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Effects of Buddhist religious chanting on brain blood flow and water content, tubulin, and microtubules as they relate to Orch OR

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.11]........Cellular and sub-neural processes

Abstract
It was previously demonstrated that the in vitro multifractal arrangement of tubulin, a key molecular element of Orch OR, changes in response to audible sounds; tubulin average fractal size and lacunarity change according to the type of sound with a two-syllable mantra inducing the most significant modifications. In this presentation, the sound analysis of the two-syllable mantra affecting tubulin is compared with that of the hexameter Buddhist religious chant - Nam-Myoho-Renge-Kyo - a chant that is associated with increased psychological resources, as well as with effects on electrolytes. Here, I present results obtained with transcranial ultrasonography demonstrating that the water content of the brain changes with breathing as it occurs during Nam-Myoho-Renge-Kyo chanting. In another series of observations using functional near-infrared spectroscopy, I demonstrate that chanting is associated with increased synaptic activity and blood flow in the prefrontal cortex (Brodmann area 10). Increase of brain blood flow and water content favors the effects of the sound waves generated by chanting on the human and microbial cells of the brain. Additionally, I show evidence demonstrating that when sound and electromagnetic waves share a common medium, and that medium has electrical properties that vary with mechanical strain, as it occurs in the brain, the two undulatory phenomena interact. Microtubules are resonant cavities filled with a piezoelectric material, e.g. proteins; resonant standing waves, either electromagnetic or acoustical, will then produce fixed patterns of electromagnetic or acoustic properties in microtubules. Microtubules, working as Fabry-Pérot interferometers, detect and interpret the interaction of sound and electromagnetic waves. It is proposed that the electromagnetic and sound waves generated during chanting interact with each other in the context of microtubules and are interpreted by their information processing machinery, ultimately contributing to changes in the level of consciousness associated with the increase of psychological resources previously observed in Buddhist practitioners who chant Nam-Myoho-Renge-Kyo. The following sequence of events may be proposed: 1. Brain activity and volition generate sound waves through chanting. 2. Sound waves modify the spatial arrangement of tubulin in neurons and possibly in other cells. 3. Changes of tubulin spatial arrangement leads to changes of information processing ability of microtubules as per Orch OR. 4. Results of microtubule quantum computation, modified as described above, regulate firing of axons that in turn leads to modified electrochemical brain activity. 5. Electromagnetic waves generated by the modified brain electric activity interact with sound waves in brain tissue. 6. Microtubules detect the interaction of electromagnetic and sound waves and their information processing ability is modified by these interactions. 7. Changes of microtubule processing ability lead to changes in the results of quantum computations that in turn lead to increased brain activity. In conclusion, repetitive production of, and exposure to sound lead to recursive functions that are generated, on one side, by the sensitivity of tubulin to sound, and, on the other, by the ability of microtubules to work as interferometers, interpret the interactions of electromagnetic sound waves, and modify accordingly axonal firing leading to increased brain activity.

C - 8

Keywords
tubulin, mechano-transduction, sound waves, Orch OR, microtubules, religious chanting, Buddhism

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The State Space Theory of Consciousness: A Novel Framework for Understanding the Mind

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.20]........Neurobiological theories of consciousness

Abstract
Background: Despite immense effort, the nature and origins of human consciousness remain mysterious. No current theory provides a satisfactory mechanistic explanation bridging brain function and subjective experience. This abstract proposes the State Space Theory, a new framework for conceptualizing consciousness centered on delay coordinate embedding (DCE) engines arranged hierarchically in the brain. Objective: To introduce and summarize the key concepts and evidence underlying the State Space Theory as a comprehensive yet empirically-grounded model of consciousness. Methods: The theory synthesizes principles from diverse fields including neuroscience, complexity science, and philosophy of mind. Evidence is drawn from neuroplasticity, perceptual illusions, neural networks, dynamical systems theory, and existing theories of consciousness. Results: The core premise is that consciousness emerges from DCE engines, which process information by embedding it in a low-dimensional neural state space representation. DCE forms the generic computational algorithm implemented throughout the cortex. DCE engines are organized hierarchically, with higher levels representing increasingly abstract concepts synthesized from lower level sensory inputs. Consciousness arises from the real-time operation of the highest-level DCE engines. Several lines of evidence support the key propositions: 1. Neuroplasticity and cortical reorganization suggest generic computational mechanisms in the brain adaptable across regions. This implies a common underlying algorithm like DCE. 2. Perceptual phenomena indicate consciousness constructs reality rather than passively reflecting it. State space representations shaped by DCE align with this constructed nature of consciousness. 3. Recurrent neural networks and large language models successfully employ DCE-like principles for processing sequences over time. This demonstrates the computational power of DCE engines. 4. The theory comports with the temporal and subjective aspects of consciousness emphasized in dynamical systems theory and various philosophical perspectives. 5. Comparison with other theories of consciousness, including higher-order thought and integrated information theory, reveals overlaps along with unique aspects of the current framework. Conclusions: By emphasizing time-dependent computation, state space representations, and individual developmental histories, the State Space Theory offers a unifying framework for demystifying observations from neuroscience and philosophy. It comports with the constructed nature of perception, reconciles mind-brain dualism, and grounds consciousness in computational brain mechanisms. While aspects require further research, this theory provides a novel, empirically-grounded perspective on the mind-brain relationship to push understanding forward.

Poster - 1 (Wed)

Keywords
Consciousness, Cognitive neuroscience, Computational neuroscience, Complexity theory, Dynamical systems, Delay coordinate embedding, Neural state spaces, Perception, Neuroplasticity, Philosophy of mind

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High Frequency (> 1.0 KHz) Signals in Neocortex at Loss and Recovery of Consciousness

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.01]........Neural correlates of consciousness (general)

Abstract
Background/Introduction: Brain oscillations have rarely been studied at frequencies beyond 200 Hz, and it remains unknown what the highest frequency of brain bioelectric activity is. We used the volatile anesthetic, isoflurane, to depress activity at behavioral endpoints of loss of righting reflex (LORR) and loss tail clamp responses (LOTC). These endpoints provided surrogate measures of loss of consciousness (LORR) and surgical anesthesia (LOTC) in rats. We recorded signals from DC to 20KHz; extending analysis of oscillatory cortical activity well beyond traditional frequency ranges. Methods: Local field potentials (micro-EEG) were recorded from layer 2/3 of frontal cortex in rats using chronically implanted electrodes. Rats were placed in an air-tight chamber with a controlled atmosphere of room air that was slowly replaced with increasing concentrations of isoflurane in oxygen, delivered from a calibrated vaporizer. Animal behavior was carefully monitored to determine LORR and LOTC responses. Recording of micro-EEG continued as rats recovered following each experiment after replacing isoflurane with room air. Results: Isoflurane produced a characteristic profile of effects, consistent with previous reports. At LORR high amplitude slow wave activity was evident that transitioned to a burst suppression pattern at LOTC. Spectral analysis revealed that increased slow wave activity was accompanied by decreased higher frequencies in the gamma and high-gamma bands, and extending to >1.0 KHz at LORR. We tested whether this high frequency activity was due to action potential discharge recorded from neurons near the electrode tip and found that it was not. High frequency activity did not appear to result from harmonics from lower frequency oscillations, since the power decay was smooth, not peaked like for harmonics. Conclusion: Isoflurane depressed high frequency cortical activity well beyond the traditional EEG frequency range of 200 Hz. Future research will investigate brain processes that are associated with this very high frequency brain activity, between 300 and 1000 Hz.

C - 22

Keywords
Key words: Anesthetic, EEG, Cortex, Unconscious, High-gamma, conscious, KHz.

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New ways to visualize EM fields generated by human brain activity at loss and recovery of consciousness

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.01]........Neural correlates of consciousness (general)

Abstract
Electromagnetic fields (EMFs) are generated by brain activity and have long been suggested to provide a medium for the mind and a mechanism for mental computation. Early evidence that was thought to refute EMF theories of mind have recently been shown to have been badly misinterpreted, and new ways of understanding EMFs are needed. EMF activity can be recorded using both electrical sensors (EEG) and magnetic sensors (MEG), both of which produce very similar responses. We begin by showing an example of the similarity of EEG and MEG signals for event related potentials/Teslas. We then used EEG responses recorded from humans transitioning between awake (responsive) and unconsciousness (unresponsive) states produced by various anesthetics. Traditional measures of EEG spectral content failed to consistently detect loss or recovery of consciousness, in agreement with earlier studies in people and animals (Mashour et al 2017; 2020). We then used nonlinear dynamic analysis of EEG signals, first to provide a means of visualizing EMFs with chaotic attractor plots, and then as a means of quantitatively measuring transitions between loss and recovery of conscious brain states. Our new measure of EMF activity provided a far better assessment of brain states for both loss and recovery of consciousness produced by various anesthetics compared to spectral measures. We provide a statistical comparison between these measures. We also demonstrate how the new nonlinear dynamic measures are just a reflection of the complexity of information processing by the brain; the awake brain exhibits far greater complexity compared to the unconscious brain. Our new results provide support for EMF theories of consciousness that link mind-brain activity into a unified whole.

WK - 5

Keywords
Electromagnetic, EMF, consciousness, unconsciousness, anesthetic, brain rhythms, oscillations, chaos, mind, brain, dualism, materialism

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The anarchically organized brain: changes in functional hierarchical organization after acute and chronic use of ayahuasca, DMT, and cannabis

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.19]........Psychedelics and psychopharmacology

Abstract
It is widely believed that psychedelics flatten the hierarchical organization of the brain, resulting in increased flexibility of brain states through the disintegration of the default mode. Limited yet compelling evidence suggests that this is the mechanism behind the action of psychedelics, but changes in the hierarchy of the brain under psychedelics are not yet well understood. The present work examined changes in the functional hierarchical organization of the brain resulting from the acute use of DMT and chronic use of ayahuasca, distinguishing effects from occasional and chronic use of cannabis to identify key drivers of alterations in brain hierarchy under psychedelics. 24 long-term users of ayahuasca, 17 psychedelic naive users of DMT, and 43 infrequent or frequent users of cannabis, defined as less or more than four times a week, respectively, were imaged at baseline and after administration of ayahuasca, DMT, or cannabis. Entropy production across the brain was estimated via non-reversibility through pairwise time-shifted correlation of the forward and reversed timeseries. A whole-brain model estimated the effective connectivity, derived from diffusion-weighted imaging, for each participant. Trophic coherence was applied to the model, yielding a directed graph of the effective connectivity, which provides the directionality and height of the brain’s functional hierarchy and regional changes in hierarchical level, estimating the functional hierarchical organization of the brain at baseline and under the influence of ayahuasca, DMT, and cannabis. The functional hierarchy of the brain was significantly flattened under ayahuasca, which was associated with an increase in total incoming and outgoing information in parietal regions and both increases and decreases in frontal cortical regions. Interestingly, DMT was not found to significantly affect functional brain hierarchy, though it correlated with decreases in incoming and outgoing information to and from frontal and parietal regions. Rather, an upward trend toward a strengthened hierarchy was found under DMT. Common drivers of changes in functional hierarchy under psychedelics were found to be localized primarily to frontal cortical regions, while common drivers between psychedelics and cannabis included primarily parietal and occipital regions. The present work establishes a differential response to psychedelics on the functional hierarchical organization of the brain. Contrary to previous work, not all psychedelics appear to flatten the hierarchy of the brain. Given the presence of MAOIs in ayahuasca, it may be the case that inhibition of MAO drives changes in the functional organization of the brain.

C - 10

Keywords
psychedelics, whole-brain modeling, brain dynamics, brain hierarchy, dynamics, hierarchy, machine learning, graph theory, information theory, trophic coherence, arrow of time

39

Effect of verbal and listening to “OM” chanting on EEG microstates: A QEEG study

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.04]........Other sensory modalities

Abstract
Introduction: Chanting “OM” involves producing and perceiving an audible sound respectively. OM chanting in meditation is reported to have a relaxation effect during both verbal "OM" chanting (VOM) and listening to "OM" chanting (LOM). There needs to be more literature regarding the EEG microstate information after VOM and LOM using qEEG compared to the resting condition. The EEG Microstates analysis gives an idea of temporal dynamics of electric fields that yield topographic maps, which remain stable for 80 to 100 milliseconds, then abruptly shift to a new map topography and remain stable. EEG microstates are considered as basic building blocks of consciousness or atom of thoughts. Methods: Therefore, to examine the effect of these actions on the brain using qEEG, it is required to compare the EEG microstates among the baseline, VOM, and LOM. In the present work, 23 adult male subjects were examined and given a paradigm designed using E- E-prime for both VOM and LOM chanting each of 5 min duration. A 128-channel geodesic sensor net was used to obtain the experimental data, which was later pre-processed, segmented, and analysed. Results: The present work is the first to report the three scalp maps topographies, i.e., microstates obtained utilizing k-means cluster analysis for the response of the VOM and LOM. Also, the 'Number of Time Frames, Global Explained Variance (GEV), Time Coverage, and Mean Duration parameters for the three maps were analyzed statistically, which were found nonsignificant. Conclusions: The study revealed an interesting perspective for short-term chanting with a predominance of Maps and serum cortisol levels between pre- and post-OM chanting. Overall, 5 minutes of structurally designed Om chanting paradigm (both listening and verbal OM chanting) was not found to induce change in the microstate parameters.

C - 8

Keywords
QEEG, Microstate topography, Verbal and Listening to 'OM' chanting.

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Scientific discovery of Consciousness: Scientific discovery of Consciousness will provide revolution in neuroscience. I have discovered Quantum source of Consciousness inside human brain.

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[01.01]........The concept of consciousness

Abstract
Neuroscience needs a revolution - My scientific discovery of Consciousness will provide that revolution. I have discovered Quantum source of Consciousness inside human brain. My discovery provides the revolution which Stuart Hameroff cited during his presentation. I was nominated for Nobel Prize in 2020 yr for my scientific discovery in medicine and physics by 3 Universities in India. Quantum Code Consciousness - discovery of Quantum source of consciousness. While I was an undergraduate student at UCH UCL London undertaking degree in Oral Surgery and while I was dissecting cadaver body, I asked my self the question what has happened to the live spark inhabiting the cadaver, where has it gone, where does it live, how does rebirth take place as neuroscience and Professor Aitkin's Essential Anatomy, Gray's Anatomy or Grant's or Ganong's physiology did not have any answers for this. This started my Journey from London of 14 yrs in search of Creator of our Universe, whom I found ....rest of new knowledge and many many new scientific discoveries flowed from there....it is a long story and battle of 4 journey's stemming 30 yrs cannot be covered in 500 words....I have discovered how death takes place, what happens after death, layers of multiple Universes, discovery of 4 different types of light... all started with my school days in London at Claremont High School, Harrow, UK when I was meditating on my own and practicing many breathing techniques, discovered mystery of Pineal Gland and 3rd eye, how to open it, 7th eye is singularity watching everything, microtubules - why Tau proteins disintegrate and people suffer from dementia, 3-D vision, Penrose and Hameroff Theory of ORCH and quantum collapse is not the source of consciousness, I will reveal more during live lectures and my slides presentations. I simply need proper time to share my discoveries. I will reveal both practical method of seeing consciousness and theory behind it, MC Theory of Everything is first theory of nature. Triple Quantum Entanglement is the key, scientific discovery of Quantum Light and its importance.

Poster - 2 (Fri)

Keywords
Quantum Code consciousness, source of consciousness, Zero Point Field, Physics of consciousness, 3-D atoms formation - sciencedoes not know how a single chemical is formed...DNA is controlled by both Zero Point Field and Quantum Code, discovery of how a single cell is made with 7 Planets, human consciousness has 7 planets, I have seen all of these planets and how they work, concept of Newton's Gravity (non fingo) and Einstein's General Theory of Relativity is flawed, Singularity is the key, I will reveal How I work from singularity, I have seen live quarks, electrons, individual photons, Sir Roger is incorrect about String Theory, Strings are real, I have seen them live and they play crucial role in consciousness, black Hole structure of 7 layers discovery, Quantum Light discovery, Quantum Universe discovery....

60

Temporal fluctuations in how strong brain structure shapes function reflect individuality and alertness-drowsiness balance

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.02]........Methodologies (fMRI, EEG etc.)

Abstract
State-of-the-art neuroimaging such as magnetic resonance imaging (MRI) provides unprecedented opportunities to non-invasively measure human brain structure (anatomy) and function (physiology). Recently, graph signal processing has emerged as a promising new methodology to integrate a brain graph (i.e., the structural connectome determined by diffusion-weighted MRI and tractography to reconstruct axonal white-matter bundles) and graph signals (i.e., the spatial activity patterns obtained by fMRI during long periods of time). Classical concepts such as filtering and spectral representations can be generalized to the graph domain, and thus, brain activity in grey matter can be analyzed by accounting for the underlying macroscale connectivity in white matter. In previous work, we derived a new measure termed the structural-decoupling index (SDI) to quantify the strength of coupling between function and structure. The brain activity was taken from a full resting-state session. Here, we propose a new time-resolved version of the SDI that is able to reveal temporal fluctuations of the SDI. Specifically, after projecting the fMRI signals into two orthogonal subspaces for structurally aligned and liberal signals, respectively, we compute the instantaneous difference in strength of both signals for all brain regions. These SDI patterns are then temporally clustered to show their most recurrent spatial configurations. When applied to two 15-minutes resting-state sessions for 100 subjects from the Human Connectome Project, 5 clusters of recurrent SDI patterns can be determined in a robust way. The expression profile of the SDI patterns has a strong intra-individual reliability as determined by test-retest sessions and large intraclass correlation coefficients. These SDI patterns also change their expression over time. Specifically, patterns that indicate stronger coupling (i.e., three patterns: a whole-brain pattern except orbitofrontal lobe and temporal pole; a pattern encompassing visual cortex and ventral temporal regions; and a pattern with somato-motor regions) are more common during the second half of the session, which is known to be associated with a higher level of drowsiness. Conversely, patterns of dominant decoupling (i.e., two patterns: a pattern with all sensory regions; and a pattern that contrasts sensory against temporal and frontal regions) are more common in the first half when alertness is highest. These results suggest that the alertness-drowsiness balance can be revealed by how strong brain activity is shaped by underlying structure. Therefore, SDI is a new promising avenue to quantify features of consciousness. Future studies are needed to assess SDI in different sleep stages and in patients with disorders of consciousness.

C - 7

Keywords
dynamic brain activity, fMRI, structure-function relationship

69

The DMT synthesis enzyme INMT is not essential for endogenous tryptamine-dependent methylation activity in rats.

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.19]........Psychedelics and psychopharmacology

Abstract
Indolethylamine N-methyltransferase (INMT) is a transmethylation enzyme that utilizes the methyl donor S-adenosyl-L-methionine to transfer methyl groups to amino groups of small molecule acceptor compounds. INMT is best known for its role in the biosynthesis of N,N-Dimethyltryptamine (DMT), a psychedelic compound found in mammalian brain and other tissues. In mammals, biosynthesis of DMT is thought to occur via the double methylation of tryptamine, where INMT first catalyzes the biosynthesis of N-methyltryptamine (NMT) and then DMT. However, it is unknown whether INMT is necessary for the biosynthesis of endogenous DMT. To test this, we generated a novel INMT-knockout rat model and studied tryptamine methylation using radiometric enzyme assays, thin-layer chromatography, and ultra-high-performance liquid chromatography tandem mass spectrometry. We also studied tryptamine methylation in recombinant rat, rabbit, and human INMT. We report that brain and lung tissues from both wild type and INMT-knockout rats show equal levels of tryptamine-dependent activity, but that the enzymatic products are neither NMT nor DMT. In addition, rat INMT was not sufficient for NMT or DMT biosynthesis. These results suggest an alternative enzymatic pathway for DMT biosynthesis in rats. This work motivates the investigation of novel pathways for endogenous DMT biosynthesis in mammals.

C - 9

Keywords
Endogenous DMT, INMT, HPLC-MS/MS

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CONSCIOUS INTENTION AND HUMAN ACTION: REVIEW OF THE RISE AND FALL OF THE READINESS POTENTIAL AND LIBET'S CLOCK

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[01.12]........Free will and agency

Abstract
Is consciousness—the subjective awareness of the sensations, perceptions, beliefs, desires, and intentions of mental life—a genuine cause of human action or a mere impotent epiphenomenon accompanying the brain’s physical activity but utterly incapable of making anything actually happen? This presentation will review the history and current status of experiments and commentary related to Libet’s influential paper (Brain 106:623–664, 1983) whose conclusion “that cerebral initiation even of a spontaneous voluntary act …can and usually does begin unconsciously” has had a huge effect on debate about the efficacy of conscious intentions. Early (up to 2008) and more recent (2008 on) experiments replicating and criticizing Libet’s conclusions and especially his methods will be discussed, focusing especially on recent observations that the readiness potential (RP) may only be an “artifact of averaging” and that, when intention is measured using “tone probes,” the onset of intention is found much earlier and often before the onset of the RP. Based on these findings, Libet’s methodology was flawed and his results are no longer valid reasons for rejecting Fodor’s “good old commonsense belief/desire psychology” that “my wanting is causally responsible for my reaching.” A review paper discussing these findings and their interpretation has been published in Consciousness and Cognition (2021 Sep:94:103171. doi: 10.1016/j.concog.2021.103171. Epub 2021 Jul 27 ).

C - 24

Keywords
consciousness, free will, Libet, intention, action, agency, epiphenomenon, readiness potential, movement initiation, bereitschaftspotential, decision, hard problem, Kornhuber

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A Dynamical Model of Conscious Perception and Perceptual Binding

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.01]........Neural correlates of consciousness (general)

Abstract
I present a mechanistic model of interconnected processes that dynamically retain mutual relationships isomorphic to a specific percept. Therefore, the modeled system can both maintain the specific relationships encoding the percept and continuously execute them to bring the corresponding phenomenal state into existence. The phenomenal state (quale) is postulated to be a property of the dynamic system which emerges and exists when that property is realized or “happens”. Therefore, the specific relationships among processes must be continuously executed and retained over time as long as the experience of the encoded phenomenal state is perceived as unchanged. The model is then used to investigate the perceptual binding mechanism between two percepts. The dynamic behavior of two coupled systems of processes is analyzed to characterize how these processes can modulate each other and reach a temporal synchrony. Further, stochastic simulations of the model are used to investigate the interplay between the binding strength and noise. The results indicate that the binding mechanism is robust against inherent noise. Also, large systems that involve more interconnected processes are less noise sensitive than small systems with fewer processes. Overall, the mechanistic model offers an intuitive mathematical tool that can be used to study how the information relevant to specific conscious percepts and neural correlates of consciousness can be deduced from dynamics of neural-like (oscillatory) systems.

Poster - 1 (Wed)

Keywords
Theory of consciousness; qualia; perceptual binding; perception; neural correlates of consciousness

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Brain dynamics reflects loss and return of consciousness

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.10]........Anesthesia

Abstract
Brain dynamics refers to the spatiotemporal properties of recurring neuronal activity patterns. It is characterized by the series of metastable states the brain acquires over time as it engages in sensory, motor, and cognitive operations. Complexity and the repertoire of brain states are properties of brain dynamics that affect information processing in different states of consciousness. Investigating brain dynamics during anesthetic modulation may thus help identify the critical neural mechanism of consciousness. A challenge to this endeavor is the difficulty in separating the specific neural correlates of consciousness from those that enable or accompany the conscious state. Also, a gradual, as opposed to abrupt, change in state-dependent neuronal events is difficult to separate from confounding anesthetic drug-effects. Brain dynamics is also scale-dependent: when the state of consciousness is altered, different changes can occur at macro, meso, and micro scales. Computational simulation of large-scale brain dynamics predicts that the repertoire of brain states reaches maximum in consciousness. Experiments confirm that anesthetics diminish the dynamic repertoire of brain states during behavioral unresponsiveness. Macroscale brain dynamics in humans is characterized by the frequent dropout of specific metastable patterns such the default and dorsal attention networks. At micro-scale, neuronal complexity decreases gradually before, and abruptly after sensory stimulation suggesting a critical neural signature of the transition to anesthetic-induced unconsciousness. Experimental stimulation of the brainstem ascending activating system augments both baseline and stimulus-related neuronal complexity in a region-selective manner, supporting a causal relationship between cortical arousal and consciousness. Interestingly, at mesoscale, the repertoire of field potential patterns does not diminish in anesthesia. Likewise, in anesthetized human participants, an increase in local functional connectivity precedes the disconnection of large-scale networks. An important remaining question is if unconsciousness can be inferred from behavioral unresponsiveness. Neuroimaging studies suggest that in rare cases, mental imagery is preserved in anesthetized participants consistent with disconnected consciousness. Further investigations into cognitive brain dynamics may help answer this question.

C - 22

Keywords
Neuron, spike, network, synchrony, dynamics, complexity, anesthesia, imagery

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A comparative study of the influence of Faradarmani Consciousness Field on the brain of women and men

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.02]........Methodologies (fMRI, EEG etc.)

Abstract
Based on Taheri’s theory introduced in the 1980s, Consciousness is defined as the fundamental element of the universe from which information, matter and energy spring forth. In this perspective, there are various T-Consciousness Fields (TCFs) with non-physical entities that their influence can be recorded through laboratory experiments. In the current study, the effect of one type of these fields named Faradarmani Consciousness Field (FCF) was investigated. Functional magnetic resonance imaging (fMRI) technique has been widely used to understand the functional activities and cognitive behavior of the brain during task or resting states. Here, 30 random volunteers (15 females, 15 males; 20 to 50 years of age) took part, and the exposure to FCF and without this treatment was considered as task and rest, respectively. While previous studies have examined the behavior of the brain in response to FCF, a comparison of the effects of this Field on the brains of men and women has not been conducted. Exploring the sex-related effects of FCF on the human brain can reveal new and different aspects of the functioning of these innovative non-material and non-energetic fields in the scientific realm. According to the results of the present study, 89% of all voxels showing activity change in both genders are associated with a reduction in activity, with 97% of these changes occurring in women's brains. In contrast, activated areas represent 11% of all voxels showing activity change, and 85% of these belong to the male brain. The most dominant function of the activated areas in both sexes is related to the motor cortex, controlling and managing voluntary movements and skeletal muscles. Following this, functions such as memory (visual and spatial) and attention are associated with the activated areas. These findings provide valuable insights into the differential effects of FCF on the brains of men and women, shedding light on the specific areas and functions that are influenced by this non-material and non-energetic field.

Poster - Remote (post)

Keywords
brain, deactivation, activation, sex-related difference, Faradarmani Consciousness Field

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An Index of Universal Consciousness Based on a Unifying Theory of Electroacoustic Energy

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[04.05]........Emergence, nonlinear dynamics and complexity

Abstract
In searching for a holistic understanding of neurodegenerative disorders an unconventional discovery was happened upon: the spark of Consciousness occurring at the cellular level. Applying principles from audio and electrical engineering, the transduction process of neuronal communication can be considered as an electroacoustic phenomenon whereby electrochemical energy is converted into mechanical energy, then back–understanding electroacoustic energy as the basis of neuronal synchronies opens new avenues for explaining the nature of Consciousness. Continuous systemic repetition of this process, combined with the piezoelectric nature of the neuronal lipid membrane and the broadly conductive nature of extracellular material (as well as resonant qualities of housing architecture) is hypothesized to lead to an additional, simultaneously-occurring, electroacoustic process which produces an audible oscillatory feedback loop, of ever-shifting resonant frequency (with attendantly-shifting nodes and correlated harmonic resonances) throughout the nervous system–a process which occurs when the piezoelectric membrane, acting in the manner of a contact microphone, passes mechanical signal (neuronal membrane vibrations) into electrical signal and back (a perpetually vibrating, system-wide resonance chain with electroacoustic properties). This project has dual concordant aims: explain how the interplay of the Electroacoustic Feedback Loop Resonance with what we know of nervous system structure-function begets Electroacoustic Consciousness; additionally, in order to understand Electroacoustic Consciousness and its place in the context of Universal consciousness (as well as when to capitalize the word) this project delineates an all-encompassing categorical index for how Universal consciousness exists in both Simple and Complex forms, while remaining a pervasive phenomenon. Abutting aspects of varied modern and ancient Theories of Consciousness, and standing on the shoulders of prior research in Consciousness Studies, Neuroscience and beyond, the Electroacoustic Theory of Consciousness presents a unique version of Panpsychism: Complex Consciousness is weakly emergent in living organisms via the nature of neuronal communication at the system-wide level (an inherently nonlinear phenomenon which answers questions of supervenience); it arises from, and is simultaneously able to be understood as “consciousness” or “Universal consciousness”—the pre-transduced energy pervasive throughout the Universe; additionally, consciousness can and should be considered: Energy conveying information (or information conveying energy) in simple and increasingly complex systems, of varying physical scope. The devised index allows for a wide breadth of examples, including real or hypothetical multi-agent scenarios and systems (based on scientific principles) to be labeled with one (or as part of a combinatory equation) of the following: Small Simple consciousness; Complex Consciousness, or Big Simple consciousness (which differs from “Small Simple” solely in scales of physical dimension); the simplicity here belied by the fact that Complex Consciousness can be broken into “Organism” and “Group” subcategories, each of which has four developmental levels; as well as the potential for “Homuncular Generations” which answer once and for all: Can a computer system be a Consciousness, on par with or superseding humanity?

Poster - 2 (Fri)

Keywords
electroacoustic, ontology, nonlinear, theory of consciousness, index, biophysics, feedback loop, resonance, piezoelectric

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Measuring consciousness among people with similar logical patterns of thinking as a semantic indication of their novel intelligence dynamic patterns

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.01]........Neural correlates of consciousness (general)

Abstract
In TSC 2022, we introduced the physical coupling theory of consciousness comprehending its perspectives in physics, biology, and psychology based on logic reasoning. The theory states that static memory, the subconscious and subjective conscious are different psychological activation level reflections of the three physical coupling states of the unobservable consciousness signals. (Ma, Primary Topic: 04.16, TSC, 2022,). In TSC 2023, we introduced our method of semantically measuring consciousness with neural correlates of consciousness (NCC) by filtering the noisy neural signals with mental twins defined as people who had the same kind of patterns of thinking (POT). (Ma, Primary Topic: 04.16, TSC, 2023,). We now attempted to briefly describe the feasibility of, and strategy of implementing, our semantic measurement of consciousness. We introduce the intelligence dynamics pattern as a means to improve the validation of our semantic consciousness measurement method together with the four mutually inclusive, co-existing elements of thinking traits with person-to-person fraction variation, a) logical linear thinking, b) illogical nonlinear thinking, c) divergent thinking, and d) convergent thinking). Utilizing the corresponding real-life examples of these four thinking traits, the feasibility of selecting the relevant four sub-cohorts for designing and performing practical measurement experiments will be detailed. Moreover, our novel semantic consciousness-measurement proposal is universal, coherently applicable to both our non-neural coupling theory testing and to existing neural theories to the least, complementary to research by Dehaene (Consciousness and the brain: Deciphering how the brain codes our thoughts: Penguin, 2014) and by Dehaene & Changeux, (Neuron, 2011). Overall, we will provide convincing evidence to the neuroscience community that this proposed semantic measure of consciousness is experimentally tangible. (Our under-review article, which details our physical coupling theory and measurement method, is available upon request. Please email us at jasonma@depontech.com. Kewei Chen participation in this work is independent of his any affiliations)

Poster - 1 (Wed)

Keywords
Neural correlate of consciousness (NCC), logical patterns of thinking (POT), illogical nonlinear thinking element, intelligence dynamics

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Leveraging subcortical arousal circuits to reverse drug-induced unconscious states and restore cognitive function

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.01]........Neural correlates of consciousness (general)

Abstract
In the United States, general anesthesia is administered to over 100,000 patients daily, enabling surgical procedures to be performed in the absence of memory, awareness, or pain. In clinical practice, general anesthesia is rapidly induced and maintained by a variety of chemically diverse and mechanistically distinct anesthetic agents; however, how the brain restores consciousness and cognitive function following such drug-induced breaks in consciousness remains an area of active investigation. Several lines of research have now demonstrated that subcortical arousal pathways play an important role in facilitating the return of consciousness following general anesthesia. In this talk, I will discuss our work investigating the role of the ventral tegmental area, a dopamine-rich hub in the midbrain traditionally associated with reward processing, in conscious and cognitive recovery following general anesthesia in rodents. We employ a variety of approaches, including optogenetic, chemogenetic and electric deep brain stimulation, to target and activate arousal circuits to restore behavioral and neurophysiological correlates of consciousness. I will also discuss our recent work employing chemogenetic activation of dopaminergic midbrain neurons to accelerate the recovery of neurocognitive function following the return of consciousness using our rodent touchscreen testing paradigm. By exploring the roles of subcortical arousal pathways in the context of anesthesia, we gain invaluable insight into the essential mechanisms underlying consciousness and offer potential avenues for refining clinical practices and optimizing patient outcomes.

WK - 5

Keywords
general anesthesia, emergence, dopamine, cognitive recovery, attention, subcortical circuits

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The Two minds of Consciousness : The Life-force at the boundary between the Quantum-Biophysical minds

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[04.14]........Quantum theories of consciousness

Abstract
Neuronal activity in the brain electromagnetically entrains interlinked neurons creating a system. This extremely low frequency (ELF) entrainment allows neuronal biomolecules such as the dendritic/axonal microtubules and synaptic receptors to become quantum entangled with other biomolecules with which they are synchronized. The neuronal entrainment at a given frequency synchronizes the system of neurons allowing their entanglement in a given bioelectric field. Memory is stable stored retrievable information. This entangled system will operate in the frequency that generated a quantum information memory representative of the bioelectric operation in the physical plane. An emergent system is a network of components that synergistically interact to generate a higher order information processing operation than just the components randomly interacting. A hologram is an example of an emergent system The quantum memory is an emergent (coherent) function that when triggered collapses into the physical plane that can generate the bioelectric neuronal pulse in the structural bioelectric circuit generating the conscious experience. The quantum information processing is determined in terms of Qubits. The quantum interactions link associated entangled memories that assign meaning. The quantum entangled system can operate coherently independent of the bioelectric system. The quantum entangled network of molecules can interact non -locally/ temporally within the system where information processing occurs with a perturbation in one network affecting another network. A perturbation in the entangled system will cause a perturbation in the entangled circuit causing processing of quantum information. The collapse of the quantum coherent function into the biophysical plane leads to the conscious moment. The boundary between the quantum entangled memory plane and the biophysical plane is the interface for the intelligent information/energetic processing in life that can be considered the life force or what some call the Chi. This quantum information/biophysical interface is where consciousness is realized. The interactions at the interface between these two different emergent level systems is an edge of chaos that create the complex emergent intelligent processes of life. The bioelectric energy like the electroencephalogram (EEG) generates a top -down energy that imprints the quantum entangled memory template of the emergent operation. The life-force is the meeting point for the biophysical structural material “hardware” and the quantum entangled informational template “software” defining living activity and consciousness. The Life-force unit is defined as Quantum information (Qubits) per Physical energy (Joule). The higher the level of the Life-force density will have a higher information Qubits processing capacity per joule of energy. The biophysical neuronal network and the quantum entangled system(s) both process information. The processing of the information in the quantum plane and in the bioelectric plane creates two inter-operative minds of consciousness, the Quantum and the Biophysical minds. The Quantum mind may access information in the (non-local /temporal) out of time space quantum plane and the biophysical mind accesses information in the (local/temporal) physical plane. The interface between these two minds is the center for consciousness.

Poster - 2 (Fri)

Keywords
Quantum Entanglement, Memory, Neurophysiology, Neuronal Entrainment, Emergent Processes, Boundary Conditions, Network Theory, Information Theory, Qubits/Joule, Electroencephalogram, Bioelectricity, Complexity theory

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Identification of Counterfeit People through Liveness Estimation: A Case Study on Brain Signals

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.02]........Methodologies (fMRI, EEG etc.)

Abstract
Counterfeit people are artificial intelligence engines that attempt to impersonate real people and can be used as security attacks to target numerous systems, including safety-critical ones (medical and autonomous). Counterfeit people can carry out seamless conversations in chat bots and can potentially guide unassuming users into harms way. Universality and permanency of the human brain has resulted in the prospective use of brain signals in several domains including biometric security. The advent of wearable and implanted brain sensors (e.g. Neuralink) and the decade long NIH Brain Initiative (2014-25) with more than $4.5 billion in funding are just samples of such a trend. The rationale of using brain in security has always been centered around its inherent inaccessibility (remote sensing is not possible), and the high entropy of the signals that can be measured such as electroencephalogram (EEG), fMRI, and Petscan. Usage of brain also enables hands-free cyber-physical security systems for users preoccupied with another task(s). While in cryptography, security guarantee is based on randomness of the key and backed by mathematical theories, in biometric systems robustness against spoofing attacks depends on nature of the input in use (fingerprint, face, voice, brain). In biometric field, there is consensus that brain signals are the ideal option due to the chaotic nature of the measured signals (e.g. EEG). This assumption is often referred to as the intrinsic liveness property of brain and is primarily backed by the point that electroencephalogram (EEG) signals are outcome of numerous neuron activities which get affected by surrounding contexts and past experiences. However, there is a lack of quantitative evidence on the assumption of intrinsic liveness and brain signal being an ideal source of randomness and entropy. Beside inherent entropy levels, robustness in security systems would depend on how well the current state-of-the-art in feature extraction and modeling techniques are capable of utilizing the full potential of the available randomness in brain signal. Liveness estimation is a mechanism to determine whether the inputs to a system is coming from a human or an AI source. Many safety and security critical systems aren’t yet equipped with liveness estimation methods to prevent them. A primary reason being the lack of robust liveness estimation methods for human traits. While a body of work exists on liveness estimation for some inputs (fingerprint, face, voice, iris), some other ones such as psychological signals (heart and brain) are assumed to possess intrinsic liveness property and to be immune against presentation attacks. We bring attention to the inaccuracy of this assumption for brain signals and emphasize the need for liveness estimation for any input sensed from the physical world. We formulated the liveness problem in general and studied it for brain signals. Utilizing an adversarial workflow, we proposed two solution approaches (model-aware and model-agnostic) and evaluated them against 43 synthetic and manipulative attacks. We successfully achieved nearly zero error rate in distinguishing between authentic and fake brain signals. This novel work shows the possibility and potentials of using the brain signals for liveness estimation.

C - 7

Keywords
Counterfeit People, Liveness estimation, Adversarial Attack, Deep Fakes, Synthetic EEG, Biometrics, Cyber-Security, Human-Machine Interface, Access Control, Authentication

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Human brain organoids as a systematic model for consciousness studies

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.11]........Cellular and sub-neural processes

Abstract
Structural and transcriptional changes during early brain maturation follow fixed developmental programs defined by genetics. However, whether this is true for functional network activity remains unknown, primarily due to experimental inaccessibility of the initial stages of the living human brain. We developed cortical organoids that spontaneously display periodic and regular oscillatory network events that are dependent on glutamatergic and GABAergic signaling. These nested oscillations exhibit cross-frequency coupling, proposed to coordinate neuronal computation and communication. As evidence of potential network maturation, oscillatory activity subsequently transitioned to more spatiotemporally irregular patterns, capturing features observed in preterm human electroencephalography (EEG). These results show that the development of structured network activity in the human neocortex may follow stable genetic programming, even without external or subcortical inputs. Our approach provides novel opportunities for investigating and manipulating the role of network activity in the developing human cortex. Applications of human brain organogenesis and the study of consciousness will be discussed.

PL-14

Keywords
brain organoids, neural oscillations, psychedelics, anesthetics, chimeras

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EEG-BASED JHANA STATES DETECTION FOR NEUROFEEDBACK TRAINING: AN OPEN DATA RELEASE

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.01]........Neural correlates of consciousness (general)

Abstract
Jhanas are endogenously induced, highly blissful altered states of consciousness [1]. Jhana data is rare due to access to experts. Existing low-N brain imaging evidence suggests altered alpha brainwave activity and activation of endogenous reward signalling [2, 3]. Understanding jhanas may have implications for well-being and addiction treatments, but currently these states are only available to advanced meditators. Here, we present the largest open data release of physiological recordings during jhanas (98 hours, 34 in jhana). EEG data in N=20 expert meditators (60+ sessions recorded; Tables 1-3). Sessions have 4 parts: 1) control muscle artifact recordings, 2) pre-meditation baselines (day planning, arithmetic, mind-wander), 3) Rupa jhana meditation, 4) post-meditation baselines. Participants indicated jhana transitions with game controller clicks (Figures 1, 2) Dataset 1 (non-TWIM) came from the Ayya Khema & Thanissaro Bhikkhu traditions, Dataset 2 from the metta-focused Tranquil Wisdom Insight Meditation (TWIM) tradition. Our open data release unlocks potential for understanding physiology during jhanas. Understanding brain activity in jhanas may allow for, neurofeedback-accelerated jhana training.

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Keywords
EEG, jhana, altered states, meditation, neural correlates

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Structural neuroimaging and exceptional human experiences

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.01]........Neural correlates of consciousness (general)

Abstract
Extended human capacities encompass a range of phenomena, including telepathy, clairvoyance, precognition, and psychokinesis, which challenge our traditional notions of space, time, and sensory perception. These experiences, known as extended human experiences (EHEs), are reported across diverse cultures worldwide. Although psychophysical evidence and functional electrophysiological correlates of EHEs have been documented, the structural neural underpinnings remain less explored. Preliminary studies hint at the involvement of specific brain regions in psi phenomena, yet further investigation is required to substantiate these claims. Understanding the neural architecture of EHEs could significantly advance our comprehension of their physiological basis. This study aims to elucidate the connection between self-reported EHEs and brain structure by analyzing regional brain volumes from structural magnetic resonance imaging (MRI) scans. Utilizing a subset of data from an ongoing larger study, we will examine fifty individuals aged 13 and above who have undergone MRI scans for research or clinical purposes. Participants will provide their scans and complete a comprehensive questionnaire detailing their experiences with 12 distinct EHEs, ranging from clairaudience to trance channeling. We will focus on investigating the grey matter volumes in several regions of interest, including the pineal gland, temporal lobe, temporoparietal junction, caudate nucleus, putamen, ventricles, and the left medial mid-frontal lobe. Our analysis will compare the brain structures of individuals who report psi experiences (cases) with those who do not (controls). We hypothesize that significant differences in at least one of the targeted brain regions will be associated with at least one type of psi experience. The research is currently in progress, and we anticipate presenting the findings in April. This study has the potential to shed light on the neuroanatomical correlates of EHEs, thereby enriching our understanding of these extraordinary human capacities.

C - 11

Keywords
structural neuroimaging, extended human experiences, psi, psychic, pineal gland, temporal lobe, temporoparietal junction, caudate nucleus, putamen, ventricles, and the left medial mid-frontal lobe

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Dynamical measures of emerging consciousness in the developing brain

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.02]........Methodologies (fMRI, EEG etc.)

Abstract
Introduction. Human consciousness emerges over developmental time. Developmental trajectories provide an opportunity to study evolving levels of consciousness if quantitative measures of changing consciousness are available. Over the last years, a growing body of evidence supports the view that complexity measures from dynamical systems theory are appropriate and reliable markers of consciousness. These measures are consistent with an Integrated Information Theory (IIT) framework for consciousness, which posits that consciousness may in principle be quantified by a mathematical measure φ. Any dynamical system is capable of information processing and the information processing capacity of a dynamical system is related to its complexity. This is the foundation for the field of reservoir computing. The electromagnetic field (EM) sustained by the brain (neuroelectric field) is a dynamical system. Refinements of IIT have proposed that the neuroelectric field is the physical substrate for consciousness. Thus, dynamical systems theory may provide a quantitative framework for a field-based IIT. Specifically, the neuroelectric field is a dynamical system that may be described mathematically by the language of dynamical systems. To measure and quantify the development of consciousness, we use dynamical systems measures that can be computed from EEG time series measurements of the brain. Using this approach, we compute several dynamical measures from a population of children and adolescents to create a longitudinal trajectory to compare with qualitative assessments of human consciousness. Methods. The phase portrait of a dynamical system is an abstract, high-dimensional geometrical representation of the dynamical behavior of a system. The phase portrait cannot be measured directly; however, the phase portrait can be reconstructed mathematically, and the dynamical invariants of the system computed from time series measurements of any component, or linear combination of components, of the system by a process called time series embedding. The dynamical EM field produced and sustained by the brain satisfies the definition of a reservoir computer – a nonlinear dynamical system – and can thus be characterized by dynamical invariants computed from EEG time series measurements. Several dynamical invariants can be computed from these invariants, including entropy measures, Lyapunov exponents, and values derived from recurrence plots and recurrence networks. The latter are projections of the phase portrait onto a two-dimensional plot. We compute dynamical invariants from a longitudinal population ranging in age from 3 months to 17 years from longitudinal data collected at a large pediatric research center. Results. Trajectories of dynamical invariants are presented, demonstrating that neurodevelopment is a process of changing complexity, where complexity is a multi-dimensional construct computed from EEG time series. These results provide empirical measures that may be compared with objective measures of cognitive function or measures of evolving consciousness. Conclusion. The EM field theory of consciousness, a version of the IIT theory of consciousness, is consistent with a dynamical systems perspective. These methods can be used to compute dynamical measures of neurodevelopment that may be useful for empirical, quantitative studies of consciousness development and for quantifying disorders of consciousness.

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Keywords
EEG, dynamical systems, complexity, consciousness, neurodevelopment, nonlinear systems

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Psychedelics and Recovery from Anesthetic-Induced Unconsciousness

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.19]........Psychedelics and psychopharmacology

Abstract
Psychedelics and anesthetics are mirror images of one another. Psychedelics enhance the richness of consciousness, expand the repertoire of accessible brain states, and increase neurophysiologic complexity. Anesthetics limit the capacity for consciousness, contract the repertoire of accessible brain states, and reduce neurophysiologic complexity. However, there has been sparse investigation of the interfaces between these two drug classes or whether one can act as a systems-level reversal agent for the other. I will describe data demonstrating that non-classical and classical psychedelics can enhance recovery of consciousness after general anesthesia and even reverse the anesthetized state. These studies highlight the potential for psychedelics to modulate arousal states, which warrants further investigation of their role in facilitating recovery from pathologic unconsciousness.

PL-6

Keywords
consciousness, psychedelics, anesthesia, arousal states

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Exploring the Relationship Between Dorsolateral Prefrontal Cortex Functional Connectivity, Ego Dissolution, and Emotional Arousal: A Placebo-Controlled, Resting-State Pharmacological fMRI Study Using LSD

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.19]........Psychedelics and psychopharmacology

Abstract
Lysergic acid diethylamide (LSD) is a classical psychedelic that triggers alterations in emotional and psychological functioning, facilitated by changes in neurochemical signaling, which can be visualized using functional Magnetic Resonance Imaging (fMRI). This research employed a seed-based approach, selecting a region within the Dorsolateral Prefrontal Cortex (DLPFC) and investigating changes in functional connectivity to this region under the effects of LSD. Analyses of these connectivity changes, in conjunction with collected covariates, revealed correlations between ego dissolution and the combined functional connectivity of the DLPFC, Thalamus, and Fusiform Gyrus. A separate analysis, focusing on emotional arousal and the right DLPFC, showed statistically significant connectivity changes with the Intraparietal Sulcus. Both analyses reveal new potential biomarkers for understanding the psychedelics experience that may be leveraged within the Transcranial Magnetic Stimulation (TMS) therapy. This novel seed-based methodology offers fresh perspectives on psychedelic research, elucidating the critical role of the DLPFC in psychedelic experiences and expanding our knowledge of how psychedelics modulate brain function. These insights contribute to our understanding of the potential therapeutic applications of psychedelics for psychological disorders.

C - 9

Keywords
LSD, psychedelics, ego dissolution, emotional arousal, resting state functional connectivity, seed based analysis, fMRI, brain networks

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Brain Functions Modify Mind’s Consciousness: Decoding Why and How

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.01]........Neural correlates of consciousness (general)

Abstract
This work delves into the intricate nexus between consciousness and the brain, offering scholars a comprehensive exploration of the current landscape in the field. With a multidisciplinary approach, it derives insights from philosophy, psychology, psychiatry, sociology, behavioral science, physics, chemistry, biology, and neural science, providing a holistic understanding of consciousness and its effects on social, mental, intellectual, and physical health and well-being. The study reveals the role of different brain areas, their temporal function and spatial structure, and the orchestration of eight distinct functional networks, each with five nodes. These networks are systematically examined for structural parallelism and interconnectedness of the intracerebral and extracerebral domains. The intricate dance of 40 brain areas, organized in 13 sequences and correlated with 40 forms of consciousness and disorders of consciousness, further enriches our understanding, offering a measurable unit of consciousness and a holistic framework for interpreting human experience. With a systematic approach, correlations become evident among biological, physical, and chemical science realities, inviting scholars to embark on journeys that transcend disciplinary boundaries. This work advances the current state of consciousness research laying the groundwork for future investigations with deep insights into the mysteries that shape our conscious existence. In neuroscience, the varying stages of mind consciousness are correlated with different brain areas. Each brain area produces an effect that transforms the level of consciousness in the mind. Brain areas are distinguished by their temporal functions and spatial structures. Temporally, a brain area functions to transform order into disorder to counteract the concordant effect of the spatial structure. Spatially, a brain area is structured to norm a network that reacts to conscious stimuli with a discordant effect of its temporal function. Collectively, the network and its components are the causative factors catalyzing the conscious response of the brain as a whole to bring order when directed by manpower, that is, the animated masculinity of human power. Without an animated conscious response by a sentient entity, discordant effects transform order into the entropy of a person as a human being. Individually, each element of the brain embodies the effect of entropy on a person’s body. Each element arcs the spatial structure into an architecture for the topological organization of the effect into adjacent areas by servicing the reproductive human effect. The architecture connects the elements into the components of the network, producing the masculinity of the human effect by consuming the feminine element with emotional affection for the limbs, breathing its sequential effect. Thus, the eight functional networks of the human brain include conscious attention (Dorsal Frontoparietal Network), para-conscious salience (Ventral Frontoparietal Network), timing control (Lateral Frontoparietal Network), causing ego (Medial Frontoparietal Network), sequencing emotion (Limbic network), forming vision (Occipital Network), norming mission (Somatomotor network), and transforming the value of the integrative essence (Central network).

Poster - 2 (Fri)

Keywords
Forms of consciousness, Disorders of consciousness, Neural correlates of consciousness, Brain functional networks, Metaphysics

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Probabilistic Modeling of Unavailable Structure (Truth) Based on its Finite Noisy Output (Reality)

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.06]........Memory and learning

Abstract
This work concentrates on providing probabilistic confidence bounds on the estimation of parametric models based on the available noisy output of the system. In this process, not only the system parameters but also the true system order (number of parameters) which can be finite or infinite, is unknown. Inspired by concepts of relative entropy, the method tackles the problem of the number of parameter selection (order selection) and provides an interesting solution to the issue of over or under parametrization. The main issue in this problem is that the observed data generated by the system is noisy. The observer is not able to receive the true output due to two possible factors: the receiver is not perfect and receives the data with some form of noise, or the path from output of the system to the receiver can introduce some additive noise. In either case, the true system must be modeled by the receiver and in this modeling, complexity of the system estimate, or its order, plays an important role. In this work for the first time, we introduce the concept of “relative complexity” and show that in modeling based on observed output, the complexity is not absolute, rather complexity is a relative concept that relates the “length of the observed data” to the order estimation. In another word, if the number of parameters of the true model is finite but the data length is also comparable to that number, this system is complex with respect to the observed data and the complexity can have a quantitative measure. As more data becomes available, the relative complexity is reduced even if the order of the true system is infinite. The approach introduces quantitative measures of validation and confidence in this parametric modeling context. The theoretical results provide practical solutions to many real-life machine learning applications, from system identification to supervised and unsupervised learning. In general, however, it manifests the behavior of modeling based on the reality, that is the observed corrupt data, for the purpose of modeling the underlying unavailable structure, that in this context is the truth. The results precisely show the effect of under or over modeling. For example, it is shown that, with a great confidence, simplifying the model with small number of parameters has its own shortcomings. On the other hand, in practice and in the reality, the observers usually tend to rely too much on the observed data and ignore the corruption or the additive noise. The theory shows the exact consequence of this over modeling that provides a much more complex model than the required simpler model to describe the system. In this complex modeling with more parameters than the optimum parameter, the noise is modeled into the parameters and causes the observer to deal with a very complex estimate of the model and wrong future predictions. Not only the work provides solutions to this interesting hyperparameter selection, it also provides theoretical explanation for the curse of dimensionality for various applications in learning from data.

Poster - 1 (Wed)

Keywords
Learning structures from data, Relative Entropy (Kullback–Leibler Divergence), System modeling based on finite outputs, Order (Complexity) Selection, Over or Under Fitting, Curse of Dimensionality

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Diagnostic and Prognostic Value of Functional Brain Network Motifs in Coma and Disorders of Consciousness

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.09]........Coma and vegetative states

Abstract
Introduction: Motifs are connection patterns within networks which recur more frequently than in random networks. When networks are constructed from the functional connections between electrodes in an electroencephalogram (EEG), motifs represent the building blocks and functional organization of the underlying neural activity. Previously, our group showed that the topological reorganization of 3-node motifs calculated from high-density EEG tracked the loss and recovery of consciousness caused by general anesthesia (Duclos et al., 2021). In a subsequent case series on three patients with disorders of consciousness (DOCs) exposed to propofol anesthesia, we demonstrated that motifs reorganized topologically in response to anesthesia in the patient who eventually recovered consciousness (Nadin et al., 2020). In this study, we examined anesthesia-induced motif reconfiguration and its ability to distinguish favourable versus unfavorable diagnoses and prognostic outcomes in coma and DOC patients. We hypothesized that patients with favorable diagnoses and prognoses would show greater motif reconfiguration than those with unfavorable measures. Methods: Coma and DOC patients (n=56) with severe brain injury had 128-channel EEG recorded during an anesthetic protocol. At baseline, patients were receiving propofol (n=37) or were off sedation (n=19) and subsequently underwent propofol withdrawal or administration (changing their level of anesthetic exposure) before returning to their baseline state. Baseline, intervention and post-intervention states were each approximately 10-minutes long. Directed functional connectivity was calculated across all combinations of electrode pairs using the directed phase lag index. Frequency, distance, and source/sink topologies of five 3-node motifs were calculated from the directed functional connectivity matrix. Reconfiguration of motif topology between anesthesia states was quantified via cosine similarity. Patient diagnosis was assessed using Glasgow Coma Scale (GCS) scores when patients were off sedation and prognosis assessed through ability to follow commands. A favorable diagnosis was defined as GCS > 8 and favorable prognosis as the recovery of command-following abilities within 1-year post-injury. Motif cosine similarity was contrasted between patients with favorable versus unfavorable diagnoses and prognoses using Mann-Whitney U tests and Benjamini-Hochberg procedure for multiple comparisons. Results: Two motifs were identified with significant frequencies across patients: one with long-range chain-like connections (“motif 1”) and another with short-range loop-like connections (“motif 5”). During propofol withdrawal, neither motif showed a significant difference in topological reconfiguration for motif frequency (M1: U=42.0, p=.914; M5: U=76.0, p=.783), distance (M1: U=26.0, p=.522; M5: U=74.0, p=.783), source (M1: U=43.0, p=.914), or sink (M1: U=41.0, p=.914) properties across diagnostic categories (favorable GCS (n=12); unfavorable GCS (n=32)). Similarly, neither motif showed a significant difference in topological reconfiguration for frequency (M1: U=16.0, p=.434; M5: U=62.0, p=.696), distance (M1: U=30.0, p=.803; M5: U=29.0, p=.078), source (M1: U=34.0, p=.962), or sink (M1: U=23.0, p=.506) properties across prognostic categories (recovered (n=22); non-recovered (n=12)). Similar non-significant results for diagnosis and prognosis were obtained during propofol administration and comparison between baseline states. Conclusion: In contrast to what has been suggested in previous literature, 3-node motifs show neither diagnostic nor prognostic value for our cohort of coma and DOC patients.

C - 7

Keywords
Network motifs, coma, disorders of consciousness, propofol, anesthesia, diagnosis, prognostication, functional connectivity

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The Symphony of the brain: Developing a closed-loop neuromodulation system

Mitchell A. Head

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.16]........Brain stimulation techniques

Abstract
In line with the present theme of cortical oscillations and traveling waves, we propose that consciousness is associated with a standing wave, instantly integrating information across disparate systems into a unified experience. Mechanisms of anesthesia show that these molecules interrupt consciousness by inhibiting transfer of information between cortical and thalamic systems, thus spatially limiting the standing wave from integrating sensory information into conscious experience. Similarly, mechanisms of action of molecules which alter consciousness, such as psychedelics and other psychoactives with pi-resonance clouds in aromatic rings, implicate the alteration of the standing wave dynamics to oscillate faster, thus integrating more information, and thus altering the resonant mode of the standing wave topology, and the emergent functional connectivity of brain regions. These standing waves may be maintained through pi-resonance electron transfer and electrical dynamics of the resonant system, guiding emergent physical connections, and thus, ultrasound, which may be able to modulate gap junction connectivity, may be the correct modality to alter these standing waves, and in-turn, consciousness. This research programme, supported by Royal Society of New Zealand, represents a pioneering endeavour aimed at developing the next generation of neurotechnology in Aotearoa New Zealand; specifically, a closed-loop, non- invasive neuromodulation system that measures and stimulates the brain in real-time. By combining cutting-edge electroencephalogram (EEG) measurement and machine learning data analysis with non-invasive Transcranial Ultrasound Stimulation (TUS), this project will revolutionise brain measurement and performance, with applications ranging from athletic performance enhancement to non-pharmaceutical modulation of mental state. In this way, such technology can have the greatest impact to our world by supporting individuals to achieve flow states and to excel at what they are most passionate about. Within both Western science, and indigenous Māori worldviews, rhythms are found to be the language of life. Inspired by traditional Māori concepts of Maramataka (lunar calendar) and harmonising with the rhythms of life, mōteatea (chanting), waiata (song) and karakia (prayer), where the unique cadence of traditional chanting is proposed to have therapeutic effects on biology. By systematically and scientifically investigating sound’s potential therapeutic effects, we can develop technology by, with, and for Māori that reflect our worldview. This project will investigate the effects of TUS on mood and EEG patterns. This innovative study aims to shed light on the potential therapeutic and performance benefits of TUS, with the ultimate goal of developing a closed-loop EEG-TUS neuromodulation system or wearable device.

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Keywords
Consciousness, EEG, TUS, ultrasound, standing wave

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Fast and slow brain oscillations report distinct forms of neural activity

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.13]........Brain networks, synchrony and scale

Abstract
Action potentials, also known as spikes, isolated from single neurons, are thought to provide the most accurate readout of brain activity. In contrast, local field potentials (LFPs), often referred to as brain waves, which reflect the electrical activity of a large number of neurons located near an extracellular electrode, are easier to measure than spikes but seem to offer only coarse-grained readouts of behavior. Previously, we discovered that spatiotemporal patterns in LFPs recorded from the rat hippocampus contain astonishingly precise information about the rat's current location within its environment. However, the question of what the relationship is between the information contained in spikes and LFPs remains to be fully detailed. To answer this question, we attempted to predict the spiking of individual hippocampal neurons, known as place cells, from LFPs in multiple frequency bands. We found that both low-frequency (~200 Hz) LFPs can be used to predict the spiking of place cells but in very different ways. At high frequencies, the LFPs measured at electrodes near the cell are highly predictive because they detect the spiking of the cell itself. At low frequencies, anatomically distributed LFP patterns are highly predictive because they detect activity in large assemblies of neurons with which the place cell co-activates. Our work shows how information embedded in various spatial scales of neural activity is reflected at distinct temporal scales of the LFP.

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Keywords
Place cells, local field potentials, brain waves, theta rhythms, action potentials, spikes

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Experimental Evidence for the Neurophysical Basis of Consciousness Obtained Using a Newly Developed Photoelectronic Sentiometer

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.12]........Quantum brain biology

Abstract
Consciousness has been postulated to be a serial process and metaphorically likened to a stream. Brain activity underlying conscious experiences could therefore be modeled as a time series. Elements of these experiences might be coded by a small subset of activity patterns unfolding in time. According to conventional neuroscience, these experience-coding patterns would consist of temporal groupings of action potentials and synaptic responses of large ensembles of neurons. Alternatively, an unconventional quantum wavefunction collapse theory of consciousness, like that proposed by Sir Roger Penrose, might hypothesize each experience-coding pattern as a temporal variation of the number of instantaneous wavefunction collapses in subcellular macromolecules such as microtubules. We speculated that, if consciousness has a causal role in the brain, these variations of the rate of collapses occurring at a focus within brain might exert a causal influence on the surrounding brain tissue, and beyond, by inducing similar temporal collapse patterns that spread spatially in a decremental fashion as a function of distance. This effect might then modulate a quantum phenomenon such as light wave interference produced by a double-slit apparatus in the peri-somatic space. Using a newly developed noninvasive photoelectronic device called a Sentiometer, we discovered that wakefulness and sleep produce robust and reproducible, differential modulation of the intensity of diffracted light waves generated by a low power laser diode close to the body. A similar peri-somatic modulation response was observed in mice, but an inverted response was detected in invertebrates and plants. The peri-somatic effect declined as a function of distance, but a change in the recorded baseline could nevertheless be detected, correlated with the presence or absence of subjects at longer distances from the Sentiometer. The peri-somatic response was significantly reduced in amplitude and altered in time course by general anesthesia in mice and showed striking variations for 4 – 5 hours after euthanasia, which depended on whether a mouse was decapitated or not. An excised mouse brain showed an inverted response, which persisted for several days post-excision, if the brain was preserved at 4 degrees Celsius in normal saline solution. No such residual response was detected in the brainless mouse body >2 hours after euthanasia. Having ruled out by experimentation all artifactual, non-specific and trivial explanations known to us for the above observations, they suggest that the brain produces a previously unrecognized biophysical effect that can be detected as peri-somatic modulation of the intensity of diffracted light specific to changes in consciousness. Furthermore, while the electrical activity of cerebral neurons might modulate this consciousness-related effect, its underlying mechanism might involve bioenergetically independent molecular interactions within the brain, which persist for some time after death in undegraded neural cellular structures, pointing towards a possible fundamental quantum neurophysical basis for consciousness.

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Keywords
Consciousness measuring device, Sentiometer, Quantum Biology, wavefunction collapse, peri-somatic neurophysical effect, mechanism of consciousness

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On Developing a Methodological Framework for Neurophenomenal Structuralist Approaches to the Neural Correlates of Consciousness

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.01]........Neural correlates of consciousness (general)

Abstract
A neural correlate of consciousness (NCC) may be defined as a minimal neural system whose states map to states of consciousness, where a given neural state is sufficient for a corresponding conscious state [1]. Traditionally, NCCs have been identified using subtractive methodologies contrasting neural activity during conscious versus nonconscious mental states [2]. Although useful, the subtractive approach is limited in its ability to distinguish between the neural substrates of consciousness and the latter’s neural prerequisites or consequences, as well as among NCCs specific for conscious contents and NCCs related to different global states of consciousness [3]. Recent proposals [4] have sought to overcome these limitations by exploring how phenomenal structure (i.e., similarities and differences in conscious experience) are systematically connected to neural structure, with this relationship determined by difference-making relationships among neural systems that have regularized effects on consciousness [5]. These proposals involve identifying multidimensional representations of neural and phenomenal structures (i.e., neurophenomenal structure) that are related to each other in both a correlative and causative manner. Such neurophenomenalist proposals have great potential for the empirical study of NCCs. Nevertheless, they have only been generally explicated to date, with limited discussion regarding the technicalities of how to empirically implement them in a valid and principled manner. Most discussion has focused on methods to characterize the neural aspect of neurophenomenal structure using multidimensional techniques such as representational similarity analysis (RSA). However, there are other multidimensional techniques utilized within the field of psychology to characterize mental structure that may also prove useful in characterizing the phenomenal aspect of neurophenomenal structure. One such technique is multidimensional scaling (MDS), a method of analysis that expresses psychological relationships among perceptual or cognitive stimuli as geometric relationships among points in a multidimensional space. This presentation will develop an initial methodological approach to characterize the phenomenal aspect of neurophenomenal structure via MDS and relate it to the corresponding neural structure identified by other multidimensional techniques such as RSA. Several examples of traditional NCC research methodology will be recast in terms of this joint MDS/RSA approach with an eye towards identifying potential methodological limitations that still need to be addressed. References: [1] Chalmers, D. (2000) What is a neural correlate of consciousness? In T. Metzinger (ed.), Neural Correlates of Conscious Experience: Empirical and Conceptual Questions, pp. 17–39, Boston: MIT Press. [2] Baars, B. (1997). Contrastive phenomenology: A thoroughly empirical approach to consciousness. In N. Block, O. Flanagan & G. Güzeldere (Eds.), The nature of consciousness: Philosophical debates (pp. 187—202). MIT Press. [3] Bayne, T., Hohwy, J., & Owen, A. H. (2016). Are the levels of consciousness? Trends in Cognitive Sciences, 20, 405 – 413. [4] Fink, S. B., Kob, L., & Lyre, H. (2021). A structural constraint on neural correlates of consciousness. Philosophy and the Mind Sciences, 2, 7. [5] Klein, C., Hohwy, J., & Bayenes, T. (2020). Explanation in the science of consciousness: From the neural correlates of consciousness (NCCs) to the difference makers of consciousness (DMCs). Philosophy and the Mind Sciences, 1(II), 4.

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Keywords
NCC, Neurophenomenal Structuralism, Multidimensional Scaling, Representational Similarity Analysis

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On the Measurability of Conscious Systems – Perspectives from Product Design and Philosophy

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.02]........Methodologies (fMRI, EEG etc.)

Abstract
With recent advances in the science of consciousness, there is an increased interest in the measurement problem of consciousness (MPC). The development of consciousness measurement systems (CMS) is still in its infancy without a formal measurement framework and established design approach. This article uses product design principles e.g. measurement process workflow and problem space analysis to define a novel framework for developing CMS. The framework proposes measurability criteria, applies them to different use cases, and identifies whether the required attribute of consciousness in a use case can be measured by existing theories and technologies. The framework defines several CMS functions within the measurement workflow. These are: (1) modeling of consciousness states and measurands, (2) validation of sensor input signals, (3) sensing, (4) model-based state estimation, (5) interpretation, and (6) CMS calibration. Each CMS function requires different theories and technologies for its implementation. For example, the sensing function can be based on behavioral, neurophysiological (e.g. EEG, MEG, fMRI, etc.), computational (based on integration information theory (IIT), and other measurements. Validation or measurability criteria for each CMS function are established and applied to different CMS use cases that are identified using a product design technique called “problem space analysis”. The objective was to identify CMS functions that can or can’t be designed for different use cases using existing theories and technologies. For example, the absence of an acceptable model of consciousness should not be a problem for measuring consciousness in use cases involving human clinical applications. Currently, available technologies can be sufficient to measure consciousness for these use cases. However, without a well-defined consciousness model, we cannot develop a CMS that can find if a humanoid robot has consciousness. Consciousness is unique among all the things that can be measured. It is all around us. We know about our own consciousness. But, the subjectivity in the consciousness of others is only an inference, however reasonable. Therefore, one might ask whether subjectivity, which can be experienced or felt only by the subject, is measurable. This paper uses concepts from mathematical logic (e.g. Gödel's incompleteness and Tarski's undefinability theorems) and from philosophy (e.g. method of agreement-disagreement in the Indian Nyaya system) to understand the measurability of subjectivity. Based on the preliminary study done so far, this paper argues that subjectivity is not measurable like other attributes of consciousness. This is a major area of study by itself and will be taken up as a future project. The key contribution of this paper is a novel consciousness measurement framework that uses measurement workflow, design principles, theories and technologies from neuroscience, and arguments from philosophy. The framework provides a precise understanding of the measurability of CMS functions for individual use cases. Researchers and engineers can use the framework to develop CMS for specific use cases without being bogged down by the complexity of unknowns in the field of MPC. [Please email tusatya1@gmail.com to get a copy of the paper]

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Keywords
Consciousness, measurement of consciousness, measurement problem of consciousness (MPC), consciousness measurement system (CMS), problem space analysis, measurement process workflow

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How to experimentally falsify the integrated information theory

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.01]........Neural correlates of consciousness (general)

Abstract
The integrated information theory (IIT) is a leading contemporary theory of consciousness. It provides a measure of the amount of consciousness in a physical system (Φ – a measure of the system’s integrated information). It also provides a mathematical model for the qualitative content of any given conscious experience (its Φ-structure or “Q-shape”). However, many have argued that IIT is unfalsifiable, and some have even gone so far as to question its scientific status. IIT is falsifiable in Karl Popper’s sense: there are possible scenarios which would unambiguously falsify IIT e.g. if one found that the neural correlates of one’s consciousness was a zero-Φ feedforward neural network. However, this is not a particularly bold or novel prediction since it does not distinguish IIT from many other theories that would also be falsified by the same scenario. Ideally, we want to try and falsify predictions that only IIT makes. If IIT survives such attempts, then IIT would be corroborated. Identifying novel testable predictions of IIT is difficult in part because of the difficulty in calculating Φ in complex biological systems like brains. To resolve this, we propose experiments that try to falsify the following prediction of IIT: if two experiences are qualitatively identical, then the neural correlates of those experiences have identical Φ (and identical Q-shapes). Measuring the exact Φ of their correlates is infeasible. But if their correlates exhibit sufficient structural differences – in ways that matter to the calculation of their Φ – then we may be able to estimate sufficiently distinct Φ-values, thereby falsifying IIT with a sufficient degree of confidence. Our examples of pairs of qualitatively identical experiences with distinct neural correlates are known as “filled/non-filled pairs”. While they are identical from the subjective point of view, one member of the pair involves significantly more perceptual filling-in. This creates a relevant difference in their correlates: the one with greater filling-in involves a greater amount of feedback connectivity. For background and preliminary experiments see philpapers.org/rec/HOPFPA. The present talk will discuss future planned experiments and how they fit into the present debate over the falsifiability and scientific status of IIT.

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Keywords
IIT, Integrated information theory, neural correlates, feedback, feedforward, testability, falsifiability, filling-in, filled/non-filled pairs, F/NF pairs

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The Hard Problem of Hardware: Neural Nets vs. Ultrabandwidth Microtubule Wavefronts

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.05.........Motor control

Abstract
After thirty years, two conceptually-distinct models, of how we sense and what we think, compete on the hardest physical terrain possible: dynamic, tomographic simulation and control. The theoretical racecourse is arranged according to the laws of math and physics, first principles first, no cheating. The scoring is meticuluous, and the prizes are amazing. In this race, the popular favorite is Neural Nets. The new-kid challenger, ultrabandwidth microtubule wavefronts, was built by two renegades sharing seventy years of physics: microtubule promoter Hameroff and math promoter Softky. Neural nets are fixed neurons, interconnected by axons and dendrites at synapses, aggregating pulses input over 1-10 msec and 1-10 microns to produce new neural pulses, completing the loop. The competition is ultrabandwidth microtubule wavefronts –– what Softky called simulatrix (2014) –– which control vibrations and nothing else. As a model, simulatrix connects the physics of quantum molecules to the informational necessity of representing 3-D space in its native form. Here is why the ultrabandwidth continuous model will likely win the race to explain the brain. Where nets are finite elements, simulatrix is a continuous volumetric 3-D mesh made of microtubules, registering synaptic events like a cloud-chamber, interfering and propagating them like blast-waves, actively turning pulses into contours, and contours into pulses, volleys of which replicate the waves elsewhere. Where nets send pulses directly to other neurons, waves in simulatrix begin at synapses but continue as 3-D contours with momentum. Where nets can compute almost anything, simulatrix can only pluck actin/myosin molecules and listen for echoes. 3-D wavefronts in simulatrix make the texture of computation match the texture of muscle and bone, so mind matches body at the molecular level. How each Net runs this race is up to its trainer, but such nets in general are best at memory, symbols, and rules, and worst at high-speed predictive tracking. Worse still, dendrites and temporal integration both impose low-pass filtering, yet also pose a paradox: How can a neuron which averages-out noise still produce such noisy spikes? (Softky & Koch, 1992 & 1993). Simplicity makes simulatrix blazingly fast, capable of nanosecond phase-precision and thus GHz interoceptive carrier waves. Calculations of energetic and representational capacity (Softky 2014), and of mathematical trust-formation (aka model-validation, Softky & Benford 2017) show this model millions-fold more efficient than neural nets in several physical ways. If this challenger wins the race, all will have prizes. The microtubule simulatix model provides a universal, principled, multiscale, predictive, zero-parameter field theory uniting vibratory and symbolic interaction, explaining most of how brains and bodies work: • Scientific mysteries: noisy neurons, warm brains, hard skulls • Alternative therapies: forest bathing, acupuncture, cranial-sacral, meridians, chakras, chiropractic, autonomous motion • Interoceptive mysteries: toroidal body fields, adhesions, releases, pops, clicks, electricity, energy, spinal breath, thermogenesis, spiritual implements, grounding, timelessness, calmness, untraceability • Urgent dangers: screen addiction, sociosensory starvation, algorithmic entrainment, leading indicator dependency • New Therapies: microtime, ultragrounding, carbon connection, human flight • Forms of Joy: pure presence, resonant connection, multilateral collaboration

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Keywords
recalibration, trust, microtubules, simulatrix, sensory metrics, neuromechanical, bandwidth, sensorimotor contingencies, toroidal, boundary-less, MHz, GHz, nanosecond, microsecond, 3-D

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The Elastic Mind: A Dialogue on Physics, Neuroscience, and Time Perception

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[03.17]........Temporal consciousness

Abstract
The problem of time in modern culture rests on an arbitrary, outdated, mechanistic view of clock time that has played a role in current crises facing humanity: time compression, processed food, 24-7 production cycles, climate change, pollution, sleep disorders, and more. The time has come for cultivating a healthier paradigm for temporal consciousness. Ideally, this paradigm would evolve through direct embodied experience, the application of the modern science of consciousness, and thoughtful, interdisciplinary dialogue. This session will proceed in four primary sections: (1) Exposition on Time Perception in Physics, Neuroscience, and Psychology; (2) Awareness Practices (with guided meditation); (3) Dialogue between the two presenters/authors---a brain surgeon and wellness scientist--on the importance of cultivating temporal awareness-; and (4) Audience Discussion. The session will first entail an exposition by the first author (Hamilton) on the role of awareness in time perception and related interdisciplinary studies. Broadly, we discuss time as a psychic and a physical construct. Part 1 covers the Foundation of Time in Physics: (a) a Review of time dilation and relativity, (b) The Quantum Realm and Time, (c) Entropy and the Arrow of Time, and (d) Time's Variance in Astrophysics. Part 2 covers The Human Perception of Time vs. Physics: (a) Awareness in Time Perception, (b) Psychological Time, (c) The Influence of Emotion on Time Perception, (d) Alterations in Time Perception; and (e) Age, Memory, and the Perception of Time. Both presenters then discuss Enhancing Time Perception Through Awareness Practices: (a) Provide strategies for altering time perception through increased awareness, such as sensory enhancement exercises, (b) Discuss the benefits of such practices, including improved well-being and productivity. Session participants will be invited to engage in several exercises to enhance time perception as a transpersonal practice. Participants debrief their experiences in paired sharing and small group discussions. The third part of the session will utilize a dialogue practice akin to that developed by David Bohm (https://www.bohmdialogue.org/). Dialogue is a freely flowing group conversation in which participants attempt to reach a common understanding, experiencing everyone's point of view fully, equally and nonjudgmentally. The purpose is to solve society's communication crises, including a deeper understanding of consciousness or, in this case, temporal consciousness. The dialogue in this third part of the session will begin with a conversation between the two presenters. In the spirit of Bohmian dialogue, the conversation will organically grow to include participants. Note. Both presenters have written about time, consciousness, and spirituality. Some references are provided below. SAMPLE REFERENCES Bennett, J. (2023). The Connoisseur of Time: An Invitation to Presence Bennett, J. (2023). Quest for Presence Book 1: The Map and Radiant Forces Bennett, J. (2023). Quest for Presence Book 1: The Soulful Capacities Sample article: Become a Connoisseur of Time | https://www.spiritualityhealth.com/connoisseur-of-time Visit website www.presencequest.life Hamilton, A. (2024). Cerebral Entanglements. Hamilton, A. (2009). The Scalpel and the Soul Hamilton, A. (2011). Zen Mind, Zen Horse: The Science and Spirituality of Working with Horses Sample article: Neurons of Compassion https://www.spiritualityhealth.com/articles/2012/01/28/neurons-compassion Visit website: https://allanhamilton.com/

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Keywords
temporality, neuroscience, dialogue, consciousness, interdisciplinarity, presence,

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Neural Network Agents That Self-Model: A Preliminary Study of the Effects on Learning

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[01.06]........Machine consciousness

Abstract
Introduction: According to some theories, consciousness derives from the brain constructing models of itself. One example of this type of theory is the Attention Schema Theory (AST) [1]. Aiming to extend this concept to machine learning, we examined the general question of agents learning to build models that predict their own internal states, and tested whether that type of self-modeling resulted in improved model generalization and performance. Methods: For this investigation, we used fully connected neural networks trained on the MNIST dataset [2], a standard benchmark in handwritten digit recognition. The self-modeling network was tasked with a dual objective: the primary task of digit classification and a secondary, auxiliary task of predicting its own internal activation states. Different versions were trained to predict the activation states of different hidden layers within the model. We compared the performance and learning characteristics of self-modeling networks against the same networks without this feature. Performance was compared through the ability to correctly classify digits. Model complexity and learning efficiency were measured through the Learning Coefficient (LC) [3], which indicates how effectively a model learns from data and its propensity for generalization, while also providing insights into the effective geometry of the model's parameter space. Results: Our initial results revealed that introducing self-modeling significantly improved the LC, particularly under certain sampling methodologies, indicating a marked difference in learning dynamics and model complexity. Altering the target of self-modeling within the network's layers influenced both the loss metrics and the LC. This finding highlights the importance of the target layer in shaping the network's learning outcomes. Furthermore, our results indicated a potential regularization effect when self-modeling was applied to larger, early layers of the network, suggesting a reduction in overfitting compared to networks whose self-modeling target layer was smaller. When we experimented with networks having uniformly structured layers, the effects of self-modeling on learning dynamics and model complexity were similar across all target layers, suggesting that the size of the target layer, and not the positioning of the layer in the hierarchical stack, determined the efficacy of self-modeling. This underscores the significant role that network architecture plays in the efficacy of self-modeling techniques. Conclusion: Our initial research demonstrates that self-modeling in neural networks can substantially influence their learning dynamics and complexity. The study suggests that strategic implementation of self-modeling, particularly in terms of target layer selection, can lead to enhanced learning efficiency and potentially reduced model complexity. These insights pave the way for further exploration into the application of self-modeling concepts in machine learning, offering promising avenues for exploring models of consciousness, such as AST, in machine learning systems. [1] Webb TW and Graziano MSA (2015) The attention schema theory: a mechanistic account of subjective awareness. Front. Psychol. 6:500. doi: 10.3389/fpsyg.2015.00500 [2] Deng, L., 2012. The mnist database of handwritten digit images for machine learning research. IEEE Signal Processing Magazine, 29(6), pp.141–142. [3] Watanabe, S., 2013. A widely applicable Bayesian information criterion. J. Mach. Learn. Res. 14, 1 (January 2013), pp. 867–897.

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Keywords
Neural Networks, Machine Learning, Attention Schema Theory, Learning Coefficient

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Weird Realities - Super Experiencers & Anomalous Cognition: A Multi-phase Multi-year Global Mixed Methods Neurophenomenological Research Study

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.08]........Neurology, neuropsychology and neuropathology

Abstract
One of the most interesting and quickest ways to revolutionize neuroscience is to study the brains of individuals who have anomalous experiences. This approach can challenge existing models of how the brain interfaces with reality and open up new horizons of analysis and understanding. One of the best ways to advance science is to focus on those anomalies which the mainstream models tend to ignore – they often contain the sparks of insight that can start a revolution. While much neuroscience research has been successfully conducted on meditators, surprisingly, very little of this kind of research has been done on individuals who have stable and regular access to other types of altered states of consciousness. Many individuals report having had an anomalous experience at some point in their lives – a precognitive dream that comes true, seeing the ghost of a relative soon after their passing, a near-death experience (NDE) after a traumatic event, or an out-of-body experience (OBE) while they were doing Vipassana meditation, and so on. Some individuals report having multiple anomalous experiences of the same category throughout their life – such as those who have seen ghosts on a number of occasions or those who have trained themselves to have OBEs on a semi-regular basis. And then there are those rare individuals – super experiencers – who for unknown reasons experience multiple types of anomalous events throughout their lives. These are individuals who have a disposition to experiencing a wide range of “weird realities.” Sometimes there is a trigger event for these experiences and other times they just seem to randomly happen. By focusing on these unique individuals who have regular access to a wide range of anomalous experiences new insights around brain structure, phenomenological experience, and cognition can be achieved. Over the course of five-years this research aims to locate and study these super experiencers and develop neuro-phenomenological and biofield (i.e., subtle energy system) profiles for them. The research will be conducted in three major phases: • Phase 1: 5000 surveys will be collected from individuals worldwide who have anomalous experiences; • Phase 2: 100 individuals will be selected from Phase 1 for in-depth interviews and psychometric assessments using over a dozen standard instruments; and • Phase 3: 50 individuals will be selected from Phase 2 for developing neurological imaging and subtle energy assessments. The goal of this research is to better understand the unique psychological, phenomenological, neurological, biophysical, and subtle energy markers and conditions that super experiencers have that play an experiential, emotional, cognitive, and biological role in their unique capacity for anomalous cognition. Through this study of weird realities current neuroscience models of perception and experience will be reviewed and revised and new models will be pioneered. And we may just discover that reality is actually weirder than we often want to admit!

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Keywords
neurophenomenology, anomalous experience, mixed methods research, super experiencers, weird realities, subtle energy, psychometrics, transpersonal psychology

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Evaluating the Impact of Pulsed Photobiomodulation on Meditation: A Randomized Controlled Study Using the Vielight Neuro Pro

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.16]........Brain stimulation techniques

Abstract
Title: Evaluating the Impact of Pulsed Photobiomodulation on Meditation: A Randomized Controlled Study Using the Vielight Neuro Pro Background: Meditative practice is receiving innovative support through technological advancements in brain stimulation. The Vielight Neuro Pro, a general wellness device by Vielight Inc., introduces a novel method to potentially enhance meditation experiences. It utilizes near-infrared light delivered through LEDs, with pulsing frequencies adjustable between 1Hz and 10000Hz. Initial anecdotal feedback from advanced meditators indicates that specific pulse frequencies may enhance meditation states. Objectives: This study is designed to empirically investigate the assertions about the Vielight Neuro Pro’s influence on meditation. Our primary goal is to examine whether active pulsed photobiomodulation (PBM) can alter meditation states, as measured by the Mystical Experience Questionnaire (MEQ) and a Post Stimulation Evaluation Questionnaire, along with assessing changes in electroencephalogram (EEG) patterns compared to sham stimulation. Methods: The study is structured into two phases and involves a crossover-randomized, single-blind exploratory approach with 20 experienced meditation practitioners. Phase I includes a baseline EEG measurement before and after meditation without the device, followed by sessions with active or sham PBM at 11 distinct frequencies. EEG data are collected pre- and post-stimulation for each session. The responses on the MEQ and Post Stimulation Evaluation Questionnaire and EEG characteristics such as Power and Coherence are analyzed to compare the effects of active PBM, sham stimulation, and baseline meditation. Phase II involves personalizing the PBM frequency for each participant, based on Phase I outcomes, and comparing the meditation effects using MEQ and post-stimulation evaluations as well as EEG measures. Results: We will present the findings from Phase I,. highlighting variations in MEQ scores, EEG changes, and the responses from the Post Stimulation Evaluation Questionnaire between active PBM sessions, sham stimulation, and baseline meditations. We will discuss the implications of these results and the potential role of PBM in meditation enhancement.

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Keywords
Photobiomoduation, Meditation, Pulsed Photobiomodulation, Infrared Therapy, Meditation Enhancement, Meditation States, Frequency Effects, Mystical Experience

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The Use of Transcranial Direct Current Stimulation to Improve Complex Motor Skill Acquisition: A Randomized Controlled Trial

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.05.........Motor control

Abstract
Background: Transcranial direct current stimulation (tDCS) has been shown to enhance motor performance in simple tasks, but its impact on complex, multi-joint movements is less understood. This study investigated the acute effects of tDCS on skill acquisition in a complex arm movement task. Methods: In a randomized controlled trial, twenty-two right-handed female adults were assigned to either a tDCS or SHAM group. The task involved performing overhand throws to a target, with motor performance quantified by endpoint error. tDCS was applied for 20 minutes over the M1 brain area during five practice blocks, followed by a post-test block each day for three days. Results: The examination of the effects of tDCS on complex motor skill acquisition yielded significant findings. Mixed-effects modeling revealed a significant main effect of the group, with the tDCS group exhibiting better performance, demonstrated by a higher average score compared to the SHAM group (p = 0.001). This improvement suggests a positive impact of tDCS in complex motor tasks. No significant changes were noted in performance across different days (p = 0.377) or practice blocks (p = 0.063), indicating consistent improvements. Additionally, an independent samples t-test on percent changes in endpoint error showed a non-significant trend toward greater improvement in the tDCS group (t = 2.072, p = 0.053). Conclusion: This study highlights the efficacy of tDCS in enhancing motor performance in complex tasks, as evidenced by the significant group effect. The consistent performance across different days and practice blocks, along with the marginally non-significant trend observed in the t-test, highlights the potential of tDCS in facilitating complex motor skill acquisition. These findings warrant further research with larger sample sizes and extended intervention periods to establish the role of tDCS in complex skill learning conclusively.

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Keywords
Transcranial Direct Current Stimulation (tDCS), Motor Skill Acquisition, Complex Motor Tasks, Neuromodulation, Motor Learning

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Protecting Developing Brains and Emergent Consciousness by Increasing Informational Nutrition in the Early Years

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[03.11]........Cognitive development

Abstract
Suppose consciousness is the ability to sense oneself as a self, understand the behavior of other “selves,” and formulate appropriate responses to that behavior. The emergence of these capacities would then be indissociable from positive brain development. Research has established that the positive development of infant brains is a highly interactive process, requiring plenty of practice sharing attention and plenty of serve-and-return interaction between infants and caregivers. Research has also established that infant and caregiver digital device use (e.g. smartphones, tablets, laptops) interferes with the joint attention behaviors and serve-and-return interactions that are so vital to brain building and emergent consciousness. And here we face a critical crux. Do we assume that we humans will adapt our way out of the problems posed by infant and caregiver digital device use? Or, do we assume that we will not? Decades of research in neuroscience tells us that because the human brain’s attentional system developed under conditions distinct from the conditions we live under today, we will not and cannot evolve beyond our need for uninterrupted social experiences filled with serve-and-return interactions. Given our increasing reliance upon digital devices to conduct essential day-to-day activities, the problem becomes then: How do we as a society ensure that the lives of infants and very young children are filled with the uninterrupted social experiences and serve-and-return interactions that their brains and nervous systems need? This is the question this paper answers. The key to the proposed solution is the concept of informational nutrition. This concept comes from “Sensory Metrics of Neuromechanical Trust” (Softky & Benford, Journal of Neural Computation, 2017). In “Sensory Metrics,” we model human information processing, communication, and trust-building in technological terms like data format, bandwidth, and latency to explain how, when it comes to processing “bottom up” signals, human brains face data integrity and compression/reconstruction-error limits similar to those that confound computer vision. A primary conclusion: trust is generated by an interactive system optimized for signals produced within the physical world. Absent such nutritious physical information, we humans become increasingly unable to tolerate uncertainty, increasingly attracted to non-nutritive digital signals, and increasingly averse to the signals our brains need to calibrate their models. Our findings about informational nutrition are most urgent for infants and toddlers because of the gap between what researchers have learned about what developing brains need and what the public knows. The “Sensory Metrics” framework translates ideas like “serve-and-return” and other activities that support positive brain development into measurable numbers. For example, a Zoom call with a grandparent contains less than 1000th of the visual information of a face-to-face interaction, and almost none of the high-precision vibratory information that conveys emotional reciprocity. A “Sensory Metrics” approach makes it easy to calculate the protective and risk factors of various interactive contexts and media, thereby facilitating the design and promotion of environments that support human connection and positive brain development. We need not accept that infant wellbeing is the price we must pay for the benefits we derive from digital technology.

Poster - 2 (Fri)

Keywords
infants, toddlers, early childhood, development, Sensory Metrics, informational nutrition, emergent consciousness, digital technology, caregivers, public policy, serve-and-return

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Harmonizing the theories of consciousness: How consciousness emerges from matter and energy using new insights to explain mismatches among the theories of consciousness.

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.01]........Neural correlates of consciousness (general)

Abstract
This work builds on my theory of how a strictly physical universe gives rise to consciousness which was presented at the CCS 2023 conference and has been recommended for testing by NSF directors. This theory frames the major role of our bodies, surroundings, and their interactions in the neurobiological processes in the brain that produce consciousness, and, sheds light on the relations between conscious experience and brain activity. The postulates of my theory align with the central ideas of leading theories of consciousness, e.g., global workspace theory (GNWT), integrated information theory (IIT), re-entrant processing theory (ReT) and higher-order theories (HOTT). By introducing a new, unconventional approach to the theories, we can resolve their problematic arguments and integrate the ideas into one theoretical account. My theory reveals how three-phased energy-driven interactions among eleven heterogeneous elements from inside and outside the brain give rise to consciousness. Consciousness, as a state of an inner awareness, emerges from a conversion of basic perceptions (“lower-order representations”) (X\*s) into “higher-order re-representations” (Y\*s) via the exercise of sensory and motor agencies. X\* and Y\* (things of subjective measure) and X and Y (things of objective measure) This conversion gives rise to a new form of existence for X\* as Y\*, where the properties of phenomenal distinction of X\* (for example, color, sound, shape, motion), identified as content, are ascribed to Y\* (sound), identified as a re-representation of that content. Y\* is a self-generated entity resulting from a pattern of motion of an agent’s speech articulators (Y). It gives rise to a realization that X\* is Y\* and \*Y\* is X\*, manifested as a sense of knowing or inner awareness. These processes engage the occipital, temporal, thalamic nuclei as well as the inferior frontal regions of the brain, forming a pattern of connectivity resulting in a conscious experience (schema is available). Once that experience has been generated, it produces a significant consequence. It establishes two independent pathways of sensory stimulation into the brain to trigger consciousness: phenomenal consciousness (PC) via sight into the occipital region (electromagnetic energy) and access consciousness (AC) via hearing into the temporal regions (mechanical energy). Both have a subjective dimension and the neural correlates of both coincide. AC can be invoked in the absence of an object and without the involvement of the prefrontal cortex. This analysis sheds light on the contradicting arguments of leading theories regarding the role of the prefrontal cortex (HOTT and GNWT), posterior “hot zone”, bottom-up processes (HOTT), and top-down processes (Re-entry theory) and on the results of recent findings around IIT and GNWT. This theoretical framework provides insights into how conscious awareness emerges from the interplay of matter and energy and how the divergent theories can be harmonized into one theoretical account. These predictions are supported by an overwhelming amount of empirical and theoretical data from diverse academic disciplines and have the potential to advance the multidisciplinary fields of consciousness and language and create new paradigms in science.

Poster - 2 (Fri)

Keywords
conscious experience, subjective, objective, awareness, matter, energy, neural correlates, consolidation of theories, global workspace , higher-order, integrated information, re-entrant processing, phenomenal consciousness, access consciousness

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Can science explain consciousness? Lessons from coma and related states

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.01]........Neural correlates of consciousness (general)

Abstract
Understanding consciousness remains one of the greatest mysteries for science to solve. How do our brains really work? Will we ever be able to understand the human mind? How can we know if some patients in coma have any consciousness left and how could we communicate with them? What are near-death experiences? What is brain death? What happens in our brains during dreaming, hypnosis or meditation? At present, nobody understands how matter (our trillions of neural connections) becomes perception and thought. We will here briefly review some neurological facts on consciousness and impaired consciousness. While philosophers have pondered upon the mind-brain conundrum for millennia, scientists have only quite recently been able to explore the connection analytically through objective measurements and perturbations of the brain’s activity. This ability stems from recent advances in technology and especially from emerging functional neuroimaging, electrophysiology, brain-computer interface and neuromodulation studies. The mapping of conscious perception and cognition in health (e.g., conscious waking, sleep, dreaming, hypnosis, meditation, trance, sleepwalking, anesthesia and psychedelics) and in disease (e.g., brain death, coma, near-death, “vegetative” unresponsive wakefulness, minimally conscious state, locked-in syndrome, seizures, hallucinations etc) is providing exiting new insights into the functional neuroanatomy of human consciousness. Our perception of the outside world (sensory awareness; what we see, hear, etc.) and our awareness of an inner world (self-awareness; the little "voice" inside that "speaks" to ourselves) seemingly depend on two separate "awareness" networks. We will conclude by discussing the ethical consequences of these scientific advances which offer the medical community unique ways to improve the clinical management and quality of life in patients with disorders of consciousness. References: Quantifying arousal and awareness in altered states of consciousness using interpretable deep learning. Lee M et al, Nat Commun. 2022. Doing what matters in times of stress: No-nonsense meditation and occupational well-being in COVID-19. Van de Velde J et al PLoS One. 2023. A neurophenomenological approach to non-ordinary states of consciousness: hypnosis, meditation, and psychedelics. Timmermann C et al Trends Cogn Sci. 2023 Altered Brain Connectivity and Network Topological Organization in a Non-ordinary State of Consciousness Induced by Hypnosis. Panda R et al, J Cogn Neurosci. 2023 Cerebral electrometabolic coupling in disordered and normal states of consciousness. Annen J et al Cell Rep. 2023 Near-Death Experience as a Probe to Explore (Disconnected) Consciousness. Martial C et al, Trends Cogn Sci. 2020

PL - 1

Keywords

333

Towards a neurophysiological understanding of psilocin action in the somatosensory cortex

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.19]........Psychedelics and psychopharmacology

Abstract
Psychedelics are a unique class of psychoactive agonists at the 5-HT2A subtype of serotonin (5-HT) receptor defined by their ability to alter thought, feeling, and perception. Psilocin and other psychedelic 5-HT2A agonists are receiving attention as promising therapeutic candidates for treating numerous psychiatric conditions including major depression, post-traumatic stress disorder, anxiety, and substance use-related disorders. Psychedelics may have potential to advance psychiatric medicine, however, the underlying cellular and circuit neurophysiology remains incompletely understood. Recent reports show that psychedelics can promote rapid and sustained structural neuroplasticity (synaptogenesis) in cortical neurons. These data motivated the hypothesis that the therapeutic effects of psychedelics are mediated by their ability to enhance measures of structural synaptic plasticity, such as dendritic spine density and synapse formation. Despite reports of psychedelic-induced structural changes to synapses, our understanding of how 5-HT2A activation alters intrinsic neuronal excitability and synaptic plasticity is limited. A key barrier to progress has been an inability to visualize which cortical neurons express the 5-HT2A receptor. Leveraging the recently developed suite of Htr2a-Cre transgenic mouse models (Chiu et al., 2023), we are using slice electrophysiology to determine the acute effects of psilocin on measures of intrinsic excitability and synaptic plasticity in 5-HT2A expressing layer V pyramidal neurons of the primary somatosensory (S1) cortex. Preliminary results show a decrease in the intrinsic excitability of S1 layer V pyramidal neurons following acute psilocin application. Elucidating the electrophysiological effects of acute psilocin treatment will advance our understanding of serotonergic modulation of sensory perception and the neurophysiological basis of psychedelic drug action. In turn, this research may enable the future design of more efficacious psychiatric medicines with reduced adverse effects.

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Keywords
psychedelics

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Cilia as Brain Clock and GPS: Decoding Their Role in Space-Time Navigation

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.01]........Neural correlates of consciousness (general)

Abstract
Primary cilia, once considered vestigial organelles, have emerged as pivotal players in brain circuits and functions, with fascinating implications for biorhythms. Our recent breakthroughs have revealed unexpected features of these organelles in the brain. We have discovered that primary cilia exhibit non-random orientation patterns aligning with primary compass or Cartesian axes, suggesting a key role in brain navigation. Further, we have observed a striking variability in cilia lengths across different brain regions, pointing to specialized functions. The dynamic nature of cilia is highlighted by their ability to adjust geometry in response to internal and environmental stimuli. A significant aspect of our findings is the role of cilia in brain timing, where cilia-associated genes in primate brains follow circadian rhythms, and physical properties show daily fluctuations. For example, we revealed that cilia length and spatial orientation exhibit daily oscillation, varying between light and dark phases. Removing cilia from areas like the striatum disrupts timing functions and circadian rhythms. Additionally, our research indicates that cilia-associated gene dynamics change throughout a human's lifespan and are implicated in psychiatric disorders, hinting at a connection between cilia and mental health. Our research reveals the crucial role of primary cilia in space-time navigation within the brain, significantly altering our understanding of these once-overlooked structures. Essential in regulating spatial orientation and circadian rhythms, cilia emerge as key elements in neural processing. This new knowledge advances our understanding of brain mechanics and hints at broader implications for understanding consciousness.

C - 18

Keywords
Cilia, Spacte-time, Brain, Orientation, Circadian, Oscillation.

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Emergence of thoughts, complex systems and cytoelectric coupling

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.06]........Memory and learning

Abstract
Hebb introduced neural ensembles in his seminal work about 70 years ago. Today, ensembles are thought to describe groups of neurons coactivated when a certain memory, thought or percept is stored or processed. In this talk, I will consider the electric fields generated by neural ensembles. I will use the theory of complex systems to show that fields control individual neurons . Latent states, like effective connectivity, seem to emerge because of self organization and to capture collective ensemble dynamics that underlie memory formation and maintenance. These evolve at different timescales from the fields that control them. This follows from the central manifold theorem and seems, as pointed out by Haken, to be crucial for consciousness. Thus,I will suggest that electric field stability could underlie the emergence of thoughts. Electric fields are ‘above’ the brain, but still ‘of’ the brain. I will present mathematical arguments in support of this hypothesis, that I call cytoelectric coupling: the electric fields that emerge from neural and the electrical activity of the cytoskeleton (e.g. proteins, microtubules) turn around and direct the activity of participating neurons for efficient information processing. Using mathematics and data analysis methods, I will describe interactions between neural activity and electric fields and will show how ephaptic coupling forms neural ensembles and low dimensional representations at the macroscale level.

PL-4

Keywords
emergence; cytoelectric coupling; complex systems;neural ensembles

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Mapping the Brain's Functional Geometry and Its Role in Consciousness

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.01]........Neural correlates of consciousness (general)

Abstract
Have you ever wondered how the brain's inner workings are connected to our conscious experiences? Imagine the brain as a vast landscape, where different areas are responsible for different tasks. Some regions handle our senses and actions, while others deal with more abstract thinking. To understand this better, think of it like describing a piece of land. You can use precise coordinates to mark its boundaries, or you can look at things like the terrain's slopes and the types of plants that grow there. We refer to this concept of defining the brain's functional terrain as "mapping the brain's functional geometry." Why is this important? Well, it helps us unlock the secrets of the brain's functions. At the same time, consciousness itself is a complex concept with many dimensions, and it's closely tied to how our brain works. So, we decided to create a framework that connects the brain's functional geometry to the different aspects of consciousness. In Dr. Huang's talk, he will dive into how the brain's functional geometry within the cortex holds clues about the many facets of consciousness. He will also explore how thalamocortical circuits play a role in shaping this brain landscape.

PL-13

Keywords

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Scientific Theories of Consciousness: A Critical Look

Aaron Schurger

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.20]........Neurobiological theories of consciousness

Abstract
Consciousness is an unusual phenomenon to study scientifically. It is defined as a subjective, first-person phenomenon, and yet science is an objective, third-person endeavor. This misalignment between the means—science—and the end—explaining consciousness—gave rise to what has become a productive workaround: the search for ‘neural correlates of consciousness’ (NCCs). Science can sidestep trying to explain consciousness and instead focus on characterizing the kind(s) of neural activity that are reliably correlated with consciousness. In parallel to the search for NCCs, many Theories of Consciousness (ToCs) have been proposed. These theories are diverse in nature, ranging from computational to neurophysiological and even quantum theoretical approaches. This contrasts with other fields of natural science, which host a smaller number of competing theories. While both theories and data have proliferated during the era of NCCs, the NCC approach was never intended as the foundation for a true explanation of consciousness. Indeed, it was proposed precisely to sidestep the, arguably futile, attempt to find one. So where does this leave us? One potential reason for the abundance of ToCs may be the lack of stringent criteria specifying how empirical data constrain ToCs. In this talk I will offer a set of such criteria, grounded in the assumption that consciousness is in fact a well-defined topic from an empirical point of view. I will review some of the most influential ToCs and look at where they stand with respect to these criteria. This analysis helps to situate these different ToCs in the theoretical landscape and sheds light on their strengths and weaknesses from a strictly empirical point of view.

PL-7

Keywords
theories of consciousness, explanation, correlates of consciousness, empirical criteria, theory versus law

365

Propofol-mediated loss of consciousness disrupts predictive routing and local field phase modulation of neural activity

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.17]........Specific brain areas

Abstract
Predictive coding is a fundamental function of the cortex. The predictive routing model proposes a neurophysiological implementation for predictive coding. Predictions are fed back from deep-layer cortex via alpha/beta (8-30Hz) oscillations. They inhibit the gamma (40-100Hz) and spiking that feed sensory inputs forward. Unpredicted inputs arrive in circuits unprepared by alpha/beta, resulting in enhanced gamma and spiking. To test the predictive routing model and its role in consciousness, we collected data from intracranial recordings of macaque monkeys during passive presentation of auditory oddballs (e.g., AAAAB) before and after propofol-mediated loss of consciousness (LOC). In line with the predictive routing model, alpha/beta oscillations in the awake state served to inhibit the processing of predictable stimuli. Propofol-mediated LOC eliminated alpha/beta modulation by a predictable stimulus in sensory cortex and alpha/beta coherence between sensory and frontal areas. As a result, oddball stimuli evoked enhanced gamma power, late (> 200 ms from stimulus onset) period spiking, and superficial layer sinks in sensory cortex. Therefore, auditory cortex was in a disinhibited state during propofol-mediated LOC. However, despite these enhanced feedforward responses in auditory cortex, there was a loss of differential spiking to oddballs in higher order cortex. This may be a consequence of a loss of within-area and inter-area spike-field coupling in the alpha/beta and gamma frequency bands. These results provide strong constraints for current theories of consciousness.

PL-4

Keywords
beta and gamma oscillations, predictive routing, propofol anesthesia, laminar neurophysiological recordings

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Dissociating Artificial Intelligence from Artificial Consciousness

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.01]........Neural correlates of consciousness (general)

Abstract
Developments in machine learning and computing power are raising the possibility that artificial general intelligence may be within reach. This raises the question of artificial consciousness: if a computer were functionally equivalent to a human, having the same cognitive abilities, would it experience sights, sounds, and thoughts, as we do when we are conscious? Answering this question in a principled manner can only be done on the basis of a theory of consciousness that is grounded in phenomenology and its essential properties, translates them into measurable quantities, can be validated on humans, and can be extrapolated to any physical system. Here we employ Integrated Information Theory (IIT), which provides principled tools to determine whether a physical system is conscious, to what degree, and the content of its experience. We consider pairs of simple systems constituted of logic gates, one of which - a basic computer - simulates the other with full functional equivalence. By applying the principles of IIT, we demonstrate that (i) two systems can be functionally equivalent without being phenomenally equivalent; (ii) that this conclusion applies no matter how one ‘black-boxes’ the computer’s gates; and (iii) that even certain Turing-complete systems, which could theoretically pass the Turing test and simulate a human brain in detail, would be negligibly conscious. # These authors contributed equally to this work

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Keywords
AI, artificial consciousness, phenomenology, IIT, Turing test

371

> Interplay between Quantum Microtubules and Consciousness: The Orch OR theory by Stuart Hameroff

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.11]........Cellular and sub-neural processes

Abstract
Recent rese­arch done by Dr. Hameroff and his co-workers have provide­d strong proof in helping the Orch OR theory, or the Orchestrated Objective Reduction theory. This the­ory connects quantum processes occuring inside microtubules, found in the cytoplasm, to how our mind works and functions. Microtubules, thin tubes found in ce­lls, have long been se­en as critical components for cell function. But eme­rging evidence sugge­sts microtubules may posse­ss unique quantum properties, challe­nging what we know about how cells work. This groundbre­aking study sheds light on the complex re­lationship between quantum physics and ke­y parts of cognition, giving us a glimpse into the nature of consciousness. The­ Orch OR theory states that awareness come­s from subtle quantum events occurring inside­ microtubules such as entanglement and superposition. They exhibit a phenomenon where particles exist in a synchronized state, allowing for quantum coherence and this state could explain the basis of consciousness. It also suggests that they can become entangled, being connected even when separated by distance, proposing that processing and integration in the brain could be studied from microtubules. The "obje­ctive reduction" aspect of the­ theory refers to a propose­d way for the collapse of the quantum wave­ function to occur. This is a process where­ a quantum system changes from existing in superposition, having multiple possible­ states simultaneously, to having just one de­finite state when it is me­asured or observed. In Orch OR theory, this collapse is suggested to be­ organized by quantum actions within microtubules. This then le­ads to conscious experience­. This re­search can also extend beyond cellular biology to be applied to celestial bodies such as the­ asteroid Bennu, adding another layer of discussion. Studying what Bennu and other space­ rocks are made of not only provides crucial insights into how our e­arly solar system formed but also offers a unique­ way to explore the chemical and physical processes that led to the emergence of life, including consciousness. The parallels between quantum phenomena in microtubules and the trajectories of asteroids in the cosmos underline interconnectedness in the micro and macro levels.

Poster - 1 (Wed)

Keywords
Orch OR, Orchestrated Objective Reduction, microtubules, quantum processes, entanglement, superposition, quantum coherence, asteroid Bennu

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The Relativistic Theory of Consciousness – a new testable solution for the hard problem

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[01.08]........The "hard problem" and the explanatory gap

Abstract
Consciousness poses one of the biggest puzzles in science. Despite critical development in our understanding of the functional side of consciousness, we still lack a fundamental theory regarding its phenomenal aspect. There is an explanatory gap between our scientific knowledge of functional consciousness and its essential part - the subjective, phenomenal aspects, referred to as the hard problem of consciousness. To date there is no theory of consciousness that solves the hard problem in a satisfactory manner. Recently, however, a new physical approach, named the Relativistic Theory of Consciousness, offers to dissolve the hard problem using the principle of relativity (the principle that guided Galileo and Einstein developing their theories). A common thread connecting most theories of consciousness is that consciousness is an absolute phenomenon. In contrast, the relativistic theory of consciousness proposes a novel relativistic approach in which consciousness is not an absolute property but a relative one, in which a system can either have phenomenal consciousness with respect to some observer or not. By changing this assumption, the theory shows how the explanatory gap can be bridged in a natural way using different cognitive frames of reference. The theory has a couple of testable predictions. One of its intriguing predictions is that cognitive maps should serve as neural correlates of consciousness. Another one is that consciousness is not private and in principle, with the right technology, we can change one cognitive frame of reference to another and experience what it is like to be someone else. This lecture is about a new physical solution to the hard problem and consciousness.Also about testable predictions in neuroscience and new suggestions for neural correlates of consciousness.

C - 18

Keywords

378

Similar problems in the search for biological correlates for chronic mental illnesses and for consciousness

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[03.13]........Neural networks and connectionism

Abstract
In contrast to other medical fields, not a single chronic mental illness is so far diagnosed by “objective” biological testing, instead a clinical interview between psychiatrist and the patient is used to ascertain diagnosis. Biological psychiatry is the realm of clinical psychiatry that attempts to explain chronic mental illnesses such as here specified for schizophrenia by distinct molecular, cellular and biological mechanisms. Problems in establishing biological markers or mechanisms to the exclusive clinical diagnoses touch three main areas: 1. A purely clinical (phenotypical) diagnosis does not allow stratification of likely heterogneous biological underlying causes leading to a dilution of potential subsets of biological definitions of schizophrenia (i.e. going circles between clinical and biological definitions), 2. A fear for a trivialization of diagnosis by descending from a “skilled art” of clinical diagnosis to a simple biological test, 3. Prevailing dualistic attitudes within a significant portion of clinical psychiatrists resisting a complete naturalization of this medical discipline. Translated into the search of of neuronal correlates of consciousness, i.e. the attempt to naturalize consciousness, respectively: 1. The lack of a clear, unequivocal definition of consciousness, i.e. what is it that we are searching a correlate for, 2. A (falsely) imagined loss of mental personal space upon a biological (i.e. material) explanation of consciousness and 3. A dualistic mindset that excludes complete naturalization of consciousness altogether. Consciousness research and biological psychiatry have so far surprisingly few interactions, reflected also in the lack of significant participation in each other’s conferences. This contrasts to the similarities of the encountered problems outlined above and hence the potential to learn from each other in solving major conceptual issues. (Part of these insights have been published in Lancet Psychiatry 2020, 7(10):911-914, available on https://shorturl.at/crGKP)

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Keywords

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Hierarchical Consciousness: the Nested Observer Windows (NOW) Model

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Categories by Discipline
2.0 Neuroscience

Primary Topic Area - TSC Taxonomy
[02.20]........Neurobiological theories of consciousness

Abstract
Foremost in our experience is the intuition that we possess a unified conscious experience. However, many observations run counter to this intuition: we experience paralyzing indecision when faced with two appealing behavioral choices, we simultaneously hold contradictory beliefs, and the content of our thought is often characterized by an internal debate. Here, we propose the Nested Observer Windows (NOW) Model, a framework for hierarchical consciousness wherein information processed across many spatiotemporal scales of the brain feeds into subjective experience. The model likens the mind to a hierarchy of nested mosaic tiles—where an image is composed of mosaic tiles, and each of these tiles is itself an image composed of mosaic tiles. Unitary consciousness exists at the apex of this nested hierarchy where perceptual constructs become fully integrated and complex behaviors are initiated via abstract commands. We define an observer window as a spatially and temporally constrained system within which information is integrated, e.g. in functional brain regions and neurons. Three principles from the signal analysis of electrical activity describe the nested hierarchy and generate testable predictions. First, nested observer windows disseminate information across spatiotemporal scales with cross- frequency coupling. Second, observer windows are characterized by a high degree of internal synchrony (with zero phase lag). Third, observer windows at the same spatiotemporal level share information with each other through coherence (with non-zero phase lag). The theoretical framework of the NOW Model accounts for a wide range of subjective experiences and a novel approach for integrating prominent theories of consciousness.

PL-6

Keywords
Hierarchical consciousness, neural oscillations, electrical coupling, neuroscience