. We suppressed dynamic biological motion videos depicting human actions (rowing, sawing, walking) from consciousness using continuous flash suppression while presenting congruent, incongruent or no action sounds. Visual stimulus contrast was individually thresholded. We measured moving dot detection rate with a 2-AFC task and accuracy of action type categorisation. Preliminary results show that when participants were unable to correctly categorise the type of visual action, they detected dot motion significantly above chance when congruent sounds were displayed. However, dot detection rate was at chance when incongruent sounds were displayed. Such effect was slightly stronger in upright than inverted biological motion stimuli. These results show that congruent sounds can boost biological motion stimuli into visual awareness that remain otherwise suppressed when paired with incongruent sounds. Thus, during the transition from unconscious to conscious visual perception, semantically congruent sounds seem to be sufficiently integrated to thrust visual stimuli into awareness.

Time Tripping: Reductions in asynchronous neural communication supports changes in consciousness induced by LSD

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Introduction, Prediction is posited to play a role in most neurobiological models of consciousness, which necessitates asynchronous feedforward and feedback processing between distributed brain regions. Psychedelic drugs profoundly impact consciousness, which are posited to result from pharmacological perturbations to recurrent processing. Specifically, reduced specificity in feedback (of earlier 'priors') results in an increase in feedforward sensory information processing (through ascending prediction errors). Such models are largely evidenced by instantaneous measures of connectivity, obviating detection of the proposed asynchronous interactions. We developed an approach to quantifying the delay architecture of the brain and have shown that conscious perception is supported by temporally long-range feedback to primary sensory regions. Extending this approach, we investigate asynchronous interactions under LSD. Based on the described models, we predict attenuated feedback into sensory regions over time to support changes in consciousness. Methods , Delayed connectivity mapping was conducted with fMRI data from Carhart-Harris et al. (2016). Fifteen healthy participants with previous psychedelics experience received a 75μg intravenous dose of LSD/placebo in a within-subject crossover design with three scans (rest, music, rest). To map delayed connectivity, activity time series were extracted from 807 brain regions. Voxel-wise delayed connectivity was estimated as the peak of the cross correlation coefficient between each region, and every other voxel in the brain. Region-wise maps were aggregated within participants and conditions prior to group-level linear mixed effects analysis to compare the effects of LSD to placebo. Results , Across conditions, versus placebo, LSD was associated with a significant average ($P<0.01$) decrease in the median lagged connections received by the calcarine gyri (~-6 secs). Similarly, the lag was significantly reduced in the posterior cingulate cortex (~-4 secs) and medial prefrontal cortex (~3 secs less). During music, increases in lags were observed in the left putamen (~6 secs). Discussion , Using asynchronous measures of functional connectivity, we show that primary visual and 'default mode network' (DMN) hubs are receptive to prior information from the rest of the brain over shorter timescales under LSD. In neurobiological models of psychedelics, the DMN is a source of high-level priors whose diminishment disinhibits feedforward information flow from sensory cortices. Our results support a comparable view in that both sensory and DMN regions are receiving less long-term, long-range information, suggesting diminished or altered constraints on sensory cortices, underlying associated changes in consciousness. More generally, our results support claims that LSD alters recurrent connectivity across the cortical hierarchy, and emphasizes time; a neglected element in extant theories of the neurobiology of consciousness.

Disentangling EEG correlates of consciousness and attention. The effects of cueing on detection, identification and ERPs.

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

It seems evident that in everyday situations consciousness without attention is an exception, rather than a rule. In this view, conscious access and selective attention are related but separable concepts. What is more, the multifaceted nature of attention makes it unlikely that different attentional mechanisms bear an identical relation with consciousness. Therefore, based on the well-established theoretical models of attentional mechanisms, we conducted a study which allowed a more detailed investigation of how different aspects of attention are related to perceptual consciousness. The aim of the present study (N=96) was to explore how the orienting and alerting mechanisms of attention, as defined by the Posner model, are related to the objective identification and subjective awareness of a visual stimulus, and to the putative early and late NCC represented by VAN and LP, respectively. To this end we used the Posner task in which a threshold level Gabor patch was presented as a target stimulus. The attentional cue was a black star. In every trial we asked participants to judge both orientation of the Gabor and rate the intensity of their awareness using the Perceptual Awareness Scale. We recorded EEG signals when participants performed the task. Behavioral analyses show that attentional cueing affected the accuracy level, and PAS ratings: the lowest accuracy and PAS ratings were observed at no cue condition; central and multiple cues resulted in higher accuracy and PAS (similar effects of both cues); and location cue was associated with highest accuracy and PAS. Additionally, relation between accuracy and awareness was consistently affected by attentional cueing, where cues increased accuracy itself but also caused higher correlation between awareness and performance, With regards to the ERP analysis, attentional cueing did not modulate VAN amplitude beyond the effect explained by variability in accuracy and PAS. We did not observe significant interactions between cue and PAS, as well as cue and accuracy on VAN. However, both PAS and accuracy did significantly influence VAN amplitude. Interestingly, though, only a location cue significantly influenced VAN, but its amplitude was reduced. These results might suggest that the VAN component is not susceptible to attentional manipulations. In addition, results suggested that the P3 component is sensitive to cueing and its amplitude is differentiated by the level of both objective and subjective tasks performance. Moreover, the effect was reduced for location cue similarly to VAN effects. Reduced effects of location cue on VAN and P3 might indicate that participants were expecting a stimulus, as in the location cue condition amplitudes were higher before the stimulus but the relative increase after an aware stimulus was the weakest.

Neural precursors of spontaneous decisions reflect general preparation to act rather than decision content

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Motor related cortical potentials (MRCP) in spontaneous actions, such as the readiness potential (RP), have been a key signal of interest in electro-encephalographic (EEG) volition research and the free-will debate. These MRCPs typically precede spontaneous movement onset by one second or more. In the case of the RP, the signal onset can be much earlier than the participants' reported time of conscious awareness of their decision to move, even when participants are instructed to be as spontaneous as possible. This has led many to claim that consciousness has no causal role in spontaneous actions. But it also suggests that, while spontaneous decisions might feel unprompted and abrupt, they may not be so at the neural level. The goal of our study was to empirically test the extent to which spontaneous movements were spontaneous at the neural level. We therefore asked participants to spontaneously decide what movement to make—either a left- or right-hand button press—at a pre-ordained time, under 3 experimental conditions, while we recorded EEG. (1) Instructed (the button to press was dictated by the pre-cue); (2) preplanned decision (participant decides in advance); and (3) spontaneous (participant waits until the last possible moment to decide). Using machine learning, we first tested which subjects had above-change left/right decoding accuracy before movement onset (9 out of 20 subjects). For those subjects, the instructed and preplanned decisions could be decoded about 600 ms before movement onset. In contrast, the spontaneous decisions were only decodable about 200 ms before movement onset. This suggests that predictive information exists in the human brain 200-600 ms before movement onset and that spontaneous decisions are also neurally more spontaneous than preplanned or instructed ones. Importantly, these results held even for subjects who exhibited MRCPs onsets 1s or more prior to their button presses. Under the reasonable assumption that the MRCPs convey no additional neural information on top of that available to EEG decoder, the much earlier onsets of MRCPs compared to the onset of predictive information in the brain suggests that the early MRCPs at best contain non-specific information about the movement, perhaps reflecting a general readiness to move.

State-based and event-based mechanisms of awareness of action

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Loss of awareness of action (AoA), the ability to recall and describe complex motor actions just performed, is a common phenomenon in everyday experience. We hypothesize that long-term, state-based mechanisms, and transiently changing, event-based mechanisms characterize the loss of AoA. Here, we probe differences in static mechanisms through long-duration blink metrics, and differences in dynamic mechanisms through event-related potentials in EEG and post-action saccades. We employ an experimental paradigm based on the classic move-based board game Rush Hour. As subjects (N=50) play the game, subjects are intermittently shown a quiz asking which move they just performed in a multiple choice question. After answering, subjects indicate their confidence in their choice on a sliding scale. We consider correct and high confidence (>75th percentile within subject) answers to indicate the presence of AoA, and incorrect and low confidence (<25th percentile within subject) answers to indicate the absence of AoA. Long blinks (400-1000 ms), have been noted to indicate drowsiness and overlap microsleep, and we investigated them as a state-based metric. We investigated these in the seconds prior to the action. Long blink onsets showed a transient increase in the three seconds preceding an action in actions without AoA (mean 0.52 long blinks/sec) compared to those with AoA (mean 0.26 long blinks/sec). In the EEG domain, the execution of a move was preceded by a robust readiness potential, and the subsequent disappearance of the board elicited a series of ERPs. Readiness potential onsets differed between moves with and without AoA, while post-action N140 (somatosensory awareness potential) and P300 were decreased in amplitude for moves without AoA. This link to somatosensation and attention demonstrates interplay of the two in forming AoA. Lastly, post-action saccade rates for unaware actions are greater than for aware actions, indicating that AoA loss may be in part caused by transient shifts in attention. In conclusion, clear state-based and event-based differences characterize actions with and without AoA. These can be seen in increased long blink onsets, changes to readiness potentials, differences in ERP amplitudes, and increased saccade rates in unaware actions. Further study of AoA with functional neuroimaging will help elucidate the neuroanatomical origins of these diverse signals.

Identification of task-relevant information but no control of selective spatial attention for unconscious information

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

A critical aspect of working memory is that it serves goal-directed behaviour, requiring the capacity to identify and appropriately use task-relevant information while avoiding distraction. This goal-directed behaviour is ensured by attention and it is traditionally assumed to require conscious awareness to be successfully implemented. An important question is whether appropriate attentional control can occur also with unconsciously presented stimuli. In this study we tried to answer whether the control of attention, manipulated with valid/invalid spatially predictive cues, would affect the prioritization of task-relevant unconscious information. Thirty-two right-handed participants performed a delayed match-to-sample task, while brain activity was measured with fMRI. The goal of the task was to remember the spatial location of a target stimulus that was always presented simultaneously with one distractor. A cue shape indicated what was the relevant target. Also, a letter "L" (left) or "R" (right), inside the cue shape, indicated the more probable side (~80%) of the target and was used to manipulate endogenous attention to one of the two sides. Continuous flash suppression (CFS) was used to manipulate the conscious/unconscious visual experience of the stimuli (target and distractor). For conscious stimuli, performance was well above chance level but was significantly worse for invalid cues. FMRI BOLD signal change for conscious trials was modulated by cue validity in prefrontal and parietal regions. This is consistent with previous findings which have attributed particular importance to parietal cortex when redirecting of attention to stimuli that have been outside the focus of processing is required, such as invalidly cued targets. By contrast, above-chance performance for unconscious stimuli was seen only for valid-cue trials. BOLD signal change for unconscious trials was significant in visual and frontal brain areas but was not modulated by cue validity. Overall, these results indicate that identification of task-relevant information can operate also on unconscious stimuli. However, they did not provide support for flexible control of selective spatial attention of unconscious task-relevant information, possibly due to a failure to activate parietal regions.

What is it like to be a person with advanced dementia?

Jason Karlawish (University of Pennsylvania), Andrew Peterson (George Mason University), Melanie Kleid (University of Pennsylvania), Kristin Harkins (University of Pennsylvania), Cameron Coykendall and Justin Clapp

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Significance: Individuals with advanced dementia have marked impairments in communication. However, case reports and survey studies suggest these persons can exhibit episodes of improved consciousness and mental clarity. This unusual behavior, called “paradoxical lucidity,” may upend assumptions about consciousness in persons with a disease assumed to destroy the mind. The clinical features of paradoxical lucidity are poorly understood. In this qualitative study, we interviewed caregivers of persons living with dementia (PLWD) to investigate the nature, frequency, and impact of paradoxical lucidity. Methods: Semi-structured, in-depth interviews with 30 family caregivers (70% partner/spouse) for 29 PLWD (MMSE less than 12; dependent IADLS; impairments in BADLS) caused by a neurodegenerative disease. The interviews assessed whether caregivers had witnessed behavior that conforms to a provisional definition of paradoxical lucidity and elicited descriptions of these episodes. Results: 33 lucid episodes were described across 25 interviews. The majority of episodes (n=21) were reported to last seconds and consisted of single utterances of a word or phrase, gestures, or facial expressions, while the others were reported to last a few minutes. 23 episodes involved utterances. Most commonly (n=14) these verbal episodes were deemed unusual because of their appropriateness to context: e.g. the PLWD accurately used a proper name of a relative. In 4 verbal episodes, interviewees described the PLWD producing language that was unusually sophisticated relative to their level of impairment. 13 lucid episodes involved nonverbal actions, such as eye contact. Caregivers interpreted lucid episodes as evidence that the PLWD retained or temporarily regained a range of mental capacities. For instance, many lucid episodes led caregivers to believe that the PLWD could temporarily remember and recognize specific people or animals. In other cases, a PLWD’s unusual behavior in a social situation evinced to caregivers a heightened capacity to understand the emotions and intentions of others. In a few instances, caregivers described unusual episodes that suggested to them their relatives were able to form and pursue goals. Caregivers’ emotional reactions to lucid episodes were typically positive. Witnessing a lucid episode generally did not cause caregivers to change their relatives’ medical care. Conclusions: Episodes of lucidity are an avenue to investigate consciousness in persons with advanced-stage dementia. In our sample, reported episodes of lucid communication were common. “Paradoxical lucidity” thus may not be paradoxical. The behaviors displayed were notable for their appropriateness to subtle contextual cues, not for the clarity or complexity of linguistic utterances. These episodes impact caregivers’ perceptions of consciousness in PLWD and may recast how we understand neurodegenerative diseases such as Alzheimer’s.

Uncertainty-oriented active sampling for motor learning results in unconscious confirmatory motor behavior

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

When tasked with maintaining the pitch percept of a self-produced sound stable in the face of random experimental disturbances applied to the acoustic feedback, in some cases, subjects involuntarily produce unconscious motor responses that follow rather than oppose the disturbance, therefore exacerbating rather than compensating it. Since such following responses are counterproductive for the task in the short term and often remain unconscious, we hypothesize that they serve motor learning and reflect an active sampling strategy for system identification. In a manual pitch control task, we show that following responses are most likely to occur when the perceived pitch motion resulting from an external perturbation appears to be in the opposite direction of what, under the established sensorimotor law, would be expected from a simultaneous causal action. In a series of simulations of motor learning under ergodic and non-ergodic disturbances in a stabilizing and in a tracking task, we demonstrate that active learning based on an uncertainty-oriented sampling policy outperforms passive "observational" (batch) learning in terms of a trade-off between maintaining a stable sensorimotor law in the face of external disturbances and adapting to consistent changes in the environment. This active learning strategy can account for the observed following responses under two conditions: First, that the controller learns an inverse model that maps from desired outcomes to necessary actions, rather than the more commonly assumed forward model that maps from actions to expected outcomes; and second, that the errors relevant for learning are defined in the action space, that is between the executed actions and those predicted from the observed outcomes. This leads to sampling regions of uncertainty in the outcome space under the learned sensorimotor model. The resulting following responses are confirmatory because they test whether an observed (but unintended) pitch effect can still be produced with the established sensorimotor law, rather than probe whether different actions might result in the same effect. These findings have implications for our understanding of motor learning and control and further let us speculate that learning more generally might often rely on errors in predicting the past rather than the future.

The altered mind: is increased synergistic information processing driving ketamine's anti-anhedonic properties?

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm, At subanesthetic dose, ketamine induces altered states of consciousness and increases measures of complex brain dynamics. Typically, these measures rely on connectivity analyses using bivariate correlations failing to uncover higher-order – yet biologically more plausible – dependencies. Partial entropy decomposition enables the detection of these higher-order dependencies and disentangles the observed information into redundant and synergistic parts, of which the latter has been shown to be specifically modulated by altered states of consciousness. The still poorly understood rapid antidepressant and anti-anhedonic action mechanism of ketamine might be linked to its modulation of precisely these higher-order dependencies, reflecting a breakup of engrained connections inducing acute alterations in the state of consciousness, and thus, facilitating a breakout of rigid behavioral patterns long-term. Focusing on ketamine's manipulation of the hedonic tone, we investigate the link between alterations in the conscious experience and complex information processing. We use ketamine to alter the state of consciousness and music to manipulate the hedonic response in 30 neurotypical subjects and 25 patients with anhedonia – clinically defined as the inability to feel pleasure – diagnosed according to ICD-10. The full within-subject design consists of 4 sessions; baseline, two treatment sessions (ketamine and placebo) counterbalanced across subjects, and a follow-up session. Four hours after administration, to assess the subacute state in which the beneficial effects start to emerge, participants complete a battery of standardized assessment scales (e.g. 5-Dimensional Altered States of Consciousness and Dimensional Anhedonia Rating Scale) as well as a resting-state scan and an aesthetic task using fMRI. The aesthetic task consists of self-selected highly moving and neutral music to examine ketamine's effect on the hedonic tone. Participants rate the induced experiences based on 3 dimensions: aesthetically moving, aesthetic chills, and valence. Here, we present a preliminary data-set for the neurotypical subjects only, evaluating whether ketamine increases synergistic information processing, implementing linear mixed effects (LME) models with the within-subjects factors of Treatment (ketamine & placebo) and Timepoint (treatment session 1 & 2). Using data from the aesthetic task, we probe whether altered synergistic information processing is associated with ketamine's modulation of the hedonic experience and what role altered states of consciousness play in this relationship implementing LME models with additional factors of Hedonic Experience and Altered States. Preliminary data shows that ketamine increases the hedonic experience. Further findings will shed light on the role of the altered mind and synergistic information.

Is my "red" your "red"?: Unsupervised alignment of qualia structures via optimal transport

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

The question of intersubjective equivalence of sensory experience is a central concern in the study of consciousness (e.g. is my “red” your “red”?). Some researchers consider the question impossible to determine due to the intrinsic, ineffable and private nature of subjective experience. Though direct description of our experiences for intersubjective comparison may be impossible, indirect characterization of experience is empirically possible. For instance, we can collect reports of subjective similarities between sensory experiences to obtain their similarity relationships (Tsuchiya & Saigo, 2021), named “qualia structures” . Intersubjective comparison of qualia structures may enable us to assess the degree of similarity of sensory experiences across individuals. However, conventional methods for comparing the similarity relationships assume that experiences elicited by the same stimuli are matched across individuals, precluding the possibility that my ”red" might be your “blue". Here, we present an unsupervised method for assessing the similarity of qualia structures without assuming correspondence between individuals. Our method is based on Gromov-Wasserstein optimal transport (GWOT), which finds an alignment between items in two domains based solely on distance relations within each domain (Memoli 2011) and has shown great success in unsupervised language translation (Alvarez-Melis & Jaakkola 2018). As a case study, we collected a large scale dataset of color dissimilarity judgements and analyzed if optimal correspondence solutions agreed with objective stimuli labels. Dissimilarity judgements for 93 colors from 426 neurotypical and 207 color-blind participants were collected via online crowdsourcing service. We divided the neurotypical participants into five groups and applied GWOT to find optimal alignments between them. We found that color qualia structures of neurotypical participants can be “correctly" aligned across groups based solely on similarity relationships. In contrast, color qualia structures from color-blind individuals could not be aligned to neurotypicals. Our results offer quantitative evidence of the interindividual structural equivalence or difference of color qualia, implying that a neurotypical person’s “red" is indeed another neurotypical’s “red", but not a color-blind person's “red". This method is applicable to any modality of experience, enabling general structural exploration of subjective experiences.

Modeling Visual Illusions with Autoregressive Recurrent Neural Networks

T. Anderson Keller (University of Amsterdam), Max Welling (University of Amsterdam)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

In the early 1800s it was discovered that images displayed in quick succession will induce an observation of apparent motion between the static images [Roget 1825, Plateau 1833]. This ‘curious optical deception’ resulted in the development of the phénakisticope, one of the first devices leveraging the stroboscopic effect to create animation, and is ultimately implicated in the effectiveness of moving-picture film. Existing computational models describe this phenomena at a mechanistic level through specific neural circuit implementations [Leonhardt 2017, Fitzgerald 2011]. While such models are realistic and effective for describing these illusions in insects with known simple circuitry, it is possible that these ‘hard-coded’ mechanisms do not accurately represent the more sophisticated and flexible visual systems of mammals. In this work, we instead propose to use a more general modern autoregressive recurrent neural network (RNN) to model such phenomena by training the network in a setting inspired by predictive coding [Huang & Rao, 2011]. Specifically, we train both a standard autoregressive RNN and a more recent biologically relevant autoregressive model (Neural Wave Machines [Keller & Welling 2023]), to predict the next frame for simple image sequences, and indeed demonstrate that such models appear to exhibit a similar form of illusory motion in their predicted outputs. In detail, we present the models with a dataset of image sequences where half of the sequences contain images of simple sinusoidal motion, while the other half contain static sinusoidal gratings. During training, the models are tasked with predicting the next frame in the sequence. During testing, we present only an initial static frame (from time t=0), followed by a black frame, and then a sequence of static frames (from time t=2). By examining the predicted next frames of our models in the test setting, we observe that all tested autoregressive models appear to infer motion in the intermediate blank frame, and furthermore appear to temporarily ‘overshoot’, predicting continued motion in a few subsequent frames despite being provided a static stimuli. While it is difficult to exactly match the experimental conditions of our model to those used in human trials, and thus our results must be considered conditionally, we believe that such models may provide another valuable modern computational avenue for exploring the perceptual phenomena of illusory motion and representational momentum [Freyd & Finke 1984]. Furthermore, in future work, given that Neural Wave Machines have been shown to exhibit complex spatiotemporal dynamics such as topographic organization and traveling waves [Keller & Welling 2023], we plan to study the abilities of such models to reproduce more complex geometric visual hallucinations previously connected to both traveling waves and such topographic connectivity [Bresloff et al. 2000].

Experimental investigation of the dynamics of spontaneous thoughts

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The question of how thoughts unfold in time has recently been the object of renewed interest both from a theoretical and empirical perspective (e.g. Mildner & Tamir, 2019, Andrews-Hanna et al. 2021; Sripada & Taxali, 2020). We approached this question using more or less constrained word generation tasks, under the assumption that such tasks can closely reflect the dynamics of spontaneous thoughts. We focused on individual differences: our main hypothesis was that more inattentive participants have a more segmented stream of thought that could result from a general tendency for exploration. Our participants (N=56) completed three tasks: In the free condition, the instruction was to say the words that spontaneously came to mind, following an initial neutral seed word; In the simple fluency condition they had to name items belonging to a given category (e.g. “fruits”); In the double fluency condition, they were instructed to name items belonging to one or the other of two target categories (e.g. “sports & animals"). Each participant completed four 3-minute series of each condition, with different target categories or seed word in each series. At the end of the experiment, participants were presented with a list of the words they had produced in the free condition, and were asked to identify the groups of words that “belonged together”, for them, at the moment when they were produced. In addition, they filled out the ADHD Self-Report Scale (ASRS, Adler et al. 2006) to assess their level of inattention as a non-clinical trait. Results show that more inattentive participants used the two categories more equally in the double fluency condition, suggesting a more systematic exploration of the semantic search space. We also found that participants with higher scores on the ASRS exhibit smaller groups of words in the free condition, suggesting a more segmented stream of thought. In addition, participants with more clusters in the free condition had more switches between the two categories in the double fluency condition, when controlling for the total number of words produced. These results suggest that both the segmentation of the stream of thought and the bias in favor of exploration in semantic searches increase with higher scores on a scale of inattention. We discuss the relationship between these two effects in light of the current cognitive and neural research on the stream of thought.

The sense making sense hypothesis

Brian Key (The University of Queensland), Deborah Brown (The University of Queensland)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Our everyday intuitions inform us that feelings motivate behaviour. We drink water when thirsty, we rest when tired, and we move out of the hot sun to feel cool—these are some of the things feelings prompt us to do. But did feelings evolve to cause behaviours, or does it only seem like they did? Moreover, does it really matter what additional roles they may have if the seeming is good enough for us to function normally? We argue that yes, it does matter. If it only seems like feelings are controlling behaviour, then target inventions that modify behaviour may be ineffectual in correcting abnormal feeling states. Joseph LeDoux has previously proposed that the feeling state of fear does not directly control fear behaviours but is instead generated independently by cortical circuits not directly related to behaviour. What then is the function of fear in such a model? Is fear merely an epiphenomenon, a by-product of underlying neural processing that adds nothing to the causal power of those mechanisms? We propose here to explore the hypothesis that subjective experience (specifically, feelings) has a function, but one radically different from that currently supposed in both philosophy and evolutionary biology. We submit that a subjective experience (such as fear) is a subject's explanation rather than cause of their behaviour. In other words, sensations are the brain's way of making sense of what it is doing, which we refer to here as the 'sense making sense' hypothesis. What evidence is there of the sense making sense hypothesis and what evolutionary function might it serve? The cutaneous rabbit illusion is a simple, yet powerful demonstration of the brain making sense of what it is doing. When proximal and distal points on the arm are alternately tapped, feelings of intervening taps hopping along the arm between these two points are experienced even when no such taps occur. The brain appears to be explaining to itself why it should be feeling two alternating taps by inferring that something is happening in between. That inference presents itself consciously to the subject as a somatosensory feeling of hopping taps. While this is an obvious illusion, in general, the brain seeks to make sense of its behaviour in terms of its feelings, in effect, by deceiving itself about the causal role of its subjective experiences, with benefits to the subject's sense of integrative behaviour.

fMRI-based decoding approaches to test contradicting predictions of global neuronal workspace and integrated information theory

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Understanding mechanisms of conscious perception is one of the greatest challenges in the field of neuroscience. Many theories explaining the relationship between consciousness and brain activity have been developed in parallel without established protocols to contrast their predictions. We developed a multisite adversarial collaboration aiming at arbitrating between two major theories of consciousness, Integrated Information Theory (IIT) and Global Neuronal Workspace theory (GNW). Two experiments were designed to test GNW and IIT predictions and data were collected using three different neuroimaging modalities including functional magnetic resonance imaging (fMRI), Magneto-Electroencephalography (M-EEG), and intracranial electroencephalography (iEEG). In this work, we focus on testing the decoding predictions of GNW and IIT using fMRI data collected while subjects (n=72) are performing the first experiment in which clearly visible visual stimuli belonging to four stimulus categories are presented either as task-relevant or task-irrelevant content. GNW posits that information about the content of experience should be present both in the prefrontal-parietal network and high-level sensory cortices implying consistent decodability of the content of experience in these regions. As for IIT, an experience is a structure presumed to be primarily located in posterior cortex. Thus, for IIT the contents of consciousness should be maximally decodable from posterior areas. To test the decoding predictions of GNW and IIT, stimulus category and orientation were decoded in the task-relevant and task-irrelevant conditions separately. In addition, generalization of decoding from task-relevant to task-irrelevant conditions and vice versa was tested. We used a multivariate pattern analysis (MVPA) approach to identify regions that contain information about stimulus category and orientation. A linear support vector machines (SVMs) classifier was trained to discriminate between the different stimulus categories/orientations based on the pattern of BOLD activity over voxels. To obtain the features to be inputted to the classifier, non-spatially-smoothed parameter estimate maps were obtained per trial by fitting a GLM with only one trial as regressor of interest and all remaining trials as one regressor of no interest. Decoding was performed using a whole-brain approach and an ROI-based approach. The whole-brain analysis was performed using a searchlight approach with 4 mm radius. Decoding ROIs were defined based on functional fMRI contrasts and constrained with anatomical ROIs identified by GNW and IIT opponents as reflecting their predictions. For both decoding approaches, statistically significant ROIs/voxels were identified and the corresponding average accuracy across subjects was calculated and displayed on a group accuracy map.

What's the Best Way to Know Oneself? The Role of Internal and External Feedback on Metacognitive Enhancement

Kristen Kilgallen (Northeastern University), Jorge Morales (Northeastern University)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The role of self-awareness in controlling our cognitive processes has been long debated. Here, we reflect upon the roles that internal monitoring and external feedback have on metacognition, specifically attempts that leverage external feedback to attain self-knowledge. Despite external cues (e.g. feedback, reward) being an efficient way to improve learning, we argue that internal monitoring remains a crucial dimension of self-knowledge, which often remains impervious to external feedback. Metacognition is the capacity to monitor and control one's cognitive states (Fleming & Lau, 2014). When you read the pages of a book, besides their being 'something it is like' to perceive the words, you can assess whether you accurately remember those pages, a form of meta-memory. But without the book, and as the only one with cognitive access to your memory, how can you be sure? Are feelings of confidence the only way to assess and improve awareness of our mental states? Feedback is a powerful tool for boosting learning and performance. For example, reinforcement learning—where animals get rewarded based on their behaviors—is quite effective (e.g. Dayan & Niv, 2008). Given that feedback boosts performance in external tasks and domains, it would be reasonable to expect that it also improves an internal domain like metacognition. However, training metacognitive sensitivity has proved difficult to achieve. In a perceptual decision-making task, feedback had no effect on metacognitive sensitivity even after seven days of training (Haddara & Rahnev, 2022). There was a reduction in metacognitive bias, but it did not transfer to a similar task, suggesting there was no metacognitive learning (see Rouy et al. 2022). In another study, external labels (feedback) indicating trial difficulty were insufficient for changing subjects' response strategy. Only when an experience of metacognitive conflict was felt independently of the explicit difficulty label did subjects incorporate this information into their future behavior (Questienne et al. 2016). Unlike reinforcement learning for task performance, in which external feedback alone is often enough for improvements, external feedback is ineffective at enhancing metacognitive sensitivity and control. In other words, how we learn about ourselves and how we monitor our cognitive states matters. These and other results may explain why some forms of feedback lead us to update our strategies, while others just don't 'click' and we persevere in old behavior. Importantly, reflecting on our mental states can produce signals that are picked up by those same metacognitive mechanisms to both sharpen themselves and improve external behavior. This opens an empirically-testable possibility to researchers: while external feedback may not help train metacognitive sensitivity directly, we could find specific ways in which monitoring our own states functions best as a kind of internal feedback, thus enhancing metacognitive capacity.

Modeling and Predicting the Attention of Other Individuals

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

It is known that people track the attention of others, often by tracking gaze. In a recent set of experiments, we found evidence that people do more than simply track attention -- they actively model and predict the attention of others using a variety of cues (spatial patterns, temporal patterns, likely objects of attention). It is unclear, however, whether people construct a single, general model of how all agents move attention, or whether people construct many, unique models in order to predict the unique attention habits of familiar agents. We have begun an experiment to investigate this question. The experiment uses gaze data collected from human participants freely viewing complex images. From that data we created a library of 3-sec videos showing a light-colored blob of attention moving about a background image. These videos are then used as experimental stimuli to test a separate pool of subjects. In each trial, a subject is presented with two videos in series. One shows the attention of individual A scanning a picture, and the other shows the attention of individual B. After viewing both videos, the subject is asked to discriminate whether individual A was shown first or second. After the trial, the subject receives immediate feedback as to whether the response was correct or incorrect. The next trial then shows another pair of videos, providing another example of individual A and B scanning a picture, and once again the subject must choose which video represents individual A. Over the course of 70 trials, given the trial-by-trial feedback as a training signal, can subjects learn to discriminate the characteristic attentional patterns of individual A from those of individual B? If, over time, performance improves significantly above chance, then the subjects will be demonstrating an ability to construct a model of attention that is specific to individuals. If, in contrast, subjects never learn to make the discrimination above chance levels, then they are evidently not able to construct individual attention models targeted to specific individuals. The experiment has just begun and we do not yet know the result. The relevance of this experiment to consciousness lies in theories, such as the Attention Schema theory, that relate social attention to consciousness. In those theories, we attribute consciousness to others partly by building models of the attentional state of others. To assess such theories, it is crucial to understand how people model the attention of others, and how rich, detailed, or person-specific those models might be.

Computing Conscious Experience: Reinforcement Learning, Neuromodulatory Systems, and Dynamic Changes in Phenomenal Experience.

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

We seek a theoretical account of ‘how conscious phenomenal experience comes to be’. Such a theory should be founded in neurobiological and behavioral data and ought to yield engineerable solutions for the spectrum of psychiatric and neurological burdens that plague human mental (and physical) experience. Recent advances in the ability to monitor dopamine release in the human brain (with sub-second temporal resolution) – while participants express adaptive behavior and report how they subjectively feel – suggest a novel hypothesis about how the contents and context of conscious experience come to be laden with subjective value and emotional affect. We hypothesize a “Dynamic Affective Core”, which combines ideas about network representations of the contents and context of experience with signals derived from computational reinforcement learning theory that can add and dynamically modulate the subjective phenomenal value of constantly changing information states. We present a brief overview of the supporting neuroscientific data including our work, which provides the first ever intracranial sub-second measurements of dopamine release in humans. We also discuss the computational principles involved and gaps in our understanding and future directions. We hope to circumscribe the challenges around characterizing the neurobiological mechanisms that give rise to conscious experience in humans and provide a path forward for investigating the spectrum of subjective human experience and associated behaviors.

Single-cell resolution functional networks in mice during NREM sleep are segregated into spatially distributed modules

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

The mechanisms underpinning the decrease in the level of consciousness during NREM sleep remain to be elusive. Previous studies have suggested that the decrease in the level of consciousness is associated with the brain's ability to integrate information. For example, it has been shown that functional networks during NREM sleep are segregated into densely intraconnected but sparsely interconnected modules (Boly et al. 2012, etc.). However, these studies have only examined functional networks on a macro scale, using techniques such as fMRI and EEG, leaving the cellular-resolution functional networks during NREM sleep largely unexplored. Here, to investigate the characteristics of cellular-resolution functional networks, we recorded the activities of approximately 5000 to 10000 neurons from mice during sleep using single-cell resolution and wide-field-of-view two-photon calcium imaging (Ota et al. 2021; Oomoto et al. 2022). The wide field of the view spanning a contiguous 3mm x 3mm area allowed us to probe functional networks composed of multiple brain regions, including somatosensory and motor cortex. We examined (1) the degree of network integration during wakefulness and NREM sleep in terms of modularity and the number of hub-like neurons, and (2) how these networks are organized in terms of the distributions of modules and hubs. First, we found that cellular-resolution functional networks had higher modularity during NREM sleep than during wakefulness. We also found that the number of connector hubs, which have connections with neurons belonging to different modules and contribute to module integration, was smaller, and the number of provincial hubs, which have connections with neurons within the modules and contribute to module segregation, was larger during NREM sleep. Second, we found that these modules were spatially intermingled; nearby neurons did not necessarily belong to the same module and distant neurons sometimes did. We also found that connector and provincial hubs were almost evenly distributed across different regions. These findings indicate that functional networks at the cellular level during NREM sleep are more segregated into modules compared to wakefulness, yet these modules are scattered in a mixed pattern. This differs from the established observation of functional networks on a macro scale, where modules are spatially localized. Our results provide novel insight into the cellular-scale organization of functional networks during altered states of consciousness.

Predictions about stimulus depth only partially explain why real objects are prioritized over their photographs in access to awareness

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The scope of our (visual) consciousness is limited, so incoming perceptual information must be filtered upon entering awareness. One approach for better understanding this filtering mechanism, is to examine the time it takes different stimuli to emerge to awareness when suppressed by masking techniques. For example, studies have shown that stimuli which match our expectations overcome suppression more easily (e.g. upright faces vs. inverted ones). In previous works, we showed that actual, tangible objects placed in front of participants escaped “real-life” Continuous Flash Suppression (“real-life” CFS) faster than their 2D photographs, but only when these objects were familiar. In a series of carefully planned replication experiments, we asked whether this result might be explained by the expectation to perceive such stimuli in 3D as opposed to 2D form. The results further strengthened the finding of real objects overcoming suppression more easily than their photographs. However, a mixed pattern was found for stimuli which are commonly experienced in 2D - letters, words and logos - either showing no difference in suppression times or faster emergence of their 2D form. These results call for further inspection of the role of expectations about depth in access to awareness, and also highlight the importance of replication attempts for novel findings, especially for complex and novel paradigms.

Extended self: neural correlates of self-face and personal objects perception

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Recognizing own face and personal belongings is a crucial ability in everyday functioning. While perception of self-face has been widely investigated, few studies have examined neural correlates of self-ownership effect, and the results are scarce. It therefore remains unclear whether the process of differentiation between mine and others rely in both cases on the same neural circuits and mechanisms. The aim of this EEG/fMRI study was to determine the common (domain-general) and stimulus-specific neural underpinnings of self-ownership and self-face perception. Participants performed a detection task with pictures of faces and objects from two categories: ‘mine’ and ‘not mine’. Prior to the study participants provided pictures of faces and personal objects. The task was completed in two separate sessions: the EEG was recorded during one session (N=37) and fMRI scanning was performed during second session (N=30, all thirty participants took part in the EEG session). The event-related potential (ERP) results analysis showed differential self-related effects in early visual processing. The earliest self-face effects were found already in the visual-evoked P1 and N170 components, whereas the largest self-ownership effect was found in a posterior visual P2 at about 200-300 msec after stimulus onset. This indicates that self-related differentiation of faces and objects begins at visual stages of processing, although self-face detection is notably faster. The fMRI results showed, firstly, the typical differences between faces and objects in the fusiform visual areas; secondly, stronger activations for self-relevant stimuli throughout the ventral visual stream, particularly in the fusiform, anterior temporal, and prefrontal areas of the right hemisphere. Although self-face related activations were generally more pronounced than self-ownership effects, we identified several areas common to both stimulus categories. In particular, we observed activity in the right inferior frontal gyrus, which may indicate an engagement of anterior areas of the core system for face perception, presumably representing the convergence of the ventral and dorsal face processing pathways. Moreover, we found self-related activity in the ventro-medial prefrontal cortex, which has been previously shown to be involved in self-referential processing.

Dissociative Theories of Consciousness: EEG Decoding During a Sperling Task Variant

Lara C. Krisst (Caltech), Gerardo Viera (University of Sheffield), Jennifer Lee (NYU), Trey Boone (Duke), Steven J. Luck

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

According to dissociative theories of consciousness (Block, 1995; 2011), there is a distinction between access consciousness and phenomenal consciousness. As a result, these theories are compatible with the phenomenal contents of experience overflowing what we can actively report or use to guide intentional action. Such theories pair naturally with neural theories that align consciousness with local recurrence in early sensory processing (Lamme & Roelfsema, 2000). On the other hand, according to non-dissociative theories of consciousness (Cohen & Dennett, 2011), phenomenal and access consciousness cannot come apart, and therefore, phenomenal overflow is impossible. These theories pair naturally with neural theories that align consciousness with globally broadcast content (Dehaene & Naccache, 2001). In this paradigm, a retrocue postdictively influences the perceptual information subjects can report. Dissociative theorists maintain that because the cue comes after the stimulus array, it cannot influence what subjects are phenomenally conscious of. Non-dissociative theorists, by contrast, maintain that the retrocue actively reshapes and determines the content subjects become aware of. For instance, non-dissociative theorists may maintain that perceptual content is vague or gist-like prior to the retrocue, which then serves to make content more precise in the process of also making it available for access. In this paper, we report on findings from a novel EEG decoding study using a modified Sperling display. Subjects were presented with a circular array of six letters around a central fixation for 50 ms. After array offset, a retro-cue appeared indicating which letter subjects should remember over the delay period. Continuous whole-scalp EEG was recorded during cued and uncued conditions. Our innovative design allows us to better understand whether the retro-cue is simply selecting from precise perceptual representations or making imprecise perceptual representations more precise. Dissociative / local recurrency theories predict that perceptual processes represent these features with high precision prior to attentional amplification, and therefore, EEG decoding for the individual letters should be maximized relatively early at around 150 ms when local recurrency supposedly takes hold. By contrast, non-dissociative / global neuronal workspace theories, should predict that decoding for individual letters will be maximized after retro-cuing when the initially imprecise letter representations are made precise and transmitted into the global workspace at around 350 ms. Our results are consistent with the latter. Preliminary results reveal an increase in decoding accuracy at ~350 ms in the retro-cueing condition as compared to the uncued condition, which remains at chance for the length of the trial interval. By measuring when decoding for letters is maximized, we can adjudicate this central aspect of debate between these theories using neural data.

Neural Correlates of the Embodied Sense of Agency: A Pre-registered EEG Study

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The Sense of Agency (SoA) is the feeling of control over our actions, and is a fundamental mechanism allowing self-other segregation that rarely reaches consciousness. It has been suggested that SoA relies on an early implicit comparing mechanism, continuously evaluating the congruency between the predicted sensory consequences of an action and the perceived afferent signals ("Feeling of Agency"), and a late explicit judgment mechanism, incorporating one's thoughts and beliefs ("Judgment of Agency"). Thus, the formation of SoA depends on the interplay between these low- and high-level mechanisms, and previous studies in our lab showed that while sensitivity to conflicts between actions and their visual consequences varies between different sensorimotor aspects, it is highly correlated between aspects. In spite of the importance of the SoA mechanism in nearly all of our interactions with the world, its underlying neural mechanism has yet to be studied extensively. In the current pre-registered EEG study, we used time-frequency and Multivariate Pattern Analysis (MVPA) to investigate the electrophysiological characteristics associated with SoA. To accomplish that, we used an established virtual reality, embodied SoA paradigm in which visual feedback of a finger movement is modulated to examine the effect of either a match or a mismatch between the expected and actual sensory feedback. Participants were presented with an anatomical or a spatial alteration (different finger or angular shift, respectively) and were asked to rate their SoA over the observed movement, while their brain activity was recorded using EEG. In accordance with our pre-registered hypothesis, we found that a reduction of SoA (reflected in participants' ratings) is associated with decreased attenuation in the alpha frequency band. Importantly, we also show that trials in which participants reported having SoA vs. not having SoA, can reliably be decoded with up to 68% accuracy starting around 200ms after movement onset. Finally, Cross-decoding analyses revealed similar neural patterns between reduced SoA in the anatomical and spatial conditions, at a later processing stage starting around 500ms after movement onset. Overall, our results provide evidence that reduced alpha attenuation is a cortical signature of loss of SoA, in line with the well-established finding of Mu suppression during voluntary motor action. In addition, decoding and cross-decoding results (using MVPA) support the hypothesis of a two-level formation of SoA – an early component that could be decoded within condition only (thus domain-specific), possibly the equivalent of the implicit Feeling of Agency, and a late domain-general component, possibly the equivalent of the explicit Judgment of Agency. Our pre-registered EEG investigation of embodied SoA sheds light on the neural correlates of the mechanisms underlying it, expanding the knowledge base of this field.

Peeking behind the veil: exploring altered visual perception in derealisation

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

What would make you question your reality? During an acute episode of depersonalization/derealisation (DP/DR), people report a complex and idiosyncratic change in their perceptual experience. Specifically, derealisation describes the experience of detachment from the external world. In this condition, people describe their surroundings as faded, foggy or dream-like; or succinctly: “As if one was looking through a veil.” Whilst some have argued that there may not be genuine perceptual changes in derealisation, this proposal is yet to be tested empirically. In this registered report (RR) study (supported by the Center for Open Science (COS) / Association for the Scientific Study of Consciousness (ASSC) RR grant initiative), we set out to investigate the potential perceptual changes in derealisation. Previous work indicated that certain image features can contribute to the experience of realness in visual perception. Our goal is to test if features such as image saturation or contrast levels can be used to gauge the severity of perceptual alterations in derealisation. To this end, we developed two sets of online experiments. In the first set, participants can evaluate previously modified static images to assess their limits on what they consider as comparable to their usual visual experience. In the second set of experiments, participants can recreate their day-to-day experiences via dynamically changing various image features. We use these tasks in conjunction with self-reported derealisation assessments to reveal the impact of DP/DR on how people interact with visual stimuli and to shed light on the relationship between faded perceptual experiences and altered sense of reality. We expect that people with more severe acute DP/DR experiences will judge the manipulated images as less real compared to people with less DP/DR experiences because of a possible hypersensitivity in their perceptual processing. We also hypothesise that people with more severe acute DP/DR will reproduce more vivid images when asked to match their day-to-day experiences because of the fadedness of their current experience. If our predictions are supported, we might be able to provide empirical data in support of the possibility that perceptual changes in derealisation are present and measurable. This in turn could also deepen our understanding of the phenomenology of derealisation and more broadly, reveal the nature of our sense of reality.

How neural similarity spaces can inform the metaphysics of perceptual experience

Christopher J. Kymn (University of California, Berkeley)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

How should the science of perception inform our metaphysical account of perceptual experience? In recent work, Adam Pautz claims that empirical findings from neuroscience and psychophysics give us a novel reason to prefer internalist (as opposed to externalist) accounts of phenomenal character. Pautz’s argument is challenged by Peter Epstein, who maintains that empirical findings can be reconciled with metaphysical accounts and carry no new philosophical force. I examine the Pautz-Epstein debate as an exemplar of how empirical arguments can thoughtfully engage philosophical premises. I will also extend Pautz’s argument by discussing two examples from neuroscience and addressing Epstein’s potential objections to them. The phenomenal character question asks: what does having a certain type of perceptual experience consist in? Most views can be classified as externalist or internalist. Externalist views, most notably naïve realism, hold that the character of experience is given by the actual character of the world. Internalist views hold that features internal to the perceiver (e.g. brain state, how the perceiver represents the world to be) determine experiential character. To focus our discussion, we’ll consider color vision. Pautz’s empirical argument for internalism claims that the similarity structure of different colors are better matched to neural firing rates in visual cortex (internal) than the luminance spectra, i.e. physical properties of the objects (external). Epstein raises two interesting lines of concern: first, a skepticism about a similarity metric for neural states, and second, the suggestion that externalists can neutralize the argument by defending color primitivism. Contra Epstein, I discuss two examples from neuroscience which could have reasonable similarity metrics and which put further pressure on externalism. First, I discuss efficient coding theories of perception, which posit that sensory neural systems are adapted to the statistics of their stimuli. I will review the empirical support for efficient coding in the context of color vision, then show how efficient coding undermines color primitivism. Color primitivism claims color is not reducible to spectral properties, but efficient coding suggests a possible reductive explanation. This reduction may be simpler metaphysically and better explain similarity judgments between colors. Second, I discuss the experimental possibility of seeing new colors. Advances in adaptive optics have made it possible to stimulate the cone photoreceptors with patterns that would not correspond to any light spectra. I suggest that even the possibility of experiencing new colors raises puzzles for externalist accounts, such as whether these cases are hallucinations and whether judgments about the similarity of new colors to normal ones are reliable. By contrast, an internalist could explain the similarity between new colors by way of similarity in the neural population activity.

Can physics solve the hard problem of consciousness? The new solution of the relativistic theory of consciousness

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

, There is an explanatory gap between our scientific knowledge of consciousness and its subjective, phenomenal aspects, referred to as the “hard problem” of consciousness. How come we can only measure in the brain neural activity (third-person point of view) and not the actual conscious experience itself (first-person point of view)? And how can the brain create such a phenomenon that cannot be measured from third-person point of view? No theory of consciousness can be complete without answering these fundamental questions. Naturalistic dualists argue that consciousness is composed of a private element. Illusionists, on the other hand, argue that it’s a cognitive illusion. We contend that both the positions are flawed because they assume consciousness to be an absolute property that doesn’t depend on the observer. We developed a new physical approach of a relativistic theory of consciousness in which a system either has or doesn’t have phenomenal consciousness with respect to some observer. Phenomenal consciousness is neither private nor delusional, just relativistic. In the frame of reference of the cognitive system, it will be observable (first-person perspective) and in the other cognitive frame of reference it will not (third-person perspective). These two cognitive frames of reference are both correct, just as in the case of an observer that claims to be at rest while another will claim that the observer has constant velocity. Neither observers frame can be privileged, as they both describe the same underlying reality. The gap is bridged because consciousness experience doesn’t need to be reduced to neural dynamics. It is a physical state that is equivalent to neural dynamics measured from different cognitive frame of reference. Different kinds of measurements that are used by different frames of reference manifest different kinds of physical properties. Based on the relativistic principle in physics and relationalism we developed both a conceptual and a mathematical argument which dissolves the hard problem.

Reverse correlating the content of mental images with electroencephalography

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

The purpose of the present study was to investigate the visual features that individuals bring to consciousness during mental imagery, a phenomenon which has traditionally been difficult to study empirically. Typically, in reconstruction experiments, a great number of images of scenes or objects are shown to a participant while their brain activity is recorded. This provides the experimenter with the building blocks from which the mental images will be reconstructed visually. Then, the participant is asked to produce a mental image of any scene while their brain activity is monitored. Finally, the experimenter tries to reconstruct this mental image based on an interpolation between the images previously shown. This is usually achieved with some model informed by the similarities between the brain activity associated with the mental image and the brain activities associated with the processing of the shown images. One problem with this approach is the extremely sparse coverage of the “scene space”, which leads to low-quality reconstructions of mental images (e.g. Shen et al. 2019). To solve this issue, we developed a novel paradigm where we shrink the “scene space” by replacing the building blocks derived from multiple scene images by building blocks created from only two images. These scene images (e.g. a beach) are presented to a participant through different sets of randomly located Gaussian apertures or “bubble masks” (Gosselin & Schyns, 2001) while their brain activity is being recorded with EEG. These building blocks are then interpolated to reveal the visual features brought to consciousness during mental imagery. So far, we have recorded the brain activity of four participants during three one-hour sessions of a first task, and three one-hour sessions of a second task. The two tasks were interleaved across the six sessions. In the perception task, participants were presented with two scene images through different “bubble masks” (1,500 trials per image in total). In the mental imagery task, participants were shown the two stimuli successively and asked to imagine either the first, or second one (450 trials per image in total). The order of the sessions were counterbalanced across participants. For each participant and for each mental imagery trial, EEG activity patterns were correlated with EEG activity patterns for every perception trial, resulting in 1,500 correlation values. These correlation values were then used to compute correlation-weighted sums of the associated bubble masks, leading to one proto-classification image per mental imagery trial. These proto-classification images were then combined to create the first “classification images” of mental images. Beyond improving the quality of reconstruction of mental images, our approach has the potential to improve our understanding of the relationship between mental imagery and visual perception, and to reveal the individual differences observed in the ability to form mental images.

Role Representationalism as a Solution to Perceptual Variation without Illusion

Yen-Tung Lee (Western University, Canada)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Representationalism about perceptual experiences is the view that every perceptual experience has a content that is determined by its phenomenal character (viz. phenomenal content), and its phenomenal character in turn supervenes on its phenomenal content. Regarding phenomenal contents, Russellian Representationalism considers them as propositions that are made of specific objects/properties, while Fregean Representationalism takes them as propositions that are composed of modes of presentation. This paper aims to 1) refute both accounts and 2) propose a new representationalist account. 1) I argue that neither Russellian nor Fregean accounts can solve the problem of perceptual variation without illusion, according to which a certain experience type can veridically represent different properties. A famous case is the color-inverted Earth, where reddish experiences veridically represent red objects on Earth but veridically represent green objects on the inverted Earth (Block, 1990, 1996). First, major Russellian accounts fail to solve the problem. The tracking accounts (Tye, 1995; Lycan, 1996) deny the color-inverted possibility without reasonable grounds. The dispositional accounts (Shoemaker, 1994, 2003) are incoherent due to the failure of individuating the dispositional properties (Thompson, 2003; Egan, 2006). Second, the Fregean account also fails. Although it explains the case of color-inverted Earth, the account fails to accommodate perceptual variation within a single experience (Millar, 2013). 2) I propose a new account, role representationalism, to solve the problem of perceptual variation. Accordingly, a phenomenal content of an experience attributes the role property of having properties that normally cause that experience type under certain perceptual conditions. First, I lay out the account and defend it from the objections from causal inefficacy of high-order properties (Yablo, 1995; Jackson, 1996) and from over-intellectualization of phenomenal contents (cf. Chalmers, 2004, 2006). Second, I argue that my account can solve the problem of perceptual variation, as it allows a token experience to veridically represent different properties. In mixed reality, where virtuality blends in with physical reality, a reddish experience can veridically represent physical redness and virtual redness at the same time. This, I conclude, not only solves the problem of perceptual variation, but also makes room for veridical perception in virtual reality.

Investigating Dimensions of Consciousness for a Comprehensive Assessment of Phenomenological Experience

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Leveraging first-person accounts of mental phenomena to interpret neurobiological data has been suggested as an approach for tackling the hard problem of consciousness. This necessitates a systematic method of quantifying and organizing first-person experiential data. One common method is to use a retrospective self-report questionnaire, which is administered to the participant after a duration of exposure to an experimental condition. Typically, the participant's observations of their experience during the period are recorded as a multidimensional pattern that consists of their ratings on latent experiential constructs such as level of arousal, direction of attention, and vividness of mental imagery. A popular questionnaire for measuring phenomenological experience is the Phenomenology of Consciousness Inventory (PhCI; Pekala, 1990). Despite its application in a broad range of phenomenological research such as meditation and altered states of consciousness, its proposed dimensionality has not been tested using rigorous psychometric methods. We evaluated whether the factorial structure consisting of 12 major dimensions and 14 minor dimensions fits data collected across five different studies (692 responses) using confirmatory factor analysis. We found weak evidence for the 12 major dimensions but could not discriminate between the proposed minor dimensions. Given this and other psychometric drawbacks of the PhCI, we conclude that the dimensionality of this scale is insufficient to paint a complete picture of our subjective experience. We leveraged other existing validated questionnaires across many subfields of psychology to create a more comprehensive assessment of phenomenology. Specifically, we used an unsupervised clustering algorithm to categorize items across all assessed questionnaires based on their semantic meaning. This machine-learning based method failed to organize the items into meaningful clusters that describe dimensions of experience. Instead, expert review of the items suggested up to 41 distinct experiential dimensions; this structure will be validated by inferring item clusters from semantic similarity ratings given by naïve participants. These clusters and their most representative items will become the basis of a comprehensive, non-redundant, and broadly applicable questionnaire that can provide a more precise measure of phenomenological experience. This project takes steps towards building an accurate description of conscious experience by discovering its invariant structure, which is imperative for the systematic investigation of the link between phenomenology and its underlying neural activity.

Threat Extinction Outside of Visual Awareness

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Anxiety and fear-related disorders are more than twice prevalent in women than in men, suggesting an important role of gender in threat learning and memory. Exposure therapy is one of the evidence-based interventions for modulating fear and anxiety; however, negative emotional responses might be elicited during exposure and pre-mature dropouts are common. Fear extinction model is commonly employed for studying the mechanisms of anxiety and fear-related disorders, as well as developing relevant psychological interventions. There is evidence to support that learning can takes place without conscious awareness. Using a Pavlovian Conditioning model, the current study examined whether acquired threat could be modulated outside of visual awareness and whether gender played a role in this type of threat learning. Forty-seven healthy adults (30 females and 17 males) were recruited in this 2-day experiment, in which participants learned to associate an aversive scream to female faces (conditioned stimuli, CS) followed by extinction of the threat association on Day 1 and a test of return of fear on Day 2. Continuous flash suppression was employed to manipulate visual awareness during extinction, with moving circles presented to the dominant eye and the female faces presented to the non-dominant eye in the condition of unaware. Pupil dilation was recorded during the acquisition, extinction, and re-extinction phase. Additionally, subjective ratings on the unconditioned stimulus (US) expectancy and confidence ratings of the CS-US relationship were measured. Our results indicated that pupillary responses and subjective ratings followed a similar pattern of extinction in both Aware and Unaware conditions. Return of fear was observed in both Aware and Unaware conditions. Interestingly, women reported greater conditioned fear and differential ratings on US expectancy compared with men during threat acquisition. Our findings suggested that conditioned threat responses might be modulated without conscious visual awareness, and there is a gender difference in self-report measures of threat acquisition and threat perception.

Electrophysiology of memory monitoring: the role of sensory processing in age-related changes in error awareness

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Aging is associated with a decline in conscious processing of errors. The error positivity (Pe) is a response-locked potential reflecting error awareness. It has been recently hypothesized that reduced Pe in older adults may be associated with age-related sensory decline. The present study aimed at investigating neurophysiological mechanisms associated with reduced error awareness in older adults. A group of 38 young adults and 37 older adults completed a memory monitoring task during EEG recordings. Stimulus-locked potentials were quantified to understand whether different stages of stimulus processing, including sensory and mnemonic mechanisms are associated with reduced error awareness in aging. Specifically, N1, P2 and N2 were extracted to track visual sensory processing while FN400 and LPC, reflecting familiarity and recollection respectively, were used as indexes of memory processes. Pe and N1 were reduced while P2 was larger in older adults. LPC was found to be comparable between age groups. N2 was modulated by the stimulus novelty in young but not in older adults and FN400 was larger in young adults than older adults for incongruent trials. There was no association between N1 and Pe. Larger P2 was associated with larger Pe in older adults only. Larger N2 and FN400 were associated with larger Pe in young adults and with smaller Pe in older adults. Larger LPC was associated with larger Pe in both young and older adults. The findings suggest that reduced error awareness in older adults is associated with impairments in perceptual processing of stimuli, thus highlighting the role of sensory decline in conscious error processing. The study provides novel evidence of age-related neural changes in memory monitoring and has relevant implications for the conceptualization of new tools to improve error monitoring.

Variational RSA applied to iEEG data

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Understanding how consciousness is instantiated in biological systems remains a central problem in neuroscience and philosophy. Various theories have been formulated to explain how a physical substrate such as the brain can enable conscious experience. Among those, Integrated Information Theory (IIT) and Global Neuronal Workspace Theory (GNWT) have received much attention in recent years. IIT posits that consciousness arises from the integrated information generated by a specific set of neural elements, while GNWT proposes that consciousness emerges from the global availability of information in the brain. These theories have gained empirical support in parallel without much cross talk, and with few exceptions, they have been tested based on different experimental assays. To begin to change this state of affairs, the COGITATE consortium has embarked in an open science adversarial collaboration testing contradictory predictions of IIT and GNWT using the same experimental assays while collecting multimodal data i.e. fMRI, MEG, and intracranial EEG (iEEG) data (Melloni et al. 2021; 2023). As theories provide multiple predictions it is necessary to integrate statistical evidence across outcomes of multiple, independent tests. This is a challenge under frequentist statistics as they only quantify evidence against the null separately for each prediction. In order to integrate and quantitatively compare predictions, we use Bayesian statistics, which enables formal assessment of the relative evidence for each prediction. As a starting point, we applied variational representation similarity analysis (vRSA, Friston et al. 2019) to the iEEG data from the COGITATE consortium, in which IIT and GNWT make independent and contradictory predictions with respect to the profile of neural activation, representation of information, and localization expected when a percepts is experienced for different durations. To the best of our knowledge, this is the first time vRSA was applied to iEEG data. Using vRSA, we quantified the independent evidence for predictions made by each theory and used the Evidence Lower Bound (ELBO) to compare the total amount of evidence for each theory across all predictions. The use of Bayesian statistics in the study of consciousness has the potential to advance our understanding of which theories, if any, best explains the underlying mechanisms of this complex phenomenon. The Bayesian framework provides a formal approach to compare theories of consciousness, integrating multiple lines of evidence and prior knowledge into a comprehensive understanding of consciousness. Friston, Karl J. et al. "Variational representational similarity analysis." NeuroImage (2019). Melloni, Lucia et al. "Making the hard problem of consciousness easier." Science (2021). Melloni, Lucia, et al. "An adversarial collaboration protocol for testing contrasting predictions of global neuronal workspace and integrated information theory." Plos one (2023)

An investigation of the relationship between fMRI and MEG functional connectivity using data from the Human Connectome Project

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Functional segregation and integration play essential roles in human cognition and behavior (Friston, 2011; Parlatini et al. 2017). Moreover, consciousness has been shown to correlate with the level of neural integration (Pal et al. 2020; Schrouff et al. 2011; Tononi et al. 1994). The two most widely used techniques to study brain segmentation and integration are functional connectivity and effective connectivity (Friston, 2011), which investigate the relationships between neural time series. Magnetoencephalography (MEG) and functional magnetic resonance imaging (fMRI) are amongst the most well-established non-invasive neuroimaging approaches to derive functional connectivity. These modalities are complementary to each other (Hall et al. 2014). Therefore, combining them holds the promise of utilizing both the high temporal resolution of MEG and the high spatial resolution of fMRI, thereby opening new research avenues. In this regard, evidence suggests that the two signals originate from the local field potential (LFP; though more indirectly for fMRI). However, a direct comparison of MEG and fMRI data is difficult, largely due to the multifaceted nature of the MEG signal, which can be decomposed across the time and frequency domains (Hall et al. 2014). Source localization in MEG has proven to be relatively reliable, enabling the comparison of MEG and fMRI in source space. Nevertheless, it remains poorly understood how and to what extent (if any) the MEG signal matches up with the corresponding fMRI signal. Here we used both resting-state MEG and fMRI data of 89 human subjects from the Human Connectome Project (HCP) to investigate the relation of the functional connectivity metrics between the two modalities. We compared the MEG source-localized ROI-to-ROI amplitude envelope correlation (AEC), weighted phase lock index (wPLI), and phase lock value (PLV) with the fMRI functional connectivity. Our results show that the PLV (zero-lag non-adjusted) reflects similar structures (e.g. the cross-hemispheric connectivity) to the fMRI functional connectivity, whereas wPLI (zero-lag adjusted) and AEC (band-passed instantaneous power) show clearly different patterns. This suggests that zero-lag phase synchrony, often considered an artifact of volume conduction in MEG, may contain some information about neural resting-state activity captured by fMRI. Hence, we provided empirical evidence that MEG and fMRI functional connectivities have some similarities; however, one cannot fully explain the other and the result might heavily depend on the MEG analysis method. This study provides insights into the origin of fMRI and MEG signals and provides a more comprehensive physiological explanation for neural activities by taking advantage of the strengths of both modalities, building a foundation for multimodal analysis in neural correlates of consciousness.

Consciousness: How Low Can You Go?

Paul Linton (Columbia University)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

The literature on the neural correlates of visual consciousness primarily focuses on the dichotomy between 'mid-level' theories of consciousness (e.g. recurrent processing theory; integrated information theory) and 'higher-level' theories of consciousness (e.g. higher-order thought; global workspace theory). However, this overlooks the distinct possibility that visual consciousness could be a 'low-level' phenomenon. Specifically, that the neural correlates of visual consciousness could be associated with feed-forward processing in the primary visual cortex (V1), the first stage of visual processing in the cerebral cortex. I advance this approach by arguing that the neural correlates of visual consciousness cannot be understood divorced from three fundamental but related questions in philosophy and neuroscience: 1. 'Spatial Experience', 2. the 'Perception/Cognition Distinction', and 3. 'Unconscious Perception'. 1. Spatial Experience: Spatial experience provides a lower bound to the search for the neural correlates of visual consciousness. In stereo vision (the vision we experience in 3D movies), our visual experience of a single 3D percept is integrated between the two eyes. But this kind of integration only begins in V1, ruling out LGN and prior visual processing. The next question is whether anything more than feedforward processing in V1 is required for spatial experience? Again, stereo vision provides an important test case. You can think of stereo vision as a 'minimal percept' – any plausible theory of the neural correlates of visual consciousness must be able to account for it. And the question is whether feedforward processing in V1 is sufficient? The consensus in the literature is it is not. However, a simpler (and more minimalistic) understanding of spatial experience is entirely compatible with the initial stereo processing in V1, and this is what I will argue that our spatial experience amounts to. 2. 'Perception / Cognition Distinction': Victor Lamme and colleagues argue that recurrent processing is necessary to account for a whole range of perceptual illusions: the Ponzo illusion, the Kanizsa triangle, and the checker shadow illusion. But it can be plausibly argued that these illusions don't affect our visual experience, but only our ability to judge our visual experience, and I will discuss experimental strategies to disambiguate these two possibilities. 3. 'Unconscious perception': Finally, feedforward processing in V1 is supposed to equate with unconscious visual processing, as evidenced by masking paradigms that have no discernible influence on behaviour. However, I provide instances of visual processing that have no discernible influence on behaviour, but which we still want to think of as conscious, so this can't be the decisive criterion. In conclusion, 'low-level' (feedforward) theories of visual consciousness remain a viable possibility which are often overlooked in focus on 'mid-level' vs. 'higher-level' theories.

Multiple experiences of the self during adolescence: a psychometric network analysis

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Adolescence is a period of significant transformation in many dimensions of the self. It is also a critical time-window for the onset of disorders that affect the experience of self (i.e schizophrenia or eating disorders). Some studies point out that the way we experience one dimension of ourselves influences other dimensions. As most of these studies focused on adults and pairwise correlations within a limited number of dimensions of the self, there is a lack of understanding about the complex nature of these relationships and nothing is known about the period of adolescence. Here we explored for the first time the complex pattern of relationships between multiple experiences of the self during adolescence. We used self-report questionnaires and network analysis, an innovative technique to analyze complex patterns of relationships in multivariate psychological data. We measured the quality of different experiences of the self in a group of 628 adolescents (10-23y) using validated scales (Multidimensional Assessment of Interoceptive Awareness [MAIA], Self Consciousness [SC], Interpersonal Reactivity Index, Social Media Engagement, Body-Esteem, Objectified Body Consciousness, Sociocultural Attitudes Towards Appearance, Resistance To Peer Influence [RPI]) and other variables (puberty, sex, gender, economic status, physical activity, chronic pain, Body Mass Index). We estimated a regularized partial correlation network. The nodes of the network represent the subscales and the edges represent pairwise conditional associations between subscales. We analysed centrality (indicating the importance of nodes within the whole network) and global strength (indicating the level of connectivity among the whole network). In the whole sample, puberty, sex, and subscales of SC and MAIA had the highest centrality. We thus divided the samples into 4 groups according to sex and puberty. Network Comparison revealed a higher global strength of the network in post-pubertal compared to pubertal girls although this difference did not reach significance ($p=.06$). The body trust subscale (MAIA) became more central in the post-pubertal group ($p=.001$) where it was the most central. Comparison between females and males revealed different nodes centrality. Body trust subscale and RPI were less central in boys. The centrality of MAIA supports theories that ground selfhood in the embodied self, specifically in interoceptive awareness. We extend previous findings that suggest a link between body mistrust and various self-experience disorders (panic and eating disorders, suicidality and complex trauma) to non-clinical aspects of self-experience. The increase in global strength indicate that the multiple dimensions of the self become more integrated at the post-pubertal stage in girls. This integration constitutes a springboard for refining selfhood. Together, results suggest that trusting your body at the end of puberty may be of a crucial importance for further self-experiences.

Increased neural activity in the lateral septum is associated with cortical slow waves and impaired consciousness in an awake mouse model of temporal lobe seizures

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Patients with temporal lobe epilepsy (TLE) often experience loss of consciousness during seizures. Clinical studies show cortical slow wave activity during temporal lobe seizures, associated with impaired consciousness. Human neuroimaging and previous rodent model investigations suggest that depressed cortical function and impaired consciousness in TLE focal limbic seizures is caused by decreased subcortical arousal. However, the full network mechanisms of decreased subcortical arousal in this condition are not known. Prior investigations in an anesthetized rat model suggest that the lateral septum (LS) may play a key role in inhibiting subcortical arousal during focal limbic seizures. Work in the anesthetized rat model showed that focal hippocampal seizures induce increased neuronal activity and increased cerebral blood flow in LS. In addition, stimulation of the lateral septum without seizures resulted in cortical slow oscillations. The LS is composed of predominantly GABAergic neurons, and is a major relay that connects the hippocampus with subcortical arousal system. We hypothesize that the hyper-excitatory hippocampal state during seizures propagates to the LS, which increases GABAergic inhibition from LS to subcortical arousal systems leading to neocortical deactivation indirectly. To investigate our hypothesis we used an awake-behaving mouse model, where focal limbic seizures were induced by stimulating the hippocampus. Local field potential (LFP) signals were recorded from the hippocampus, with simultaneous LFP from the orbitofrontal cortex (OFC) and multiunit activity (MUA) recordings from the LS. Mouse running wheel behavior was also recorded. We found that impaired consciousness, measured by decreased running speed, was associated with slow wave activity in the OFC, and with increased LS neuronal MUA firing during seizures. This result demonstrates direct correlation between neocortical deactivation, behavioral arrest, and increased LS activity in the presence of a hyper-excitatory hippocampal state in a temporal lobe seizure model. To further investigate network and neurotransmitter mechanisms we have begun selective measurement of GABAergic neuronal activity and neurotransmitter release with optical methods in this model. With further investigation, identifying the mechanisms of impaired consciousness in focal temporal lobe seizures may lead to novel treatments for this disorder.

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

In a behavioral study, we examined the impact of individual differences in the vividness of visual mental imagery on five domains of imagery: object shape, color, written words, faces, and spatial relationships. The study involved 117 healthy participants who reported different levels of imagery vividness, including 44 who reported experiencing absent or nearly absent visual imagery, a condition known as "aphantasia". We used an online version of the French-language Battérie Imagination-Perception (eBIP) to assess participants' abilities in both visual imagery and visual perception tasks and recorded the accuracy and response times of their responses. The results showed that individuals with congenital aphantasia had similar accuracy on all tasks compared to the other groups but had slower response times in both imagery and perceptual tasks, and lower confidence in their responses on perceptual tasks. The findings suggest that individuals with aphantasia experience a slowing in processing visual information in both imagery and perception, but the precision of their processing remains unaffected. Moreover, there was an inverse correlation between subjective vividness and response times for the entire participant group, which was consistent across all domains. This evidence provides support for the idea that aphantasia is primarily caused by metacognitive issues or that alternative strategies other than visualization are employed to access preserved visual information. Our findings are consistent with the "access" and "phenomenal" consciousness distinction proposed by Ned Block. According to this distinction, access consciousness refers to the ability to use information in cognitive processing, while phenomenal consciousness refers to subjective experience. The study suggests that individuals with aphantasia have intact access consciousness but may lack phenomenal consciousness in the domain of visual imagery. Further, these behavioral data are in line with our findings using ultra-high resolution 7T fMRI, where typical imagers and individuals with aphantasia performed the eBIP. During visual mental imagery, a region in the left fusiform gyrus, known as the Fusiform Imagery Node (FIN), was consistently engaged in both groups when contrasted with a non-imagery task involving abstract words. However, in typical imagers, the FIN was found to be functionally connected with lateral fronto-parietal (FP) areas, orbitofrontal cortex, and domain-preferring high-level visual regions. On the other hand, in aphantasic subjects the FIN was functionally isolated, both in visual mental imagery and perception. This suggests that aphantasia may be due to a functional disconnection between the FIN and FP networks, leading to a lack of experiential content in VMI. These findings provide support for the hypothesis that conscious visual experience, whether imagined or perceived, depends on the integrated activity of high-level visual cortex and FP networks.

GNW vs. IIT: Decoding of consciously perceived stimuli in the MEG signal

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Many theories have been advanced to explain how conscious experience arises from neuronal activity, yet a unified experimental framework is still lacking. COGITATE, as a collaborative effort across eleven labs, has been established to test and compare two theories: Global Neuronal Workspace (GNW) and Integrated Information Theory (IIT). Here, we describe the Magnetoencephalography (MEG) results for the multivariate decoding of the content of consciousness. , In the experiment, participants were presented with images of four categories (faces, objects, letters, false fonts) that were clearly consciously visible, while their brain activity was recorded using MEG. Subjects were instructed to attend to specific images in each block and therefore images were either task-relevant or task-irrelevant. According to the GNW theory, conscious content is mainly represented by phasic activity within the 300-500ms range in the prefrontal area, while according to the IIT theory, conscious content would be mainly present in the posterior area of the brain in a sustained manner. To test the two hypotheses, we performed multivariate decoding of category and orientation information in the region of interest proposed by the two theories. To boost the signal-to-noise ratio for decoding analysis, we have developed an optimized pipeline that includes pseudo-trial averaging, temporal moving-average, and feature selection. We will present results of decoding analysis (n =65) to explore the decodability as well as the temporal dynamic of this decoding considering the GNW and IIT theory predictions.

Explanatory Relevance of Nonstructural Qualia

Kristjan Loorits (University of Helsinki)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

According to a conventional understanding, the hard problem of consciousness concerns the apparent existence of qualia: simple qualitative sensations like the experienced blueness of bright summer sky or an intense toothache. Qualia pose a challenge due to their seemingly nonstructural nature, which is a problem against the background of scientific structuralism: a prominent view according to which all objects of science are analyzable in fully structural terms. It has been argued, inter alia, that if qualia cannot be described in structural terms, then they cannot play any role in scientific theories and explanations, which rely on precise structural descriptions. Contrary to that understanding, I will argue that some psychological phenomena and their behavioral effects cannot be explained without acknowledging the existence of observable yet structurally unanalyzable properties. Instead of focusing on paradigmatic qualia examples (simple color sensations, pain, etc.), I will consider the role of observable aesthetic properties that are structurally unanalyzable in practice. It is widely agreed that art that follows all the known laws of aesthetics as obediently as possible is not the most valuable. Great art is expected to transcend the known laws by providing “something extra” whose value can be detected (by experts and audience alike) yet not analyzed in fully structural terms in the context where it is identified. The above interpretation has at least two significant implications on the philosophical qualia debate. First, even if a property cannot be analyzed in fully structural terms, it may still be observable and explanatorily relevant: part of the reason why great works of art are highly valued is that their perceived beauty and elegance cannot be analyzed in fully structural terms in the context where these aesthetic properties are identified and appreciated. Second, the fact that there are observable yet structurally unanalyzable properties creates no need for extreme views like panpsychism, illusionism, or eliminativism. The more sober alternative would be a form of perspectivism: observable yet structurally unanalyzable qualities are perspective-induced impressions – psychologically effective and explanatorily relevant appearances with no direct counterpart in the perspective-independent domain.

Subjective, physiological and EEG effects of continuous infusions of DMT

Lisa Luan (Imperial College London)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

N,N-Dimethyltryptamine (DMT) is a serotonergic psychedelic that induces profound but transient changes in consciousness including vivid visual imagery and a sense of immersion into another world. These experiences are often deemed profound and have the potential to challenge beliefs about the nature of reality and consciousness. The effects of vaporized or smoked DMT are short-lived with peak effects at around 2 minutes and a total duration of 15 minutes. The effects are difficult to sustain for longer periods of time, however, the continuous IV infusion of DMT provides a new way to maintain the altered state for a prolonged period, allowing for a more in-depth exploration of its effects on consciousness. Using pharmacokinetic data from previous studies, we derived dose regimens for the continuous IV administration of DMT, necessary to maintain the DMT experience over an extended time. In two single-blind, placebo-controlled studies, 28 healthy volunteers received five different doses of continuous IV DMT over 30 minutes. 256-channel EEG activity was recorded during the experience, as well as autonomic responses including heart rate, galvanic skin response and body temperature. Subjective effects were measured acutely through experience sampling and retrospectively through VAS scales, questionnaires and micro-phenomenological interviews. We will discuss the protocol used for the continuous administration of DMT and present data on the subjective experience, as well as the physiological and neurological changes that occur during the infusion. The presentation will highlight the potential of continuous infusion DMT as a tool for consciousness research, with implications for understanding the nature of consciousness and its underlying neural correlates.

Functions of Consciousness in Emotional Processing

Dylan Ludwig (York University)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Across different tasks, individuals, and species, conscious processes form a diverse class of psychological phenomena supported by a variety of neurobiological mechanisms. Contrary to leading “monolithic” accounts like Global Workspace and Information Integration Theories, it is a compelling and fruitful hypothesis that consciousness facilitates a range of different functional capacities specific to different information processing domains (e.g. visual perception, emotion, decision making); a position I call functional pluralism. In previous work, I articulate a general theoretical framework for articulating and evaluating claims about the function(s) that consciousness contributes to information processing systems. This paper appeals to that general framework in order to defend the claim that conscious experience facilitates a variety of different functional capacities specific to the domain of emotional processing. My account is rooted in a model of emotion that consolidates current research from philosophy, neuroscience and psychology—what I’m calling a Valence Theory of Emotion—according to which emotion consists of valenced representational content, and the activity of the set of mechanisms responsible for generating, maintaining and modulating it. Evidence for genuine unconscious emotional processing is first reviewed, drawing on a) experimental research employing the tools of vision science (i.e. masking and suppression of emotionally relevant stimuli), and b) theoretical and clinical research on emotional disorder (i.e. generalized anxiety). After carefully comparing the functional capacities of the relevant unconscious and conscious emotional processes, I argue that conscious experience facilitates a cluster of functions in the domain of emotional processing, including conceptualization, inhibition, and flexible response.

Hedonic reversal of interpersonal fear and humiliation as support for the higher-order theory of emotional consciousness

Dezhi Luo (The University of Edinburgh)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Hedonic reversal refers to the “mind over body” process to enjoy an innately negative experience induced by certain aversive stimuli (Rozin et al. 2013). It is suggested to be enabled by the realization of one’s distance from actual danger, accompanied by the fact that the bodily reaction toward that stimuli is capable of triggering a sense of reward. The present work investigates the hedonic reversal process of the submissive participants in BDSM practices (the overlapping acronym of bondage and discipline, dominance and submission, and sadism and masochism). Within said context, the submissive side enjoys the emotional experience usually consisting of fear and shame that is due to threat and/or humiliation induced by the dominant side through bodily or social action. Past research has focused on the involvement of the survival circuit in the hedonic reversal process (Dunkley et al. 2019). The autonomous release of endogenous opioids in response to fear and social rejection has been shown to co-activate the limbic reward system. Submissive participants within a consensual BDSM scene acknowledge that no actual danger and hostility is involved, enabling them to perceive the bodily feedback as enjoyable. In this thesis, I provide a complementary analysis of such explanations, along with the original theory of hedonic reversal, under the framework of the Higher-order Theory of Emotional Consciousness (LeDoux & Brown, 2017). Essentially, the survival circuit response merely provides input to the cognitive assembly of the conscious emotional experience rather than directly responsible for it. A comprehensive theory of hedonic reversal should thus explain how the conscious state with positive valence is derived. I maintain that the interpersonal context of the BDSM scene determines that the engagement of the survival circuit must be triggered by a second-order state of working memory. This is because the detection of threat and humiliation in this case necessarily involves identifying gestural and linguistic information from a first-order perception based on factual knowledge and social schema. I argue that this second-order state could not have been conscious given that the actual conscious state is experienced as positive, which is formed after integrating a conception of safety that certainly forbids the activation of the survival circuit. The hedonic reversal in this case is therefore a further representational process of the non-conscious state under emotional schema, through which bodily feedback coalesces with the conception of safety, deriving a positive experience. A conceptual self is postulated in the process as formulating the conception of safety would require autobiographical memories and self-schema. In conclusion, I argue that hedonic reversal in the case of BDSM challenges the first-order view of emotional consciousness as it implies the involvement of a non-conscious higher-order state as well as a conceptual self.

Why do people have the ability to change subjective experience so as to misrepresent reality?

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Phenomenological control (PC) is the stable trait ability to alter subjective experience to fit goals, measured by response to imaginative suggestions (e.g. for apparently involuntary movement, hallucination and amnesia). Because PC is experienced as involuntary, it can be attributed to external causes, and may thereby influence beliefs. In a large sample pre-registered study (n = 503) we tested predictions arising from the hypothesis that PC evolved to promote experiences of a spirit world in order to support religious beliefs (Dienes & Perner, 2007). Reports of three types of anomalous experience and associated beliefs were measured: past lives, out of body experience, and contact with spirits. Context effects were minimised by independent administration of each measure. As predicted, linear regression of both anomalous experience and spirit world beliefs on Phenomenological Control Scale (PCS) scores showed substantial relationships and small intercepts. These results contrast with weaker relationships and large intercepts for regression on PCS scores of reports of experiences which are not posited to depend on PC: flow experiences for housework, exercise, and essay writing. Also as predicted, the relationship between PC and belief in a spirit world was partially mediated by the tendency to have related anomalous experiences. These results are consistent with the proposal that experiences of a spirit world depend on PC, that these experiences support belief in a spirit world, and therefore that PC may have evolved to support experiences of a spirit world. We also summarise the results of other recent large sample studies: 1) evidence for no relationship between PCS scores and reports of the vertical-horizontal illusion; 2) out of context replications of substantial relationships between PCS scores and measures of auditory experience for silent video stimuli (vEAR), tingling sensations in the head and neck in response to video stimuli (ASMR) and no relationship with the Müller-Lyer illusion (adding to similar results for the Ebbinghaus illusion). These results show that relationships between ASMR or vEAR and trait PC remain in the absence of context effects and that PC effects do not seem to occur in some classic visual illusions. Together, these studies illustrate the broad reach of phenomenological control. In a scientific experiment, generating experience consistent with demand characteristics can meet the goal of being a ‘good participant’. Having experiences consistent with cultural beliefs, e.g. of a spirit world, can meet social goals such as group bonding and enhanced status. The historical focus on a single context for PC (‘hypnosis’), may have obscured important roles in other situations. The theory that PC has the function of supporting culturally relevant beliefs - such as belief in a spirit world or belief in the outcome apparently presumed by an experimenter - shows its usefulness in this set of pre-registered predictions.

Cross-modal correspondence between tactile onomatopoeia and color and its association with affective response

Jingyi Ma (Nagoya University), Ai Mizokawa (Nagoya University), Shinji Yamagata (Nagoya University)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Recent cross-modal correspondence studies have reported the association between tactile sensations and color, but little is known about its association with the affective aspects of individuals. Additionally, there are limited studies on cross-modal correspondence between tactile sensations and color in the East Asian context. The Japanese language is notable for its abundance of onomatopoeic words for tactile sensations. Acknowledging this, this study focused on tactile onomatopoeia, a unique Japanese linguistic expression for tactility (e.g. zara-zara for roughness), and investigated its correspondence with color, and assessed the effects of the correspondence on pleasant or unpleasant affect and bizarreness. In Experiment 1 ($N = 30$), we used Scheffe's method of paired comparison to examine the cross-modal correspondence between tactile onomatopoeia and color. Results indicated that each tactile onomatopoeia was associated with a specific color. To identify psychological positional relationships, a multidimensional scaling (MDS) method was used to map the pairs of tactile onomatopoeia and colors onto a two-dimensional space. Further, based on the results, we created cross-modal congruent and incongruent stimuli for Experiment 2. In Experiment 2 ($N = 52$), we used the semantic differential method. Participants were asked to evaluate each of the cross-modal congruent and incongruent stimuli, tactile onomatopoeia-only stimuli, and color-only stimuli for pleasant or unpleasant affect and bizarreness. Bizarreness evaluations were used to confirm that participants discriminated cross-modal congruent from incongruent stimuli. The results showed that cross-modal incongruent stimuli evoked stronger unpleasant affect in addition to bizarreness than cross-modal congruent stimuli. However, cross-modal congruent stimuli were rated as more unpleasant than single stimuli. To explore the reasons for the above results, we reanalyzed data by considering the affective valence (i.e. positive vs. negative) of tactile onomatopoeia and color. The reanalysis revealed that cross-modal congruent stimuli evoked stronger pleasant affect, especially in the combinations of positive tactile onomatopoeia and positive color. Overall, these findings highlight the existence of cross-modal correspondence between tactile onomatopoeia and color and suggest how cross-modal correspondence is associated with affective response.

A working model of the relationship between phenomenal experience and brain functioning in psychosis

Paola Magioncalda (and Matteo Martino) (Graduate Institute of Mind Brain and Consciousness, Taipei Medical University (Taiwan)), Matteo Martino (Graduate Institute of Mind Brain and Consciousness, Taipei Medical University (Taiwan))

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Psychosis is mainly defined by hallucinations and delusions, which occur in various conditions. Hallucinations are phenomenal experiences with high sensorial intensity (and considered real) occurring without correspondent environmental stimulation of sensory organs. Delusions are fixed ideas unchangeable by experience/reasoning. Understanding psychosis represents a challenge for psychiatric neuroscience research and has implications for the investigation of consciousness. This work aims to: review the current data on the neural correlates of psychosis (hallucinations and delusions); propose a working model of the relationship between phenomenal experience and brain functioning in psychosis. Based on the reviewed data, hallucinations are mainly associated with: transient (modality-specific) activation of sensory cortices (primary/secondary auditory areas in the superior temporal gyrus, primary/secondary visual areas in the occipito-temporal cortex, somatosensory areas in the postcentral gyrus, and interoceptive areas in the insula) during the hallucinatory experience; increased intrinsic activity/connectivity of associative areas, primarily default-mode network (DMN) areas (middle temporal gyrus/temporoparietal junction, posterior cingulate cortex/parahippocampal areas, and/or medial prefrontal cortex), along with their increased connectivity with sensory areas; and deficits in the sensory systems (such as decreased activation of sensory cortices by environmental stimuli). Analogously, delusions are mainly associated with increased intrinsic activity/connectivity of associative/DMN areas (especially the medial prefrontal cortex). Integrating these data into our three-dimensional model of brain functioning and phenomenal-behavioral patterns (Martino and Magioncalda, Mol Psychiatry, 2022), we propose the following model of psychosis. Hyperfunctioning of brain's associative (mainly DMN) areas, in relation to deficits in the sensory systems, may drive neuronal activations in the sensory (auditory/visual/somatosensory) areas and insular (interoceptive) areas with spatiotemporal configurations predominantly related to associative processing and largely independent from current environmental stimuli, manifesting in a dissociation of the phenomenal experience from the current environment (psychosis). Accordingly, hallucinations and delusions might consist of imaginary experiences/ideas composed of exteroceptive-like and interoceptive/affective-like components showing: abnormally increased phenomenal intensity relative to decreased phenomenal intensity of perceptions (thus such imaginary experiences/ideas show an intensity indistinguishable from perceptions' and consequently are considered related to the current environment, i.e. subjectively real); and minimal changeability by environmental stimuli (thus such imaginary experiences/ideas are fixed). Our model could prompt a better understanding of psychosis and consciousness.

Still you: connectome fingerprints across psychedelic states of consciousness

Pablo Mallaroni (Maastricht University), Natasha Mason (Lilian Kloft), Johannes Reckweg (Hanna Tolle), Enrico Amico (Kim van Oosouw), Johannes Ramaekers

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The creation of neural phenotypes of cognition and behaviour are primary objectives for neuroscience. The ability to derive clinically relevant outcomes from one's connectome "fingerprint" has sparked a shift in methodology to single-subject analyses accommodating idiosyncratic differences between individuals. However, to fully leverage uniqueness, both the inherent and extraneous dependencies of functional connectivity must first be distinguished. For example, while it is well known that one's conscious experience rests on the brain's ability to sustain rich dynamics, it is unknown whether such individual features are masked in the absence of a coherent connectivity architecture such as in pathological states. Here, altered states of consciousness (ASCs) such as those elicited by serotonergic psychedelics offer an opportunity to reversibly perturb idiosyncratic brain organization. To exemplify this, we will present recent findings of a differentially reconstituted connectome fingerprint from studies using psilocybin and ayahuasca. We will discuss how contextual constraints on spontaneous thought phenomena constrain may either amplify or attune interindividual differences in functional connectivity and highlight the behavioural relevance of keypoint edges. Lastly, evidence from the 'psychedelic renaissance' suggests that an aspect of the therapeutic efficacy of psychedelics is the highly subjective experience from which patients can draw insights into their condition. We will as such discuss heuristic approaches with which to identify biological predispositions to relevant experiential facets.

Multimodal assessment of Disorders of Consciousness using parallel EEG, anatomical, functional, diffusion MRI, and PET recordings

Dragana Manasova (Paris Brain Institute (ICM)), Laouen Belloli (Paris Brain Institute (ICM)), Emilia Flo Rama (Paris Brain Institute (ICM)), Brigitte Kaufmann (Paris Brain Institute (ICM)), Jacobo D. Sitt

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Disorders of consciousness (DoC) have been a source of both inspiration and testing of theories of consciousness. However, as the elephant in the dark analogy, a single biomarker in a given neuroimaging modality can bring light only to some aspects of these complex pathologies. The challenge comes from the fact that a plethora of etiologies causes the disordered state, and the brain damage can range from hardly visible on an anatomical MRI image to a visually disturbing one. Current studies have used either single or bimodal sources to study DoC patients, and their combination has been done analytically or using machine learning. In this work, we extend the multimodal approach by using all of the available scans done for the clinical evaluation at the Pitié Salpêtrière Hospital. The database of 380 patients, out of which 100 have at least three modalities, allows us to test various hypotheses - relating either to applied clinical decision-making or fundamental neuroscience knowledge. We test these hypotheses using early fusion machine learning models. From each modality, we obtain markers that have been studied in previous works in DoC patients or other states of consciousness. We split the functional markers into three conceptual families: spectral (eg. power spectral density, spectral entropy); connectivity (eg. weighted symbolic mutual information, functional connectivity), and information theory (eg. complexity measures, Hurst exponent). We first study the informative value of each modality and their combination both for diagnosis and prognosis. Using random forest classifiers we obtain the highest AUC (0.68 +- 0.02) for the multimodal classification. The rest of the single modalities have AUC values ranging from 0.52 to 0.66. A second hypothesis is regarding the importance of static modalities (such as aMRI, and dMRI) which inform us of the preserved anatomical structure; in contrast to dynamical modalities which give functional information (such as EEG, fMRI, and PET). Preliminary results show higher AUC values when training on EEG markers (both from resting-state and the local-global task) data compared to anatomical and diffusion MRI scans. Although the range of AUC values can seem low, they have to be interpreted within the behavioural diagnostic context which has a high margin of error (up to 30%). Furthermore, we aim to study the informative weights of either cortical or subcortical regions. By keeping the most informative regions using recursive feature elimination, we analyze the diagnostic and prognostic regional relevance for major etiology groups (anoxia and traumatic brain injury). This multimodal approach can allow us to better study the nuances of loss of consciousness in this clinical group and analyze quantitatively the mutual and shared information of the different modalities. Through feature importance analyses we can understand better the implications of certain regions in the state and recovery of these patients.

Strange face illusions – a novel model with preliminary supporting empirical evidence.

Joanna Mash (University of Hertfordshire), Paul M Jenkinson (ISN Psychology, Institute for Social Neuroscience, Melbourne, Australia), Keith R. Laws (University Of Hertfordshire)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Strange face illusions are commonly experienced when fixating on face stimuli for prolonged periods under low light levels. Illusions involve either the perception of distorting features on the actual face being observed or the perception of new faces. A recent review and meta-analysis by Mash et al. (2023) reveals strange face illusions as robust, with illusions of new faces exhibiting a mean prevalence rate of 58% in healthy individuals. Yet current explanations have struggled to account for the diversity of illusions reported in this paradigm. In contrast to existing psychodynamic/cognitive explanations, we provide a novel theoretical model derived from observing these phenomena through a lens of predictive processing. This model reveals how key environmental and behavioural factors can influence precision weightings, and how these may combine to profoundly overweight top-down influence, thereby inducing perceptual instability. We describe how this paradigm potentially provides a unique opportunity to observe the dynamics of prediction error minimisation strategies in relation to specific perceptual states. Furthermore, new strange faces are proposed to represent the transition from illusion to hallucination, which we propose occurs as perception becomes untethered from the sensory information. In support of this model, an empirical investigation was conducted to examine the relationship between gaze fixation and perceptual states. Fifty-one healthy participants underwent a 7-minute mirror gazing task, under low light levels. Eye movements were captured using the EyeLink1000plus. We examined the relationship between fixation duration and illusions from 2 perspectives. Firstly, a between groups analysis was conducted to investigate the role of fixation in relation to illusion induction, using a priori groups (free-gaze vs fixation). Secondly, a retrospective regression analysis was conducted into the relationship between average fixation duration and type of illusion reported using groups defined by their perceptual experience (i.e. no illusions, feature distortions only, new faces). Results showed that participants that were instructed to fixate their gaze reported significantly higher number of illusions compared to participants who moved their gaze freely. Furthermore, we demonstrate that average fixation duration can predict perceptual experience. Our model clearly defines the relations between different perceptual states and prediction error minimisation strategies (i.e. saccadic exploration and perceptual hypothesis switching). These preliminary findings provide some empirical support for our model by specifically demonstrating that prolonged fixation is a key factor in illusion induction and can predict phenomenal content (i.e. feature distortions or new faces). Therefore, strange face illusions may reveal novel insights into the dynamics of prediction error minimisation strategies and our conscious experience.

Overflowing oceans or overflowing puddles? Rethinking the evidence from partial report experiments.

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

There has been a long debate on the complexity of conscious experience. According to one view, experience is limited to a few elements at a time. According to another view, experience is much richer than can be reported, and the limited reports arise from an “overflow” when passing rich phenomenal contents through reporting bottlenecks. Arbitrating between these two views is a central debate in consciousness science, with extensive implications for how we interpret experimental results and build theories. The key evidence in support of overflow comes from Sperling-style partial report experiments, which suggest that rich stimulus information is stored in iconic memory and available to the observer for a brief period of time. It is routinely assumed that iconic memory has a near-unlimited capacity, often taken to suggest that conscious experience too has a near-unlimited capacity. Given that iconic memory plays such a crucial role in the overflow debate, here we discuss the evidence supporting this assumption. In our work we presented observers with letter arrays of varying sizes and performed subtle manipulations of the cue-to-memory-readout timing. First, we found that if the cue is presented directly at target offset, it does not appear to come in time to provide a full readout of iconic memory. Instead, the cues need to be presented in the last stages of online perception to reach a high-capacity readout stage in time, suggesting that many previous studies might have underestimated the early stages of iconic memory. However, even when taking into account these delays, we found the capacity of iconic memory to still be rather limited. Second, we found that already during stimulus presentation there are limitations in information readout, in line with previous work on lateral masking. This suggests that even online cued perception is not a veridical copy of the world, and iconic memory, even at their highest capacity, can only be as detailed as online cued perception. Thus, the extrapolations from previous research using smaller-size arrays to larger arrays may not hold true, suggesting that capacity limits of iconic memory might have been overestimated. Third, we found that, regardless of the size of the presented array, the availability of information reduces to working memory capacity already around 150 ms after stimulus offset. We take an agnostic stance towards what neural mechanisms are sufficient for conscious experience, but we do assume that, at the very least, some form of recurrent visual processing is necessary for a visual representation to become conscious. Our findings suggest that, by the time that such processing can take place, most information may already be gone from iconic memory. These capacity limitations do not deny the possibility of overflow, but they do set an empirical boundary. Partial report experiments appear to indicate an overflow that is more of a perceptual “puddle” rather than a perceptual “ocean”.

Forward masking reduces priming effects of unconscious visual stimuli

Uwe Mattler (Georg-August University Göttingen), Nicolas Becker ()

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

One approach to determine the scope of unconscious processing examines the effects of masked prime stimuli on motor, semantic and cognitive control processes. To ascertain that the observed priming effects result from unconscious prime stimuli studies have attempted to establish masking conditions that sufficiently reduce prime visibility. To this end some studies employed sandwich masking procedures in which the effective prime stimulus is preceded by a forward mask and followed by a backward mask. To determine the scope of unconscious priming with this approach, it has to be assumed that masking procedures do not affect priming effects. The present study examined the effects of forward masks on priming effects in a motor priming paradigm with arrow stimuli. Results show a reduction of priming effects which increases when the duration of the forward mask increases and when the temporal distance between the forward mask and the prime declines. Findings suggest that priming effects are based on stimulus processing that differs from the processing which leads to conscious perception of the prime stimulus. While backward masks exclusively interfere with processing for perception, forward masks seem to have an additional effect on the processes that mediate priming effects. The results suggest that forward masking methods could lead to an underestimation of the magnitude of the effects of unconscious stimuli.

Mapping the functional asymmetry of visual processing

Chiara Mazzi (University of Verona, Italy), Davide Bonfanti (University of Verona, Italy), Silvia Savazzi (University of Verona, Italy)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The visual system has long been considered equivalent across hemispheres. However, an increasing amount of data points towards asymmetric hemispheric processing of visual information, with the right hemisphere more involved in coarse visual analysis, and the left hemisphere handling finer details. Most of these studies rely on imaging techniques, like EEG and fMRI, which establish correlational relationships. Remarkably, TMS of a specific cortical area combined with EEG provides the opportunity to non-invasively and causally assess the engaged functional network with a millisecond time resolution. The purpose of this study is thus to characterize the emergence of visual awareness and the spatiotemporal dynamics resultant from the stimulation of left or right occipital cortices in order to detect possible hemispheric asymmetries. Eighteen participants were tested by stimulating left and right early visual areas. At the beginning of each experimental session, the individual hotspot was functionally identified and the phosphene threshold (i.e. the intensity eliciting a conscious percept on half of the trials) assessed for each stimulation site (corresponding to the electrode locations O1 and O2). While recording EEG from 64 channels, single-pulse TMS was administered at threshold intensity in the subsequent experiment consisting of 360 pulses per site. After each TMS pulse, participants were asked to report the presence or absence of phosphenes by pressing respectively two keyboard keys. The order of the stimulation sites was counterbalanced across participants. TMS-Evoked Potentials resulting from the occipital stimulation showed a significant main effect of stimulation side and phosphene awareness. The interaction was also significant and thus phosphene-present trials were contrasted against phosphene-absent trials, separately for each stimulation site. Significantly, distinct electrophysiological patterns were found to reflect similar perceptual experiences: left stimulation elicited earlier clusters of significant activity mainly located over posterior regions while right stimulation elicited clusters of centro-parietal activation at later latencies (from 300 ms onwards). We also considered the mean interhemispheric signal propagation (ISP) index across five time-windows previously identified around the peaks of the global mean field power, finding that around 100 ms after the TMS pulse, left side stimulation elicited a higher modulation in contralateral electrodes than in ipsilateral ones if compared to right side stimulation. Our results show that left and right occipital TMS elicits differential electrophysiological patterns in the brain, both per se and as a function of phosphene perception. These distinct patterns of activation may suggest a different role of the two hemispheres in processing visual information and giving rise to perception.

Thalamic Awareness Potential Elicited in Mice

Sarah H. McGill (Yale University), Mrinmoyee Guha (Yale University), Charlie W. Zhao (Yale University), Lim-Anna Sieu (Yale University), Tramy Nguyen, Quentin Perrenoud, Jess Cardin, Hal Blumenfeld

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Sensory components of the nervous system transduce and encode a rich representation of stimuli in the surrounding world, but at any given time only a subset of these stimuli enter conscious perception. Experiments conducted by our lab in human subjects have shown that perceived stimuli, elicit a rapid (within a few hundred milliseconds) series of responses in both cortical and subcortical activity, while unperceived stimuli do not. The thalamic awareness potential (TAP), a biphasic event related potential of the intralaminar thalamus, forms one component of this response, and is hypothesized to provide a subcortical arousal boost to subsequent processing. Although analogues to the cortical components of the perceived stimulus response have been observed in animal models, it is not yet known if other species exhibit an analogue to the human TAP. In order to investigate this possibility, we developed a mouse model of auditory conscious perception. Adult c57bl6 were surgically implanted with twisted-pair bipolar electrodes targeting the primary auditory cortex, frontal association region, and intralaminar central lateral nucleus of the thalamus. Steel headplates were additionally fastened to their skulls to allow for head fixation during recording. After recovering from this procedure, the mice were trained in a go/no-go assay to lick or to withhold licking of a spout in response to the presence or absence of an above-threshold auditory stimulus. Access to the spout was mechanically restricted to a one-second period in each post-stimulus to minimize the effect of electromotor signals on electrophysiological measurements. Following up to four weeks of training, the mice were able to successfully distinguish between the presence and absence of a stimulus using this behavioral response ($d' > 1.25$). Event related potentials were observed with a transient early response in thalamus as well as the primary auditory cortex, with later signals observed in the frontal association cortex in response to the above threshold stimuli. These data support the presence of a TAP in the mouse model during auditory perception. Establishing this model will enable future mechanistic studies to investigate the functional role of intralaminar thalamic signals in auditory perception.

The DebiaSyn Toolbox: Pushing the Boundaries of Information-Theoretic Estimators for Neuroimaging Data

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The recent application of partial information decomposition (PID) and derivative measures such as ΦID (Mediano et al. 2021) to neuroimaging data is opening a promising research direction for the scientific study of consciousness, including novel methods for estimating empirically powerful metrics of integrated information. Indeed, recent findings have shown that ΦID metrics (like synergy and redundancy) predict relevant cognitive phenomena (Luppi et al. 2022) and level of consciousness (Luppi et al. 2020). However, information-theoretic measures like those provided by PID and ΦID are susceptible to systematic sampling bias — i.e. they may be consistently over- or underestimated when estimated from limited data. This is particularly relevant to fMRI data, which is often restricted by short time series, and to integrated information metrics, which rely on the estimation of high-dimensional probability distributions. To address this important issue, we present a novel procedure to tackle systematic sample bias in PID and ΦID quantities, with an accompanying toolbox. Our toolbox generates plausible synthetic data for which it can calculate approximations of known values of various information-theoretic measures, and provide statistically well-calibrated estimates of bias and variance. It then builds on existing (Panzeri & Treves, 1996) and novel bias correction methods to provide ways to minimize this bias. By empowering more researchers with the tools needed to apply these methods to neuroimaging data, our toolbox aims to extend the power of information-theoretic methods and their rigorous application to the study of the neural bases of consciousness.

Subcortical structures of the visual system can process faces also in the absence of perceptual awareness

Sonia Mele (University of Verona, Italy), Chiara Mazzi (University of Verona, Italy), Chiara F. Tagliabue (University of Trento, Italy), Shai Gabay (University of Haifa, Israel), Marlene Behrmann, Carneige Mellon University, USA and Silvia Savazzi, University of Verona, Italy

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Robust evidence from phylogenetic and ontogenetic studies has highlighted that subcortical structures are implicated in face perception, with the amygdala and the superior colliculus as the most likely candidates. However, the specific contribution of such subcortical areas is still a matter of debate in the current literature. Gabay and colleagues pointed out that subcortical regions have a functional role in the perception of face stimuli especially under monocular viewing conditions. Using a Wheatstone stereoscope and presenting two consecutive images of faces, cars or words to the same or to different eyes, they asked participants to make a same/different judgment task. Since the visual input is known to be monocularly segregated from the early stages of the visual system to layer IV of the striate cortex, such a technique allows indeed to manipulate which eye receives visual stimulation, thus separating monocular and binocular channels. The performance of their participants was significantly enhanced when the images were presented to a single eye and this monocular benefit was selective for face stimuli. Therefore, these results suggested that subcortical mechanisms are implicated in face processing, although subcortical representations are coarse and able to support simple tasks only. The aim of the present study is then to verify whether subcortical structures are functionally implicated in face perception also in the absence of perceptual awareness by testing patients with lesions involving the primary visual cortex. A group of eight hemianopic patients and a group of healthy participants matched for gender and age performed the experimental task using a Wheatstone stereoscope. A same/different judgment task was administered following the presentation of two consecutive images (faces or cars) in the left or right hemifield and presented to the same or different eye. Importantly, one of the two stimuli always appeared within the blind portion of patients' visual field, while the other was presented in the corresponding position to their healthy visual field. The behavioral performance, considered in terms of inverse efficiency in order to take into account both accuracy and reaction times, resulted to be enhanced when faces (but not cars) were presented to the same eye. Since these results were reported for healthy participants as well as the blind field of hemianopic patients, subcortical structures were confirmed to subserve complex perceptual tasks in line with previous literature and, more importantly, without the need of consciousness. This involvement of subcortical regions in visual processing occurring also in the absence of perceptual awareness provides evidence going beyond the established idea of an exclusive contribution of cortical networks.

Putting theories to test: an overview of the Cogitate Consortium - an open science adversarial collaboration testing GNW and IIT

Lucia Melloni (Max Planck Institute for Empirical Aesthetics), Liad Mudrik (Tel Aviv University), Michael Pitts (Reed College), Cogitate Consortium ()

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

In recent years, several neuroscientific theories of consciousness have been proposed, without, however, converging on one unified account that explains consciousness. Instead, theories have developed in parallel without much cross-talk between them, while also offering explanations for the neural substrate giving rise to consciousness that are often contradictory. To start changing this state of affairs, we are experimenting with a new model of science based on open science adversarial collaboration contrasting two leading theories of consciousness: Global Neural Workspace and Integrated Information Theory. The aim of the Cogitate consortium is to test conflicting hypotheses of these leading theories of consciousness, in two experiments that were developed with, and endorsed by, the theories' proponents. These experiments were preregistered and run in six theory-impartial laboratories using three complementary methods: functional Magnetic Resonance Imaging (fMRI), Magneto-Electroencephalography (M-EEG), and intracranial electroencephalography (iEEG). A key asset of this approach is to put theories to test on the basis of the same data, including identical experimental conditions and analytical approaches, while testing predictions that theory proponents deem relevant to test contradictory predictions of the theories. In doing so, the explanatory and predictive power of the theories can be evaluated in an impartial and unbiased way. In this poster, we will provide an overview of the aims and approach of the Cogitate consortium. In particular, we will explain the two experimental protocols that have been devised and how they together and separately test key contradictory predictions of each theory. We will also detail the predictions made by each theory and describe how the accumulation of evidence across predictions as well as across methods puts theory to a more stringent test, while also describing the challenges entailed in accumulating information across predictions, experiments, and neuroscientific methodologies. This poster will serve as background for a series of 7 other posters that present the final results of one of the experiments of the cogitate consortium, including results from fMRI, M-EEG, and iEEG. This series of posters will provide the audience with a rich picture of how theories fair across multiple stringent tests. We hope that this innovative model of large-scale, collaborative, and open science practice will serve as an example for other researchers, hereby paving the way for similar endeavours.

A link between social cognition and visual consciousness

Rachel Metzgar (Princeton University), Michael Graziano (Princeton University)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Many current theories suggest that consciousness is closely related to social cognition. These theories suggest that consciousness and social cognition share neural machinery that represents a type of theory of mind (ToM) – we attribute a state of conscious experience to others, and to ourselves, because it serves as a useful way to monitor and predict behavior. One specific version of this perspective is the Attention Schema Theory (AST), which posits that the brain constructs a model of its own attentional state (an attention schema), as well as models of the attention of others. According to AST, consciousness, or awareness, is an attribution, and serves as a useful way to model the process of attending to something. If ToM and consciousness share an underlying neural mechanism, then activation of this mechanism from social tasks may interact with the systems used during visual awareness, causing a measurable behavioral effect on awareness thresholds. We tested this prediction using a behavioral experiment that measured the effect of a social cognition task on visual awareness thresholds. Participants performed two tasks, one requiring social attention modeling during a ToM task, and the other a nonsocial control task. Immediately following either task, a visual probe for the subject's own awareness was presented near detection threshold. The design tested whether modeling the attention of others measurably affected a person's ability to be aware of subsequent stimuli. We observed a priming effect in which people's reported awareness of a visual stimulus near threshold was improved by a preceding social task as compared to a preceding nonsocial task. These results suggest a neuroanatomical and mechanistic overlap between social cognition and consciousness.

Simulation of pharmacological treatments for recovery from disorders of consciousness using Whole Brain Modeling

Ivan Mindlin (Paris Brain Institute), Rubén Herzog (Paris Brain Institute), Dragana Manasova (Paris Brain Institute), Laoeun Belloli (Paris Brain Institute), Yonatan Sanz Perl, Jacobo Sitt

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Disorders of consciousness (DoC) are a group of post-comatose conditions that may occur after certain brain lesions. These are broadly categorized as: Unresponsive Wakefulness Syndrome (UWS, or otherwise known as vegetative state) where patients show total loss of awareness and Minimally Conscious State (MCS) where they may show intermittent signs of clear awareness. Most of the research done on these disorders has been focused on their diagnosis and prognosis and not on possible treatments. This is mainly due to the lack of understanding of what drives consciousness to be recovered. In order to develop better pharmacological treatments for DoC, it is necessary to understand the neural mechanisms that explain the increase of consciousness. Here, we performed in silico experiments with the Dynamic-mean-field (DMF) model to simulate the application of different drugs to a DoC brain state. We first fitted the DMF to UWS, MCS, and Healthy controls to generate baseline simulations of their brain signals. DMF is a biologically interpretable model in which pools of excitatory and inhibitory neurons are intercoupled, mean approximated and connected to other pools to form a whole brain parcellation. We used the gene expression of 48 neuromodulator receptors to perturb the DoC models to reach a healthy state. For this we incorporated the spatial information for all nodes in the DMF by scaling their structure in different free parameters of the model. We then measured the effort required to generate a significant similarity to the healthy condition’s dynamics for each neuromodulator in order to assess which was the most effective. The greatest improvement was achieved when modulating the inhibitory to excitatory strength, also called feedback inhibition control (FIC). This effect was seen in all receptors and the achievable dynamics were the same for all of them. They only distinguished themselves by the perturbation parameter landscape that was required to better approximate a healthy state dynamic. When modulating parameters of the model other than the FIC, there was no significant change with respect to the baseline DoC model signal. Although we computed the perturbation force required to transition to a wake state, there was no evidence showing that a particular receptor was more effective for the task. The uniformity in the neuromodulation effect suggests that future research should be focused on more complex modelisations such as those considering the interactions between multiple receptors. Nonetheless, we found that tuning the FIC in a biologically plausible manner is enough to model a transition from a DoC state to a different state with a more rich-informed signal similar to a healthy brain state. This result is aligned with the importance stated in the literature regarding the role of FIC when regulating brain dynamics.

Valence colors all our perceptions, but do perceptions have to be conscious for that to happen?

Léa MONCOUCY (Université Libre de Bruxelles), Inès MENTEC (Université Libre de Bruxelles), Ivan IVANCHEI (Université Libre de Bruxelles), Nathan SAINT-LAGER (Université Libre de Bruxelles), Romane POISOT, Axel CLEEREMANS

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Is conscious experience intrinsically valenced? That is, is it the case that every conscious percept elicits an affective disposition towards its contents? In support of this idea that affect is primary, Zajonc (1980) wrote: “We do not just see ‘a house’: we see ‘a handsome house’, ‘an ugly house’, or a ‘pretentious house’” (p. 154). In other words, valence would color all of perception, even in non-affective contexts, and even with respect to affectively neutral objects. Lebrecht and collaborators (2012) proposed that affect is not only involved in the processing of strongly valenced stimuli such as smiling babies or angry faces, but that it colors every conscious experience. Thus, they argued, even apparently neutral objects such as teapots and umbrellas are associated with a “micro-valence” that reflects people’s subjective attitude towards the objects. In an unpublished study, Lebrecht showed how such micro-valences can influence people’s performance in a categorization task where two objects have to be judged as being identical or different. Thus, for instance, participants were faster in deciding that two teapots are different from each other when they were associated with opposite micro-valences. , The finding that even neutral objects appear to be processed affectively directly supports the hypothesis that all conscious perception is valenced. This idea, if confirmed, profoundly changes the way we think of phenomenal experience. Affect, from this perspective, does not involve a distinct and optional processing step in a perceptual hierarchy, but is instead a feature of perceptual experience. Here, we report on our initial efforts at probing these ideas empirically. , In a first study, we improved on Lebrecht’s design by obtaining individual rather than group level estimations of people’s micro-valences with respect to different neutral objects. Our results partially replicated Lebrecht’s demonstration that people’s identity judgments in a categorization task are influenced by affective congruence. , In a second study, we asked whether it is only conscious perception that is valenced. If phenomenal experience has a function, perhaps it is to make it possible to assign value to everything that we do, and, by extension, to everything that we perceive (Cleeremans & Tallon-Baudry, 2022). But if that is the case, then one would not expect percepts that fall below the threshold of conscious perception to be valenced. To explore this issue, we systematically vary the visibility of stimuli in the same categorization task as in Study 1, and ascertain how visibility changes people’ s performance with micro-valenced stimuli. Visibility will be manipulated either by masking or by presenting stimuli for the sub-millisecond durations made possible by our lab’s modern tachistoscope. Results will be presented at the meeting.

Towards a measure of metacognition in autobiographical memory

Chris J.A Moulin (LPNC, UNIVERSITÉ GRENOBLE ALPES), Fabien Carreras (LPNC, UNIVERSITÉ GRENOBLE ALPES)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Most models of autobiographical memory (AM) propose a higher-order control process. However, empirical research which directly explores the capacity to evaluate autobiographical retrieval metacognitively is somewhat lacking. This is possibly due to the fact that the verification of personal recall is difficult, rendering metacognitive sensitivity analyses based on 'ground truth' impossible. Moreover, division of memories into 'correct' or 'incorrect' is somewhat irrelevant in current conceptualisations of AM. In response, we based our design on AM organisation. AMs are theorised to be organised into a coherent structure, a chronology reflecting the memories of the individual incorporated into the lifespan. We took retrospective confidence judgements (RCJ) for judgements based on the coherence of AM organisation. Eighty-three participants retrieved AMs. These memories were then re-presented to participants in pairs, for which the participant had to report in which order the events occurred. Participants made two such judgements of order for the pairs, which allowed us to categorise the judgements as coherent or non-coherent. Participanst made an RCJ based on this ordering. We found that participants were able to distinguish pairs of memories that were coherent with their AM chronology from pairs which were not. There was also an effect of response time and task difficulty on confidence, indicating that response fluency was used as a metacognitive cue, suggesting common properties between metacognition for autobiographical memory and other forms of memory. Critically, this is an important step towards a paradigmatic approach to considering metacognitive processes in autobiographical memory.

Neural Substrates of Metacognition Under Sequential Decision-Making

Yoshinori Nanjo (National Institute for Physiological Sciences, Japan), Tetsuya Yamamoto (National Institute for Physiological Sciences, Japan), David Aguilar-Lleyda (Riken Center for Brain Science, Japan), Rei Akaishi (Riken Center for Brain Science, Japan), Norihiro Sadato, National Institute for Physiological Sciences, Japan

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Metacognition has been thought to consist of two functions of generating confidence about behavioral states (metacognitive monitoring) and controlling them with the confidence (metacognitive control). Some researchers have investigated confidence in single decision tasks and associated the functional role of metacognitive monitoring with lateral prefrontal cortex (PFC). However, little is known about whether metacognition has a functionality in sequential decision situations and how the brain works in such behavioral contexts. We hypothesized that 1) confidence at a given decision timing enhances modulate the continuation of the same decision in subsequent decision timing, 2) neural substrates of metacognitive monitoring and control in sequential decision-making are distinct in areas of medial PFC. To test these hypotheses, we conducted a task-based functional magnetic resonance imaging (fMRI) experiment in which subjects performed two sequential decisions. A total of 34 healthy normal subjects performed a sequential perceptual decision-making task with confidence ratings. This task required subjects to see two circular stimuli, indicated which stimulus was larger and rated their confidence in this decision. Then they saw the same stimuli again and made the size decision and reported confidence in this second decision timing. The first and second decisions could repeat the same decision or change their mind. Across trials, four differences in size between two circles were presented. For each subject, all trials within each size difference were classified into high/low confidence trials according to median of reported initial confidence. In behavioral data analysis, change of mind was more frequent in low confidence trials, suggesting that metacognitive monitoring influenced subsequent decision-making. Next, we analyzed fMRI data to elucidate which brain areas are associated with this behavior. This revealed higher activity in the anterior part of the medial PFC in high confidence trials during first decision whereas the dorsal anterior cingulate cortex (ACC) was more active at the second decision when changes of mind occurred. Crucially, we found that these two activity patterns overlapped at the perigenual ACC. Our results suggest the behavioral and neural processes of metacognitive monitoring and control are related to each other, implying that metacognition can work as a part of sequential decision process.

Suboptimal Inference of the Self? Physiological Signals Dissociate Explicit and Implicit Measures of Agency

Ophir Netzer (University of Haifa), Asaf Appelbaum (Bar-Ilan University), Yoni Stern (University of Haifa), Oz Mashiah (Bar-Ilan University), Gabriella Panishev, Amir Gilad, Yair Zvilichovsky, Roy Salomon

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

The Self is a fundamental aspect of consciousness and a central construct of the human psyche. Yet, we have limited insight of the mechanisms underlying the assembly of the Self. Recent studies highlight the role of sensorimotor predictive processes in the formation of the Self. A central mechanism for delineation of the Self is Sense of Agency (SoA), the feeling of control over our actions. When functioning, SoA is not consciously experienced and we feel seamless control over our actions. However, disrupted SoA is distinctly sensed, and is a hallmark of several disorders (e.g. schizophrenia), in which there is a striking discontinuity in the sense of Self and feelings of alienation from one’s body. A prominent model describing the neurocognitive processes underpinning SoA suggests that it consists of two components: An implicit component, relying on a sensorimotor predictions comparator mechanism, comparing predicted motor plans to actual sensory feedback (allowing for online motor control). If predictions and feedback largely mismatch, SoA is lost and can be explicitly reported. The second component is explicit, high-level judgments, factoring in prior beliefs. The evaluation of SoA in humans often includes asking subjects to make explicit SoA judgments. In such manner, both explicit and implicit components of SoA are collected together. It is unclear what is the interplay between these components and how they affect the conscious SoA experience. Here, we used a virtual reality paradigm in which we introduced sensorimotor conflicts between participants' real hand and the viewed virtual hand, asking them to make explicit SoA judgments. We also recorded implicit physiological signals and examined whether these signals are indicative of sensorimotor conflicts and their relationship to explicit SoA judgments. Using machine learning algorithms, we found in an exploratory (N=35) and a preregistered (N=40) study preliminary results demonstrating that three physiological signals: pupillometry, oculomotion and motion kinematics, allow classification of sensorimotor conflicts. Critically, SoA classification from implicit kinematic signals outperformed participants' explicit SoA judgments. A between-subjects' cross validation indicated high predictive power of our model. Dissociation between implicit sensorimotor information and explicit SoA judgments indicates that the brain holds information of the conflict, which is not used for conscious judgements. This “suboptimal inference” suggests the computational process by which the brain constructs the conscious experience of SoA: The brain implicitly resolves sensorimotor conflicts via online motor corrections. Yet, this does not directly inform explicit SoA judgments, occurring only when sensorimotor conflicts exceed the tuning curve of the Self. This “suboptimal inference” may serve to maintain a smooth subjective SoA experience and perhaps sustains our stable, continuous Self-consciousness phenomenology.

Neural signature of phenomenological attitude toward perceptual experience

Satoshi Nishida (Center for Information and Neural Networks (CiNet), Advanced ICT Research Institute, National Institute of Information and Communications Technology (NICT)), Hiro Taiyo Hamada (Neurotechnology R&D Unit, Araya Inc.), Takuya Niikawa (Graduate School of Humanities, Kobe University), Katsunori Miyahara (Center for Human Nature, Artificial Intelligence, and Neuroscience (CHAIN), Hokkaido University)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

When we experience objects in our ordinary life, we are typically concerned with issues related to the object themselves, such as their properties and usefulness. In phenomenology, a sub-discipline in philosophy focused on the study of consciousness, this ordinary stance is referred to as the “natural attitude” (NA). Phenomenologists claim that the study of consciousness requires that we direct our attention away from objects and focus instead on conscious experience as such (i.e. the ways in which we are conscious of them). This alternative stance is called the “phenomenological attitude” (PA). Despite its theoretical importance both in philosophy and science of consciousness, the neural mechanisms underlying PA are unknown. To address this issue, we introduced an original behavioral task in which experimental participants are imposed to alternate between NA and PA toward stimulus-evoked subjective experiences from trial to trial. In each trial of this task, participants are asked to determine which of two sentences correctly describes a visual-scene stimulus. The two sentences are designed to automatically induce either the participants’ NA or PA (NA and PA conditions, respectively). We examined the neural signature of PA by analyzing the changes in fMRI signals depending on the task conditions. We found that participants exhibited lower error rates but slower reaction times in the PA condition compared to the NA condition. This indicates that these two conditions do not simply have different task difficulties. The task conditions were successfully classified using the multivoxel activation patterns of fMRI signals in the premotor cortex, the posterior parietal cortex, the supplementary motor area, and the cerebellum. The activation strength in these regions was lower in the PA condition relative to the NA condition. These regions are involved in action planning and/or the perception of affordance. Thus, the results suggest that PA depends on neural processes that suppress action representations induced by sensory information. To our knowledge, these findings provide the first evidence for the neural signature of PA toward conscious experience.

Neural populations involved in the sparse encoding of visual diversity: an fMRI adaptation study

Liam J. Norman (Durham University), Robert W. Kentridge (Durham University)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Is our visual experience rich or sparse? There is some experimental evidence to suggest it is rich: e.g. an observer can report the amount of colour diversity (variance around the mean) in an unattended ensemble of objects [1]. This suggests that, even under the impoverished conditions of inattention, an observer still has a perceptual experience of each individual object's colour. An alternative account, however, is that an observer is able to do this only because they have a visual experience of diversity as an abstract statistical property of the ensemble [2]. Strong evidence in favour of the sparse view would be to demonstrate the existence of neural populations that encode diversity at a level that dissociates from the encoding of the individual features. There is some psychophysical evidence to imply that the visual system does encode diversity in this way [3], but here we use neuroimaging to reveal, for the first time, the brain regions involved. We used the method of fMRI adaptation, which relies on the principle that neural populations that encode a particular visual property will show a reduced response with repeated presentations of stimuli that share that property. Following the adaptation period, a deviant stimulus is presented that differs to the adapting stimuli, causing a rebound of activation in brain areas that encode the relevant property. As adapting stimuli, we used visual patterns whose orientation diversity (i.e. variance) was held constant across changes in the mean. The diversity of the deviant stimulus was parametrically varied relative to the adaptors. This design eliminates adaptation effects based on individual features as well as the central tendency of those features, and instead isolates the neural populations involved specifically in the encoding of diversity as an abstract ensemble property. Results showed a peak response to the deviant stimulus in the anterior intraparietal sulcus (aIPS) – an area also previously shown to encode numerosity as an ensemble property [4]. Recent psychophysical experiments have also shown that the perceived diversity and numerosity of an ensemble are not independent from one another [5], raising the possibility that the apparent richness of visual experience might be best explained in terms of a sparsely coded and abstract visual property such as entropy. The results from the present study not only show that there are neural populations that encode diversity at a level that dissociates from the encoding of the individual features – supporting a sparse account of visual experience – but also further highlight the aIPS as an important neural substrate of sparse encoding generally. 1.Bronfman et al. (2014). Psychological science, 25(7), 1394-1403. 2.Ward et al. (2016). Cognition, 152, 78-86. 3. Norman et al. (2015). Journal of vision, 15(4), 3-3. 4.Castaldi et al. (2016). NeuroImage, 143, 364-377. 5.DeWind et al. (2020). Journal of Vision, 20(4), 4-4.

Bodily illusion enhances subjective fear by margin-of-safety violation around the experienced self

Ryu Ohata (Karolinska Institutet), Henrik Ehrsson (Karolinska Institutet)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

All living organisms, including humans, must flexibly change defensive responses according to the distance between one's body and potential threats. This indicates that the brain represents threat locations relative to one’s own body and exhibits corresponding emotional responses. Most previous studies of threat proximity investigated emotional fear responses by manipulating distance from the body; however, the functional role of the sense of bodily self, i.e. the perception of one's own body being in the center of the perceptual world, in the link between fear and threat locations is not fully understood. We hypothesized that the sense of the bodily self would enhance the spatial perception of threats from the perspective of the self (i.e. egocentric space perception), which may result in sensitive fear reactivity to threat locations. To test this hypothesis, we employed a full-body ownership illusion to manipulate the sense of a body in view as one’s own or not (i.e. sense of body ownership). Forty-one and 42 healthy volunteers participated in the two separate experiments. They lay on a bed wearing head-mounted displays and watched immersive stereoscopic videos that filmed a mannequin's body lying on a bed from the first-person perspective. Participants received (temporally and spatially) congruent visuotactile stimulation to their own body parts and the corresponding parts of the mannequin, which triggered the illusory feeling that the mannequin was their own body; incongruent visuotactile stimulation served as a control in otherwise equivalent conditions. Participants then viewed a realistic 3D spider or butterfly animation, as a fearful or emotionally neutral stimulus, respectively. The stimuli were presented at one of the two locations relative to the mannequin (proximal or distal) in Experiment 1 and at one of five locations (closest, second closest, middle, second farthest, or farthest) in Experiment 2. We found that subjective ratings of fear were more sensitive to the location of the fearful stimuli in the congruent condition than in the incongruent condition. We also found that the congruent condition increased fear ratings of the fearful stimuli regardless of the stimulus location. Furthermore, there was a significant correlation between participants' ratings of illusion strength and the levels of their reported fear. These findings suggest two aspects of how the sense of bodily self contributes to fear experience: to increase sensitivity to margin-of-safety violations and amplify fear/anxiety in response to threat appearance.

A top-down cortical circuit triggers somatosensory perception

Yasuhiro Oisi (Haptic Perception and Cognitive Physiology Laboratory, Center for Brain Science, Riken), Yusuke Atumi (Haptic Perception and Cognitive Physiology Laboratory, Center for Brain Science, Riken), Yoshiki Ito (Haptic Perception and Cognitive Physiology Laboratory, Center for Brain Science, Riken), Yoshihito Saito (Haptic Perception and Cognitive Physiology Laboratory, Center for Brain Science, Riken), Takayuki Suzuki, Maya Odagawa, Chie Matsubara, Hiroyuki Uwamori, Shigeki Kato, Kazuto Kobayashi, Kenta Kobayashi, Midori Kobayashi, Masanori Murayama

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Understanding how perception arises in the brain is one of the fundamental challenges for neuroscience. Several theories of perception emphasize the important role of long-range projections, including bottom-up and top-down inputs. These theories are being tested by many studies of the neural correlates of perception in monkeys and humans. However, it remains unclear how such hierarchical interactions contribute to perception due to methodological limitations in dissecting and manipulating circuits precisely in time and space in primate research. We have previously reported a recurrent hierarchical circuit consisting of cortical long-range projections between the secondary motor cortex (M2) and the primary somatosensory cortex (S1) in mice (Manita et al. Neuron 2015). Furthermore, somatosensory stimulation sequentially induced activity in S1, M2, and S1 on the recurrent circuit. M2 top-down input can trigger dendritic spikes and burst firing in S1 neurons. Based on these results, we hypothesized that the M2 top-down projection to S1 contributes to somatosensory perception. Here, we tested this hypothesis using optogenetic, chemogenetic, pharmacological, and lesions of the circuit during a somatosensory stimulus detection task. We defined a perceptual detection threshold in each mouse that performed the behavioral task and investigated how the threshold changes with circuit manipulations. First, we found that S1 and M2 lesions, pharmacological and optogenetic inhibition of each area significantly increased the threshold, indicating impaired perception. Pathway-specific optogenetic and chemogenetic inhibition of both the S1->M2 bottom-up and M2->S1 top-down projections also impaired perception. These results suggest that the S1-M2 recurrent circuit contributes to perception via bottom-up and top-down inputs. Next, we tested whether activation of either bottom-up or top-down projections is sufficient for somatosensory perception. Pathway-specific optogenetic activation of both S1 bottom-up and M2 top-down projections was able to induce illusory somatosensory perception. Finally, we investigated which pathway is closely correlated with perception. Pathway-specific activation of M2 top-down inputs with pharmacological M2 inactivation was able to induce illusory perception. In contrast, activation of the S1 bottom-up input with pharmacological S1 inactivation impaired perception. These results support our hypothesis that somatosensory perception requires S1 activity that is evoked by recurrent M2 top-down inputs.

Perception of facial emotional expressions in experienced users of classic psychedelics: a cross-sectional ERP study

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Psychedelics, such as psilocybin, LSD, mescaline, and DMT, have potential to significantly alter perception and the state of consciousness. One of the most profound acute effects of psychedelics is a shift in perception and processing of emotions. Specifically, psychedelics seem to facilitate processing of positive stimuli (Kometer et al. 2012) and impair processing of emotionally negative stimuli (Kometer et al. 2012; Kraehenmann et al. 2015). However, little is known about the long-term effects on emotional processing related to the use of psychedelics in a naturalistic context. In our previous study, we analyzed a large sample of cross-sectional questionnaire data, which indicated that psychedelic users are characterized by higher positive emotional reactivity and lower negative emotional reactivity when compared to non-users (Orłowski et al. 2022). In the present study we test the same hypotheses using electrophysiological measurements, namely we investigate whether using psychedelics regularly in a naturalistic setting might be related to lasting effects on perception and processing of emotions. We conducted a study using EEG to compare the processing of emotional stimuli in experienced psychedelic users (15 or more lifetime experiences with psychedelics, $N = 56$) and non-users ($N = 55$). During the experimental procedure participants were presented with photographs of neutral, happy, angry, and fearful facial expressions. An analysis of event-related potentials (ERPs) was conducted. Analysis of the amplitude of the face-selective N170 component yielded a significant Emotion x Group interaction ($p = 0.046$). Post-hoc comparisons indicated that the amplitude of the N170 component in the psychedelic users group is more positive during perception of fearful faces compared to happy ($p < 0.001$) or neutral faces ($p = 0.009$). No differences were found between emotions within the non-users group. Also, there was no between-group effect for N170 in any of the emotional conditions. In case of analysis of the N200 ERP component we also find a significant Emotion x Group interaction ($p = 0.005$). Specifically, we found that the perception of fearful faces resulted in less negative amplitude in the user group than in the non-user group ($p = 0.023$). Comparisons within groups indicated that the amplitude of the N200 component in the non-users group was lower during the perception of angry faces compared to faces belonging to other conditions (angry vs fearful: $p < 0.001$; angry vs happy: $p < 0.001$; angry vs neutral: $p < 0.001$). No differences were found between emotions within the user group. Our study is the first to use neuroimaging methods to investigate the long-term effects of naturalistic use of psychedelics. The obtained results indicate that naturalistic use of psychedelics is associated with long-term differences in emotional processing compared to non-users.

An enhanced, task-relevant autoencoder approach to characterizing information transfer between high-level visual and cognitive regions in the brain

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Ventral Temporal Cortex (VTC) is believed to lie at the interface between perception and cognition, and is a major input to the prefrontal cortex (PFC); PFC, in turn, supports higher cognitive functions such as decision-making and goal-based behavioral guidance, executive functioning, and perhaps even conscious awareness. What information flows from VTC to PFC to allow for such complex, flexible behavior? Understanding the nature of information sent from high-level visual areas to PFC would facilitate future computational and neurobiological investigations. However, a major challenge with understanding information represented in VTC and PFC in humans – and information shared between these regions – is that functional magnetic resonance imaging (fMRI) data are often noisy and contain extraneous information. fMRI data also can contain thousands of voxels (features) but only a few hundred samples, making even advanced computational models prone to overfitting. Here, we used an autoencoder-based model (a Task-Relevant Autoencoder with Classifier Enhancement; TRACE; Orouji et al. 2022) to reveal lower dimensional representations of high-dimensional fMRI data. We previously showed that TRACE can extract low-dimensional task-relevant information in VTC by using information relevant to a participant's task to filter out physiological or other noise; it can thus reveal "purer", gist-like representations in a region of interest. Here, in two new analyses we applied TRACE to fMRI data from humans who performed a high-level object categorization task by viewing 3600 images from 40 categories of animals and man-made objects. First, we applied TRACE to examine representations of object categories in PFC by taking PFC as both input and reconstruction target for TRACE. Second, we used VTC as input to TRACE to predict voxel activity in PFC, to examine shared information and how it might differ from information encoded in each region separately. Preliminary results suggest that TRACE can surpass input-based benchmarks for class specificity and classifier accuracy in PFC, as previously found with VTC (Orouji et al. 2022). However, we also observed that up to three times as many dimensions may be necessary to maximize model performance in PFC data, and the same appears true for predicting PFC activities from VT. These results imply that information represented in PFC fundamentally differs from that encoded in VTC in both its nature and compressibility, i.e. that PFC might contain more complex information and hence require more features in the latent space to be properly encoded, as suggested by others (Shibata et al. 2019), and to flexibly adapt to changing task demands even given identical input (Mante et al. 2013). Ongoing work seeks to comprehensively explore these effects and expand TRACE using explainable AI approaches, with the goal of understanding and characterizing the nature of information transfer between high-level visual areas and prefrontal cortex.

EEG correlates of rapid filling-in and perceptual awareness in a contour erasure paradigm

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Contour erasure (Anstis 2013) is a phenomenon in which adaptation to the flashing black and white outlines of a stimulus renders invisible a gray test stimulus that is subsequently presented in the same location. It has been proposed that this adaptation causes a failure to detect the object boundaries of the test stimulus, leading to rapid "filling-in" of luminance information from surrounding areas of visual space. This effect is proposed to occur early in visual processing, but the exact time course and processing stages involved remain unknown. To assess the time course of this filling-in process that obliterates awareness, we recorded EEG while participants (N=5, ongoing) viewed a contour erasure stimulus in which the outlines of two bilaterally presented stars ("inducers") flashed for 2s, and were immediately followed by one or two test stimuli. In the illusion condition, one of the test stimuli matched in orientation with the inducers and was rendered invisible, while the other test stimulus was rotated such that its contours mismatched the inducers, allowing it to remain visible. In the perceptual control condition, only a single rotated, and therefore visible, test stimulus was presented. Thus, participants' subjective experience was identical across the two conditions, with the key difference being the presence or absence of an invisible stimulus. This design allowed us to exploit the contralateral organization of the visual system to examine EEG activity recorded contralateral vs ipsilateral to the filled-in invisible stimulus, as well as to the fully visible stimulus. Surprisingly, comparing contralateral vs ipsilateral ERPs in the illusion and perceptual control conditions revealed virtually identical patterns of results, as if the invisible stimulus in the illusion condition had not been presented at all. We did, however, observe a posterior negativity between ~200-250ms contralateral to the visible stimuli in both conditions, consistent with the previously reported Visual Awareness Negativity. To test if informative differences were present in the pattern of electrical activity across the scalp that may have been obscured in the averaged ERP waveforms, we trained an SVM decoder to distinguish between illusion trials and perceptual control trials. This decoder did not exceed chance accuracy, again suggesting no detectable differences between conditions. As a control analysis to ensure adequate signal-to-noise ratio in our data, the location of the visible stimulus (left vs right) was decodable with >85% accuracy in both the illusion and perceptual control conditions from ~120ms after test stimulus onset, with these decoders successfully generalizing across conditions. Together these ERP and decoding results support an extremely early locus of this filling-in process, likely prior to the P1 at 100ms, and potentially in the time range of the C1 component and thus V1, consistent with previous psychophysical findings (Anstis 2013).

Brain interoceptive fingerprint of self-induced cognitive trance

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Self-induced cognitive trance (SICT) is a form of non-ordinary state of consciousness derived from shamanic trance. It is described by expanded inner imagery, altered somatosensory processing, and an altered sense of self and time. Recent research suggested that one mechanism that might be involved in SICT is it's the brain efficiency to integrate interoception signals. Interoception is the bottom-up sensory information from visceral stimuli, which includes the ability to perceive internal body states. Although the involvement of an interoceptive modulation mechanism during SICT has been postulated, this hypothesis has never been tested. Here, our aim was to better understand the interoceptive interaction with the brain during SICT. We first identified the specific features of the heart and brain regions involved in SICT compared to an imaginary task, and then tested the hypothesis that interactions between brain and heart features can predict a SICT state as well as the subjective intensity experienced during this state. The cardiac and brain signals of 25 SICT-expert participants were recorded in three conditions: resting state, SICT, and an imaginary condition of a previous intense trance. Subjective intensity was collected during SICT. Five min of clean signal of brain activity (recorded with high density EEG-256) and electrocardiogram were used. Time and frequency domain metrics of heart rate variability was computed, and EEG cortical reconstruction source was performed by using a weighted minimum norm solution on the brain template (MNI-152). We calculated means of power spectrum density for the canonical frequencies band. Cardiac features which discriminate SICT to rest and imaginary condition were retained to perform an interaction between all brain features. Machine learning models based on linear discriminant analysis were used to classify differences in heart-brain interactions between SICT and imaginary condition, decoding accuracy were corrected for the multiple comparison problem. High frequency (HFn) of heart rate variability showed significant lower interactions with bilateral mid-cingulate, posterior cingulate cortex, bilateral insula cortex as well as right medial frontal cortex in delta and theta bands between SICT and imaginary condition. While higher interactions were found between HFn of heart rate variability and right occipital, right pole temporal cortex as well as left frontal dorso-lateral and medial temporal cortex. Moreover, the lower interactions found in the theta band showed positive association with interindividual subjective intensity of SICT. Our results indicate that the key interoceptive nodes in the low frequencies showed lower interaction with the heart during the SICT and this change was associated with the intensity of the subjective experience during SICT. This suggests that interoceptive signals may play a critical role in the physiology of SICT as well as in the subjective awareness.

Measuring the duration of an illusory motion percept – Findings from a staircase probe procedure with the Ring Rotation Illusion

Lotta Ottensmeyer (Georg August University of Göttingen), Robert Fendrich (Georg August University of Göttingen), Uwe Mattler (Georg August University of Göttingen)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The generation of motion percepts is based on the visual system's ability to integrate information over space and time, but the temporal relationship between those percepts and the stimulus events that give rise to them can be difficult to specify. In apparent motion paradigms, the flashed objects can be seen in-between positions, moving along an illusionary trajectory as if back-projected in space and time. We developed a paradigm to access the start and end times of an illusory motion in temporal relation to its initiating events. In the "Ring Rotation Illusion" when a static outline circle is transformed into a ring of evenly spaced points the ring of points is perceived to undergo a brief illusory rotation. We presented a visual probe whose onset time could be varied relative to the appearance of the ring of points. In a double random staircase procedure, subjects indicated whether their perception of movement had ceased before the probe appeared, providing an estimate of the time the perceived rotation came to a halt relative to the presentation times of the stimuli that generated this rotation. The interstimulus interval (ISI) between the outline circle and ring of points and the duration of the outline circle were varied. We found that while the subjective clarity of the movement was judged to be higher for short durations of the outline circle, this duration did not affect when the motion ceased to be seen. However, the cessation of the perceived rotation of the ring of points decreased linearly with a slope of one as the ISI between the outline circle and ring of points increased, so that the period in which the illusory rotation can be seen maintains a value of about 200ms. Together, these results indicate the processes that generate the motion percept are initiated at the offset of the outline circle rather than the onset of the ring of points and suggest a possible heuristic that interprets the sequence of the circles as a global movement with a constant duration.

Complex Consciousness in Musical Experiencing: A TMS-EEG investigation of brain complexity during jazz improvisation

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The presence of consciousness depends on the brain's capacity to support complex activity patterns, with complexity being high when consciousness is present (e.g. wakefulness) and low when consciousness is absent (coma). By combining transcranial magnetic stimulation with electroencephalography (TMS-EEG), the increasingly validated Perturbational Complexity Index (PCI) seems to provide a principled account and a laboratory-based measure of both the quantity and the quality of subjective experience, successfully differentiating levels of consciousness in the context of physiological, pharmacological, and pathological perturbations. However, its heuristic potential hasn't been explored beyond conditions of relatively reduced complexity, leaving wakeful states largely unexplored and undifferentiated. Jazz improvisation has consistently provided a reliable test-case for the behavioural and neuroscientific study of creative thought - a phenomenal and neurophysiologically complex conscious state characterized by relatively unconstrained and hyper-associative modes of cognition. Our main goal is to use TMS-EEG - and, in particular, PCI protocols - during live jazz improvisatory performance so as to determine how creative though modulates brain complexity, and ultimately, heightens our capacity for conscious experience. Also, by directly probing both local and widespread changes in brain neurophysiology in response to TMS, we aim to provide a novel characterization of the neural properties of cortical-thalamocortical circuits during creative cognition using other transcranial-invoked potentials (TEPs) indexes, namely natural frequency, effective connectivity and cortical excitability. Following a within-subject design, one to three professional jazz pianists will interchangeably improvise (creative thought condition, consisting of improvising freely but according to a pre-established harmonic structure depicted on a screen), reproduce a given melody (control condition) or sit idly (resting state control condition) while brain responses to TMS are recorded. At the same, audio recordings of improvisatory performances will be obtained, and posteriorly independently rated for their creativity by 2 expert judges following Amabile's Consensual Assessment Technique for creative products. Our expected results are as follows: (i) jazz improvisation will be associated with higher PCI values, compared to non-improvisatory performance and resting state conditions; (ii) inter-trial variability of musical creativity in the improvisation condition - as assessed by musical judges - will be accompanied by significant changes in brain complexity, where high-creativity improvisations will be associated with increased brain complexity, compared to low-creativity improvisations. In the end, we expect to deliver valuable insights about daily mental states, but also brain processes that underlie music cognition, performance, and creativity.

The exclusionary approach to consciousness

Marlo Paßler (Humboldt Universität zu Berlin)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The standard approach in consciousness research is to identify the neural correlates of consciousness (NCCs) by comparing neural activity between conscious and unconscious trials. However, this approach has been criticized due to a lack of consensus on how to operationalize and measure consciousness. In this talk, I propose an alternative approach: the exclusionary approach. Instead of using near-threshold conditions to contrast conscious and unconscious trials, this approach takes advantage of the widely accepted notion that subjective reports are reliable under normal conditions. This can be done by assessing whether consciousness remains relatively stable across trials while other factors such as reports, task, stimulation, or attention are manipulated. The resulting contrasts can be used to exclude certain types of neural events as candidate NCCs for the aspects of experience under investigation. I argue that this use of reports is reliable, even for many skeptics, and allows for the establishment of hard bottom-up criteria for theories of consciousness independently of the operationalization problem. Moreover, it does not require the development of new research paradigms, but can incorporate existing studies, especially those designed to identify confounding factors.

Neural correlates of consciousness in an inattentional numbness paradigm

Dr. Antje Peters (University Muenster), Maximilian Bruchmann (University Muenster), Torge Dellert (University Muenster), Robert Moeck (University Muenster), Insa Schlossmacher, Thomas Straube

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Neural correlates of consciousness (NCCs) are defined as neural activity that is sufficient to generate conscious experience and correlates with stimulus awareness. Measuring NCC without confounds by task-relevance or report needs certain types of experimental designs. One approach is the use of “inattention paradigms”, in which some participants remain unaware of task-irrelevant stimuli due to attentional distraction. Inattention paradigms have been shown to reveal NCC without post-perceptual confounds in the auditory and visual modality. Such studies show strongly reduced NCC in non-sensory regions as compared to studies with task-related confounds. The present functional magnetic resonance imaging (fMRI) study investigated NCC in the somatosensory modality using an inattentional numbness paradigm. Participants (n = 44) received weak electrical stimulation near the detection threshold while performing a demanding visual task. Half of the participants were informed that the somatosensory stimuli would be present during the experiment. In contrast, the other half were not informed about the stimuli. About a quarter of participants of each group did not consciously perceive the stimuli during the visual task according to unexpected ratings after the experiment. The comparison of brain responses to the weak electrical stimuli between aware and unaware subjects revealed increased activation in the contralateral secondary somatosensory cortex in the aware group. However, we found no effects of stimulus awareness in frontoparietal areas, which have been suggested to be involved in the NCC. Our results support the hypothesis that somatosensory stimulus awareness is mainly based on activation in the somatosensory cortex and does not necessarily require strong or extended activation in anterior or posterior brain networks, which are typically activated when stimuli are task-relevant. Thus, our study supports theories suggesting a priority role of sensory areas and disagree with the need for strong, widespread frontoparietal activation in conscious detection.

Robotically induced Presence Hallucination in healthy participants alters numerosity perception of digital humans

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Hallucinations have fascinated philosophers, neuroscientists and clinicians for centuries. Despite the desire to unravel the mechanisms of these aberrant perceptions and their clinical relevance in medical conditions such as schizophrenia and Parkinson's disease, the investigation of hallucinations has been hampered due to difficulties to induce and quantify them in controlled experimental settings. To overcome these current limitations, we developed a robotic procedure and method to repeatedly induce Presence Hallucination (PH – the sensation that somebody is nearby when no one is actually present and can neither be seen or heard), in healthy participants and patients with Parkinson's disease, experimentally using different sensorimotor conflicts. While this robotic method enables the investigation of PH in real-time within a controlled environment, the procedure has relied on explicit ratings, which are sensitive to participant and experimenter biases. Here, by merging our robotic platform with immersive Virtual Reality (VR) we designed a new task (Numerosity Estimation of Humans – NEH) to implicitly quantify PH. Based on the evidence that blindfolded participants overestimate the number of people felt-close when a presence is experimentally induced with the robotic system and that humans overestimate the number of objects as dots in a visual display for numerosities just above the subitizing range, we tested whether this overestimation was also present for human stimuli in VR, and whether this overestimation depends on the induction of PH. During NEH, participants were asked, after the robotic sensorimotor stimulation, to estimate the number of digital humans they saw in a virtual environment briefly presented in the Head Mounted Display. In a series of three experiments on healthy participants (n=78), using our VR-enhanced robotic platform, we show that participants overestimate digital humans, that this effect is larger in the PH-inducing condition and that the effect is absent in several control conditions. This suggests that the experimental induction of an invisible presence alters the perception of humans, leading to an overestimation. More generally, our results suggests that NEH in VR is a robust, implicit and quantitative measure of PH, paving the way for a better investigation and diagnosis of hallucinations in psychiatric and neurodegenerative diseases.

Ganzfeld induced alterations in consciousness

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

In the absence of sensory stimulation, the brain produces its own reality. More specifically, when our visual system is faced with no changes in visual information, i.e. perceptual deprivation, hallucinations may emerge. While hallucinations are commonly studied in a psychiatric context, they can be induced in non-clinical settings by the unique phenomenon of the Ganzfeld (GF) effect. The GF effect involves homogeneous, unstructured sensory stimulation. Individuals subjected to a GF report the emergence of illusory percepts ranging from subtle dots and patterns, to more vivid and complex faces, animals and nature elements. In addition, the GF effect is characterized by instances of perceptual blackouts. This effect has also been found to induce effects on various facets of consciousness. As such, the experience is characterized by inward-directed thoughts, an absorptive state with reduced vigilance and self-awareness (Schmidt, 2019). Remarkably, the GF effect has been used by light artists such as James Turrell. Observers describe these GF artworks as incredibly immersive experiences. Given that participants indicate to have been fascinated by the effect ever since they first experienced it, we wonder what happens during this immersion and what role consciousness plays in the experience of GF art and the emergence of aesthetic appreciation. The present study forms the experimental foundation of this line of research. As opposed to the frequently used GF glasses, we created a GF lab using a curved screen made of a particular fabric that renders a diffused light with rear projection using flood lights, thus creating a homogeneous field of light. In a first experiment, 28 participants experienced a GF light installation in red. In a second experiment, 45 participants experienced the same installation with varying colors over time. In both experiments, a multimodal GF, i.e. homogeneous visual and auditory stimulation (white or brown noise) was applied. Participants wore an EEG device, an eye-tracker and headphones and were given a rotary dial to report hallucinations and blackouts. After the 25 minute GF session, participants were interviewed and asked to complete a questionnaire assessing altered states of consciousness (OAV) (Studerus, 2010). The results in Experiment 1 show support for the induction of alterations in consciousness with significant deviations from zero for all dimensions ($df = 27$, $p < .05$), e.g. Disembodiment, Blissful State, Insightfulness. We are currently analyzing eye movements to test the hypothesis that eye movements increase during hallucinations and decrease during blackouts. Previous GF research has found that reports of hallucinations were preceded by accelerated alpha activity in the brain. We will investigate this further by analyzing the EEG data of both experiments. In a future study with an artistic light installation, we will examine the role of alterations in consciousness in the emergence of the art experience.

Semantically congruent sounds increase perceptual dominance times of human images during binocular rivalry

Giusi Pollicina (Royal Holloway, University of London), Polly Dalton (Royal Holloway, University of London), Petra Vetter (University of Fribourg)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

During binocular rivalry, two different images are presented to each eye at the same spatial location, and observers perceive a fluctuation between the two. Binocular rivalry can be modulated by stimuli from other sensory modalities, for example sounds can facilitate the perception of semantically congruent images (Chen, Yeh and Spence, 2011). Neural activity in early visual cortex is correlated with conscious perception of binocular rivalry (e.g. Lee and Blake, 2002; Haynes et al. 2005), and fMRI results from our lab (Pollicina, Dalton & Vetter, in prep.) revealed that early visual cortex represents information about human sounds preferentially to other sounds. This prompted us to focus on the audio-visual integration of human-related stimuli and to investigate the necessary degree of semantic relatedness between sounds and images promoting conscious perception during binocular rivalry. We presented participants with human images (e.g. people, feet or hands) paired with either vehicle or animal images, while they listened to congruent sounds, ‘relevant’ sounds (which were human-related but not congruent with the image), incongruent sounds, or silence. Our results show that human sounds increased the mean perceptual dominance times of human visual stimuli, but only when these were specifically congruent to the image. Hearing relevant (but not entirely congruent) sounds of a human nature did not influence perceptual dominance of human images. This effect was not found for sounds congruent with animal or vehicle images whose dominance times did not differ from the no sound condition. These results support the idea that semantically congruent sounds can promote disambiguation of ambiguous visual percepts during binocular rivalry, particularly when sounds and images are human and strictly congruent.

Informational theories of consciousness

Paavo Pylkkanen (University of Helsinki, Finland and University of Skovde, Sweden)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Some theories of consciousness give information a central explanatory role. The Integrated Information Theory (IIT) identifies consciousness with a certain kind of physically (and not merely functionally) integrated information. Consciousness is intrinsic to certain causal structures present in a grouping of elements within a system that have physical cause-effect power upon one another (Fallon 2023). Chalmers' (1996) double-aspect theory of information connects with Wheeler's quantum mechanical view that the physical derives from the informational ("it from bit"). Information is truly fundamental, and experience is information from the inside, while physics is information from the outside. Here yet another informational theory is explored, based on Bohm's (1990) "active information" view. Information is understood literally as in-forming, as when the form of the radar waves (which reflect the form of the environment) informs the movement of a ship on autopilot; or when the form of the DNA molecule actively in-forms the construction of proteins. In subjective experience, when reading a map, we are in-formed about the various possible routes we might take and then choose one of them. Radically (cf. Wheeler) Bohm proposed that active information applies even at the quantum level. His "pilot wave" interpretation of QM postulates that an electron is a particle always accompanied and guided by a wave. The wave is not pushing and pulling the particle mechanically, but the form of the wave literally in-forms the movement of the particle. Quantum active information has radically new properties: it enables context-dependence, non-locality and a very special, irreducibly holistic way in which the information carried by the quantum wave of a many-body system orchestrates the behavior of a group of particles (e.g. in superconductivity). In Floridi's (2015) terminology, active information is environmental (the form of the quantum field is correlated with the form of the environment, e.g. the form of the 2-slit experiment); but it is also semantic (both factual and instructional) because it is about something (the environment, slits), it is for the particle, and it helps to bring about something (movement of the particle). If this kind of holistic, dynamic and semantic information is a fundamental aspect of reality, what (if any) relevance might this have for a theory of consciousness? For Bohm the mind involves a hierarchy of levels of active information, with the possibility of transcending any given level by a meta-mental step. He was inclined toward a higher-order theory of consciousness, for he assumed that where there is information about the environment there is a kind of "awareness" (cf. Chalmers), but that for consciousness "awareness of awareness" is required. I will consider the prospects of developing a theory of consciousness in the active information scheme, comparing and contrasting it with Tononi's IIT and Chalmers' double-aspect theory.

Are brain oscillations emergent?

Hardik Rajpal (Imperial College London), Pedro Mediano (Imperial College London), Fernando Rosas (University of Sussex), Henrik Jeldtoft Jensen (Imperial College London)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The problem of emergence is key to understanding how the phenomenological experience of consciousness can arise from discrete firing patterns of neurons at the microscopic level. Thus, quantifying emergence is an important mathematical quest that has expanded over the last few years. Most recently, information theoretic measures have suggested some practical ways of calculating statistical measures of emergent properties through a data-driven approach. However, these information measures often quantify emergence by measuring the amount of excess predictive information present in the emergent feature of the system than the parts alone. This approach, although mathematically elegant, overestimates the contribution of the parts by over-counting the redundant or shared information among the parts of the system. Thus, for biological systems like the brain which favour high-redundancy (for resilience), these measures provide negative values drowning the effect of any synergistic interactions present in the system. , Here, we explore these measures of emergence in network models of Izhikevich (Iz) neurons that exhibit oscillatory behaviour. Incorporating the framework of Phi-Information Decomposition (PhiID) allowed for correcting the over-counting of redundancy present in these systems. This is achieved by iteratively adding the redundant information atoms to the original measures of emergence. Post correction, we are able to identify the role of network size, excitatory-inhibitory balance and time-delays in Iz network models that lead to emergent dynamics. Finally, we discuss the behaviour of these measures near the order-disorder phase transition exhibited by variations of the Iz network models. The PhiID framework thus enables to quantify the emergent properties and establish their relationship to the phase-transitions and symmetry breaking from the perspective of statistical mechanics.

The Effects of Psilocybin on Top-Down Visual Illusions and Cognition

Sidath Rankaduwa (Western University), Michael Bach (University of Freiburg), Adrian M. Owen (Western University)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Users of psychedelics have been known to report a variety of benefits to visual perception, although, they often fail to demonstrate any objective improvements when tested. Is it possible that psychedelics could offer specific visual benefits, while impairing most faculties? Recent theories have proposed that psychedelics alter perception by disrupting top-down cognitive processes, thereby reducing the influence of perceptual priors. While our visual system constructs whole objects and scenes from basic features in our environment (e.g. shape, texture, motion), much of what we see is influenced by these top-down inferences. Many illusions, for instance, are the result of top-down mechanisms which often lead us to misperceive a given image; we might see two equal lines as differing in length (such as the Müller-Lyer illusion), or observe a hollow mask as being convex (known as the Hollow Mask illusion). However, if psychedelics disrupt top-down processes, then we may not expect a user to make the same incorrect judgements -- could this, perhaps, be a case in which psychedelics yield an improvement in visual perception? We can investigate this by observing how psilocybin (a classic psychedelic) affects well-understood top-down visual illusions. Our hypothesis is that individuals in a psilocybin state will be more resilient to higher-level illusions (such as the Müller-Lyer or Hollow Mask) compared to a sober condition, while being largely unaffected in their sensitivity to mid-level/lower-level illusions (e.g. retinal illusions). Due to reduced top-down priors, an individual under psilocybin might instead have an enhanced ability to make more accurate judgements on certain illusions; they might observe the Müller-Lyer lines as being equal in length, when in fact, they are; or perhaps, they might be able to correctly indicate when a Hollow Mask is being shown in its hollow orientation. Preliminary data suggests that the strength of visual illusions can effectively be quantified using online psychophysics assessments. To help administer this test in global psilocybin users, we have devised a novel "trip sitter protocol" that will allow us to collect experimental data from within the psilocybin state. This framework can easily be leveraged for other online studies that wish to collect behavioural data from within the psychedelic state (e.g. for cognitive testing, which we will also assess). Several writers and researchers have alluded to perceptual "benefits" from psilocybin, however, there has yet to be definitive evidence supporting these claims. If users are more likely to make accurate judgements on visual illusions in a psilocybin state, we may very well identify a specific case in which a psychedelic offers a so-called "advantage" -- interestingly, we would observe a perceptual improvement as a result of a visual impairment.

The experience of memory: How eye movements inform the relationship between memory accuracy and retrieval confidence

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Most memory researchers would agree that memory accuracy and memory confidence often coincide. However, in law, which is one of the most important areas of applied memory science, a common view recently highlighted by the California Supreme Court is “that ‘eyewitness confidence is generally an unreliable indicator of accuracy’” (People v Lemcke, 2021). These contrasting views might suggest that the relationship between confidence and accuracy varies depending upon the circumstances surrounding the memory and subsequent confidence decisions. Eye-movements during expressions of memory may provide insight into the details of the retrieval experience and help identify circumstances of convergence or divergence between memory accuracy and memory confidence decisions. Here, we investigated the relationship between spatial memory precision, participant eye-movements, and memory confidence. A sample of 40 adults between the ages of 18 and 35 (mean = 22.03, SD = 3.27) engaged in a visual search task using complex, multi-object indoor room stimuli that all contained a common target object. During five learning blocks, we recorded participants’ eye movements in x-y coordinate space as they performed the task of locating the target object within each room. Similarly, during subsequent memory retrieval, we again recorded participants’ eye movements as they self-reported back the target object location in corresponding x-y coordinate space by clicking the location on the screen using a mouse. Post-test, overall subject memory confidence was collected on a 5-point scale, where a score of 1 effectively indicated no confidence, and 5 indicated complete confidence in the accuracy of the memory decisions. Under these conditions, we found a significant correlation between individual differences in memory precision and post-test confidence judgments, such that increased memory precision was associated with increased confidence. Furthermore, differences in participant eye movements during memory encoding and retrieval predicted individual differences in both memory precision and confidence, such that participants who were able to retrieve memories with overall finer granularity appeared to view the presented stimuli differently than did those who provided less-precise memory reports. Similarly, more confident participants appeared to view stimuli differently than did their less confident counterparts. For example, participants who were more accurate overall spent a higher percentage of time looking in the correct quadrant of the screen across encoding and retrieval trials. Additionally, participants who self-reported as more confident also spent a higher percentage of their time looking in the correct quadrant of the screen during both the encoding and retrieval phases. Overall, this study adds to a growing understanding of the relationship between memory confidence and accuracy.

Multimodal assessment of prognostic markers in clinically unresponsive ICU patients outperforms unimodal predictions

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Background: Prognostication of clinically unresponsive ICU patients following acute brain injury is a medical, scientific and ethic challenge. Multimodal Assessment (MMA) using behaviour, neuroimaging and neurophysiology is recommended by international guidelines although supported by scarce evidence. Methods: The aim of this study was to assess the benefit of MMA over unimodal prognostication in a prospective cohort of clinically unresponsive acute brain injured patients assessed in a reference center. All patients assessed for neuroprognostication following an acute brain injury from 2009 to 2021 in the neuro ICU of La Pitié Salpêtrière Hospital have been included. One-year functional outcome was categorized using the Glasgow Outome Scale – Extended (GOS-E). Univariate prediction accuracies (sensitivity, specificity, predictive and negative predictive values for favorable outcome (defined as a GOS-E≥4) for clinical, neuroimaging and neurophysiological makers were compared to in-person meeting collective predictions as well as a multivariate predictive model based. Results: Three hundred forty-nine patients (36.4% cardiac arrest and 18.9% traumatic brain injuries) have been assessed during the 12-years period. Over this study time period, the number of prognosis marker increased (from 2 to 10) and proportion of uncertain prognosis decreased (from 60% to 10%). Prognosis of favorable outcome emitted in 22% was dependent from etiology, previous medial history and all MMA markers but independent from age and delay from brain injury. In-person meeting collective predictions based on MMA as well as multivariate predictive model outperformed all individual prognostic markers (Se, Sp VPP, VPN for Real-life collective decision). Importantly, predictive performance of MMA remained significant after the exclusion of patients that underwent withdrawal of life sustaining therapies, although this situation was more frequent for patient with poor emitted prognosis. Conclusion:, Prognostication based on MMA as recommended by international guidelines outperforms unimodal predictions' accuracy of long-term functional outcome in acute brain injured patients.

The Catecholaminergic Neuron Electron Transport (CNET) Action Selection Mechanism Hypothesis

Chris Rourk (Citizen scientist)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Evidence has been obtained of long-distance electron transport between soma of catecholaminergic neurons, such as the substantia nigra pars compacta (SNc) (1). The underlying mechanism is electron tunneling associated with ferritin, evidence of which has been obtained by many researchers, as well as the ability for ferritin to perform a switching or routing function associated with that electron transport (2). This function in those neurons would explain how they are able to selectively route dopamine for control of action selection and cognitive processing and could also provide a binding mechanism for the experiential component of consciousness. For example, it has recently been shown that SNc neurons provide dopamine to the striatum in a manner that is spatially and temporally precise, to mediate action selection (3). These observations are consistent with predictions made in 2018 about the hypothesis, which is referred to as the Catecholaminergic Neuron Electron Transport (CNET) action selection hypothesis (4). The proposed poster would provide an overview of CNET, how it relates to known behavior of the SNc, and evidence that was obtained after CNET was first proposed in 2018 that is consistent with the hypothesis. As noted by Fred Hoyle, science is prediction not explanation. In this regard, the CNET hypothesis is different from many theories of consciousness, which not only fail to make predictions, but which are also based on providing explanations for consciousness. CNET is not a theory of consciousness but is instead an action selection/binding mechanism hypothesis that is relevant to many (if not most) theories of consciousness. A proposed consciousness co-processor as described in U.S. Patent 10,817,780 will also be discussed. , (1) Rourk, C. "Indication of quantum mechanical electron transport in human substantia nigra tissue from conductive atomic force microscopy analysis." Biosystems 179 (2019): 30-38. (2) See, e.g. Rourk, C. et al. "Indication of Strongly Correlated Electron Transport and Mott Insulator in Disordered Multilayer Ferritin Structures (DMFS)." Materials 14.16 (2021): 4527. (3) Liu, C. Goel, P. and Kaeser, P. "Spatial and temporal scales of dopamine transmission." Nature Reviews Neuroscience 22.6 (2021): 345-358. (4) Rourk, C. "Application of the Catecholaminergic Neuron Electron Transport (CNET) Physical Substrate for Consciousness and Action Selection to Integrated Information Theory." Entropy 24.1 (2022): 91. The Hard(ware) Problem of (Machine) Consciousness - YouTube: https://www.youtube.com/watch?v=_VoOXebCEgg

The frequency and duration of off-task episodes

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Consciousness varies in time. In natural settings, we shift our attention from one topic to another, even when we intend to keep our focus steady on one particular task or idea. This has long been recognized in scientific psychology, at least since the time of William James (1890), but due to immense methodological challenges, has not been very much studied in experimental cognitive psychology. In the past 20 years or so the flourishing field of mind wandering studies has lead to the recognition that, in laboratory tasks, participants are sometimes "on-task" and at other times "off-task". A lot of effort has been devoted to the study of the neural and psychological determinants, intrinsic nature and consequences of these two states of consciousness. Yet, we know still next to nothing concerning the dynamics of the alternations between on-task (focus) and off-task (mind-wandering, distraction, blank) states. Indeed, the gold standard method for accessing the inner states, thought probing, provides an instantaneous estimate of the current state of mind. Therefore it can only yield an estimate of the average duration spent on- or off-task, leaving the relative durations of the two kinds of consciousness in the dark: Two participants might spend the same time off-task, but one might have many short episodes, while the other might have a few longer mind-wandering episodes. In the present study we try to disentangle the duration and the frequency of off-task episodes in a laboratory task, by means of a new paradigm that combines long duration trials with thought probing. We introduce the controlled duration Operation Span task, where participants are instructed to perform a traditional working memory Operation Span task under constant load, but with controlled duration. Under the assumption that success in a trial requires participant's continuous attentional orientation to the task, we predict performance decreases in longer trials, as they contain more occasions for distraction. We validate this idea by means of thought probing, showing that failures do correspond to attentional lapses. We show how to estimate, at the participant level, the relative contributions of duration and frequency of off-task episodes to the average proportion of time spent off-task. We discuss the theoretical and clinical implications of the results.We believe that the task could be used in the study of individual differences and clinical dimensions of the variability of the stream of thought. In particular, it could be of use in testing the hypothesis that people with Attention Deficit Hyperactivity Disorder (ADHD) have more (but not longer) episodes of off-task thoughts.

Consciousness, Metacognition and Emergence in a collective game

Madalina Sas (Imperial College London), Pedro Mediano (Imperial College London), Fernando Rosas (University of Sussex, Imperial College London), Hillary Leone (Independent artist, New York), Daniel Bor, Andrei Sas, Dagmar Divjak

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

There is a long-standing debate concerning whether consciousness is an emergent property of the brain. Recently, we developed a mathematical algorithm that was able to quantify causal emergence in complex systems [1, 2]. This enables us, at least putatively, to test this hypothesis. For instance, we have shown that vegetative state patients have a reduced emergent neural fMRI signature compared to healthy controls [3]. Here we extend this body of work by examining emergence between individuals, in a collective task, using a bespoke open-technology sandbox environment, coined Synch.Live (SL). Furthermore, previous theoretical work has suggested a link between consciousness and integrated information [4], implying that “higher level” cognition might be related to consciousness. Such “emergent” conscious thoughts might serve the purpose of providing innovative insights to solve otherwise intractable problems [5]. Using Synch.Live we can investigate whether collective emergence is possible and is dependent on awareness of collective strategies. Synch.Live is designed to quantify self-organised collective behaviour in humans. The work takes inspiration from emergent systems in nature, like flocks of birds and synchronising fireflies, and tests whether a group of strangers can manifests flocking behaviour without talking or touching. A central system uses the lights on the headsets worn by the players to extract trajectories in real time and compute how emergent their behaviour is, based on our algorithm [1]. The game is completed once the group passes a specific emergence value, and manifests behaviour analogous to birds flocking. Synch. Live was carried out on 18 groups of 10 participants each. Questionnaires were given both before and after the game, to examine changes in various emotional states, such as a sense of connectedness to others. Furthermore, awareness of strategies and what specific strategies were utilised were recorded. Those groups who were able to pass the emergence threshold achieved a significantly higher sense of connectedness compared with the groups who failed ($p=0.0373$) [6]. Those who were aware of their strategies were also more likely to solve the game. This work demonstrates that collective emergent behaviour is possible, opening up a window to explore many social aspects of conscious and cognition. Furthermore, these results provide a possible link between emergence and metacognitive awareness of emergent-related strategies. 1.Rosas, F.E. et al.. PLOS Computational Biology, 2020. 16(12): p. e1008289. 2.Mediano, P.A.M. et al. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 2022. 380 (2227): p. 20210246. 3.Luppi, A.I. et al. NeuroImage, 2023. 269: p. 119926. 4.Mediano, P.A.M. et al. Trends in Cognitive Sciences, 2022. 26(8): p. 646-655. 5.Bor, D. and A.K. Seth. Frontiers in Psychology, 2012. 3. 6. Watts, R. et al. Psychopharmacology (Berl). 2022 Nov;239(11):3461-3483

The Role of Interoceptive Efficiency in the Experience of Arousal and Mental Health

Paul W. Savoca (UCLA Department of Psychology), Bridget L. Callaghan PhD (UCLA Department of Psychology)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The brain’s integration, modeling, and perception of information origination from the internal milieu of the body (i.e. interoception) is a critical component of our conscious experience. Previous research has demonstrated that individual differences in the awareness and sensitivity of this bodily information is associated with mental health outcomes. This research has primarily focused on the end points of interoception, rather than considering the temporal dynamics of how efficiently this information in incorporated by the brain. To address this limitation, we propose that a novel construct of interoceptive efficiency may provide additional insight into how our integration, modeling, and perception of interoceptive information may alter mental health outcomes and more broadly our everyday conscious experience. We designed an affective reactivity task that allows us to record a semi-continuous (~6 sample/second) measure of self-reported arousal simultaneously with measures of peripheral psychophysiology (ECG, EDA, and respiration). We then take a novel analytical approach to probe the temporal delay between changes in subjective and objective physiological arousal – a proxy for interoceptive efficiency. In this initial study, we recruited (n=70) undergraduate college students to complete our interoceptive efficiency task, as well as questionnaire measures of mental health. Using self-report measures of anxiety and depressive symptoms, we then plan to test if individual differences in our measure of interoceptive efficiency are associated with variation in mental health. We suggest that by accounting for temporal dynamics in interoception, we can build on existing work and inspire future studies to better understand the relationships between interoception, well-being, and our conscious experience of arousal.

Searching for predictive coding during sleep: First results of a full-night MEG/EEG study using auditory stimuli

Manuel Schabus (University of Salzburg), Malgorzata Wislowska (University of Salzburg), Pavlos Topalidis (University of Salzburg)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

To what extent do the brain's predictive abilities remain intact during sleep? The purpose of the present study is to determine whether predictive neural signals can be found in the sleeping human brain. To that end, participants (N=18) implicitly learned grammatical rules underlying a sequence of auditory stimuli and were subsequently re-exposed to the same stimuli during sleep while E/MEG brain activity was recorded. Stimulus-locked responses as well as time-frequency analysis of the pre-stimulus interval could reveal whether prediction-related brain signals endure during sleep, and which oscillatory fingerprints underlie the transfer of this information across the brain. Here, we present the experimental paradigm and study protocol as well as a few of the preliminary Event-related and Time-Frequency results in wakefulness. The amplitudes of the random and predictable auditory stimuli could not be differentiated. However, there was higher theta power at 100-300ms after a stimulus that allowed for predicting the next upcoming one (i.e. the predicting stimulus) compared to a stimulus that could not be used to make such predictions. At the same time, there was a reduction in pre-stimulus alpha power at -300 to -500ms when contrasting predictable minus random stimuli. It is possible that the observed theta power could reflect memory retrieval processes while the alpha power could be related to predictive processes. We currently explore whether similar effects are observed during different sleep stages.

Color is how the brain creates and demarcates visual space

Arthur Shapiro (American University)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

What is color? Most answers to this question describe color in terms of its attributes (e.g. hue, brightness, saturation), its function (e.g. color helps break camouflage, identify targets, send social signals), or its correlation to physical wavelength or reflectance. A different approach is set out in two recent articles that emphasize the “inextricable connection between color and space” (Shapley, Nunez, and Gordon, 2019; Shapiro and Hedjar, 2019). These articles stress that color physiology and color phenomena depend upon spatial aspects of the stimulus, but typical color models lack spatial parameters and are therefore “space blind.” Here I propose that the brain uses color to construct visual space. The main observations are as follows: 1. Perceived colors always have spatial extent (color can be attached to objects; cut across multiple objects, as with illumination; or float with eye movements, as in the case of afterimages or other entoptic images); 2. Without color, the experience of visual space does not exist (as at the edges of our visual periphery or scotomas); 3. Spatial variations of color create whole visual worlds (pointillism, color monitors, etc.). I show demonstrations from my laboratory that suggest separate color/space systems: a separation between color vision and color contrast vision; and a separation between fine-scale (high spatial frequency) and coarse-scale (low spatial frequency) color vision. As evidence for separate color/color contrast systems, I present variations of the Contrast Asynchrony paradigm (Shapiro, 2008): a colored disk surrounded by a differently colored annulus creates separable dimensions for the color of the disk and the color-contrast between the disk and the surround. As evidence of fine- and coarse-scale color vision, I demonstrate the ubiquity of low frequency color masking (for instance, Shapiro, 2021), and show that many color and brightness phenomena can be explained simply as an application of low frequency masking. The demonstrations suggest that under many conditions the brain is simply unaware of low spatial information even though that information exists in the environment. I further show that under other conditions the brain is capable of encoding and switching between different types of spatial color information (for instance, changes in illumination primarily correspond to changes in low frequency color information, whereas high spatial frequency color information remains invariant). It therefore seems that not only are color and space inextricably connected, but color can be understood in terms of color systems that extract different spatial aspects of the visual world. From this framework, different perceptual tasks (e.g. object and scene perception in IT [Conway, 2018]) require selection and binding of a subset of these spatial color systems; furthermore, different perceptual modes correspond to extraction of different types of information that already exist in the environment.

Characterizing the metaperceptual function across visual field location and signal quality

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

In visual tasks, observers can overestimate their performance – i.e. feel more confident than they “should” – in the visual periphery compared to conditions with matched performance in the center of the visual field. This phenomenon is called “subjective inflation” and has been proposed to account for rich phenomenology where vision is impoverished or unreliable. However, until now, subjective inflation has not been comprehensively evaluated under varying levels of signal properties such as strength and reliability, across a wide range of performance levels. It has also not been assessed as a function of visual field location, even though performance has typically been found to be better along the horizontal meridian compared to the vertical meridian across many visual tasks. Here, we ask whether subjective inflation magnitude varies as a function of stimulus strength and noise, and visual and polar angle. In a 2AFC luminance comparison task, observers report which of two flickering circular patches is brighter on average and their decision confidence. On each trial, the patches vary in eccentricity (2 or 8 degrees of visual angle), relative luminance (the mean difference between the patches), overall luminance level (high or low signal strength), and luminance variability (high or low variance). The patches appeared on either the vertical or horizontal meridian in each block. We apply a new analytic approach to characterize the metaperceptual function, which captures the relationship between stimulus discrimination performance and confidence across different performance levels. Our results show that, while confidence increases with performance across all task conditions, performance is overall lower and confidence is higher (relative to performance) for peripheral relative to centrally-presented stimuli. Moreover, this subjective inflation effect is stronger at the vertical meridian than at the horizontal meridian, especially under high levels of stimulus noise. Here, we have conducted the first systematic investigation of how inflation effects behave across the visual field under a wide range of stimulus conditions, expanding our understanding of this important phenomenon. These findings demonstrate that our novel experimental paradigm and metaperceptual analytic approach provide a powerful framework for characterizing the relationship between visual performance and confidence across stimulus strength and reliability, eccentricity, and polar angle. Our findings align with previous reports that the degree of subjective inflation inversely covaries with signal quality. That is, for a fixed level of discrimination performance, confidence is higher when perceptual processing is noisier – even when this noise is due to fundamental differences in precision as a function of visual field location.

Reexamining the functional significance of the readiness potential: Does it index decision-making or anticipation?

Yarden Shir (Tel-Aviv University), Uri Maoz (Chapman University; University of California, Los Angeles; California Institute of Technology), Aaron Schurger (Chapman University), Liad Mudrik (Tel-Aviv University)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The Readiness Potential (RP) is a well-known, highly replicated EEG component, mostly interpreted as an index of preparation for action and decision-making. In the context of the free-will debate, the onset of the RP prior to the reported conscious experience of deciding to move was taken as evidence against free will. Yet the RP is very similar in shape and spatial distribution to the Contingent Negative Variation (CNV), another EEG component, found when responding to a predicted cue, thus marking anticipation. This similarity can lead to confusion, where studies reporting an RP might have probed the CNV. Notably, if the two components are not functionally distinguishable, they cannot be taken as distinct markers for the cognitive processes ascribed to them. Thus, it is crucial to test whether they are two distinct components. To the best of our knowledge, this has yet to be done in a paradigm that minimizes potential confounds. Here, we directly compared self-initiated movements with cued responses—a typical control condition in RP experiments. However, cued responses were either predictable or abrupt, providing overall three experimental conditions with similar paradigms (within-subject design). To manipulate self-initiated movements, we followed the classical Libet design, known to elicit the RP: a clock was presented to participants with a dot rotating along its edges, and they were asked to press a key when they feel the urge to do so. Then, they were asked to move the dot to the location it was in when they first felt the urge to move. To manipulate cued responses, the same clock and rotating dot were presented, and a second, fixed dot, appeared abruptly: participants were either asked to wait for the two dots to meet, and then press a key (predictable response); or to press it as soon as the second dot appeared on screen (abrupt response). The response times in these blocks (i.e. the time of the two dots meeting or the time of the second dot appearing) were yoked to the times in which each participant made the self-initiated movements, in a randomized order. As expected, an RP and a CNV, respectively, were found for the first two conditions, and neither was found for the last condition. We found that the CNV had a larger amplitude than the RP, yet no evidence was found for a difference in scalp distribution between the two components. Thus, one interpretation of our results is that anticipation might drive both components, being stronger for external, predicted cues than for internal decisions. Another interpretation is that the same system is generating both components, but in one case it is driven by a strong anticipatory signal (a predicted cue; CNV), while in the other there is mostly accumulation of random fluctuations (self-initiated movements; RP). Both interpretations of our results cast doubts on the view of the RP as an index of decision making and call for further investigation of the difference between the two components.

How might subcortical structures contribute to the readiness potential?

David N. Silverstein (Agora for Biosystems, Sigtuna Foundation), Krisztina Szalisznyó (Dept. of Medical Sciences, Uppsala University; Theoretical Neuroscience and Complex Systems Research Group, Wigner Research Centre for Physics), Hans Liljenström (Agora for Biosystems, Sigtuna Foundation; Dept. of Energy and Technology, Swedish University of Agricultural Sciences)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

The readiness potential (RP) has been observed to occur with EEG as well as with MEG as a readiness field, immediately prior to self-paced decision making and motor action, but the cause of this neural correlate is still under debate. Some have suggested that the presence of a RP before conscious recognition and report of a decision to act indicates an absence of conscious free will. EEG measures RP signals at the Pre-SMA, SMA and motor cortices. While EEG generally measures surface neocortical activity, human electrode studies have shown evoked responses correlated with the RP in the basal ganglia and thalamus. Additionally, motor and cognitive disorders that involve the basal ganglia such as OCD may exhibit stronger RPs while Parkinson’s disease may have opposite effects, showing weaker RPs. We propose a hypothesis that cortico-basal ganglia-thalamo-cortical (CBGTC) loop dynamics and subcortical structures including the basal ganglia and thalamic nuclei play important roles for inhibition and control during RP generation as well as motor preparation. In order to investigate this hypothesis, we have developed a computational dynamical systems model of CBGTC loop dynamics that includes representations of relevant brain areas as neural masses and the corresponding connections between them. The RP is often characterized as having early and late components that may have different generators. Deciding when to act includes cognitive control, response inhibition and selection. Our model seeks to validate a hypothesis that the early RP having a variable length represents preparation with intention to act prior to decision commitment, while the late RP with a fixed length represents the release of response inhibition and motor initiation. The model predicts possible abstract neural dynamics of brain areas during the early and late RP and the transition between them. It may also provide insights on disorders of volition and related neuropathophysiologies such as OCD and Parkinson’s. Simulations suggest that the early RP indicates preparation, inhibition and a readiness to act, but does not represent action initiation in the absence of free will.

Why are We Conscious? Cooperation Between Neural Signals as Replicators and the Emergence of Phenomenal Experience.

Daniel Skorich (Australian National University)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

A resolution to the hard problem of consciousness (Chalmers, 1995) – that is, the problem of why and how it is that there is something it is like to be conscious – remains elusive. In this paper, I will propose a novel framework for understanding the “why” aspect of the hard problem: that consciousness emerges as a solution to competition between neural signals. I will first argue that neural signals are replicators, and that, like other (biological) replicators (e.g. genes, chromosomes, genomes etc.), individual neural signals compete within populations of neural signals and are subject to a form of natural selection. I will then suggest that, like other replicators, neural signals and the organisms in which they are generated can accrue benefits from overcoming the competition between them and will therefore do so under the right conditions. I will draw on the work of Szathmary and Maynard-Smith (1995; Maynard-Smith & Szathmary, 1997; Szathmary, 2015) on major evolutionary transitions to argue that the integrative, holistic, irreducible nature of qualitative experience emerges from a tendency for neural signals as replicators to produce higher-order informational structure through a form of “cooperation”. I will specify how this structure can emerge from a process of “stochastic correction” (Szathmary & Demeter, 1987) and the way in which the structure might manifest in different levels of neural coding, including a level that can be conceived of as conscious. I will then discuss how this understanding of consciousness relates to other relevant models of consciousness – including Integrated Information Theory (Tononi, 2008; 2012; Tononi et al. 2016) and Neural Darwinism (Edelman, 1987; 1989) – and to the conceivability of philosophical zombies. Finally, I will draw an analogy between biological organisms and their constituent parts (e.g. genes, genomes, cells, organs etc.) and global conscious experience and its constituent parts (e.g. neural signals, macroscopic neural oscillations, local states, qualia etc.) in order to (speculatively) propose a way forward in the search for an answer to the “how” aspect of the hard problem of consciousness.

Sport metacognition: How do basketball players use the visual cue to assess the outcome of their free throws?

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Although most studies on metacognition have focused on the perceptual and memory domains, the motor domain has seen a recent surge of interest (e.g. Arbuzova et al. 2020; Constant et al. 2021). Indeed, being aware of one's motor skills can be crucial in everyday life as well as in sports. Many athletes believe that they do not need visual feedback to predict the outcome of their sports performance. In other words, the information from their motor command and/or proprioceptive feedback of their movement would be sufficient for them to evaluate their performance. The effect of the amount of visual information on our ability to assess the outcome of sports actions has been evaluated in the field of anticipatory action (e.g. Aglioti et al. 2008). This literature shows that the more visual information we have on the action in progress, the more we are able to predict the outcome of the action. Nevertheless, to our knowledge, no study seems to have investigated this question in the field of motor monitoring. Our objective was therefore to address this gap in the literature. In the present study, we investigated the impact of the amount of visual information on forty-two basketball players' ability to monitor their sport performance on a free throw task. Participants shot a total of 100 free throws in which a visual occlusion was triggered either immediately after the ball left the player's hands or 200, 400, 600, or 800ms later. Participants were then asked to predict whether the ball was in the basket and to indicate how confident they were in their answer (on a four-point scale). Players' metacognitive abilities were assessed via a mixed effects logistic regression between the accuracy of their prediction (i.e. successful versus unsuccessful throw) and their confidence level, with the slope highlighting whether they adequately adapted their confidence level to their prediction. The results indicate that the more visual information players have about their shot, the more appropriately they adjust their confidence to their prediction (i.e. to say that one is confident when the prediction is correct and to say that one is not confident when the prediction is incorrect). This effect was observed for successful throws but not for failed throws suggesting that the cues used to make metacognitive judgments differ depending on the outcome of the throw. We discuss these results with reference to metacognitive and movement models.

How does the brain represent the presence vs the absence of a stimulus?

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Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Recent evidence from neural data points to a link between evidence accumulation mechanisms and perceptual consciousness. So far, this link has only been assessed in experiments where participants are required to detect or pay attention to the presence of a stimulus. Here, we inquire whether evidence accumulation processes are tied to perceptual experience itself or to task demands about stimulus presence. We also assess if evidence is accumulated for the absence and phenomenal magnitude of perceptual contents. In a systematic behavioral investigation of the role of response effectors on multidimensional perceptual reports, we presented participants with a sound sequence that varies in intensity around their auditory threshold. Participants performed a continuous detection task under two conditions. First, in a typical condition, participants were asked to give online reports about their perceptual experience by pressing a button while they heard a sound. The strength at which they pressed was recorded and used as a proxy to measure phenomenal magnitude. Second, in an inverted condition, participants used button presses to report the absence of the stimulus, and were asked to release the button whenever they started hearing a sound. Assuming that behavioral reports reflect decisional processes beyond perceptual awareness, we sought to characterize markers of evidence accumulation across conditions. Preliminary data indicate that reports of phenomenal magnitude reflected stimulus strength and were consistent with reaction times reflecting evidence accumulation processes. We also found that reporting about absence vs. presence decreased response sensitivity and increased reaction times to changes in sound intensity. We will discuss these behavioral findings in light of the leaky evidence accumulation framework, which links evidence accumulation processes to perceptual consciousness and monitoring.

Scanning the Neural Correlates of Consciousness: When Can Scientists Claim an Indirect Task Advantage? The Case of fMRI Studies

Joaquim Streicher (University of Amsterdam), Timo Stein (University of Amsterdam), Sascha Meyen (University of Tübingen), Volker Franz (University of Tübingen)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

A key question of consciousness and neuroimaging research is which perceptual and cognitive processes can occur unconsciously. To investigate this, researchers typically compare a direct task (e.g. a perceptual discrimination) to an indirect task (e.g. priming effects or fMRI activity). The direct task is assumed to measure conscious processing. If performance in this task is not significantly different from chance, researchers conclude that participants could not consciously discriminate the stimuli. If, nevertheless, there is a significant effect of the same stimuli in the indirect task (e.g. faster responses or higher fMRI activity), researchers conclude that these indirect effects must reflect unconscious processing of the stimuli. However, this reasoning is flawed because it implicitly assumes that the indirect task showed higher sensitivity for the stimuli than the direct task. This implicit assumption is flawed because sensitivities are never compared in the typical approach. Meyen et al. (2022, J Exp Psych: Gen) demonstrated this problem for behavioral studies and provided a method to compare sensitivities. They concluded that the flawed reasoning has likely led to an overestimation of the scope of unconscious processing in behavioral studies. Here, we tested whether similar problems exist in studies using fMRI to test unconscious neural processing. We made a first attempt to extend the sensitivity comparison method to fMRI data, and reanalyze results of 25 typical fMRI studies: We estimated sensitivities from fMRI z-scores and t values, both for univariate and multivariate analyses and compared these sensitivities to the sensitivities in the corresponding direct tasks. We found that most studies did not provide evidence that the indirect task showed higher sensitivity than the direct task. When added to the global picture of common biases in consciousness research we depict, those results question widely used methodology in this area. We recommend future studies to perform a direct comparison of sensitivities between brain and behavioral data. Measures should be performed in similar conditions, with the same experimental design and statistical power. We will discuss the pros and cons of the design choices of our extension of the Meyen (2022) method. If our extension survives scrutiny of the scientific community, then this would have serious consequences for the interpretation of the neuroimaging literature on unconscious processing.

Does Emotional Language Use in Dream and Mind-Wandering Reports Reflect Mental Well-Being and Ill-Being?

Nanna M. Strid (University of Turku), Jarno Tuominen (University of Turku), Ryan Bernstein (Stanford University), Manuela Kirberg (Monash University), Katja Valli, University of Turku, University of Skövde; Antti Revonsuo, University of Turku, University of Skövde; Jennifer Windt, Monash University; Tristan Bekinschtein, University of Cambridge; Valdas Noreika, Queen Mary University of London; Pilleriin Sikka, Stanford University, University of Turku, University of Skövde.

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Do the words we describe our experiences with mirror how we feel? Recent decades have seen a growing interest in whether the language people use (e.g. in social media) can reflect their well-being and ill-being. However, little is known about how the content of spontaneous thoughts and experiences—reports of daytime mind-wandering (or daydreaming) and nighttime dreaming—reflects waking well-being and ill-being. Here, we investigated the relationship between emotional language use in mind-wandering and dream reports and well-being and ill-being. We asked participants to fill in scales measuring different aspects of well-being (i.e. life satisfaction, domain satisfaction, positive affect, psychological well-being, peace of mind) and ill-being (i.e. negative affect, symptoms of anxiety and depression). We then used ecological momentary assessment by asking participants to provide reports of mind-wandering and dreaming in daily logs over a two-week period. 1781 dream reports from 172 healthy adults and 1496 mind-wandering reports from 153 healthy adults were analyzed using the Linguistic Inquiry and Word Count (LIWC) text analysis software. Multilevel regression models showed that measures of ill-being predicted the negative tone ($\beta = 0.185$, 95% CI [0.127; 0.245], SE 0.030, $z = 6.162$, $p < .001$) as well as the use of negative emotion words ($\beta = 0.231$, 95% CI [0.157; 0.307], SE 0.038, $z = 6.068$, $p < .001$) in mind-wandering reports. Similarly, measures of ill-being predicted the negative tone of dream reports ($\beta = 0.101$, 95% CI [0.030; 0.173], SE 0.036, $z = 2.771$, $p = .006$). Additionally, measures of well-being predicted the use of positive emotion words in dream reports ($\beta = 0.153$, 95% CI [0.049; 0.257], SE 0.052, $z = 2.975$, $p = .003$). These findings show that natural language use across different states of consciousness (from waking mind-wandering to nighttime dreaming) reflects waking ill-being and well-being. The results also provide support for the continuity of affective experiences across different states of consciousness. Clinically, these findings may open the doors to novel and more effective prognostic and diagnostic tools in psychology and psychiatry. Using language in this manner to track well-being and ill-being may pave the way to faster, more cost-effective, and broadly accessible mental health resources. However, additional research is required to corroborate the observed relationships and establish their causal direction.

Intuitive judgments of semantic coherence depend on perceptual and semantic fluency

Joanna Sweklej (SWPS University), Robert Balas (Institute of Psychology Polish Academy of Sciences), Ewelina Kowalewska (Centrum Medyczne Ksztalcenia Podyplomowego), Anna Redel (SWPS University)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

The study of the Remote Association Test (RAT) has revealed that individuals can accurately detect the semantic coherence of word triads even without knowing their common associates. This research was carried out using the Dyads-of-Triads task, which presents participants with a pair of word triads: one containing semantically coherent words and the other consisting of random words. The participants are then asked to select a coherent RAT item. Previous studies have shown that intuitive judgments of coherence are influenced by the affective valence of solution words. For example, the positive affect induced by positively valanced solutions enhances the accuracy of intuitive detection, even if the solutions are not explicitly retrieved from memory. This current study (N = 300) was to explore how the accuracy of intuitive coherence judgments of RAT items is affected by perceptual and semantic fluency. The results demonstrate that both perceptual and semantic fluency can enhance positive affective response toward solvable triads and/or interfere with affective cues already induced by valanced solutions, leading to an impact on the accuracy of intuitive coherence judgments. Furthermore, the study also investigated the mechanisms behind the ability of individuals to detect semantically incoherent items even in the absence of explicit knowledge of the basis for semantic coherence. It found a similar mechanism underlying this ability, which they extrapolated to the attitudinal processes involved in social judgment. In general, this study provides information on how cognitive processes, such as perceptual and semantic fluency, and affective valence influence intuitive coherence judgments in RAT items. The findings suggest that both of these factors play a significant role in enhancing or interfering with affective cues, leading to an impact on the accuracy of intuitive coherence judgments. Furthermore, the study contributes to understanding the mechanisms behind the ability to detect semantically incoherent items and its potential application in the attitudinal processes involved in social judgment.

Assessing the structural consistency of mental representations of natural objects with unsupervised alignment

Ken Takeda (College of Arts and Science, The University of Tokyo), Genji Kawakita (Department of Bioengineering, Imperial College London), Yuko Yotsumoto (Graduate School of Arts and Science, The University of Tokyo), Masafumi Oizumi (Graduate School of Arts and Science, The University of Tokyo)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

How can we be sure that others see the world in the same way as we do? To address this question, it may not be possible to directly compare sensory experiences (qualia) across individuals. A promising approach is the intersubjective comparison of the similarity relations of sensory experiences, called "qualia structures" (Kawakita et al. psyArxiv, 2023). To assess the equivalence of qualia structures, we should not use a conventional method that assumes a correspondence of experiences between individuals. To this end, we have recently proposed an unsupervised alignment method based on Gromov-Wasserstein optimal transport to evaluate the similarity of qualia structures without assuming the correspondence of labels (Kawakita et al. 2023). Our previous study showed that the unsupervised alignment method can "correctly" align the qualia structures of colors across neurotypical participants. However, it remains unclear whether the structures of more complex and higher dimensional mental representations of visual objects beyond colors are equivalent across individuals. To address this question, we analyzed a large-scale dataset of odd-one-out similarity judgments for 1854 objects, the THINGS dataset (Hebart et al. 2022). This dataset is ideal for this research because (1) the number of objects is very large (1854 objects), (2) the number of triplets is large enough (5 million triplets) to accurately estimate the embeddings, and (3) it contains data from participants with different attributes (gender and age), allowing us to compare how the structures differ across attributes. We divided the subjects into several groups and estimated 60-dimensional psychological embeddings for each group, following the previous study (Hebart et. al. 2020). We first examined whether the embeddings can be aligned across groups using the Gromov-Wasserstein optimal transport and manifold alignment method. Here, we superimpose the embeddings in the same space without using the label information and test whether the same object from different groups is embedded in the neighborhood of each other. We found that the psychological embeddings were almost perfectly aligned for subject groups with the same attributes. The corresponding objects were located in the neighborhood of each other, suggesting that their structures were highly similar. In contrast, the percentage of correct alignments was lower between the subject groups with different attributes. However, misalignments mostly occurred between similar objects, and the macroscopic structures were similar.In addition, we found that unsupervised alignment tended to be more successful as the number of objects and the number of relationships increased. These results demonstrate the consistency of qualia structures of natural objects across individuals and the utility of unsupervised alignment for assessing the degree of similarity of high-dimensional mental representations.

Mind wandering as inference

Devin Terhune (King's College London), Naya Polychroni (Goldsmiths, University of London)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Accumulating evidence indicates that contextual information can influence mind wandering reports. However, the roles of contextual constraints and top-down factors in shaping mind wandering reports have largely been neglected in contemporary models of mind wandering. Here we propose a novel hypothesis of mind wandering in which judgments regarding mind wandering states are conceptualised as a form of Bayesian inference. According to this account, mind wandering reports reflect a Bayesian cue combination process in which contextual cues (priors) and metacognitive representations (likelihood states) are combined to form inferences (posteriors) regarding whether one was mind wandering or not. Thus, contextual information, such as performance cues, can function as priors that act as a source of bias in one's metacognitive estimate regarding their current experiential state. Following principles of Bayesian inference, we further suggest that cue combination is supported by precision-weighting mechanisms such that strong (precise) priors will have greater impact on mind wandering reports, particularly when meta-representations regarding mind wandering states are noisy or characterized by uncertainty. This account provides a parsimonious explanation for the role of performance monitoring in mind wandering reports and offers multiple testable predictions regarding confounding factors in the assessment of mind wandering. It also suggests a path forward for the integration of current theories of mind wandering with contemporary approaches to predictive processing. Dissociating the role of priors and metacognitive processes offers further opportunities for clarifying the cognitive and neural underpinnings of intra-individual heterogeneity in mind wandering states.

A neural network model for the distributed nature of conscious content

Panagiota Theodoni (Department of Philosophy, National and Kapodistrian University of Athens, Athens, Greece; Center for Brain, Mind and Consciousness, Department of Philosophy, New York University, New York, USA)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Ongoing debates on theories of consciousness still lack the contribution of theoretical neuroscience through neural network models. Most neural network models for conscious perception are non-biophysically realistic and correspond to local circuits in the brain. Nevertheless, evidence suggests that the neural correlates of conscious perception are distributed across the cortex. Here, I present a neural mathematical model for conscious perception, that adresses key questions of the scientific study of consciousness. Specifically, I developed and examined a large-scale, multi-regional, anatomically and physiologically constrained neural network model of the macaque cortex simulating Binocular Rivalry (BR). The model is based on a previously studied neural network model for working memory [1], which we have expanded to account for subjects' behavior and neural activity in a detection task [2]. BR emerges when dichoptically viewing dissimilar images induces perceptual alternations dissociating the sensory stimulation from the conscious content. These alternations involve two rivalrous stimulus representations embedded in two distinct neuronal assemblies that compete for activity dominance. We have previously shown that a biophysically realistic local neural circuit can explain the statistics of the perceptual dominance periods and the local neural dynamics [3,4]. The key components of this local circuit are two neural excitatory populations with spike-frequency adaptation, noise, and cross-inhibition via neuromodulators. In the multi-regional model, each area is represented by such a local circuit, and there are 30 areas of the macaque cortex, hierarchically organized from visual to prefrontal, and wired according to inter-areal connectivity data from retrograde tracing experiments. The model reproduces the neural encoding of conscious content along the cortical hierarchy, consistent with electrophysiological recordings. This enables us to understand how these areas interact to encode multiple conscious contents. Additionally, simulated lesions and targeted intracranial electrical stimulation experiments -both disruptive and targeted- are set forward to test existing predictions of different theories, such as the minimal inter-areal neural network required for consciousness and the role of the prefrontal cortex -the protagonist in neural theories of consciousness- in terms of whether it is causal, constitutive, or consequential to the conscious content. This is an ongoing research program aimed at investigating the underlying neural mechanics of consciousness. [1] Mejías JF, Wang XJ (2021) eLife, [2] Klatzmann U, Froudist-Walsh S, Bliss DP, Theodoni P, Mejías J, Niu M, Rapan L, Palomero-Gallagher N, Sergent C, Dehaene S, Wang XJ (2022) BioRxiv, [3] Theodoni P, Panagiotaropoulos TI, Kapoor V, Logothetis NK, Deco G (2011) Frontiers in Human Neuroscience, [4] Theodoni P (2014) PhD Thesis, Universitat Pompeu Fabra, Spain

Contrasting the predictions of the Global Neural Workspace theory and Integrated Infomation Theory using fMRI conjunction maps

Yamil Vidal (Donders Institute), David Richter (Donders Institute), Aya Khalaf (Yale University), Hal Blumenfeld (Yale University), Floris de Lange (Donders Institute); Cogitate Consortium

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Understanding how the brain can give rise to consciousness remains as one of the most central and challenging problems in neuroscience. Several theories have emerge, trying to address this question. Two prominent theories among those are the Global Neuronal Workspace theory (GNW) and the Integrated Information Theory (IIT). While GNW proposes that consciousness emerges from global availability of information resulting from a broadcast to the prefrontal cortex, IIT proposes that consciousness arises from the integrated information generated in sensory cortices. Despite providing at times conflicting explanations for the mechanism supporting consciousness, both theories have gained empirical support, largely testing their predictions without direct contrast. To change this state of affairs, the COGITATE consortium has embarked in adversarial collaboration testing contradictory predictions of GNW and IIT, using functional magnetic resonance imaging (fMRI), Magnetoencephalography (MEG), and intracranial recordings (iEEG) data. In this poster, we present the results of an analysis aiming to differentiate between areas that could potentially be involved in visual consciousness from those related to its consequences, such as performing a task on the conscious content. Using data acquired during a visual task in which stimuli were clearly conscious, we have performed conjunction analyses of fMRI activation maps. The first two of these analyses aimed at identifying brain areas that are involved in the consequences of consciousness and are as opposed to consciousness per se. The third analysis aimed at identifying areas that may be related to conscious processing and/or sensory precursors to visual consciousness. In essence, we identified the conjunction of areas sensitive to changes in the content of consciousness (stimulus vs. blank ITIs), regardless of the relevance of the stimuli with respect to the task at hand. This analysis was performed using both univariate fMRI activation maps and multivariate fMRI decoding maps. GNW hypothesizes that specialized neurons which constitute the global neuronal workspace are located in prefrontal areas. Therefore, we should observe effects in prefrontal cortex for all conditions, after ruling out the effects of task goal and task relevance. IIT hypothesizes that the maximally irreducible complex of neural units is located mainly in posterior cortex, so that we should observe more consistent effects in posterior vs. frontal areas, independently from task goal and task relevance. We note that the contrasts used might overestimate the neural correlates of consciousness and that the fast event related design adopted here, might be suboptimal to detect activity changes in some areas, potentially underestimating regions that might be involved in conscious processing. We therefore have adopted a conservative approach that distinguishes between areas that might participate in consciousness vs. those that definitely do not.

The neural correlates of everyday confabulation and choice blindness: a fMRI study

Gabriel Vogel (Lund University), Johan Mårtensson (Lund University), Peter Mannfolk (Lund University), Petter Johansson (Lund University)

Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Explaining the reasons for our own behaviour seems like a natural and seamless activity. However, despite our confidence and ease, several experiments have shown that we are prone to unknowingly confabulate when asked why we made a certain decision. We make up plausible but inaccurate stories after the fact. In this paper, we study the neural correlates of everyday confabulation with fMRI. To produce confabulations, we used the choice blindness paradigm, in which participants, failing to notice the mismatch between their choice and its outcome, spontaneously explain why they chose something they never chose. We show that failures to detect false feedbacks rely on the precuneus, SMA and the insula, areas similarly involved in reasoning and the sense of agency. We discuss to what extent the overlap between correlates of confabulated and non-confabulated explanations supports the view that self-interpretative confabulation prone mechanisms are always involved in self-explanation.

A computational approach to affect generation in perceptual decisions

Alan Voodla (KU Leuven / University of Tartu), Andero Uusberg (University of Tartu), Kobe Desender (KU Leuven)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Decisions are often accompanied by feelings with positive or negative valence with some intensity, also called affect. It's unclear what are the mechanisms underlying the generation of affect in decisions. Inspired by Control Process theory (Carver, 2015), we model affect as the difference between expected and actual progress in an evidence accumulation framework. Actual progress is mapped onto the (traditional) drift-rate parameter and expected progress onto a (novel) expected drift-rate parameter during a perceptual decision. Affect is computed as the difference between expected and actual amount of evidence in a trial. We then test model predictions for affect in a perceptual decision-making experiment, where expected and actual progress are systematically manipulated. We find that affect reflects the sum of actual and expected progress, but not their discrepancy as predicted by Control Process Theory. Comparing empirical data with model predictions shows that our model is able to simultaneously account for choice, reaction times and affect in perceptual decisions.

Dreaming and mind wandering in disorders of consciousness

Jasmine Walter (Monash Centre for Consciousness and Contemplative Studies, Monash University, Melbourne, Australia), Thomas Andrillon (Paris Brain Institute, Sorbonne Université, Inserm-CNRS, Paris, 75013, France), Jennifer Windt (Monash Centre for Consciousness and Contemplative Studies, Monash University, Melbourne, Australia)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Fluctuations in the presence, experiential quality and contents of consciousness occur naturally during sleep and wakefulness and are core features of the healthy human mind. Here, we propose that such fluctuations, including mind wandering and dreaming, may also be important elements of experience in patients with disorders of consciousness (DoC) who retain the capacity for consciousness, even those who appear behaviourally unresponsive. Current diagnostic tests for DoC focus on externally-directed conscious states where a range of cognitive functions are online and where outward signs of responsiveness can be detected (e.g. command following, visual pursuit). These states are often presumed to be the highest "level" of consciousness a patient can attain, and are easier to clinically operationalise due to having outward manifestations. However, dreaming and mind wandering are examples of "offline" conscious states that involve rich experiences and complex cognitive processes but with limited responsiveness to environmental stimuli. If such states occur in DoC, possibly with similar or even greater frequency than in healthy subjects, they might be overlooked by standard diagnostic tests. We draw on research about dreaming and mind wandering from both philosophy and cognitive neuroscience to infer how these phenomena may manifest in DoC in both wakefulness and sleep. We argue that it is prudent to assume that conscious DoC patients experience mind wandering and dreaming. This broadened conceptual terrain of consciousness in DoC has important implications. For one, it impels us to rethink our approach to diagnosis to ensure that it is adequately sensitive to the full range of states that could make up conscious experience in DoC. Furthermore, the occurrence of spontaneous thought and its dynamics in DoC may also have implications for our understanding of and avenues for improving the health and wellbeing of these individuals.

Managing uncertainty in disorders of consciousness

Mona-Marie Wandrey (University of Cambridge)

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

The question of whether brain-injured patients retain conscious awareness or not has profound implications for their medical care, including issues of pain management, rehabilitation and end-of-life decisions. Clinically diagnosing disorders of consciousness depends on assessing evidence of consciousness by searching for behavioral markers or neural correlates of consciousness. However, both of these approaches face severe limitations regarding their diagnostic accuracy. Specifically, I argue that most behavioral markers of consciousness lack sensitivity, while most neural correlates of consciousness lack specificity. This gives rise to diagnostic uncertainty in the form of false negative and false positive results. I examine two approaches that have been suggested for managing the uncertainty in diagnosing disorders of consciousness, the precautionary personhood principle (Braddock 2017) and reasoning by consilience (Peterson 2016). I argue that these approaches disregard important differences in the diagnostic accuracy of the available techniques. Hence, I suggest a strategy that combines the strength of these approaches, while avoiding their limitations. This strategy involves a two-step procedure for assessing evidence of consciousness in brain-injured patients, first using techniques with high sensitivity for identifying all patients that might still be conscious, and then using techniques with high specificity for confirming or rejecting these results. This two-step procedure is combined with precautionary reasoning to mitigate the risks associated with false negative results. This approach offers a more nuanced way of managing the uncertainty involved in diagnosing patients with disorders of consciousness and, if implemented in clinical practice, could potentially improve the medical care of these patients.

Young children’s discrimination and metacognition performance with congruence effect at a brief glance of a natural scene photograph.

Ryoichi Watanabe (Kyoto University), Naotsugu Tsuchiya (Monash University), Liang Qianchen (Monash University), Masako Myowa (Kyoto University), Yusuke Moriguchi

Poster Session 3, Sunday June 25th, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

At a brief glance, how well can we discriminate between what we see from what we do not? Recent studies showed that adults could discriminate between what they have seen or not accurately and with high confidence; however, they failed to notice a modification of a critical object of the photograph. Few studies, however, have examined children's rapid visual experience because of the difficulty of experiments with children and limitations in their cognitive ability and motivation for tasks. Thus, it is unclear how rapid visual experience evolves over the course of development. In the current study, we developed a new paradigm for children to overcome the above issues to examine the development of visual experience, referring to the Massive Report Paradigm of Qianchen et al. (2022). We examined young children’s discrimination and metacognition performance and the congruence effect at a brief glance (133 ms, which is the time when the gaze cannot be shifted) natural scene photograph in Experiment 1. Twenty-seven 5-6-year-olds participated in the online natural scene discrimination task. In each trial, participants first viewed a target natural scene image. The target image was either semantically congruent (e.g. a man scratching a disc), or incongruent with a critical object modified (e.g. a man scratching a pizza). After that, participants answered six questions, each asking them to view a small image patch, judge whether the patch was part of the target image or not, and also report their decision confidence. The image patches consisted of present patches (made from the target image), modified patches (made from the modified critical object of the target image), and absent patches (made from different images). The results showed that the discrimination performance was 0.79 (0.5 is at chance accuracy and 1.0 is perfect accuracy) and the metacognition performance was 0.72. It is unclear whether these 5-6-year-olds' performances are better or worse compared to older children and adults, and how the performances develop. Based on these results and Qianchen et al.'s adult results, we plan to extend the age range to 5-12 years and adults in Experiment 2. The current study was supported by Funding Consciousness Research with Registered Reports. In our presentation, we will report the results of Experiment 2.

Implicit Semantic Processing as Revealed by Representational Similarity Analysis Applied to EEG

Vincent Weber (Faculty of Psychology, UniDistance Suisse, Switzerland), Nicole H. Skieresz (Faculty of Psychology, UniDistance Suisse, Switzerland), Nicolas Rothen (Faculty of Psychology, UniDistance Suisse, Switzerland), Thomas P. Reber (Faculty of Psychology, UniDistance Suisse, Switzerland)

Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Most researchers agree that some stages of object recognition proceed implicitly. No consensus has been reached regarding the depth of implicit processing. Answering this question informs debates on theories of consciousness as they disagree on this question. A particularly informative method to explore the time courses of informational content in neural representations is representational similarity analysis (RSA). Here we apply RSA to EEG data recorded while participants either explicitly or implicitly processed the semantics of visually presented objects. An explicit focus on semantics was given when participants classified images of objects as manmade or natural. For implicit processing of semantics, participants merely judged the location of images on the screen. Images of objects were chosen such that they can be grouped according to various levels of semantic abstraction ranging from concrete, entry-level categories (fruits, flowers, furniture etc.) to abstract categories (manmade/natural, animate/inanimate). We find that the category animate/inanimate as well as more concrete, entry level categories are processed implicitly whereas the category manmade/natural is not processed implicitly. Our results support theories of consciousness that postulate feasibility of implicit processing of abstract semantics. These theories hold that abstract semantics can be processed when the relevant semantic dimensions have been learned during development, such as is the case for entry-level categories, or have been ingrained by evolution, as it is the case for the animate/inanimate dimension.

Development and changes of children's prosocial behavior: a Bayesian network analysis

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Prosocial behaviors are voluntary and beneficial behaviors of individuals that are important for children's psychosocial development. Investigation of preschool children's strategies of prosocial behavior contributes to the understanding of the occurrence and development of early prosocial behaviors. The present study investigated the developmental changes in strategies of preschool children's prosocial behaviors (such as self-interest, reciprocity, fairness, and generosity), possible social cognitive mechanisms and environmental factors. In this study, 125 children aged 3.25-6.25 years were recruited to complete the Adaptive Dictator Game Task, False Beliefs Task, and Emotional Understanding Task. The corresponding strategies of children's pro-social behavioral, social cognitive abilities (theory of mind and emotional understanding), and family environment (socioeconomic status and presence of siblings) were collected. The data were analyzed using Bayesian networks. We found that the strategies of preschool children's prosocial behaviors changed from self-interest to reciprocity, fairness and generosity as they grew older. This change was positively associated with social cognitive abilities. The stronger the social cognitive ability, the more children tended to adopt reciprocity and generosity strategies. Family environment influenced children's pro-social behavior through social cognitive abilities. Our findings contributed to the understanding of the occurrence and maintenance of early prosocial behavior and how internal cognitive mechanisms and external environmental factors influence the development of prosocial behavior.

Reshaping priming effects through response-deadline variation

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

The method of response priming is a useful paradigm to investigate response-conflict on a visuo‐motor level. The classical response paradigm demands participants to respond as quickly and as accurately as possible to a target stimulus preceded by a prime. The prime and the target can either be mapped to the same response (consistent) or to a different response (inconsistent). This usually leads to large priming effects in response times and error rates that increase with the stimulus-onset asynchrony (SOA) between prime and target. Previous studies of response times, pointing movements, and other measures indicate that the effect is based on prime-triggered response activation that is time-locked to prime onset and invariant with SOA. In this study, we impose different response-deadlines to accomplish three goals: 1) to alter the speed-accuracy tradeoff to move effects from mean RT to mean error rate or vice versa; 2) to reduce the variance in the respective dependent measure to increase power and precision. Analyzing the response time distributions by event-history analysis further allows us to trace the occurrence of priming effects over time. This way, we can 3) determine whether the onset of response priming effects in the distribution remains invariant when the response deadline is altered. We report extensive data from twelve participants based on 500 trials per condition and participant. First, we find that priming effects are virtually absent in mean error rates at long response-deadlines, and mainly present in mean RT. Second, as response deadlines are shortened, effects move from mean RT to mean error rate. Third, at the shortest deadline, effects in mean RT are missing and completely shift to error rate. Thus, depending on the chosen response-deadline, a shift from covert effects of response conflict in RT to more overt effects in error rates can be achieved. Fourth, shorter response-deadlines decrease variance in response time effects, increasing power and precision. Finally, while effects shift from one dependent measure to the other when dealing with mean RT and error rate, distributional analysis reveals merely a shift in magnitude of effects between hazard rate and conditional accuracy, and allows to track the onset of these effects. We further give recommendations for choosing response-deadlines yielding optimal information about the response activation process.

Dreaming experience as immersive imagination: Response to the problem of dream report by Schwitzgebel

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Schwitzgebel challenges the reliability of dream reports by referring to his research on reports of dream coloring over the years. In this paper, I suggest that dreaming experience is fundamentally a piece of thought, instead of an experience. In this case, I argue that Schwitzgebel’s conceptualization of the dreaming experience is problematic, which leads to problems with his research method and confusing interpretations of people’s dream reports. The first part of this paper proposes the imagination* theory: dreaming experience is an immersive imagination without the subjective awareness of the process of this imagination (to distinguish this imagination* from ordinary imagination during waking states, I label it as imagination*). This theory suggests that the significant difference between imagination* and imagination in a normal waking state is that in the former case, the lack of interaction with the environment contributes to the missing proprioceptive awareness of the subject, making him lose the sense of situatedness in the world. In this case, I suggest that the subject will lose the awareness of his own thinking intention in dreams, leading to the immersive imagination* during dreaming states and making him confuse the imagination* with his actual experience. The imagination* theory suggests that there is no possibility of interaction between the colors we dream about and we, the dreamers, meaning that there’s no “object” of perception in dreams whose characteristics our “subjective” experience can make mistakes about. Following this, I will argue that dreams are subjective thoughts instead of experiences about objective facts, which has two implications: 1) the content of the dreams, compared to actual experiences, is less detailed and more susceptible to the time interval between the happenings of the dreams and the recalls. I will explain that Schwitzgebel's research method failed to consider these characteristics, making the reports he collected unsuccessful in reflecting the actual dream content of the subjects, and his attempt at chronological comparisons of dream reports failed; 2) fundamentally as a piece of thought, the encoding of dream content in the experiencing stage is quicker and more direct than the encoding of normal perceptual experience, which implies that, under proper experimental design (i.e. in-time recall, like right after the REM stage), we can give credit to the subjective report because the rate of forgetting what I just “thought about” is low enough. However, if we wait for a long enough time, the memory of the dreaming experience can decay rapidly because the encoding process of it is too simple and involve much fewer modalities than normal perceptual experience.

Looking up or looking down: Towards a behavioral measure of experienced first-person perspective and its modulation by gravity

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Poster Session 1, Friday June 23rd, Greenberg Lounge, 1.15pm-2pm and 4pm-5pm,

Out-of-body Experiences (OBEs) are peculiar states during which one feels to be located outside one's physical body, perceiving the world from a higher, disembodied viewpoint and looking down at one's own body. Previously we developed an experimental setup combining mixed reality technology and a human motion platform to trigger OBE-like illusion with visual and vestibular stimulations. In the experiment, we induced feelings of disembodiment and lightness associated with elevated self-location (Wu et al. ASSC 2022). However, despite initial promising results (Pfeiffer et al. 2016) there is still no well-established, implicit measure of changes in the experienced direction of first-person perspective (1PP) during OBE and related states of self-consciousness. Here we propose a new behavioral measure of experienced 1PP changes using the concept of peripersonal space (PPS). PPS refers to the space immediately surrounding the body and encoded by multimodal neurons in premotor and parietal areas (Fogassi et al. 1996; Iriki et al. 2001). PPS measured by the hand-blink reflex has been found to be modulated by gravity: it enlarges in the opposite direction of the gravity, arguably to prepare the organism for potential threats from above the body (Bufacchi & Iannetti, 2016). As threats are more likely to fall down, following the direction of gravity, lying supine with an up-looking 1PP shrinks back PPS and enlarges torso PPS. In turn, lying prone with a down-looking 1PP enlarges back PPS and shrinks torso PPS. Using an auditory-tactile PPS paradigm (Canzoneri et al. 2012; Serino et al. 2017), Study 1 ($n=17$) demonstrated that participants' PPS in the back indeed was enlarged in the prone position and reduced in the supine position (repeated measures ANOVA, main effect of Body Position: [$F(1,512) = 10.39$, $p = .001$]), suggesting a potential modulation of the PPS boundary by gravity. Based on these observations, we hypothesize that participants' PPS would be modulated similarly when they experience a change in 1PP direction during an OBE-like illusion induced by our mixed reality setup (Study 2). We expect to observe an enlarged back PPS during the OBE-like illusion. That is, when participants have the feeling of looking down at their body from an elevated, disembodied viewpoint, their back PPS should be enlarged compared to in the baseline condition in which no OBE-like illusion is induced and participants simply lie supine and look up at the ceiling. These results will inform the understanding of the experienced 1PP, help establish an objective measure for 1PP, and contribute to the study of visual-vestibular mechanisms in OBEs.

Subcortical mechanisms of visual perception: preliminary results from thalamic recording and stimulation

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The neural mechanisms of transient conscious perception have broad scientific and clinical implications. Most previous studies have focused on cortical signals as there lacks a recording method that can target subcortical areas with high temporal precision. Thus, subcortical signals, despite their known role in arousal, remain relatively under-investigated. Recent progress in long-term thalamic electrode implants in patients with epilepsy has provided a unique opportunity to directly record and stimulate the thalamus during transient perception of sensory stimuli. Leveraging this unique patient population, our lab recently identified a novel thalamic awareness potential (TAP) contingent upon conscious perception. However, it remains unclear whether this signal directly modulates conscious perception. To this end, two patients with epilepsy chronically implanted with depth electrodes (Responsive Neurostimulator System, NeuroPace, Inc.) targeting the centromedian nucleus of the intralaminar thalamus were recruited. The subjects were presented with, against a noise background, a 50ms human face, whose opacity was titrated to 50% of each subject's perceptual threshold. The stimulus appeared randomly in one of four possible locations. The subjects were asked to report if they perceived the stimulus and where it was. The task includes three conditions: (1) no stimulation; (2) thalamic stimulation delivered during the onset of visual stimulus; (3) delayed stimulation delivered two seconds after stimulus onset. For all subjects, the stimulation was biphasic square waves at 100Hz, 120ms pulse width per phase for 300ms. The stimulation amplitude was adjusted for each subject based on their tolerance level (3.0mA and 2.0mA, respectively). In the no-stimulation condition, a perception-specific TAP was observed, consistent with previous work. Notably, perceptual sensitivity, as assessed by the percentage of trials where the subjects both perceived the stimulus and correctly identified the location, appears to be modulated by thalamic stimulation. Specifically, for stimuli on the side of the screen contralateral to the side of thalamic stimulation, perceptual sensitivity increased by 28.7% ±8.4% (n=2), compared to no stimulation. The increase for the ipsilateral side stimuli was less pronounced at 15.1% ±37.8%. Interestingly, thalamic stimulation delivered two seconds after stimulus onset does not appear to have this augmentation effect over the no-stimulation condition (contralateral: 12.3%±24.8%; ipsilateral: 7.3%±14.5%). These preliminary results suggest that thalamic stimulation could augment perceptual awareness of concurrently delivered visual stimuli. These results support a modulatory role of subcortical regions in the transient visual conscious perception. Future work may better shed light on this modulatory role by recruiting more patients as well as by testing the effect of thalamic stimulation on cortical responses measured by EEG.

Determining the Neuroanatomical Basis of Unconsciousness in Patients with Acute Ischemic Stroke

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Rationale, Acute ischemic stroke (AIS) causes severe disturbances of consciousness including coma in approximately 2-5% of cases. AIS may manifest brain infarction in different parts of the brain, providing an opportunity to investigate anatomical relations to impaired consciousness. Modern neuroimaging methods have not previously been applied to identify locations that may be implicated in stroke related coma. The purpose of the present study is to determine the significance of anatomical lesions associated with coma in patients with AIS in comparison to control AIS patients without coma. Methods, The study is based on analysis of retrospective AIS data from Yale New Haven Hospital. Patients who underwent MRI scans within 7 days from clinical brain ischemic stroke and coma onset are included. MRI data include diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC), T1- and T2-weighted images. Primary analysis groups are patients with AIS and coma or with AIS and normal consciousness based on Glasgow Coma Scale and clinical chart review. Patients with intermediate levels of impaired consciousness, or with causes of impaired consciousness not attributed to AIS (e.g. toxic-metabolic dysfunction, head trauma, seizures, medications, etc.) are excluded. Results, So far 799 patients with AIS have been identified as meeting inclusion criteria, among which 18 patients with AIS are identified as having coma with coma duration varying from 1.75 hours to 6 days. Locations of AIS lesions based on DWI and ADC map in patients with coma include bilateral or unilateral brainstem, cerebellum, thalamus and widespread areas of cerebral cortex. Quantitative analyses of AIS lesion locations associated with coma in comparison to controls without impaired consciousness are ongoing. Conclusion, While this study is still in progress, we anticipate that the analysis will enable us to determine possible associations between loss of consciousness and (1) damage to subregions in the brainstem or other subcortical structures (e.g. hypothalamus, thalamus); and (2) damage to specific regions of bilateral parietal and/or frontal cortex or other cortical regions. With further investigation, we hope that this study can identify anatomical lesions causing coma, benefit the clinical diagnosis and management of patients with AIS, and shed light on critical cortical and subcortical brain regions necessary for normal consciousness.

Blurring the lines between cognition and metacognition: the case of meta-metacognition

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Poster Session 2, Saturday June 24th, Greenberg Lounge, 1.15pm-2pm and 3.30pm-4.30pm,

Cognition and metacognition are often conceptualized as two separate systems. These systems are typically assumed to depend on different neural substrates and to have access to different information. Despite its dominance, this conceptualization remains controversial. Here we sought to examine a related distinction that carries much less historical baggage: the distinction between metacognition and meta-metacognition. Participants (N = 40) performed a perceptual decision-making task, and in one condition, they provided (1) an object-level, Type-1 response about the identity of the stimulus, (2) a metacognitive, Type-2 response (low/high) regarding their confidence in their Type-1 decision, and (3) a meta-metacognitive, Type-3 response (low/high) regarding the quality of their Type-2 rating. In a separate condition, those participants performed an identical task with only a Type-1 response followed by a Type-2 response given on a 4-point scale. Critically, the individual ratings produced by a combination of binary Type-2 and binary Type-3 scales map directly onto the individual ratings in a 4-point Type-2 scale. For example, low Type-2 & high Type-3 rating maps onto Type-2 rating of 1 on a 4-point scale, whereas high Type-2 & high Type-3 rating maps onto Type-2 rating of 4 on a 4-point scale. Using this mapping, we found that the two conditions produced equivalent results such that the combination of a binary Type-2 and a binary Type-3 responses acts equivalently to a 4-point Type 2 response. Specifically, both conditions produced evidence for above-chance meta-metacognitive ability (that is, metacognitive efficiency was higher for high compared to low Type-3 ratings), and showed the same relationships with task accuracy and reaction time. Finally, we found clear evidence for the existence of signal-dependent metacognitive noise (Shekhar & Rahnev, 2021) but no evidence for Type-3 meta-metacognitive noise. These results suggest that it is unlikely that there is a genuine distinction between Type-2 and Type-3 systems (metacognition and meta-metacognition) in perceptual decision making. Instead, it appears that a single system produces both Type-2 and Type-3 ratings. This conclusion raises the question as to whether there is also no clear dividing line between Type-1 and Type-2 systems (cognition and metacognition) in the context of perception.