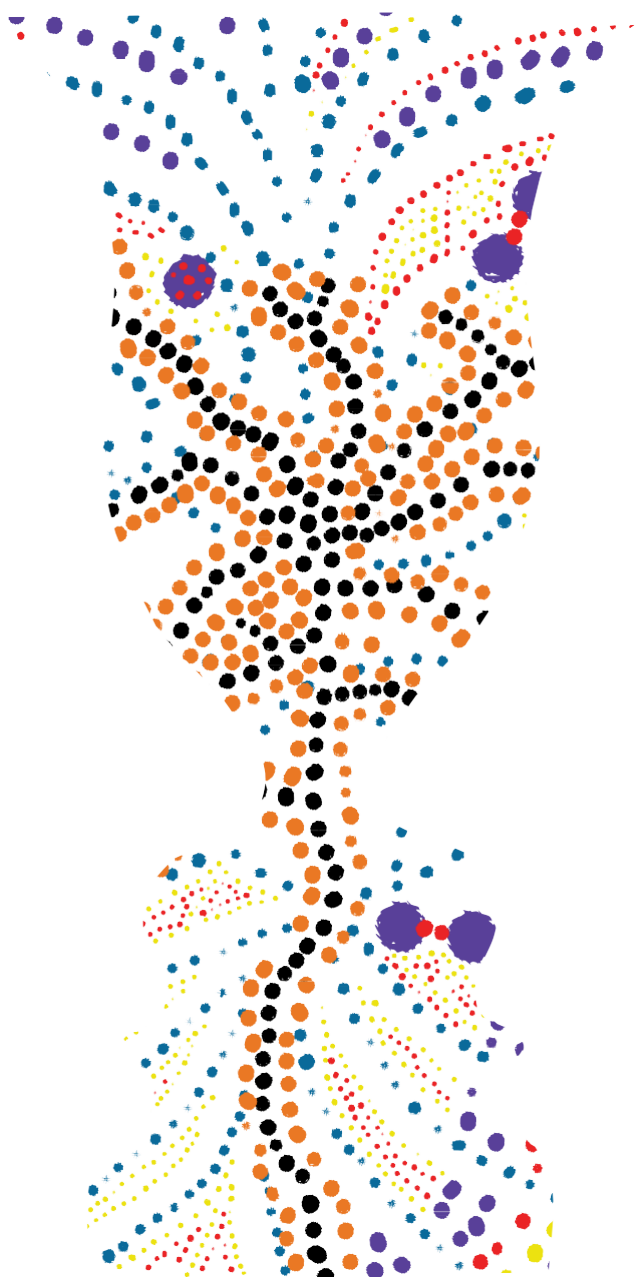


ASSC 18

The Association for the Scientific
Study of Consciousness

www.theassc.org



Keynote speakers

- David Chalmers
- Sheng He
- Jesse Prinz
- Emery Brown
- Melanie Wilke

Special talks

- Jack Pettigrew
- Diana James
& Inawinytji
Williamson
- Stanislas Dehaene

ASSC Program

Wednesday July 16

Time	Event	Presenter(s)	Room	Page
9:00	Morning Short Course <i>Integrated Information Theory of Consciousness</i>	Giulio Tononi Christof Koch Naotsugu Tsuchiya Masafumi Oizumi Larissa Albantakis	AEB Auditorium	20
12:00	Lunch break			
13:00	Tutorial Workshops <i>Olfactory Consciousness</i> <i>Seeing what's not there and measuring it: conscious perception without a stimulus</i> <i>Theory of Neuronal Cognition and Consciousness</i>	Andreas Keller Joel Pearson Claude Touzet	AEB, rm 601 AEB, rm 301 AEB, rm 313	21
16:00	Welcome	Bruno van Swinderen & Olivia Carter	AEB Auditorium	
16:15	James Prize Introduction	Steve Fleming	AEB Auditorium	
16:20	James Prize Lecture	To be announced	AEB Auditorium	
17:10	Presidential Address <i>The Hard Problem of Consciousness: 300 Years on</i>	David Chalmers (Introduced by Steve Fleming)	AEB Auditorium	22
18:30	Opening Night Reception		AEB lobby	
20:00	SPECIAL TALK 1 <i>Through a Glass Darkly: Inferring the Palaeolithic Mind</i>	Jack Pettigrew (Introduced by Olivia Carter)	AEB Auditorium	22
21:00	Opening Night Reception		AEB lobby	

Thursday July 17

9:00	Keynote 1	Sheng He (Introduced by Abbey Nydam)	AEB Auditorium	22
	<i>Binocular Rivalry and Visual Awareness</i>			
	Posters Up		AEB walkway	
10:00	Coffee		Global Change Atrium	
10:30	Concurrent Session 1			
	<u>Stream A: Neural Signatures and Models of Consciousness</u>		Steele, rm 206	
	<i>Patterns of event-related potentials reflect fast unconscious semantic analyses of how images relate to subjective connotations of time</i>	Stefan Bode		32
	<i>Spectral phase and power predict stimulus category, but only power predicts visual awareness in intracranial EEG in humans</i>	Jochem van Kempen		32
10:50				
	<i>Resource allocation during the attentional blink: an MEG study using machine learning</i>	Sebastien Marti		33
11:10				
	<i>Conscious, but not unconscious, across-trial conflict resolution is associated with theta-band oscillatory neural modulations in dorsolateral prefrontal cortex</i>	Simon van Gaal		33
11:30				
	<i>Spectral signatures of brain networks in disorders of consciousness</i>	Srivas Chennu		33
11:50				
	<i>"Aboutness" revisited: The implications for, and applicability of, relativizing the content-specificity of qualia in neuroscience</i>	Yasuko Kitano		34
12:10				

10:30	<u>Stream B: Perception and Attention</u>	Steele, rm 309	
	<i>The influence of stimulus visibility in priming depends on the type of masking</i>	Uwe Mattler	34
10:50	<i>A model of acquired perceptual warping</i>	Guy Wallis	34
11:10	<i>Shape perception simultaneously up- and down-regulates neural activity in the primary visual cortex</i>	Peter Kok	35
11:40	<i>Neural correlates of subjective awareness for natural scene categorization of color photographs and line-drawings</i>	Qiufang Fu	35
12:00	<i>Predicting visual consciousness from brain activity: Roles for noise and adaptation</i>	Robert P. O'Shea	35
12:10	<i>Attention and consciousness may operate through different gain functions</i>	Jeroen J.A. van Boxtel	36
10:30	<u>Stream C: Body, Self and Agency</u>	Steele, rm 329	
	<i>Self-Touching Illusion and Bodily Self-Consciousness</i>	Caleb Liang	36
10:50	<i>Process, Consciousness, and Self</i>	Karen Yan	37

11:10	<i>Audience Effect as Evidence for Mirror Self-Recognition in Chickens</i>	Alexis Garland	Steele, rm 329	37
11:30	<i>Altered experiences of control in expertise, schizophrenia and hypnosis: Measuring and understanding changes to the sense of agency</i>	Vince Polito		37
11:50	<i>Experimentally induced changes in Bodily Self Consciousness affect semantic processing</i>	Elisa Canzoneri		38
12:10	<i>Intentional Binding With a Robotic Hand - To what extent is agency modulated by embodiment?</i>	Emilie Caspar		38
<hr/>				
12:30	Lunch break			
	Student Mentor Event		St Lucy's Cafe	
<hr/>				
13:30	Concurrent Session 2			
	<u>Stream A: Anaesthesia, Sleep and Seizures</u>		Steele, rm 206	
	<i>Brain networks dynamics before sedation predict subsequent loss of consciousness</i>	Tristan Bekinschtein		39
13:50	<i>Breakdowns in parietal network functional connectivity reflect agent-invariant network changes underlying anaesthetic-induced reductions in consciousness</i>	Levin Kuhlmann		39
14:10	<i>Disruption of hierarchical auditory predictive coding during sleep</i>	Melanie Strauss		39
14:30	<i>Consciousness during Sleep: what happens to it? Its relevance to Insomnia?</i>	Leon C. Lack		40
14:50	<i>Inducing task-relevant responses in the sleeping brain</i>	Sid Kouider		40

15:10	<i>Mechanism of impaired consciousness in childhood absence seizures</i>	Hal Blumenfeld	40
13:30	<u>Stream B: Predictive Processes</u>	Steele, rm 309	41
	<i>Expect surprises</i>	Anya Farennikova	
13:50	<i>Consciousness in the Predictive Mind</i>	Jakob Hohwy	41
14:10	<i>Hierarchical Temporal Intentionality</i>	John Thornton	41
14:30	<i>Predictive Perception of Sensorimotor Contingencies: Explaining perceptual presence and its absence in synaesthesia</i>	Anil Seth	42
14:50	<i>Task demands modulate the effects of perceptual expectations in early visual cortex</i>	Elexa St. John-Saaltink	42
15:10	<i>Mechanisms of deviance detection are affected by visual consciousness</i>	Bradley N. Jack	42
	<u>Stream C: Time Perception and Temporal Processing</u>	Steele, rm 329	
13:30	<i>Hierarchical processing in the infant brain: a late response might signal conscious access in three-month-old infants</i>	Ghislaine Dehaene-Lambertz	43
13:50	<i>On the modulation of interoception: Insights from the use of food deprivation in healthy females and cognitive-behavioral therapy in anorexia nervosa.</i>	Olga Pollatos	43
14:10	<i>Experimental Evidence That Illusory Percepts Are The Basis Of The Flow Of Time</i>	Ronald Gruber	43

14:30	<i>New evidence for the differences in time perception during foveal and parafoveal vision</i>	Eve A. Isham		44
14:50	<i>Altered Time Perception in Patients with Bipolar Disorder</i>	Francesco Giorlando		44
15:10	<i>Modulating temporal recalibration with degraded visual awareness</i>	Regan M. Gallagher		44
15:30	Coffee		AEB lobby	
	Symposium 1			
	<u>Consciousness Across The Species: The adaptive Value of Pain</u>	Chair: Adam Shriver	AEB Auditorium	
16:00	<i>Talk 1: Do fish feel pain?</i>	Victoria Braithwaite		25
16:30	<i>Talk 2: Experimental design and strength of inferences regarding affect during loss of consciousness</i>	Dan Weary		25
17:00	<i>Talk 3: Identifying nociception and the experience of pain in the octopus</i>	David Edelman		25
17:30	<i>Talk 4: In defense of function</i>	Paula Droege		26
18:00	Pizza Dinner		AEB lobby	
19:00	SPECIAL TALK 2 <i>Songlines of the Western Desert: Art and Consciousness</i>	Diana James & Inawinytji Williamson (Introduced by Bruno van Swinderen)	AEB Auditorium	24
20:00	Student Social		Regatta Hotel	

Friday July 18

Time	Event	Presenter(s)	Room	Page
9:00	Keynote 2			23
	<i>Are Consciousness and Attention Dissociable?</i>	Jesse Prinz (Introduced by Leonie Kirszenblat)	AEB Auditorium	
10:00	Coffee		AEB lobby	
10:30	Symposium 2	Chair: Jacobo Sitt and Aaron Schurger	AEB Auditorium	
	<u>Quantifying Consciousness: Theoretical and clinical implications</u>			
10:50	<i>Talk 1: Stability as a signature of neuronal adequacy for subjective report.</i>	Aaron Schurger		26
11:10	<i>Talk 2: Towards an objective index of the level of consciousness</i>	Marcello Massimini		27
11:50	<i>Talk 3: Insights and applications from contrasting conscious states</i>	Jacobo Sitt		27
12:10	<i>Talk 4: Quantitative measures of conscious level: prospects and perils</i>	Anil Seth		27
12:30	Lunch break			
	Early Research Career Panel		AEB, rm 301	
13:30	Poster Session		AEB	
	<u>Coffee & Snacks</u>			
16:00	Keynote 3	Emery Brown	AEB Auditorium	23
	<i>The Neurophysiology of the Unconscious Brain under General Anesthesia</i>	(Introduced by Michael Troup)		
17:30	Ferry Cruise and buses to Lone Pine dinner		The UQ Boat Terminal & UQ Chancellors Place bus stop	
	<i>The ferry will leave from the UQ Boat Terminal. Buses will leave from outside the UQ Chancellors Place. (see map, p97)</i>			
	<i>If making one's own way: Take the 432, 428 or 427 bus from UQ Chancellors Place to Indooroopilly Shopping Centre Station. Then take the 445 bus to Lone Pine.</i>			
18:30	Conference Dinner		Lone Pine Sanctuary	
22:00-23:30	Shuttle buses back to UQ.			
	<i>2 buses will leave Lone Pine Sanctuary at 10pm, 1 bus at 11pm and 1 bus at 11:30pm</i>			

Saturday July 19

Time	Event	Presenter(s)	Room	Page
9:00	Keynote 4 <i>Spatial awareness and its disorders</i>	Melanie Wilke (Introduced by Chase Sherwell)	AEB Auditorium	23
10:00	Coffee		AEB lobby	
10:30	Symposium 3 <u>Unconscious perception: Does it exist, and if so, should we require from evidence?</u>	Chairs: David Carmel & Axel Cleeremans	AEB Auditorium	
	<i>Talk 1: Unconscious perception is not a single thing</i>	David Carmel		28
11:00	<i>Talk 2: Using unconscious information for sensory and bistable decisions</i>	Joel Pearson		28
11:30	<i>Talk 3: Improving on the null hypothesis: Bayesian objective and subjective thresholds</i>	Zoltan Dienes		29
12:00	<i>Talk 4: The mind's sea serpent</i>	Axel Cleeremans		29
12:30	Lunch break (45mins)			
13:15	Concurrent Session 3 <u>Stream A: Action and Behaviour</u>		Steele, rm 206	
	<i>(Almost) twenty years of pictorial illusions, perception, and action</i>	Melvyn Alan Goodale		45
13:35	<i>The evolutionary function of conscious information processing is revealed by its task-dependency in olfaction</i>	Andreas Keller		45
13:55	<i>Seeing through action: Implicit action cost constrains the perceptual decision making</i>	Nobuhiro Hagura		45
14:15	<i>Does a fly know when it is in control?</i>	Leonie Kirszenblat		46
14:35	<i>Egocentric representation and the two-visual systems hypothesis</i>	Robert Foley		46
14:55	<i>The Impact of Prior Expectations on Subliminal Behavioral and Electrophysiological Responses</i>	Leonardo S. Barbosa		46

13:15	<u>Stream B: Metacognition and Clinical Studies of Awareness</u>		Steele, rm 309	
	<i>Trust your feelings, Luke! Metacognitive awareness guides the selection of low-conflict contexts in the absence of prime awareness</i>	Kobe Desender		47
13:35	<i>The influence of visual identification on perceptual awareness ratings</i>	Michal Wierzchon		47
13:55	<i>Oscillatory mechanisms related to (pre-)reflective decision-making</i>	Martijn E. Wokke		47
14:15	<i>Selective impairment in perceptual metacognition following anterior prefrontal lesions</i>	Stephen M. Fleming		48
14:35	<i>EEG responses to stimuli of personal relevance in healthy controls and disorder of consciousness patients</i>	Manuel Schabus		48
14:55	<i>The use of pupil dilation to communicate with locked-in syndrome patients</i>	Olivia Carter		48
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	<i>Cross cultural difference in unconscious process in implicit learning</i>	Lulu Wan	Steele, rm 262	49
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14:55	<i>A window of subliminal perception</i>	Kristian Sandberg		49
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15:35	<i>Don't make me angry: Manipulating volitional choices to act or inhibit by subliminal emotional faces</i>	Jim Parkinson		50
15:55	<i>Attending to the Unseen: The Effects of Spatial Attention on Neural Responses to Visible and Invisible Stimuli</i>	Cooper Smout		50
15:15	Coffee (15mins)		AEB lobby	

15:30	Symposium 4: <u>Consciousness in sleep: what it is like, what can it tell us, and how it can be measured</u>	Chair: Chiara Cirelli	AEB Auditorium	
	<i>Talk 1: Neurophysiology of sleep</i>	Chiara Cirelli		30
16:00	<i>Talk 2: Investigating sleep consciousness using high-density EEG</i>	Francesca Siclari		30
16:30	<i>Talk 3: Sleep, dreams and consciousness: A neuroimaging perspective</i>	Michael Czeisler		31
17:00	<i>Talk 4: Dreaming, consciousness and the self: Spatiotemporal self- location and minimal phenomenal selfhood</i>	Jennifer Windt		31
17:30	Closing Remarks		AEB Auditorium	
19:00	Public Lecture <i>Understanding Consciousness: from the lab to the clinic</i> <i>For transport from the conference to The State Library, catch bus 66 from UQ Lakes bus stop (map p97)</i>	Stan Dehaene	State Library Auditorium 1 Southbank	24
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Poster Session Friday 18th July

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ASSC 18 Morning Short Course - 9am 16th July

Integrated Information Theory (IIT) of Consciousness

Speakers:

- Giulio Tononi (University of Wisconsin, USA)
- Christof Koch (Allen Institute for Brain Science)
- Naotsugu Tsuchiya (Monash University, Australia)
- Masafumi Oizumi (Riken Brain Science Institute, Japan)
- Larissa Albantakis (University of Wisconsin, USA)

Venue: The AEB Auditorium

Schedule:

9:00 - 9:15 Koch: Why do we need a theory? 9:15-

10:00: Tononi: Basic concepts of IIT 10:00-10:15

Koch: Evolution of consciousness

10:15-10:35: Albantakis: Measures of IIT applied to artificial adaptive systems 10:35-

10:45: break

10:45-11:05 Oizumi : Practical measures of IIT (1)

11:05-11:25 Tsuchiya: Practical measures of IIT (2)

11:25-11:30 Tononi: Summary

11:30-12:00 Questions and Discussions

This event is sponsored by ARC Center of Excellence for Integrative Brain Function.



Australian Research Council
Centre of Excellence for
Integrative Brain Function

ASSC 18 Tutorials - 1pm 16th July

TUTORIAL 1: “Olfactory Consciousness.”

Andreas Keller (The Rockefeller University, USA)

Venue: AEB, Room 601

The word “visual” appears 222 times in last year’s ASSC Conference program book. The word “olfactory” appears only once. This is unfortunate because the olfactory system is much simpler and more primitive than the visual system, yet it is perfectly capable of processing information consciously. In many other fields of biology, studying simple model systems has been spectacularly successful in increasing our understanding of basic processes. There is no reason to believe that this would be any different in consciousness researchers. The goal of my proposed tutorial is to introduce consciousness researchers to olfaction as a simple, evolutionary conserved, and well-understood model system for consciousness research. I will point out some facts about visual consciousness that are often assumed to be true for all perceptual consciousness, although they depend on special adaptations in the visual system. I will also discuss several attempts to falsify or confirm theories of consciousness in the olfactory system. I am currently co-editing a Research Topic “Olfactory Consciousness across Disciplines” for *Frontiers in Consciousness Research* and some of the material presented will be based on the 15 contributions to this collection.

TUTORIAL 2: “Seeing what’s not there and measuring it: Conscious perception without a stimulus.”

Joel Pearson (University of New South Wales, Australia)

Venue: AEB, Room 301

Hallucinations, mental imagery, synaesthesia and many illusions can all create a wakeful conscious experience without a corresponding stimulus or sensory stimulation. Historically research into such dimensions of conscious experience has suffered criticism and lacked scientific traction due to the methodological constraints caused by the inherent private nature of such experiences. Accordingly, empirical consciousness research has tended to focus on the inverse situation: neural stimulation without consciousness awareness (Binocular rivalry, masking, continuous flash suppression). However, recently objective research methods have been introduced that allow a more direct investigation into the mechanisms and neural substrates of conscious experience that lacks a direct external cause. This tutorial will offer researchers at all levels an overview of pertinent methodological and conceptual issues and will cover:

- The range of new and old research and relevant methods.

- The theory behind these methods.

- Some practical hands on experience.

- The capabilities, limitations and implications of using such methods.

- How these methods can be used for applied research in clinical and non-clinical settings.

Together, these new methods can expand empirical consciousness research by investigating conscious experience when stimulation has been removed. Questions and interactive discussion will be emphasized

TUTORIAL 3: “Theory of Neuronal Cognition and Consciousness.”

Claude Touzet (Aix-Marseille University, France)

Venue: AEB, Room 313

Formalized in 2010, the Theory of neuronal Cognition and Consciousness (TnCC) departs from all existing materialist theories of mind by claiming that our brain does not process information, but only represents information. The logical implication is that we are only a crystallization of our interactions with the environment. Since « extraordinary claims require extraordinary proofs », the goal of my tutorial is to provide researchers at all levels with the neuronal blueprints of a (large) number of cognitive functions and concepts. After the description of the cortex as a hierarchy of self-organizing associative memories, I will show how the synergy between sensory and sensory-motor maps generates behaviors. I will then offer explanations about intelligence (a side effect of the observer knowledge), consciousness (an automatic verbalization), endogenous and exogenous attentions, episodic and semantic memories, motivation or joy (a side effect of associative memories functioning). TnCC also offers tentative explanations about a few brain diseases (schizophrenia, depression, Alzheimer’s disease, autism) and answers to long-lasting questions such as why we must sleep, how hypnosis works, what is the placebo effect, and how unsupervised systems achieve homeostasis. However the biggest TnCC result relates to the fact that the absence of free-will is a sure guaranty that we must promote altruism to increase our personal happiness.

ASSC 18 Abstracts

PRESIDENTIAL ADDRESS: The Hard Problem of Consciousness: 300 Years on.

David Chalmers (Wednesday 16th July, 5:30pm, AEB Auditorium)

Australian National University and New York University

I will discuss the history of the hard problem of consciousness, the strategies that have been applied to solving or dissolving it over the last twenty years, and what I see as the currently most promising prospects for progress.



SPECIAL TALK 1: Through a Glass Darkly: Inferring the Palaeolithic Mind

Jack Pettigrew (Wednesday 16th July, 8pm, AEB Auditorium)

University of Queensland, Australia

Bradshaw rock art of Australia's Kimberley shares many unusual features in common with the rock art of African San people, such as hair-breadth brush-strokes, veridical depictions of animals, trance-related content, self-referenced physical features such as peppercorn curls, small stature, etc. Although San occupied most of Africa long before the advent of Bantu-speakers, they are usually overlooked in consideration of the post-Toba migrations of humans out of Africa. In addition to the already-mentioned links between San and Palaeolithic Australians, my work this year has shown that living San have hands that more closely resemble the stenciled hands of Palaeolithic European cave artists,not modern human hands.

The putative San lineage in Australia, represented by Bradshaw rock art, is extinct, as is the putative European San lineage, judging by the absence of any San-specific genetic markers in modern Europeans. Rapid assimilation of the San is also taking place in present-day Africa, hence the urgent need for studies of "natural" populations. The current field study measured the "switch" in 50 San, all from small villages still using traditional hunting methods and located far from towns. We used portable apparatus to present seven diverse, dynamic, rivalry displays, with a view to exploring the background for the ancient San practice of trance, as well as the remarkable ability of some modern San to enter a 5HT-1A-agonist-like trance without pharmacological assistance.



KEYNOTE 1: Binocular Rivalry and Visual Awareness

Sheng He (Thursday 17th July, 9am, AEB Auditorium)

University of Minnesota, USA and Chinese Academy of Sciences

When two different images are presented separately to the two eyes at the corresponding retinal locations, observers often experience a perceptual alternation between the two images - binocular rivalry. In this talk I will present behavioral evidence to support the proposal that binocular rivalry occurs primarily in the Parvocellular pathway while information processed in the Magnocellular pathway tend to be integrated. I will also describe experiments investigating the interactions between attention, awareness, and interocular competition. Our results show that observers' spatial attention could be guided by interesting but invisible images; voluntary attention can be eye-specific, modulating visual processing within a specific monocular channel, despite that fact that observers normally do not have explicit access to the eye-of-origin information; and sustained binocular rivalry ceased and interocular competition remain unresolved without attention. Interestingly, even invisible spatial patterns contribute to interocular competition.



KEYNOTE 2: Are Consciousness and Attention Dissociable?

Jesse Prinz (Friday 18th July, 9am, AEB Auditorium)

City University of New York, USA

A wide body of evidence links consciousness and attention, suggesting that the two may be one and the same. There have been numerous recent efforts, however, to establish dissociations between the two. Here a case is made for the thesis that consciousness is attention, and several recent efforts to refute this thesis are critically examined. For example, some studies that aim to demonstrate attention in the absence of consciousness merely establish orienting in the absence of consciousness. Competing definitions of attention are also reviewed, and it is argued that attention must be distinguished from several correlated but independent processes, including orienting and selection through lateral inhibition. Attention is defined as a neural process that allows information to flow to working memory. By distinguishing between closely associated processes, we can move closer to identifying the neural correlates of consciousness.



KEYNOTE 3: The Neurophysiology of the Unconscious Brain under General Anesthesia

Emery Brown (Friday 18th July, 4pm, AEB Auditorium)

Massachusetts Institute of Technology, USA

General anesthesia is a drug-induced, reversible condition comprised of five behavioral states: unconsciousness, amnesia (loss of memory), analgesia (loss of pain sensation), akinesia (immobility), and hemodynamic stability with control of the stress response. The mechanisms by which anesthetic drugs induce the state of general anesthesia are considered one of the biggest mysteries of modern medicine. We study three problems to decipher this mystery. First, we present findings from our human studies of general anesthesia using combined fMRI/EEG recordings, high-density EEG recordings and intracranial recordings, which have allowed us to give a detailed characterization of the neurophysiology of loss and recovery of consciousness due to propofol. Second, we present a neuro-metabolic model of burst suppression, the profound state of brain inactivation seen in deep states of general anesthesia. We show that our characterization of burst suppression can be used to design a closed-loop anesthesia delivery system for control of a medically-induced coma. Finally, we demonstrate that the state of general anesthesia can be rapidly reversed by activating specific brain circuits. Our results show that it is now possible to have a detailed neurophysiological understanding of the brain under general anesthesia, and that this understanding, can be used to control anesthetic states. Hence, general anesthesia is not a mystery.



KEYNOTE 4: Spatial awareness and its disorders

Melanie Wilke (Saturday 19th July, 9am, AEB Auditorium)

University Medical Centre Goettingen, Germany

At every moment when we are awake, our brains create an 'inner world', filled with percepts, imaginations and feelings. How does physical matter such as neurons in our brains lead to these subjective states and is there a special 'hardware' or dynamic required? Drawing conclusions from electrophysiological and fMRI experiments in monkeys and humans, the talk will address the question where and which signals in the brain correlate with our subjective impressions. In addition, a special focus will be on recent experiments with inactivation, deep brain and transcranial brain stimulation methods, testing the timing of the causal contribution of specific thalamic and cortical structures to spatial awareness.



Songlines of the Western Desert: Art and Consciousness

Presentation by Dr Diana James and Inawinytji Williamson (Thursday 17th July, 7pm, AEB Auditorium)

Abstract: Diana James

Australia is a land mapped by song, criss-crossed by intangible tracings that mark the routes of the ancestral creator beings of the Law and the Dreaming. These ancient paths are known only by those elders whose living memory banks hold detailed mnemonic mindscapes of vast tracts of country mapped in song. Knowing the song enables travellers to survive in the harsh Western Desert region of Australia. As the Martu say, 'we don't need a map!'

The Western Desert block is a vast region incorporating the desert lands of Western Australia, north-west South Australia and the south-west of the Northern Territory.

This region is united by a shared Aboriginal language, custom and ceremonial life that has created a rich network of Tjukurpa songlines, Law and Dreaming tracks. The term songline is a cross-cultural metaphor conveying the concept of Tjukurpa tracks; the complex song maps of tracts of country, foods, waterholes, languages and social structures of Aboriginal Law and Dreaming. Songline stories and songs tell of the creative acts and journeys of the ancestors who shape-shifted between animal, plant and human form. The performance of song embodies the Aboriginal ontological interconnectivity between all living and non-living in the lands and waters of country. The songlines are etched on the minds and souls of initiates through the visceral process of performance. Reciprocally the living pulsing essence of being in country is kept alive by their dance and song.

Songlines are intoned into the Western Desert acrylic art of today admired throughout the world. Painting the song of the land is only possible for people who hear music when they see country. The Western Desert Anangu artist's perception is synesthetic: hearing the song produces mental visual images of country; seeing painted symbols invokes a chorus of many voices, hands clapping and feet stamping, flooding the brain with song. The land is perceived as a tonal liminal landscape, the focus constantly shifting between the tangible and intangible tones of the physical and metaphysical ground of being. These tones are absorbed through all the senses: touched as the rough or smooth toned surfaces, heard in voice tones of story and song, felt as emotional tone of bodies vibrating in dance, smelt in tones of dryness as earth explodes with wetness of first rain, seen as tones of colour splashed across the undulating land and sky. The enchanted tone of song in ceremony opens perception to the spirit of Tjukurpa in the land. The artists, singers and dancers are offering another way of perceiving and knowing human connectivity to country.



PUBLIC LECTURE: Understanding Consciousness: from the lab to the clinic

Stanislas Dehaene (Saturday 19th July, 7pm, State Library Auditorium1, Southbank)

INSERM-CEA Cognitive Neuroimaging Unit, Collège de France

How a subjective state of consciousness arises from brain tissue is often considered as the Holy Grail of neuroscience. However, as I explain in my recent book "Consciousness and the brain", in the past twenty years the problem has ceased to be insurmountable. Tens of experimental paradigms, thousands of studies and several theories have begun to address the C challenge. In my conference, I will show how we can use visual illusions, subjective reports, and advances in machine learning to "decode" subliminal images from brain signals and to identify the signatures of consciousness that emerge when these images pop into consciousness. Although much theoretical work remains needed to relate these macroscopic signals to the underlying neuronal computations, those empirical advances are already being transferred to the clinic, where they facilitate the detection of residual consciousness in some vegetative state patients.



SYMPOSIUM 1: Consciousness Across The Species: The adaptive Value of Pain

Thursday 17th July, 4pm, AEB Auditorium

Chair: Adam Shriver

Summary:

Nociception without conscious awareness allows organisms to avoid tissue damage in certain situations. Spinal cords detached from brains are capable of learning complex responses to noxious stimulation. Yet, as we are all-too-aware, humans have the capacity to consciously feel pain and to suffer, presumably because these types of experiences have offered evolutionary advantages over mere nociception. In this panel, we will explore the adaptive value of conscious pain by taking a closer look at what we know about nociception and pain across different classes of animals. The speakers will discuss innovative methods used for assessing whether nonhuman animals are capable of experiencing pain, looking closely at relevant similarities and differences between species, and will situate our current knowledge in a theoretical framework that emphasizes the adaptive value of conscious pain.

TALK 1: Do fish feel pain?

Victoria Braithwaite

Pennsylvania State University, Pennsylvania, USA

The question of whether fish feel pain is currently a heated topic of debate. Fish clearly have a similar nociceptive system to those found in birds and mammals, but there is disagreement about whether fish have a sufficiently sophisticated brain for it to support affective states and feelings associated with pain. Lesion work has demonstrated that specialized regions within the fish telencephalon function in ways that are similar to an amygdala and a hippocampus, furthermore behavioral studies indicate that fish can behave in flexible ways and they make informed decisions demonstrating complex cognitive skills. The extent to which these skills are underpinned with an awareness of feelings and emotions, such as the hurt associated with pain, will be discussed.



Talk 2: Experimental design and strength of inferences regarding affect during loss of consciousness

Dan Weary

The University of British Columbia, British Columbia, Canada.

Behavioural changes during induction to anaesthesia may be responses to the felt pain and associated non-pain distress, or an unfelt excitatory response. Moreover, some anaesthetic agents are thought to be anxiogenic, so that the lack of obvious behaviour may be interpreted as a freezing in response to fear. Responses of trained animals in approach-avoidance and approach-aversion tasks allow for stronger inferences, but even in these cases the lack of response may reflect a motivation to escape or loss of muscle control. Conditioned place avoidance testing has further benefits, but can require repeat exposures introducing another confound. I review the results of recent studies of each type on laboratory rats, mice and fish and critically discuss the strength on inferences regarding affect.

Talk 3: Identifying nociception and the experience of pain in the octopus

David Edelman

Bennington College Vermont, USA.

There has been much speculation regarding the capacity of invertebrates with modest nervous systems and nociceptive pathways (i.e., crustaceans and insects) to feel pain. However, this particular subjective state has often been assumed to arise solely in the complex nervous systems of vertebrates. The octopus represents an interesting case because of its large nervous system and the fact that evidence for nociceptive pathways remains elusive. Indications of nociception in the octopus would not, in themselves, be evidence of the capacity for pain; in vertebrates, nociceptive pathways commonly reside in the spinal cord, well outside the brain and frequently independent of conscious pain perception. Nevertheless, nociceptors have been found in gastropod molluscs, and behavior consistent with nociception and pain perception has been observed in some cephalopod phyla. Here, I will discuss strategies for identifying nociceptive pathways and the neural circuitry necessary to support the experience of pain in the octopus.



Talk 4: In defense of function

Paula Droege

Pennsylvania State University, Pennsylvania, USA.

Consciousness can be conceived of in various ways: as a mysterious quality accompanying human sensation, as the result of an information calculus, as a workspace architecture, or a higher-order commentary on mental states. All of these theories suffer from the problem of the explanatory gap; consciousness is inexplicable either because it is non-physical or because the explanation bears no necessary connection to consciousness. The solution is to conceive of consciousness in terms of function. If a convincing case can be made that consciousness serves a distinct function, then evidence for that function is evidence for consciousness. Pain presents an important test because simple nociceptive response seems to exhaust adaptive value. I suggest that the function of conscious pain is to allow the animal to modulate its response in relation to a variety of options. Sometimes the best option may be to endure the pain in order to achieve a goal.



SYMPOSIUM 2: Quantifying Consciousness: Theoretical and clinical implications

Friday 18th July, 10:30am, AEB Auditorium

Chair: Jacobo Sitt and Aaron Schurger

Summary:

The field of consciousness research has reached a critical turning point: we have begun to validate theory-driven quantitative measures of consciousness (ref. Casali 2013, King 2013, Schurger 2010, Seth 2011) that enable us to discern whether or not a human subject (or patient) is in a conscious state, or is conscious of a particular stimulus, based only on patterns of brain activity. With these advances, consciousness research moves from “neuronal correlates” towards “neuronal signatures” of consciousness. Whereas correlates are apparent in the average over many trials or subjects, a signature can predict whether a single subject is in a conscious state, or whether a single episode elicited a specific conscious sensation, thus moving us one step closer to understanding how consciousness is “implemented” by the brain. Tests capable of detecting consciousness will be of enormous value in both clinical and research settings. A handful of new quantitative measures of consciousness have emerged in recent years. Based on theory, but applicable in practice, these metrics can reliably classify brain states as “conscious” or “non-conscious” at the single-subject, and in some cases single-trial, level. While each is different from the others in important ways, they also appear to be converging on certain specific properties of conscious brain states. In this symposium we will explore these new measures and discuss their theoretical, experimental, and clinical implications.

Talk 1: Stability as a signature of neuronal adequacy for subjective report.

Aaron Schurger

Center for Neuroprosthetics, École Polytechnique Fédérale de Lausanne, Switzerland.

Consciousness can be measured along two different dimensions: the overall state of consciousness, and the emergence and evolution of the “content” of consciousness. The stability of patterns of neural activity over a small time window is shown to be a reliable and specific signature of conscious perceptual events, and can be used to predict, at the single-trial level, whether or not a subject will report consciously experiencing a threshold-level visual object. Whereas the amplitude of the P300 evoked potential covaries with both subjective report and object category, stability is selectively modulated only by subjective report. The relative stability of perceptual decision states is predicted by dynamical systems theory and imparts efficacy in the readout of information for report, providing a basis for deciding “Yes, I saw it.” We connect this finding to prior research by showing that stability within-trials is also associated with reduced variability (higher reproducibility) across trials.



Talk 2: Towards an objective index of the level of consciousness

Marcello Massimini

The University of Milan, Italy

Consciousness can be generated in the brain independent of sensory inputs and motor outputs, however, establishing a dependable index of consciousness that does not rely on a subject's capacity to access/respond to the surrounding environment is still challenging. I will show how this task can be accomplished in three steps. First, starting from theoretical principles that suggest which properties are fundamental for a physical system to give rise to conscious experience. Second, devising a practical mean to gauge these properties in human brains. Third, testing the candidate metric in different controlled conditions - such as wakefulness, sleep, anesthesia, and brain injury - in which consciousness is known to be present, diminished or lost. Experimentally, this procedure yields a reliable, graded measurement scale along the unconsciousness/consciousness spectrum providing an objective frame of reference to assess subjects who are completely disconnected from the external environment.



Talk 3: Insights and applications from contrasting conscious states

Jacobo Sitt

L'Institut du Cerveau et de la Moelle Épinrière, France

Neuronal theories of conscious access tentatively relate consciousness to the integration and availability of information across distant cortical and thalamic areas. This framework has led us to propose a series of potential brain measures that might distinguish conscious from non-conscious processing. In this talk I will present a rigorous and systematic analysis of the efficacy of a panoply of different measures for differentiating subjects in "conscious" and "unconscious" states. Results show that traditional spectral measures, measures of EEG complexity, and estimates of long-range information exchange index conscious states best. Moreover, our analysis shows that these measures are complementary, because a gain in discrimination accuracy was obtained by combining several EEG measures using machine learning. Finally I will evaluate the clinical benefits and theoretical insights that are gained as a result of these findings.



Talk 4: Quantitative measures of conscious level: prospects and perils

Anil Seth

University of Sussex, UK

The quantitative measures of consciousness described by Schurger, Sitt, and Massimini are remarkable in showing, for the first time, that theory-grounded yet empirically applicable metrics can combine both sensitivity and specificity in detecting conscious states. In this talk I will critically reflect on these recent achievements, focusing on the extent to which they construct bridges from so-called "neural correlates" towards "explanatory correlates" of consciousness, where the latter refers to neural processes that 'account for' phenomenological properties of conscious experiences. I will argue that the current state-of-the-art still leaves some important gaps between true translations of theory into empirical measures, and it remains to be seen whether such truly 'explanatory' measures gain additional empirical purchase because of, rather than in spite of, their theoretical heritage. I will illustrate this argument with new data from the application of 'causal density' and 'integrated information' to intracranial EEG signals obtained under different conscious levels, as well as with new detailed simulations.



SYMPOSIUM 3: Unconscious perception: Does it exist, and what should we require from evidence?

Saturday 19th July, 10:30am, AEB Auditorium

Chair: David Carmel and Axel Cleeremans

Summary:

Which processes require awareness, and which can be accomplished in its absence? Making this distinction is widely considered a promising approach toward understanding the functions and architecture of consciousness. Recent years have seen an explosion of studies demonstrating unconscious perceptual and cognitive processing. Their abundance stems from a current zeitgeist that views unconscious processes as “cool”, as well as the popularity of easy-to-use 2 methods (e.g., continuous flash suppression) for suppressing stimuli from awareness. Uncritical acceptance of all recent findings might lead one to conclude that consciousness has little, if any, role in determining the outcome of perceptual and cognitive processes.

But should we take all such findings at face value? What criteria should we set for accepting claims of no awareness, and are these criteria met in published reports?

This symposium will bring together researchers who work on unconscious processing and others who are critical of recent trends. We all acknowledge the need for rigor in verifying claims of unconscious processing, and are concerned that some recent reports may have been overblown. We will present work pertaining to the distinction between objective and subjective measures of (un) awareness, the role of metacognitive processes in such distinctions, and the need to rule out explanations that do not invoke unconscious processing before concluding that it has occurred. We will each give a presentation on recent relevant work, and will then conduct a group discussion – and hopefully, a constructive debate – on the best ways to produce believable reports of unconscious processing. We feel this is a discussion the field desperately needs.

Talk 1: Unconscious perception is not a single thing

David Carmel

University of Edinburgh, UK

A host of methods are commonly used to suppress stimuli from awareness, and successful suppression is assessed with various objective and subjective measures. But findings are often described under the all-inclusive heading ‘unconscious processing’, making the implicit – and almost certainly false – assumption that a unitary mechanism underlies results obtained with different combinations of methods and measures. In this talk, I will describe recent work employing different suppression methods and various measures of (un)awareness. I will contrast a masking study of subjectively-unconscious emotional processing with two continuous flash suppression studies of (objectively assessed) unconscious learning. I will discuss the different conclusions each measure affords, and the different mechanisms that may underlie different methods’ effects, concluding that ‘unconscious processing’ cannot be regarded a unitary concept. Finally, I will present ongoing work on the evolution of suppression over time, demonstrating that its effectiveness cannot be assumed just because it worked in the past.



Talk 2: Using unconscious information for sensory and bistable decisions

Joel Pearson

The University of New South Wales, Australia

Recently, there has been a surge of interest in exploring how different types of sensory, motivational and cognitive information continue to be processed without conscious awareness. Here, I will describe recent work on how different types of information can be processed and accumulated without conscious awareness. Results suggest that sensory, emotional and ambiguous information can be processed and affect simultaneous and subsequent behaviour without awareness. In light of these data I suggest that some sensory, emotional and cognitive processes continue although somewhat attenuated, without conscious awareness. When unconscious information like this modulates our behaviour, are we aware of the behavioural change or is it unconscious along with the informational cause? These data suggest that some behavioural changes are accompanied by awareness (metacognition), while others are not, depending on the type of information. Whether these unconscious processes can comfortably be called



unconscious perception remains debatable.

Talk 3: Improving on the null hypothesis: Bayesian objective and subjective thresholds

Zoltan Dienes

University of Sussex, UK

A fundamental problem applies to many demonstrations of subliminal perception, or to its denial. Typically, concluding perception is subliminal relies on asserting the null hypothesis of chance identification of the stimulus. Non--- significance has been the near universally used criterion for asserting the null. We all know that this is entirely invalid; fortunately now we have the tools to do considerably better. These Bayesian tools allow previous conclusions to be re--- evaluated, as will be demonstrated. It is not that the skeptics have been more rigorous; their denial of subliminal perception often rests on asserting the null hypothesis of no priming under certain conditions --- based only on non--- significance. We all know that this is entirely invalid. Thus, such claims will also be re---evaluated. I will show how both objective and subjective measures can be easily implemented to explore subliminal perception while escaping the inferential pitfalls of significance testing.



Talk 4: The mind's sea serpent

Axel Cleeremans

Université Libre de Bruxelles, Belgium

The idea that information processing can proceed without awareness has a long history. Like the mythical sea serpent, it keeps coming back with even more vigor each time it is thought to have been vanquished. While no one can deny that information processing takes place without awareness, the extent of such processing continues to be fiercely debated. Recent controversies about priming in both social and cognitive psychology show just how distant contrasting theoretical perspectives about this issue continue to be. Here, I will address the complex conceptual, epistemological, and methodological challenges associated with demonstrating that information processing can take place without awareness by drawing on recent research that specifically illustrates how the same results may yield different interpretations. I close by suggesting that experiments aimed at documenting unconscious information processing — be it in the domain of perception, memory or action — would benefit from a full adoption of Baars' contrastive approach, that is, they should be systematically designed so as to make it possible to compare, in the very same study, information processing with and without awareness.



SYMPOSIUM 4: Consciousness in sleep: what it is like, what can it tell us, and how it can be measured

Saturday 19th July, 3:30pm, AEB Auditorium

Chair: Chiara Cirelli

Summary:

Studying consciousness during sleep is, in principle, a powerful approach to understand how changes in brain activity relate to changes in consciousness. This is because during sleep the level of consciousness changes dramatically: it fades away in deep sleep early in the night, only to return in the form of vivid dreams late in the night. The content of consciousness also changes in remarkable ways during sleep. Often, reflective consciousness is severely diminished, but it can return, for example in lucid dreams. It is even possible to experience "bodiless" consciousness, where the first person perspective seems to shrink to just a point in space and time. Such extreme modifications of consciousness are only found, outside sleep, in severe neuropsychological disorders. Therefore, studying sleep consciousness offers a way to explore major changes in its level and content in healthy

subjects, in a reversible manner, and with the advantage of withinsubject analysis. Yet, rigorous scientific studies on this topic have been limited and remain difficult to perform.

Dreams are usually defined as vivid sensorimotor hallucinatory experiences that follow a narrative structure. Classical experiments based on reports after awakenings from different sleep stages or at different times of night found vivid dream recall in up to 80% of REM sleep awakenings, compared to only 7-9% of awakenings from NREM sleep. Based on these results, it was natural to conclude that the low-voltage fast activity that characterizes the electroencephalogram (EEG) during REM sleep, which is very similar to that during wake, is the reason why humans are conscious and dream during REM sleep but not during NREM sleep, when the EEG is dominated by high amplitude slow waves. However, subsequent studies demonstrated that the initial equation, REM sleep = dreaming, is at best an oversimplification. Indeed, when the question was changed from “did you have a dream?” to “what was going on in your mind just before you woke up?” it became clear that reports of conscious experiences during NREM sleep are much more frequent than previously thought. Specifically, upon awakening from NREM sleep stages N2 and N3 (N3 is the deepest stage of NREM), reports of some mental experience occur in 50-70% of cases, most often late at night, when NREM sleep reports are also longer and more hallucinatory. Indeed, up to 30% of all NREM sleep reports are indistinguishable by any criteria from those obtained during REM sleep. Considering that NREM sleep accounts for up to 75% of all sleep, this means that full-fledged NREM sleep dreams represent a significant portion of all typical dreams.

If classical dream reports can be obtained during any stage of sleep, and vice versa, some awakenings can yield no report, even from REM sleep, where do we stand now with respect to the relationship between brain activity and consciousness during sleep? This symposium will present a series of studies suggesting that this question can only be solved by moving away from the classical dichotomy NREM-REM sleep and beyond traditional sleep staging. Indeed, traditional staging treats brain activity as uniform in space and in time by using only a few EEG electrodes, and by collapsing EEG traces into 30-sec epochs. By combining recent powerful methods, Siclari, Czigic and Massimini will show how a refined spatial analysis can help identifying regionally specific predictors of dreaming and indicate, in real time, whether dream reports will be obtained. Siclari will describe her high density EEG experiments showing how, during both NREM and REM sleep, EEG activity preceding awakenings with conscious experiences differs from awakenings without conscious experiences. Czigic will describe EEG/fMRI experiments showing how functional connectivity decreases during slow wave sleep, but does so at different times in cortex and thalamus. He will also compare typical dreams, which are usually characterized by a significant decrease of voluntary control of action and thought, with lucid dreams, which are to some extent under the dreamer control, and show how lucid dreaming is associated with a reactivation of areas which are normally deactivated during REM sleep. Massimini will discuss experiments that combine high density EEG recordings and transcranial magnetic stimulation (TMS), and show that the response of the brain to a TMS pulse can offer a more sensitive measure of the inner state than does spontaneous EEG. Finally, Windt will discuss why dreams are interesting for the philosophy of consciousness, and propose specific experimental approaches that can build a stronger connection between dream research and philosophy of mind.

Talk 1: Neurophysiology of sleep

Chiara Cirelli

University of Wisconsin-Madison, USA

Dr. Cirelli will introduce the topic by describing sleep stages and the underlying neural correlates at the thalamocortical level, with a special emphasis on the UP and DOWN states of the slow oscillation, the fundamental cellular phenomenon that underlies the occurrence of slow waves during NREM sleep



Talk 1: Investigating sleep consciousness using high-density EEG

Francesca Siclari

University of Wisconsin-Madison, USA

Dreaming is a form of consciousness that occurs during sleep, while we are disconnected from the environment. It varies considerably in the course of the night, ranging from its near-absence soon after falling asleep to the vivid, hallucinatory experiences that are typical of REM sleep dreams. In a recent study, we aimed to investigate what determines the level of consciousness during sleep. To this aim we specifically developed a serial awakening paradigm that was used in combination with high-density EEG, a technique that provides an advantageous combination of temporal and spatial resolution. 800 awakenings were performed to systematically assess the presence and the content of sleep consciousness. Among the results, I will show how during both NREM and REM sleep, EEG activity preceding awakenings with conscious experiences differs from awakenings without conscious experiences. Moreover, I will describe how EEG activity changes in the transition from wakefulness to sleep and how these changes relate to the phenomenology of conscious experiences.



Talk 2: Sleep, dreams and consciousness: A neuroimaging perspective

Michael Czisch

Max Planck Institute of Psychiatry, Germany

Sleep is characterized by varying levels of conscious awareness, being lowest in deep nonREM sleep and reaching levels close to wakefulness during REM sleep. Altered cerebral activity and neural networking during sleep may cause these phenomenological changes. I will present simultaneous EEG/fMRI data derived from all sleep stages which characterize waxing and waning of consciousness during sleep, and compare these results to pharmacologically induced loss of consciousness. Exploiting lucid dreaming, I will also show how normal REM sleep dreaming and lucid dreaming differ in terms of cerebral activity, which may help to explain higherorder consciousness as observed in this particular dream state.



Talk 3: Dreaming, consciousness and the self: Spatiotemporal self- location and minimal phenomenal selfhood

Jennifer Windt

Johannes Gutenberg University of Mainz, Germany

The analysis of phenomenal selfhood in dreams is the key not only towards a deeper theoretical understanding of dream experience, but also towards isolating and empirically grounding the necessary conditions for minimal phenomenal selfhood. In our talk, we propose an empirically informed conceptual framework distinguishing potentially dissociable dimensions of phenomenal selfhood in dreams: bodily experience, epistemic agency, and spatiotemporal self-location. We present a multilevel model of dream experience, suggesting how transitions from wakefulness, via hypnagogic imagery, to dreams, but also from nonlucid to lucid dreams are related to changes in self-related processing. By focusing on the phenomenal-functional property of spatiotemporal self-location in dreams, we argue that dreaming extends insights from recent research on full-body illusions and propose a revised concept of minimal phenomenal selfhood. We close by formulating several open questions for interdisciplinary consciousness and dream research.



TALK CONCURRENT SESSIONS 1-3

Concurrent Session 1 - Thursday 17th July, 10:30am

Stream A: Neural Signatures and Models of Consciousness

Steele Building, Room 206

Patterns of event-related potentials reflect fast unconscious semantic analyses of how images relate to subjective connotations of time

Stefan Bode [1], Daniel Bennett [1,2], Jutta Stahl [3], Carsten Murawski [2]

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In everyday life, not every piece of perceived information is processed in a conscious, deliberate fashion. However, mere exposure to pleasant and rewarding stimuli can bias peoples' choices towards either immediate or delayed gratification. We hypothesised that this phenomenon might be based on carry-over effects from a fast, unconscious assessment of the abstract 'time reference' of an image, i.e. how the image relates to one's personal understanding and connotation of time. Here we investigated whether participants' post-experiment ratings of task-irrelevant, positive background visual stimuli for the dimensions 'arousal' (used as a control condition) and 'time reference' could be predicted from patterns of event-related potentials (ERPs) during passive image viewing. A 64-channel electroencephalogram (EEG) was recorded from 21 participants performing a demanding foreground choice-reaction task while on each trial one image (depicting objects, people and scenes) was presented in the background. A multivariate linear support vector regression (SVR) analysis was conducted to predict participants' subsequent ratings from spatio-temporal patterns of ERPs. Using SVR, both 'arousal' and 'time reference' ratings could be predicted from ~200 ms post-stimulus. In conclusion, our study found that brain activity during early stages of stimulus processing reflected both dimensions, even though participants were unaware about their subsequent importance. This demonstrates an early, automatic semantic stimulus analysis, which might be explained by the high relevance of 'time reference' to everyday decision-making, preference formation, and constructing a meaningful conscious experience.

Spectral phase and power predict stimulus category, but only power predicts visual awareness in intracranial EEG in humans

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Previous studies of the neural correlates of visual awareness have explored several possible candidates of neuronal features, including single neuron spikes, synchrony of the spikes, as well as collective neuronal activity probed by spectral power in the local field potentials. Phase information in lower frequencies (<10Hz) has been largely neglected, because of their response latency, which seems rather slow compared to instantaneous formation of visual percept. Here we tested if low-frequency phase can rapidly encode visual information, especially about the trial-by-trial fluctuation of visual percept. We analyzed intracranial EEG data recorded from lateral and ventral temporal lobes of 8 human epilepsy subjects, during their epilepsy-monitoring period. We used a machine-learning decoding technique and compared the latency and accuracy of encoded information based on power and phase from short-time Fourier transform with varying sizes of the time windows. In a fixation task, where subjects were presented with 5 stimulus categories, both the spectral power and phase features encoded stimulus category at comparable latencies and performance. In a continuous flash suppression (CFS) task in which visual awareness was manipulated, only power predicted awareness and phase decoding was near chance level. Our current findings imply (1) a possible neural coding mechanism of object categories at the high-level visual cortex in the lateral and ventral temporal lobes based on the timing of the collective neural response (i.e., the phase of the field potentials), and (2) that power, but not the phase, of on-going oscillations at these sites is correlated with visual awareness.

Resource allocation during the attentional blink: an MEG study using machine learning

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When participants are asked to perform two tasks in close succession, the performance to the second one is typically degraded. Recent studies suggested that the conscious perception of the second target stimulus is delayed by the execution of task 1 (the psychological refractory period, PRP), or can even fail if this execution is too slow (the attentional blink, AB). In the present study, we used multivariate pattern analysis to track the brain processes related to two independent tasks. Subjects were instructed to identify a sound (high or low pitch) followed at a variable asynchrony (100-900 ms) by a letter (Y or Z) embedded in a series of distractor. At short target asynchrony, we found a mixture of trials where the target letter was seen but the response was delayed, and trials where the letter remained undetected by the subject. Decoding analysis revealed that up to ~300-400 ms, brain activations related to task 1 and 2 were completely parallel and did not interfere with each other. After ~400 ms however, the brain activity became serial: task 2-related activations were decodable only once task 1 was completed. Importantly, parallel brain activations were observed in both seen and unseen trials while serial brain processes were measured only in seen trials. These results support models of a serial bottleneck in conscious perception and argue against models of shared resources in dual-task situations.

Conscious, but not unconscious, across-trial conflict resolution is associated with theta-band oscillatory neural modulations in dorsolateral prefrontal cortex

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Recent findings have refuted the common assumption that executive control functions of the prefrontal cortex exclusively operate consciously, suggesting that all cognitive processes could potentially operate in two distinct modes: a conscious one and an unconscious one. Although many cognitive functions can be launched temporarily unconsciously, several theoretical models of consciousness assume crucial qualitative differences between the two, which become fundamental when high levels of control have to be maintained across longer periods of time. According to the global workspace theory, conscious information processing relies on several high-level inter-connected cortical regions, primarily involving the dorsolateral prefrontal cortex (DLPFC). To test the assumption that consciousness is fundamental for long-term executive control and to explore the role of the DLPFC therein, we extracted oscillatory power dynamics from electroencephalographic data recorded while subjects performed a masked priming task in which conflict was elicited by conscious or subliminal stimuli. In line with the conflict-monitoring model, instantaneous conflict elicited a typical midfrontal theta-band (~4-9 Hz) power increase, which was virtually identical for conscious and subliminal conflict. However, conflict-induced behavioral adjustments on the next trial ("Gratton effect") were accompanied by increased theta power at dorsolateral prefrontal electrodes after conscious conflict only. In line with previous studies, this suggests that the initial detection of conflict by the medial frontal cortex (MFC) is automatic and unconscious. However, sharing and routing of conflict information between the MFC and the DLPFC, necessary to maintain conflict information across longer periods of time, is possibly a unique feature of conscious cognitive control.

Spectral signatures of brain networks in disorders of consciousness

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Theoretical advances in the science of consciousness have proposed that it is concomitant with balanced cortical integration and differentiation, enabled by efficient networks of information transfer across multiple scales. Here, we apply graph theory to compare key signatures of such networks in high-density electroencephalographic data from 32 patients with chronic disorders of consciousness, against normative data from healthy controls. Based on connectivity within canonical frequency bands, we found that patient networks had reduced local and global efficiency, increased modularity and fewer hubs in the alpha band. We devised a novel topographical metric termed modular span which showed that the alpha network modules in patients were also spatially circumscribed, lacking the structured long-distance interactions commonly observed in the healthy controls. Importantly

however, these differences between graph-theoretic metrics were partially reversed in delta and theta band networks, which were also significantly more similar to each other in patients than controls. Going further, we found that metrics of alpha network efficiency also correlated with the degree of behavioural awareness. Intriguingly, some patients in behaviourally unresponsive vegetative states who demonstrated evidence of covert awareness with functional neuroimaging stood out from this trend: they had alpha networks that were remarkably well preserved and similar to those observed in the controls. Taken together, our findings highlight distinctive signatures of brain networks that characterise disorders of consciousness. In the significant minority of vegetative patients who follow commands in neuroimaging tests, they point to putative network mechanisms that could support cognitive function and consciousness despite profound behavioural impairment.

“Aboutness” revisited: The implications for, and applicability of, relativizing the content-specificity of qualia in neuroscience

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In philosophy, conscious experience has traditionally been characterized by (1) quality and (2) “aboutness”. (1) is often phenomenologically defined as qualia, and is sometimes interpreted as opposed to function. (2) is often thought of as content-specific, such as the redness of red, and occasionally interpreted as reflectivity. Neuroscience has studied both (1) and (2) as a function or product of consciousness—the relationship between awareness, attention, and other meta-cognitive issues having received particular attention. For example, Wilke et al. (2009) suggest that the neural correlates of qualia can and should be distinguished from neural activity that is associated with cognitive access and perceptual reports, especially as a function of introspection. As a result, (2) has been positioned as an a priori of consciousness studies. However, Kanai and Tsuchiya (2012) observe that there are two conceptions of qualia in the recent neurosciences: narrow and broad. For an example of the latter they argue that Balduzzi and Tononi (2009) characterize one quale as a phenomenal experience that at any moment covers multiple sensory modalities (such as vision, touch, and so on). I firstly address the crucial differences between these two understandings of qualia. The former remains congruent with (2). In contrast, the latter conception, broad qualia, seems to be discontinuous in that it relativizes (2). Secondly, I investigate the implications and (clinical) applicability of relativizing the content-specificity of qualia.

Stream B: Perception and Attention

Steele Building, Room 309

The influence of stimulus visibility in priming depends on the type of masking

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One approach to determine the role of consciousness consists in the analyses of the limits of effects of unconscious stimuli. Various studies reported that semantic priming effects increase with increasing stimulus awareness, indicating that consciousness contributes to semantic processing. Motor priming effects, in contrast, do not necessarily depend on conscious awareness of the effective stimuli. From this pattern of results it has been speculated whether semantic processing requires consciousness whereas simply responding does not. Here we show that this difference between motor priming and semantic priming might result from differences in the masking procedures. We found priming effects independent of prime visibility when metacontrast masking was used with both motor and semantic priming. With pattern masking, however, priming effects with motor and semantic priming depended on prime visibility. This data cast doubt on a fundamental distinction between semantic and motor processing regarding the role of consciousness.

A model of acquired perceptual warping

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What we perceive is not simply a veridical mapping of the outside world to an internal space. The mapping is distorted, or ‘warped’. One of the best known manifestations of this warping is categorical perception (CP). CP is the phenomenon by which physically continuous stimuli are perceived in a non-continuous manner. A rainbow, for example, is perceived as having bands of colour rather than a continuously changing spectrum of colours despite its inherently continuous nature. Originally studied in the auditory domain, more recent studies have also revealed CP for complex visual patterns. While some forms of CP may be explained by the inherently non-linear nature of the sensory systems involved, CP of complex visual stimuli is regarded as an important phenomenon in cognitive science because it provides compelling evidence that internal categorical concepts can fundamentally alter how external stimuli are perceived. I argue that CP forms part of a general ability humans have to learn

mappings from external to internal representations. This ability allows us to perform sophisticated visual discrimination of items within categories with which we are familiar - cars, butterflies, trees, styles of architecture, fingerprints etc. etc. Specifically, I offer a model of how our visual system learns to warp its representation of visual input in a manner which enhances perceived differences between regularly viewed, similar-looking items, whilst at the same time diminishing perceived differences between objects of less interest.

Shape perception simultaneously up- and down-regulates neural activity in the primary visual cortex

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An essential part of conscious visual perception is the grouping of local elements (such as edges and lines) into coherent shapes. Previous studies have shown that this grouping process modulates neural activity in the primary visual cortex (V1) that is signaling the local elements. However, the nature of this modulation is controversial. Some studies find that shape perception reduces neural activity in V1, while others report increased activity in V1 during shape perception. Predictive coding theories of perception offer a potential solution to this controversy. Within this framework, the effect of feedback on early visual cortex may be either enhancement or suppression, depending on whether the feedback signal is met by congruent bottom-up input. Here, we directly tested this hypothesis by examining retinotopic neural activity in V1 during the perception of illusory shapes. Using functional magnetic resonance imaging (fMRI) and novel reconstruction methods in humans, we find that shape perception concurrently up-regulates neural activity in regions of V1 that have a receptive field on the shape but do not receive bottom-up input, and suppresses activity in regions of V1 that receive bottom-up input that is predicted by the shape. These effects were independent of attention. Together, these findings suggest that shape perception changes lower-order sensory representations in a highly specific and automatic manner, in line with theories that cast perception in terms of hierarchical generative models.

Neural correlates of subjective awareness for natural scene categorization of color photographs and line-drawings

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In this study, we aimed to investigate the neural correlates of subjective visual awareness by adopting color photographs and line-drawings in a natural scene categorization task. On each trial, a natural scene of six categories was flashed for 13 ms, and then followed by mask stimuli for 100 ms and a blank for 500 ms. The SOA between the image and the mask was 13, 26, 40 or 213 ms. Participants were asked to report the scene category by pressing a key and then report "how clearly did you see the image" with four possible options (1. no experience; 2. brief glimpse; 3. almost clear experience; 4. absolutely clear experience) by pressing a corresponding key. There were 10 blocks of 96 trials, during which ERPs were recorded. The behavioral results showed that there was no accuracy difference between color photographs and line-drawings for each awareness level, whereas participants reported less brief glimpse (not consciously visible) but more absolutely clear experience (consciously visible) for color photographs than for line-drawings. Importantly, the ERP results revealed that N2 and LPC (late positive complex) amplitudes varied with awareness level for both color photographs and line-drawings, while N1 and P2 amplitudes changed with awareness level only for color photographs but not for line-drawings. The results suggest that N1 and P2 are too early to reflect the emergence of conscious awareness while N2 and LPC are closely associated with the generation of subjective awareness. The results help resolve the current debate about neural correlates of conscious awareness.

Predicting visual consciousness from brain activity: Roles for noise and adaptation

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Recently, O'Shea, Kornmeier, and Roeber, (2013, PLoS ONE) used event-related potentials (ERPs) to predict the contents of visual consciousness during intermittent binocular rivalry. On each of numerous trials, they showed a first, 1000-ms, rival display—a vertical grating to one eye and a horizontal grating to the other—yielding visual consciousness of one or the other grating. Then they showed a 200-ms display of darkness, and then showed exactly the same gratings in a second, 1000-ms, rival display, yielding consciousness of either the same or the other grating. O'Shea et al. found that greater ERP activity 180 ms after onset of the first rival display predicted a change in visual consciousness in the second rival display. They suggested that greater initial

activity of neurons processing one grating meant they won the competition for consciousness in the first rival display, but that they adapted faster, making them likely to lose the competition in the second rival display. In the current study, we preceded the first rival display (now 533 ms) by a 533-ms monocular-adaptation display—one of the gratings to one eye and darkness to the other—yielding visibility of the displayed grating. In the first rival display, observers perceived the other grating—flash suppression. We found greater ERP activity 180 ms after onset of the monocular-adaptation display predicted a change in visual consciousness in the second rival display. We suggest that this predictive activity is consistent with a role for noise in brain activity mediating visual consciousness.

Attention and consciousness may operate through different gain functions

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The precise relationship between selective attention and visual consciousness is unknown. It seems that, generally, attention enhances conscious perception. However, it has recently been shown that focal attention and visual consciousness can have opposite effects on afterimage duration, and motion aftereffects. We showed that for afterimages, paying attention to the inducer caused a decrease in afterimage duration. Experimentally, focal attention was distracted with a central task; visibility was manipulated through the presence/absence of an inter-ocular mask. Here we used the same design, but studied the influence of inducer contrast on afterimage duration. Inducer contrast was 3, 6, 12, 25, 50 and 100% (0.2 cycles/°, 4°-peripheral Gabor patch). The dependence of afterimage duration on contrast was investigated in a 2x2 design, manipulating independently the presence/absence of attention and consciousness. We replicated previous findings that attention decreased the afterimage duration, and consciousness increased the afterimage duration. Interestingly, we found that reported visibility of the inducer (i.e. consciousness) causes a strong horizontal shift in the curves (suggestive of a contrast gain function for consciousness; $p < 0.05$ (t-test) between 6.3-25% contrast). Attention, on the other hand, caused a modest vertical shift (especially present in the invisible stimulus $p < 0.05$, 50 and 100%, t-test); suggestive of an activity or response gain function for attention. These data suggest that attention and awareness work through different gain functions.

Stream C: Body, Self and Agency

Steele Building, Room 329

Self-Touching Illusion and Bodily Self-Consciousness

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Recent studies on the rubber hand illusion (RHI) and full-body illusions have engendered two outstanding issues: the relationship between body-part and full-body ownership, and the relationship between body ownership and “experiential ownership” (whether I represent myself as the unique subject of experience). We conducted a series of experiments that combined RHI and the “body swap illusion” (Petkova and Ehrsson, 2008). The subject wore a head mounted display (HMD) connected with a stereo camera set on the experimenter’s head. Sitting face to face, they use their right hand to brush each other’s left hand. The subject watched through HMD either the experimenter’s hand from the first person perspective (1PP), and/or the subject’s own hand from the third person perspective (3PP, 180°), or the subject’s full body from 3PP (180°, with or without face). Here are our findings: (1) Compared with the asynchronous condition ($n=27$), the synchronous full-body condition generates a “self touching illusion”: the subject feels that “I am brushing my own hand!” ($n=26$, $p < 0.001$) (2) Questions about full-body ownership were presented to participants ($n=114$) both in the body-part and full-body conditions. Data suggest that the distinction between body-part and full-body ownership is only a matter of degree. (3) When subjects considered whether “it is me who is being brushed, not someone else”, the statistics do not really support the immunity principle (Shoemaker, 1968). We further suggest that the sense of full-body ownership provides an empirical interpretation of what philosophers call “self-as-object” but not “self-as-subject”.

Process, Consciousness, and Self

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This paper concerns the subjective dimension of consciousness. Thomas Nagel (1974) characterizes this subjective dimension in terms of the phrase “something it is like for the organism” (436), and claims that it “is essentially connected with a single point of view” (437). This issue has been approached mostly from the framework of substance metaphysics. In this paper, I challenge this presupposition and propose an alternative based on the framework of process metaphysics. One way to theorize about the subjective dimension of consciousness is to ask whether the point of view of consciousness has any connection to some kind of self. Is it the case that consciousness is necessarily for a self or from the self’s point of view? I analyze possible kinds of self from the framework of substance metaphysics—narrative self, psychological self, bodily self, and minimal self, and lay out possible relations between consciousness and these kinds of self. I show that none of them can be an adequate relation to ground the subjective dimension of consciousness. Having shown that, I argue for an alternative according to which consciousness is necessarily for itself. Moreover, this intrinsic reflexivity (for itself) of consciousness is best explained by treating consciousness ontologically as a ‘process’ in a technical sense. I show that this alternative can be further supported by Georg Northoff’s (2013) neuroscientific work on default-mode network and Antonio Damasio’s (2010) neuroscientific work on the connection between some subcortical structures and consciousness.

Audience Effect as Evidence for Mirror Self-Recognition in Chickens

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In some bird and mammalian species, an ‘audience effect’ is apparent in the context of either alarm or food calls, where an individual will only make a call if an audience (typically conspecifics) is present. For roosters (male *Gallus gallus*), this appears to be the case when making alarm calls warning of aerial predators. We present evidence gathered from 30 roosters of three different breeds (Breda, Bergischer Kräher, and Rheinländer) that demonstrates a clear audience effect, where individuals are much more likely to alarm call in the presence of either a male or female conspecific (of a same or different breed) rather than when the neighboring arena is empty, or when faced with a mirror. This evidence suggests at least a basic ‘self-other’ self-recognition distinction, as they are significantly less likely to alarm call in the visual presence of their reflection as opposed to other conspecifics.

Altered experiences of control in expertise, schizophrenia and hypnosis: Measuring and understanding changes to the sense of agency

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Sense of agency, the sense we have of controlling our actions, is an integral part of our conscious experience. Most of the time this sense is obvious and uncontroversial. There are situations, however, where sense of agency is reduced or breaks down completely. Three prominent examples of agency alteration are: actions made by expert sportspeople or musicians, which are often described as happening spontaneously in a state of ‘flow’; actions made by clinical patients with passivity symptoms, which are often described as occurring without any conscious intention; and actions made in hypnosis, which are often described as occurring with surprising ease and automaticity. Paradoxically, sometimes feelings of reduced agency are seen as mark of excellence (e.g., when a tennis player spontaneously returns a high speed serve), whereas other times reduced agency is experienced as highly distressing (e.g., impulsive movements in schizophrenia). I will report on a series of studies that analysed agency alterations across contexts in order to quantify and better characterise the phenomenology of these disruptions. This research resulted in the development of a new psychometric measure, the Sense of Agency Rating Scale, and identified two distinct factors underlying agentic experience: Involuntariness and Effortlessness. I will discuss how this two-factor conceptualisation relates to other theoretical accounts of sense of agency and prospects for using the Sense of Agency Rating Scale as an experimental tool in consciousness research.

Experimentally induced changes in Bodily Self Consciousness affect semantic processing

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Bodily self-consciousness (BSC) refers to the experience of the Self, as being located in one body, which occupies a spatial location and is felt as one's own. We propose that the experience of the embodied self grounds any level of information processing, including semantic processing. We manipulated BSC, by using the Full Body Illusion (FBI): when participants feel touch on their back, while synchronously viewing the back of an avatar being touched, they incorporate the avatar's body. While experiencing the FBI (and in a control condition of asynchronous visuo-tactile stimulation), participants underwent a modified version of a Stroop-task. They were asked to determine whether a word was presented either close to their body or far from them (i.e. at the location of the avatar), on virtual landscape scenes. The words conveyed semantic contrasts in terms of physical (Near, Far), or social distance (Us, Them). So, words' "semantic" distance could be congruent or incongruent with words location. In the control condition, participants were faster in determining the location of words of congruent "semantic" distance, meaning that physical and psychological distances were processed in terms of distance from the physical body. Instead, when subjects experienced the FBI, which induced a displacement of the Self towards the avatar, words' position was coded in terms of distance from the avatar's body. These results suggest that semantic processing is referenced to the Self, which is normally experienced as being located at the physical body, but whose experience can be experimentally altered by inducing the FBI.

Intentional Binding With a Robotic Hand - To what extent is agency modulated by embodiment?

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The Sense of agency is the feeling that we control our actions, and through them, the external world. In 2002, Haggard, Clark and Kalogeras developed an innovative measure of agency called Intentional Binding (IB). The IB effect refers to the subjective experience that the temporal interval between a voluntary action and its consequence is shorter than what it actually is. Strikingly, the experienced temporal interval between an involuntary action and its consequence is actually longer than in reality. IB studies, however, often fail to replicate real life conditions. Participants generally act alone, whereas in social contexts, people generally accomplish tasks with partners. Joint-action paradigms address this issue. In such paradigms, studies have shown that the IB effect occurs when the partner is a human being rather than a computer. Here, we propose a novel paradigm to explore the IB effect. In this paradigm, participants control a robotic "rubber hand" that is capable both of duplicating the hand movements of participants as well as to act on its own through a programmable interface. In a first experiment, we show that people can integrate this mechanical member as a part of their body, thus replicating the classic "rubber hand illusion". In a second experiment, we asked participants to carry out an IB task using the robotic hand. Results show that participants exhibit an IB effect, but only when they experience ownership and agency of the robotic hand. The IB effect vanished when participants could not control the hand or when the movement was not congruent with their own movement (i.e., moving the index resulted in the hand's moving its little finger). Our study demonstrates that, in contrast to previous studies, an IB effect can be observed when interacting with extraneous artefacts, but only when they are fully embodied.

Stream A: Anaesthesia, Sleep and Seizures

Steele Building, Room 206

Brain networks dynamics before sedation predict subsequent loss of consciousness

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Sedatives are commonplace for inducing unconsciousness in clinical anaesthesia. However, the search for reliable brain markers to identify appropriate dosage for inducing unconsciousness, and for tracking changes in the level of consciousness alongside sedation, remains an ongoing research challenge. Here we report the application of spectral connectivity analysis to high-density resting state electroencephalographic data acquired from 22 healthy volunteers during mild, progressive propofol sedation, administered alongside measurements of behavioural performance and blood concentration of the drug. Employing graph-theoretic analysis of connectivity, we identified changes in the modular structure of brain networks in the alpha frequency band that were correlated with the impact of sedation and degree of behavioural accuracy. As previously suggested, there was characteristic emergence of frontally centered hyperconnected alpha network clusters, but only in subjects who were significantly behaviourally impaired by propofol. Interestingly, in comparison to relatively unimpaired subjects who were still able to respond to perceptual stimuli while sedated, impaired subjects had significant differences in the modularity and centrality of their alpha band networks even before sedation. This was despite the fact that the two groups were statistically indistinguishable in terms of behavioural accuracy, alpha power or peak frequency before sedation. In other words, individual variability in alpha networks before sedation partially explained why some subjects would eventually become behaviourally impaired by propofol, despite registering similar levels of it in their blood. These findings contribute to current interest in the brain network properties of (un) consciousness, and could help reduce the clinical incidence of intra-operative awareness.

Breakdowns in parietal network functional connectivity reflect agent-invariant network changes underlying anaesthetic-induced reductions in consciousness

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Electroencephalographic (EEG) studies with the general anaesthetic propofol (gamma-aminobutyric acid - GABA - receptor agonist) and the weak anaesthetic nitrous oxide (N-methyl-D-aspartic acid - NMDA - receptor antagonist) have implicated a breakdown in parietal brain network functional connectivity as a common network change observed with these anaesthetics at doses leading to reductions in consciousness. Here we demonstrate that reductions in consciousness induced by the general anaesthetic Xenon (NMDA receptor antagonist) are also linked to a breakdown in parietal brain network functional connectivity, as well as other network changes. Three subjects underwent increasing levels of Xenon inhalation (8%, 16%, 24% and 42% Xenon/Oxygen) until loss of responsiveness was obtained and while high density 64 channel EEG was recorded. For full-brain, frontal and parietal level networks functional connectivity was defined as the topological global efficiency in the network (derived from surrogate-corrected zero-lag correlations). Responsiveness was tracked using an auditory task. Loss of responsiveness was obtained in 1 subject and 2 subjects at peak gas levels of 24 and 42%, respectively. For each individual, loss of consciousness coincided with statistically significant ($p < 0.05$; Mann-Whitney U test) reductions on the order of 25% in parietal level functional connectivity compared to rest. These findings, together with prior studies, suggest that a breakdown in parietal brain network functional connectivity is the common brain network change underlying agent-invariant anaesthetic-induced reductions in consciousness. These findings are important for understanding how anaesthesia causes reductions in consciousness and point to a potential parietal backbone for generating global states of consciousness.

Disruption of hierarchical auditory predictive coding during sleep

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To what extent does the sleeping brain continue to process external stimuli? The Mismatch Negativity (MMN) and the P300 components of the auditory event-related potential, which reflect two stages in the detection of auditory novelty, have been inconsistently observed across sleep stages. To clarify this issue, we recorded simultaneous electro and magneto-encephalographic signals before, during and after sleep in normal subjects listening to a hierarchical paradigm with short-term (local) and long-term (global) auditory regularities that disentangles the MMN and the P300. The global response, reflected in the P300, vanished during sleep, in line with the hypothesis that the P300 is a correlate of high-level conscious error detection. The local mismatch response remained across all sleep stages (N1, N2 and REM sleep), but with an incomplete structure: compared to wakefulness, a specific peak previously attributed to prediction error was missing. The mismatch response was larger for auditory stimuli introduced only during sleep than for stimuli previously heard during wakefulness, with a propagated response into the cingulate cortex. In conclusion, the results indicate that sleep leaves intact basic auditory responses and stimulus-specific adaptation processes, but specifically disrupts both long-term and short-term auditory predictive coding.

Consciousness during Sleep: what happens to it? Its relevance to Insomnia?

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Forced awakenings from all stages of sleep usually elicit subjective reports of mental activity prior to the awakening. The nature of these reports vary with the stage of sleep with Rapid Eye Movement (REM) sleep associated with the most dramatic reports usually identified as dreams. Does this suggest that consciousness exists across most of the sleep period? If so, why is so little of this putative activity recalled following sleep? This has been explained by the absence of the memory consolidation mechanism during sleep. Whatever the fate of all this apparent conscious activity, the last remnants of it upon awakening can be misinterpreted as wakeful thinking activity. Our research studies have investigated the effects of this recognized mental activity on judgments of prior sleep or wakefulness when awoken from sleep. Good sleepers were compared with those suffering chronic insomnia. People with insomnia usually underestimate the amount of time they objectively sleep and that assessment, in the context of recommendations for eight hours of sleep, can contribute to anxiety and the perpetuation of their insomnia. While good sleepers guess on about 30% of forced awakenings that they had already been awake, chronic insomnia sufferers guess prior wakefulness about 70% of forced awakenings from sleep. With several awakenings across the night it is very likely that insomniacs then judge continuous wakefulness between sequential awakenings leading to underestimating total sleep amount. This research has implications for the use of cognitive therapy in the treatment of chronic insomnia.

Inducing task-relevant responses in the sleeping brain

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Sleep is characterized by a lack of behavioural responses to the environment, but the extent to which the brain continues to process external stimuli remains largely unknown. In two experiments, we combined a task induction strategy with electroencephalographic (EEG) measures of response preparation in order to study whether sleeping subjects can perform decisions on the meaning of spoken words. Awake subjects performed semantic categorisation (animal vs. object word) or lexical decision (word vs. nonword) while transitioning towards sleep and then continued being tested for covert response preparation towards the appropriate category during early non-REM sleep. Brain markers of intention-to-act, in the form of lateralized readiness potentials, revealed that the participants continue to trigger category-specific responses even after falling asleep. These findings show that despite the absence of awareness and behavioural responses, individuals can still extract task-relevant information from external stimuli and prepare for the appropriate response during sleep.

Mechanism of impaired consciousness in childhood absence seizures

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Absence seizures are transient episodes of impaired consciousness accompanied by 3-4 Hz spike-and-wave discharges on electroencephalography (EEG). Prior work has shown that the severity of impaired consciousness varies from one absence seizure to the next. The mechanism of this impaired consciousness and its variability is not known. We performed simultaneous EEG-functional magnetic resonance imaging (fMRI) and high-density 256 channel EEG on pediatric patients while they performed either a simple repetitive tapping task (RTT) or a more challenging continuous performance task (CPT). A total of 598 seizures were captured in 37 patients. Performance on the behavioral tasks varied across patients and across seizures, with some seizures having poor performance and others good performance. fMRI signals were analyzed using a data-driven model-free approach

revealing sequential involvement of three major brain networks during seizures: 1. Default mode network; 2. Task positive network; 3. Primary sensorimotor thalamocortical network. The amplitude of both the fMRI increases and decreases in all three networks was greater in seizures with poor performance than in those with good performance. Quantitative analysis of high-density 256 channel EEG similarly revealed larger signal amplitude in widespread brain networks during seizures with poor versus good performance. These findings demonstrate that impaired consciousness in absence seizures is related to sequential abnormal activity in core brain networks necessary for conscious information processing including the default mode network, task positive network, and primary sensorimotor cortices. Further investigation of the coordinated involvement of these networks may lead to improved treatments to prevent impaired consciousness in this disorder.

Stream B: Predictive Processes

Steele Building, Room 309

Expect surprises

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Experiences of the unexpected involve immediate reactions to novel, unanticipated, or atypical features or events: e.g., seeing an elephant disappear in the circus trick, or spotting a new building on the way to work. There is, however, a question about whether perceiving the unexpected is always a result of unsuccessful or suboptimal predictions. At a circus, ignorance is bliss; we delight in the unforeseen. In life, the unexpected can bring harm and demands fast responses. This sets certain optimality conditions: we ought to maximally predict and prepare for the unexpected. But is the latter possible? Can an observer expect the unexpected? Can the novel or the atypical serve as targets for perceptual prediction, or are they always consequences of prediction failure? I focus on two forms of perceiving the unexpected: experiences of change and experiences of absence. I show that the optimization of these forms of perception is both implied by predictive coding approaches to perception (Rao & Ballard, Friston, Clark), yet presents a challenge for those approaches. I offer a solution to this puzzle and discuss implications for predictive coding and expectancy paradigms in animal and infant cognition.

Consciousness in the Predictive Mind

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Neuroscience and philosophy are still unable to explain how the brain gives rise to and shapes our conscious experience. None of the many theories of consciousness have truly come to dominate, and there is still considerable disagreement about what it would even take to explain consciousness. Most contemporary theories are what might be called top-down theories: they begin with some favoured characteristics of consciousness, and then construe a theory that explains them. This gives rise to a selective and heterogeneous theoretical landscape. This talk advocates a different, seldom adopted, bottom-up approach: begin with an overall theory of brain function, and then seek to recover an account of consciousness from within that theory. The overall theory in question is based on Friston's free energy principle, the increasingly influential theory that the brain is nothing but a sophisticated hypothesis-tester. If this theory is true, then the mind is essentially all and only predictive. Crucially, the mechanisms underlying consciousness must then also be found within the Predictive Mind. The talk sets out this bottom-up approach to the science of consciousness and considers its prospects. Though it is challenging to situate consciousness in the predictive mind, the approach has great potential for unifying aspects of existing theories and for providing new explanations for aspects of consciousness.

Hierarchical Temporal Intentionality

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In recent years, a more unified understanding of the functioning of the neocortex has emerged. This understanding sees the neocortex as a hierarchically structured Bayesian prediction machine that perceives and acts according to a delicate interaction between direct inputs from the body and environment, and feedback within the brain concerning what it expects those inputs to be. This hierarchical predictive coding model provides an elegant account of how attention, perception, cognition and action can be understood as different aspects of a single process that aims to minimise prediction errors. Nevertheless, predictive coding models are not immediately concerned with predicting the future, but rather with predicting what is to happen now. As such, the predictive coding paradigm leaves the temporal horizons of experience unexplained. These horizons were first clearly identified in Husserl's investigations of the unified tripartite structure of temporal consciousness. Several recent attempts have been made to explain how such a tripartite structure could be realised within current understandings of neocortical processing,

but, as yet, none have been convincing. In this paper I introduce Jeff Hawkins' model of neocortical processing that extends hierarchical predictive coding by proposing that the entire neocortex is engaged in sequence learning. This hierarchical temporal memory (HTM) model provides a coherent mapping between processes occurring in the brain and the structures of temporal consciousness. The paper also provides a phenomenological examination and re-interpretation of the meaning of the HTM model. This re-interpretation takes both consciousness and neocortical functioning to be fundamentally structured in terms of intentionality.

Predictive Perception of Sensorimotor Contingencies: Explaining perceptual presence and its absence in synaesthesia

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Normal perception involves experiencing objects within perceptual scenes as real. This property of "perceptual presence" has motivated "sensorimotor theories" which understand perception as the mastery of sensorimotor contingencies. However, the mechanistic basis of sensorimotor theory has remained unclear. The theory also struggles to explain instances of perception, like synaesthesia, that appear to lack perceptual presence and where relevant sensorimotor contingencies are difficult to identify. On alternative "predictive processing" theories, perceptual content emerges from probabilistic inference on the causes of sensory signals, however this view has addressed neither perceptual presence nor synaesthesia. Here, I describe a theory of Predictive Perception of Sensorimotor Contingencies which (i) accounts for perceptual presence in normal perception, and its absence in synaesthesia, and (ii) operationalizes the notion of sensorimotor contingencies and their mastery (Seth, A.K., 2014, Cognitive Neuroscience). The core idea is that generative models underlying perception incorporate explicitly counterfactual elements related to how sensory inputs would change on the basis of a broad repertoire of possible actions, even if those actions are not performed. These "counterfactually-rich" generative models encode sensorimotor contingencies related to repertoires of sensorimotor dependencies, with counterfactual richness determining the degree of perceptual presence associated with a stimulus. While the generative models underlying normal perception are typically counterfactually rich (reflecting a large repertoire of possible sensorimotor dependencies), those underlying synaesthetic concurrents are hypothesized to be counterfactually poor. In addition to accounting for the phenomenology of synaesthesia, the theory naturally accommodates phenomenological differences between a range of experiential states including dreaming and hallucination.

Task demands modulate the effects of perceptual expectations in early visual cortex

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Expectations can influence our conscious perception, and modulate how stimuli are processed. Are such effects of expectation automatic, or do they require attention? To investigate this, we orthogonally manipulated spatial attention and perceptual expectation. We acquired fMRI data in 30 healthy human subjects. On each trial, a grating annulus surrounding a noisy, coloured letter at fixation was presented following a tone. Tones predicted the orientation of the upcoming grating with either 100% or 50% validity. To manipulate attention, participants responded to the spatial-frequency of the gratings (grating task) or performed one of two fixation tasks: a 1-back task on letter (perceptual task) or 2-back task on colour (working memory (WM) task). The grating-evoked response in early visual cortex was strongest during the grating task, weakest during the perceptual task, and intermediate during the WM task. Task set determined whether predictions led to a suppression or enhancement of grating activity. During the perceptual task, activity was reduced when perceptual expectations about the grating were strong (100% blocks) versus weak (50% blocks). However, during the grating task, activity was increased with strong expectations. There was no effect of expectation during the WM task. Our results suggest that task demands modulate the effect of perceptual expectations on the response. The neural response to predicted stimuli is facilitated when stimuli are task relevant; suppressed when they compete with task resources (perceptual task); and unaffected when they do not (WM task).

Mechanisms of deviance detection are affected by visual consciousness

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We tested whether visual consciousness affects our processing of predictability of visual inputs. We used event-related potentials from 12 participants to reveal differences to infrequent gratings—deviants, randomly presented in a sequence of frequent, orthogonal gratings—standards. To prevent participants from perceiving the gratings in some blocks, we presented gratings to one eye and a 10 Hz random sequence of Mondrian patterns to the other eye. To allow participants to perceive the gratings in other blocks, we presented a blank field to the eye viewing the Mondrians whenever we presented a grating to the other eye. To distinguish adaptation-based and prediction-error-based mechanisms, in other sorts of blocks we presented the same gratings

along with others of different orientations so that all were equiprobable. Participants performed an unrelated task at fixation on all blocks. Forced-choice judgements of grating orientation in a post-test showed that performance was at chance for non-perceived gratings and above chance for perceived gratings. We found similar deviance-related activity (DRA) at posterior right electrodes from about 100 ms after stimulus onset to about 370 ms for perceived and non-perceived gratings. By comparing these DRAs to responses to equiprobable gratings, we show that visual consciousness does not affect the adaptation-based DRA, up to about 150 ms, but that it affects DRA later: There was prediction-error activity at about 200 ms for perceived gratings and up to about 350 ms for non-perceived gratings. We conclude that visual consciousness speeds our processing of predictability of visual inputs.

Stream C: Time Perception and Temporal Processing

Steele Building, Room 329

Hierarchical processing in the infant brain: a late response might signal conscious access in three-month-old infants

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In adults, conscious access is correlated with an increase of neural activity in a large network of cortical regions connected by long-distance fibers. Looking for the same neuronal markers in infants is a first step to understand how consciousness emerges during development. In this study, we presented audio-visual vowel sequences whose regularity was occasionally violated, to three-month-old infants while high-density EEG was recorded. We showed that infants processed novelty in temporal sequences at two distinct levels. Violations of local expectancies, such as perceiving a deviant vowel “a” after repeated presentation of another vowel i-i-i, elicited an early auditory mismatch response. Conversely, violations of global expectancies, such as hearing the rare sequence a-a-a-a instead of the frequent sequence a-a-a-i, modulated this early mismatch response and remarkably led to a late frontal negative slow wave, whose cortical sources included the left inferior frontal region. Thus, violations of local and global regularities affect distinct time windows suggesting hierarchical brain mechanism similar to what is observed in adults. In particular, the late frontal response which was only recorded for the violation of a global rule, suggests that an elementary form of conscious-level processing may already be operative at this age.

On the modulation of interoception: Insights from the use of food deprivation in healthy females and cognitive-behavioral therapy in anorexia nervosa.

Olga Pollatos [1] Sarah Weiss [1]

[1] Health Psychology, Institute of Psychology, University of Ulm, Germany

Internal signals like one's heartbeats are centrally processed via specific pathways and both their neural representations as well as their conscious perception (interoception) provide key information for many emotional and cognitive processes. While humans differ essentially in interoceptive awareness, research is sparse aiming at the question how interoceptive processes can be modulated. In a first study, we investigated how short-term food deprivation interacts with interoceptive processes. Results show that an imbalance in sympathovagal activation evoked by food deprivation accounted for an increase in interoceptive sensitivity. In a second study, we focused on the interoceptive processes in anorectic females in the time course of a cognitive-behavioral therapy. We could demonstrate that interoceptive awareness can be modulated and that this interacts with self-regulation, behavior associated with feelings of satiety and tasks referring to somatic markers required for guiding individual behaviour.

Experimental Evidence That Illusory Percepts Are The Basis Of The Flow Of Time

Ronald Gruber [1], Michael Bach [2], Richard Block [3]

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The Block Universe Theory and related physical theories contend that the flow of time (FOT) is an illusion. There is a low-level FOT that the world is dynamic and b) a high-level FOT that events pass from future to present to past. As a consequence, people believe they are the same person throughout their life despite any changes that may occur. We present experimental results suggesting that the FOT is based upon two perceptual illusions, a) perceptual completion and b) object persistence. Perceptual completion is a necessary component for robust perception of the world. Apparent motion (AM) is an example of this transformation over spatiotemporal gaps. We recently described a new illusory percept, happening, resulting from a series of spatiotemporal or temporal-only stimuli. It is an unrecognized distinct percept evoked at frequencies as low as 0.6 Hz. Unlike AM, a continuity illusion, happening is a percept of completion involving the spatiotemporal transformations of all events (stimuli). It is omnipresent involving all sensory modalities as our demonstrations indicate. Both percepts provide a dynamic view of the

world. If, as these experiments indicate, perceptual completion between all events is illusory any percept (object persistence in this case) emanating from those spatiotemporal gaps is of necessity a perceptual illusion also. The net result is that the flow of time in its entirety can be deconstructed to two perceptual illusions: object persistence and perceptual completion.

New evidence for the differences in time perception during foveal and parafoveal vision

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While there is a growing body of evidence suggesting a close link between spatial attributes and time perception, there remain a number of unanswered questions in regards to the mechanisms of this spatio-temporal relationship. The current study explored an aspect of this relationship by asking whether accuracy of the perceived duration of a visual object depends on its location in the visual field. If so, it is possible that the mechanisms underlying differences in visual acuity may also be involved in the precision of time perception. In three experiments, we measured the perceived duration of a stimulus that appeared at different locations in the visual field. Specifically, participants were asked to maintain their gaze at a central fixation cross while covertly keeping track of the duration of a visual stimulus (e.g., a circle). The stimulus appeared either right below the cross (i.e., projected onto the fovea) or at one of the eight locations in the visual periphery along the horizontal meridian. The participants reported the perceived duration by pressing a key to start and end a timer after the stimulus disappeared. We observed that the perceived duration was shorter and more accurate when the stimulus appeared in central vision. Additionally, the perceived duration systematically increased as the stimulus position deviated horizontally from the central position in both left and right directions ($p < .05$). These findings provide empirical support for a spatio-temporal interaction in time perception, implicating that temporal precision may depend on mechanisms responsible for differences in spatial acuity.

Altered Time Perception in Patients with Bipolar Disorder

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Introduction: It is difficult to imagine being conscious without having a perception of time. However, in people who have an altered experience of time, temporal disintegration, this usual and effortless relationship with time is fundamentally altered. Here we explore whether alterations to time perception in daily life are reflected in sub-second timing tasks thought to rely on fundamental aspects of neuronal processing. **Methods:** We used a prospective, repeated measures study design with 21 patients with bipolar disorder, conducted at Barwon Health in Geelong, Australia. It combined questionnaires of mood and dissociative symptoms, electroencephalography, and a psychophysical method of assessing altered sub-second temporal performance. Participants observed a pair of closely flashed visual stimuli timed to coincide with saccadic eye movements, and were asked which flash came first. It has previously been shown that this type of stimulus causes “temporal inversion” (Morrone et al. 2005), where the second flash is perceived before the first in a proportion of trials. **Results:** Temporal inversion occurred in 47% of trials. More importantly, the proportion of inverted temporal judgments correlated with both dissociative symptom scores (CADSS unreality subscale, Pearson’s $r = -0.36$, $p < 0.05$) and with the Young Mania Rating Scale (YMRS) score (in linear model, $p < 0.01$). Electroencephalography results also showed higher beta band activity in temporal electrodes during temporal inversion. **Discussion:** Patients with bipolar disorder experience changes in their perception of sub-second temporal stimuli associated with symptoms changes and changes in mood, providing a new avenue to explore how time perception is tied to underlying neurological processes.

Modulating temporal recalibration with degraded visual awareness

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The mechanisms underlying audio-visual timing judgments are not well established. Prolonged exposure to temporally offset audio and visual signals (adaptation) results in a distortion of perceived timing; events presented in the same order and near the same offset as the adapted stimuli are more likely to be judged as synchronous. Does this flexibility of perceived timing involve the conscious processing of timing relationships? Some evidence suggests the determination of audio-visual timing takes place pre-attentively, and other evidence suggests the relative timing of the two signal streams must be attended. We therefore decided to investigate the role of awareness – the assumption being that TR should be degraded for subliminal adaptation if conscious attention of timing is required for audio-visual temporal judgments. As a control condition, we measured the tilt aftereffect (TAE), which is known to be robust for subliminal adaptation. We used dichoptic presentations to mask awareness of the dynamics and orientation of visual adaptors and tests. Consistent with previous findings, we found that the TAE could be elicited by either supra- or sub-liminal adaptation. In contrast, we found that only supra-liminal adaptation resulted in a robust TR. These results

suggest conscious awareness of the adapting visual dynamics is important for recalibrating temporal relationships, an effect we attribute to the need to consciously attend the adapted audio-visual temporal offset.

Concurrent Session 3 – Saturday 19th of July, 1:30pm

Stream A: Action and Behaviour

Steele Building, Room 206

(Almost) twenty years of pictorial illusions, perception, and action

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Nearly twenty years ago, we reported that anticipatory scaling of a grasping movement appeared to be insensitive to the familiar Ebbinghaus (or Titchener's circles) illusion (Aglioti, DeSouza, & Goodale, *Current Biology*, 1995). In other words, even though perceptual estimates of the size of a target disk in the illusion display were affected by the presence of the surrounding annulus, maximum grip aperture between the index finger and thumb of the grasping hand, which is typically reached about 70% of the way through the movement, was scaled to the real not the apparent size of the disk. This dissociation was interpreted as evidence for the well-known distinction between vision-for-perception and vision-for-action (Goodale & Milner, *Trends in Neuroscience*, 1992). Since our original report, the dissociation has been replicated many times using a wide range of different size-contrast illusions. Nevertheless, other studies have shown that action and perception are affected in the same way by these illusions. It has been suggested that the apparent difference in sensitivity between perceptual judgements and grip scaling is due to other factors such as differences in attention and/or the slope of the psychophysical functions describing the relationship between target size and the required response. In this presentation, I review some of the critical factors that determine whether or not pictorial illusions will have an effect on visually guided actions – and will present new evidence that goes some way to providing a resolution to this debate.

The evolutionary function of conscious information processing is revealed by its task-dependency in olfaction

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Although many responses to odorous stimuli are mediated without olfactory information being consciously processed, some olfactory behaviors require conscious information processing. I will here contrast situations in which olfactory information is processed consciously to situations in which it is processed non-consciously. This contrastive analysis reveals that conscious information processing is required when an organism is faced with tasks in which there are many behavioral options available. I therefore propose that it is the evolutionary function of conscious information processing to guide behaviors in situations in which the organism has to choose between many possible responses.

Seeing through action: Implicit action cost constrains the perceptual decision making

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Perceptual decisions refer to decisions made based on certain feature of the sensory signal. The decisions are usually expressed through actions, however, in daily life, the physical effort (motor cost) that involves in each action can vary between decisions. Here, we show that the motor cost associated with a perceptual choice is integrated with the perceptual decisions when the cost is provided implicitly. Participants judged the direction (left/right) of a visual motion by moving a robotic device, which was held one in each hand. (i.e. leftward motion requires left hand movement). Resistance for the left movement was increased by a small amount for every movement, so that the participants were unaware of the resistance. In the other experiment, resistance increased in one single step, causing the participants to become aware of the manipulation. Implicit increase of resistance to the left biased the judgment towards a direction to avoid the leftward decisions. This bias was not observed when the participants were aware of the cost. Further experiments demonstrated that such perceptual bias transfers to judgements using different effectors, showing that the implicit motor cost influences the decision at the level of visual categorisation, not only at the level motor selection. Model-based analysis under drift diffusion model suggested that the bias is induced by the change in the read-out process of the signal. The study indicates that our daily perceptual decision that we believe we made it based on the sensory input may be, in fact, constrained by the simple physical cost to act.

Does a fly know when it is in control?

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Visual attention to our surroundings is influenced by awareness of our own actions. –This raises the question of whether having control over a visual stimulus may engage the brain in different ways. We addressed this question in the fruit fly, *Drosophila melanogaster*, by examining brain-wide neural responses during visual attention tasks. Behavioural and neural responses were simultaneously recorded in tethered walking flies responding to visual stimuli. Flies were able to control the position of a flickering stripe in a virtual reality arena, using their body movements to keep the stripe in front of them. Neural responses to the flickering stripe were observed in the steady-state visual evoked potentials (SSVEPs) in the brain, oscillating at the same frequency as the flicker. Active control of the stimulus corresponded with an increase in SSVEPs across the fly brain compared to when the fly was not controlling the stimulus. Velocity of the visual stimulus also influenced SSVEPs; when the stripe was moved at speeds that mimicked the fly's own behaviour, the SSVEP receptive fields were larger than those of more artificial movements. Finally, attention-like behaviour was associated with increased coherence of SSVEPs between central and peripheral brain regions. Together, our results uncover SSVEP and coherence effects in the fly brain that depend on the ability to control, predict, or pay attention to visual stimuli.

Egocentric representation and the two-visual systems hypothesis

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The two visual systems hypothesis (TVSH) has been criticized as being implausible on the basis of perceptual experience: that the dissociation of function between the ventral and dorsal streams cannot account for our visual experience. According to this argument: • The dorsal stream processes visual information egocentrically. • The ventral stream processes visual information allocentrically. • The contents of the ventral, but not the dorsal, stream contribute to the contents of visual experience. • Therefore, according to the TVSH, the contents of visual experience must be entirely allocentric. • However, goes the argument, this is clearly wrong because we clearly do not visually perceive the world in only allocentric terms: we also experience objects and scenes relative to us. However, this challenge is based on a conflation of two notions of “egocentric” that are entirely separate: • Dorsally mediated egocentric processing (E1) • The perceptual notion of egocentric processing (E2), appealed to in the argument above. The argument against the TVSH is based on the false assumption that the latter depends on the former, and thus dorsally processed visual information must contribute to the contents of visual experience. A distinction, in the scene perception literature, between (1) ‘prominent object’ or ‘surface’ representation; (2) ‘multiple-component’ representation; and (3) ‘global emergent features’ representation; can illustrate why this is wrong: • (1)+(2) are the appropriate level to talk about allocentric ventral stream processing. • E2 is best considered as being a feature of (3), not (1) or (2). • But (3) is not constituted out of the processing at levels (1)+(2).

The Impact of Prior Expectations on Subliminal Behavioral and Electrophysiological Responses

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In recent years it has been proposed that motor activation may provide a window into perceptual decision. More specifically, De Lange et al (2013) showed that the bias in perceptual judgment caused by prior expectations correlates with the bias in choice-specific motor activity. In this study we investigate how the bias in motor activity modulates subliminal action priming on behavioural decisions. More specifically, we examined whether it is possible to bias the influence of a masked arrow stimulus in a 2AFC task (left vs. right direction of the arrow) by using a prior predictive cue (high/low probability of left/right arrow). We tested two assumptions. First, that the predictive cue should increase the accumulation of evidence, reflected here by the readiness potential, and facilitate the subliminal processing of the masked stimulus. A second assumption is that when the motor decision is biased, as reflected here by the lateralised readiness potential (LRP), the bias should take over and decrease the impact of subliminal information. These two assumptions predict a non-monotonic pattern according to which subliminal action priming correlates with the amount of motor preparation but then decrease as soon as there is a bias due to prior expectations. To test this we presented the masked stimulus after the cue with a random SOA between 50 ms and 1550 ms. Behavioural results revealed that, as expected, subliminal action priming in the unbiased condition has a constant effect for all SOAs, while in the biased condition it starts increasing with SOA but then decreases after 800ms. The correlation with EEG indices of motor preparation are currently being analysed and will be presented at the conference.

Stream B: Metacognition and Clinical Studies of Awareness

Steele Building, Room 309

Trust your feelings, Luke! Metacognitive awareness guides the selection of low-conflict contexts in the absence of prime awareness

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[1] Free University Brussels, Belgium, [2] Ghent University, Belgium

In experimental psychology, subliminal priming is one of the most popular tools to study unconscious processing. Stimuli which are never consciously perceived are assumed to completely escape consciousness. However, although masked stimuli themselves may not be consciously accessed, this does not necessarily imply that participants also remain unaware of the consequences of these stimuli. On the contrary, we claim that participants can accurately introspect about their own performance, and we therefore assign metacognitive awareness an important role. In the current study, we examined whether metacognitive awareness might guide participants' preference for contexts which are experienced as easy compared to difficult. For this purpose, we designed a masked priming task comprising mini-blocks. At the onset of each block, participants were free to choose whether they performed the task in either of two boxes on the screen. Unknown to them, in one of these boxes the masked stimuli were helpful in 80% of the trials. In the other box the masked stimuli were helpful in only 20% of the trials. Results showed that participants who picked up this difference in task difficulty (i.e., correct metacognition) indeed developed a clear preference for the easiest context. On the contrary, participants who felt no difference at all did not develop any preference. Crucially, behavioral performance on the priming task was identical in both groups. Thus, only subjects who were able to accurately introspect about their own behavior were able to preferably select the less demanding context. We conclude that metacognitive awareness can exist in the absence of stimulus awareness, and that the former has the functional role of guiding behavior.

The influence of visual identification on perceptual awareness ratings

Michał Wierzbach [1], Marta Siedlecka [1], Borysław Paulewicz [2]

[1] Consciousness Lab, Institute of Psychology, Jagiellonian University, Krakow, Poland, [2] Warsaw School of Social Science and Humanities, Faculty in Katowice, Poland

Does perceptual decision influence perceptual awareness? Here, we present the results of three experiments aiming to investigate the effects of visual identification task decision on subsequent awareness ratings. Participants performed visual identification task and rated stimuli visibility with perceptual awareness scale (PAS) either before, or after the identification decision. Results of the first two experiments showed that awareness ratings strongly predicted accuracy, but the overall relationship between awareness ratings and performance was weaker when awareness had been rated before identification response. We therefore concluded that the identification task must affect subsequent awareness ratings. In the third experiment we aimed to replicate these results and find out whether awareness was affected by the time factor (more time to estimate awareness if the identification decision comes first) or the identification decision itself. Therefore, we separated awareness rating time from the decision-rating order. The results show the effect of decision on awareness ratings that seems to be in line with the assumptions of higher-order theories of consciousness.

Oscillatory mechanisms related to (pre-)reflective decision-making

Martijn E. Wokke [1,2], K. Richard Ridderinkhof [1,2]

[1] Amsterdam Brain & Cognition, University of Amsterdam, The Netherlands [2] Department of Psychology, University of Amsterdam, The Netherlands

In settings when a quick and complex decision is crucial to a successful outcome people often rely on pre-deliberate decisions. For instance, in crisis situations or in tennis ('a game of emergencies') a quick and intuitive response to a complex situation is critical for saving lives or, less dramatic, for winning a match. Through extensive training and experience intuitive decisions can often become highly sophisticated and adept. In this talk I will present data demonstrating how expertise modulates neural responses during perceptual decision-making. We recorded EEG signals while participants were asked to make a diagnosis after seeing a sample (a complex visual pattern) of fictive patient data. This sample could either belong to a sick or to a healthy patient. Participants gradually learned to distinguish sick from healthy patterns, while indicating on each occasion how they made their decision (i.e., guessing, intuitive or rational choice). Results demonstrate that the level of (conscious) knowledge about the decision is reflected in increased levels of frontocentral and occipital theta power during evidence accrual and enhanced frontopolar and occipital beta power prior to the actual choice. Further, we observed different amounts of fronto-occipital beta coherence briefly before the choice was made, suggesting enhanced fronto-occipital functional connectivity as the level of expertise increased. These findings indicate that expertise increases top-down control and boosts information integration in the brain during perceptual decision-making.

Selective impairment in perceptual metacognition following anterior prefrontal lesions

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Humans have the capacity to introspect about self-performance, known as metacognition. Convergent evidence supports a role for anterior prefrontal cortex (aPFC) in metacognitive judgments of perceptual processes. However, it is unknown whether metacognition is a global phenomenon, with aPFC supporting metacognition across domains, or whether it relies on domain-specific neural substrates. To address this question, we measured metacognitive accuracy in patients with lesions to aPFC (N=7) in two distinct domains, perception and memory, by assessing the correspondence between objective performance and subjective ratings of performance. Despite performing equivalently to a brain-damaged control group (N=13) and healthy controls (N=19), patients with lesions to the aPFC showed a selective deficit in perceptual metacognitive accuracy (meta-d'/d', 95% confidence interval 0.28-0.64). Crucially, however, the aPFC group's metacognitive accuracy on an equivalent memory task remained unimpaired (meta-d'/d', 95% confidence interval 0.78-1.29). Our results support a causal role for aPFC in perceptual metacognition, and indicate that the neural architecture of metacognition, while often considered global and domain-general, can be fractionated into domain-specific components following neurological insult.

EEG responses to stimuli of personal relevance in healthy controls and disorder of consciousness patients

Manuel Schabus [1,2], Renata del Giudice [1], Julia Lechinger [1], Malgorzata Wislowska [1], Dominik P.J. Heib [1], Kerstin Hoedlmoser [1,2]

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Among auditory stimuli, the own name is a very powerful one which can automatically capture attention and elicit robust electrophysiological responses. The subject's own name (SON) or the voice of a relative is preferentially processed in the right hemisphere, mainly because of its self-relevance and emotional content. In the present study we used EEG and asked 14 participants to count a target name (active condition) or to just listen to the SON as compared to other unfamiliar names uttered by a familiar or unfamiliar voice (passive condition). Data revealed that the "counted" target name (i) elicited a stronger alpha event-related desynchronization (ERD) with respect to non-target names and (ii) that in addition a theta synchronization (ERS) was evoked. In the passive condition, as expected, alpha ERD was observed for familiar voice and SON stimuli in the right hemisphere. We speculate that participants engage additional attentional resources when counting a target name which is indexed by theta synchronization whereas pronounced alpha ERD, indexes a release of inhibition after successful memory matching. Enhanced alpha ERD to personally relevant stimuli may indicate controlled memory access during self-referential or emotional processing. Preliminary data with patients in disorders of consciousness revealed that whereas observed EEG patterns are similar in locked-in syndrome, vegetative state patients show a spectrum of non-reactivity to findings resembling controls, depending on the severity of injury. Altogether we believe that EEG paradigms of that kind, using emotional relevant stimuli, are sensitive in identifying residual capacities for information processing and conscious awareness.

The use of pupil dilation to communicate with locked-in syndrome patients

Olivia Carter [1], Josef Stoll [2], Camille Chatelle [3], Christof Koch [4], Steven Laureys [3], Wolfgang Einhauser [2, 5]

[1] Psychological Sciences, University of Melbourne, Australia, [2] Neurophysics, Philips-University, Germany, [3] Coma Science Group, University and University Hospital of Liege, Belgium [4] Allen Institute for Brain Science, USA [5] Center for Interdisciplinary Research (ZiF), Bielefeld University, Germany

For patients with severe motor disabilities, a robust means of communication is a crucial factor for their well-being. Despite recent progress in research using brain computer interfaces, developing a system that provides the patient maximal autonomy remains challenging. Here we exploit pupil size as an alternative simple and robust measure for communication. After first establishing a protocol that uses increasing or decreasing cognitive load (i.e., performing mental arithmetic or not) to control pupil size to signal answers to yes/no questions. The system was then tested in eleven patients suffering from locked-in-syndrome (LIS). Finally, we tested command-following responses with the same system in a single patient in a non-communicative minimally conscious state (MCS). We found that all healthy controls could use the system for communication, with an average decoding performance of over 90% and significant decoding in each individual. The responses of six out of seven typical LIS patients could be decoded above chance level, with three reaching significance individually. In contrast, none of the atypical LIS patients reached a performance significantly different from chance. Finally, in the MCS patient, who was explicitly instructed to react either to the "yes" or the "no" alternative in each question, the response could again be decoded significantly above chance. Our data provides proof-of-principle that pupil size can be used as a means of communication with at least a subset of LIS patients. In addition, the MCS data suggests this tool might provide opportunities to communicate with individuals whose state of consciousness is in question.

Stream C: Subliminal Processing

Steele Building, Room 262

Cross cultural difference in unconscious process in implicit learning

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We investigated cultural differences in the acquisition of unconscious knowledge. We conjectured that Eastern people would acquire rules referring to global (long-distance) dependencies more easily than Western people, and Western people would learn local dependencies more easily than Eastern people. Global dependencies were present in the repetition structure of the strings and local structure was present in the bigram structure of the strings. Participants were required to memorize a series of grammatical strings each composed of five letters in the learning stage and then informed that all the learning strings were generated by a set of complex rules. In the test stage, participants were asked to classify strings as to whether they had the same structure as the training strings. Test strings included grammatical and ungrammatical strings, which either violated the repetition structure or the bigram structure in the final (fifth) letter. Then subjects indicated the basis of that judgment: guessing, intuition, familiarity, rules or recollection (collapsed first three options as unconscious knowledge and the remaining last two as conscious knowledge). Our results showed that repetition structures were learned by both British and Chinese participants. However, only British but not Chinese participants could learn bigram structure. For specifically unconscious knowledge, British participants obtained the repetition and bigram structures, but Chinese participants only obtained repetition structure. For conscious knowledge, British participants only learned repetition structure, but Chinese participants got both repetition and bigram structures. The results suggest that cultural biases can influence people process information unconsciously.

Unconscious Salience Accelerates Conscious Access

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[1] School of Psychology, University of Sussex, [2] Department of Informatics, University of Sussex, [3] Sackler Centre for Consciousness Science, University of Sussex

It is established that the salience of a stimulus reliably affects the speed with which it is given conscious access; for example, highly familiar or emotional stimuli break through continuous flash suppression more rapidly than unfamiliar or emotionally neutral stimuli (e.g. Stein et al. 2012). Here we asked whether this preferential access extends to stimuli which have never been consciously perceived but which have acquired “unconscious salience”. We first manipulated unconscious salience by pairing novel subliminal shapes with either reward or non-reward. We then compared the rate at which those shapes broke through continuous flash suppression with that of shapes not given prior subliminal exposure. Shapes subliminally paired with reward ($M=3876$, $SE=412$), broke through more rapidly both than shapes paired with non-reward ($M=4649$, $SE=586$), $t(54)=2.23$, $p=.030$, and shapes given no prior exposure ($M=4552$, $SE=546$), $t(54)=2.64$, $p=.011$. Shapes subliminally paired with non-reward did not differ in break through times from those not given prior exposure, $t(54)=0.43$, $p=.667$. Interestingly, while unconsciously acquired salience accelerated conscious access it had no effect on the relative valence of the stimuli; the rated pleasantness of shapes subliminally paired with reward ($M=264$, $SE=12$), neither differed significantly from those subliminally paired with non-reward ($M=270$, $SE=14$), $t(54)=.33$, $p=.664$, nor those not given prior exposure ($M=263$, $SE=12$), $t(54)=0.07$, $p=.946$. These results advance our understanding of the relationship between salience and accelerated conscious access, demonstrating for the first time that faster access extends to stimuli that have acquired salience without conscious perception and which do not differ in consciously perceived valence.

A window of subliminal perception

Kristian Sandberg [1,2] Bo Martin Bibby [3] Simon Hviid Del Pin [1,4] Morten Overgaard [1,4]

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Numerous studies have found evidence of processing of stimuli below the subjective threshold of awareness, but it has rarely been examined if such subthreshold perception is found at particular stimulus intensities and what might explain this. Here, we examined the behavior of human participants in a primed word stem completion task with inclusion instructions (i.e. “complete word stem using the primed word if able”) as well as exclusion instructions (i.e. “complete word stem without using the primed word if able”). Several stimulus intensities were used and three different methods were used for quantifying the magnitude of subthreshold perception. Specifically, objective performance under inclusion instructions was calculated at the subjective threshold (when participants claimed to have no experience of the prime); the lag between the increase in accuracy and awareness as functions of stimulus intensity was estimated; and finally, the impact of unconscious processing was calculated using the Process Dissociation Procedure (PDP). All methods indicated a peak in the estimated amount of subthreshold perception around the same stimulus intensities. Next, we demonstrated that a signal detection theory based model is able to account for these effects without changing the criteria for the type II response (i.e. the threshold of awareness) or the metacognitive capacity

of the observer (meta-d') across stimulus intensities. Furthermore, the model explains previously incompatible findings in the literature and has implications for further studies of subthreshold perception as it allows for estimation of peaks in subthreshold perception across stimulus saliency given known subjective criteria.

Measuring Intuition: Unconscious Emotional Information Boosts Decision-Making Accuracy and Confidence

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The long-held popular notion of intuition, despite lacking strong scientific support has garnered much attention both academically and conversationally. While most agreed on intuition involving emotionally charged, rapid, unconscious processes, little compelling evidence exists in its support. Here, we employ a novel empirical paradigm and diffusion decision models to show that the infusion of unconscious emotional information can boost accuracy in an emotion-free decision task, with stronger effects for more difficult decisions. Participants decided the direction of random dot motion stimuli presented concurrently with emotional images that were suppressed from awareness using continuous flash suppression. The binary emotional valence of the images (positive or negative) predicted the direction of the motion in the decision stimulus (right or left) 100%. We found that decision accuracy was significantly higher on trials where motion stimuli were paired with suppressed emotional images, compared to phase-scrambling version of those images. However, accuracy was no higher when the decisional stimulus was paired with different categories of non-emotional images. Further, unconscious emotion boosted reaction times and decision confidence. These effects improved with practice and were contingent on the specific arrangement of emotional valence and decisional outcome. A diffusion model that simultaneously accumulates unconscious emotion and conscious direction of motion provided an accurate description of subjects' performance and confidence. These findings support the long-held notion that unconscious emotions can bias behaviour - a process of intuition.

Don't make me angry: Manipulating volitional choices to act or inhibit by subliminal emotional faces

Jim Parkinson [1,4], Sarah N Garfinkel [3,4], Zoltan Dienes [1,4], Anil K Seth [2,4]

[1] School of Psychology University of Sussex, [2] Department of Informatics University of Sussex, [3] Brighton and Sussex Medical School, [4] Sackler Centre for Consciousness Science University of Sussex

Intentional choices to execute or inhibit one's own actions are a vital aspect of human conscious experience. Can such choices be influenced by subjectively invisible emotional stimuli? Typically, late-breaking forms of inhibitory control, occurring at the very final stages of voluntary action, have been thought to require conscious effort and awareness. We have previously shown that subliminal arrow stimuli that are explicitly associated with 'Go' or 'NoGo' responses can affect the conscious, intentional choice to act or inhibit one's own actions (ASSC16). Here, we show that intentional self-control can also be non-consciously manipulated by naturalistic, emotional stimuli that, importantly, are not explicitly associated with action or inhibition responses within the experiment. In a modified Go/NoGo task, participants responded to frequent green circles with a speeded button press (Reactive Go). Rare red circles indicated the response should be withheld (Reactive NoGo). Yellow circles indicated participants should make a quick, spontaneous decision whether to execute or withhold the prepotent button press (Intentional Go/NoGo). Crucially, prior to targets we presented backwards-masked subliminal faces, which had either angry or emotionally neutral expressions. EEG was recorded. Intriguingly, whilst primes had no effects on response times (neither Reactive nor Intentional), angry face-primes reduced the rate of choosing to act, compared to neutral primes. Moreover, EEG showed that angry primes produced increased theta band activity in fronto-central areas, which has been associated with motor inhibition. Our results elucidate an important new channel by which briefly seen or invisible emotional stimuli can modulate apparently volitional behaviour.

Attending to the Unseen: The Effects of Spatial Attention on Neural Responses to Visible and Invisible Stimuli

Cooper Smout [1,2], Jason Mattingley [1,2]

[1] Queensland Brain Institute, [2] The University of Queensland

Recent theories have suggested that attention and conscious awareness are distinct phenomena, and can thus dissociate at the neural level (Dehaene, Changeux, Naccache, Sackur, & Sergent, 2006; Koch & Tsuchiya, 2007). Here we investigated whether the voluntary allocation of attention to a cued region of space modulates the neural representation of subjectively invisible stimuli. Participants (N = 23) attended covertly to one of two flickering image streams on either side of fixation, and reported which of two consecutive intervals contained a target (the 'signal') embedded in dynamic noise. Signal coherence was manipulated to be highly visible, moderately visible, or invisible. Electroencephalography (EEG) was used to measure neural responses to the flickering signal and noise stimuli. Fourier analyses of these recordings revealed activity peaks over contralateral occipital electrodes at

the unique frequencies of signal and noise stimulation. Attentional enhancement of neural responses to noise stimuli indicated that the manipulation of attention was successful. Additionally, behavioural data confirmed that the manipulation of signal awareness was successful. As expected, spatial attention modulated neural responses to visible targets, which were enhanced briefly after target onset and suppressed toward the end of the interval. Crucially, preliminary analyses also suggest that spatial attention modulated neural responses to invisible targets, supporting recent theories that attention and conscious awareness can be dissociated. The nature of this modulation was qualitatively different to that of visible targets, however, with no early enhancement but a late suppression with attention. Possible reasons for this interesting, yet unexpected, pattern of results are discussed.

POSTER SESSION – Friday 18th of July

1:30pm, AEB Lobby Hallway

Philosophy Assorted

1. Limitations to theories of the mind imposed by bandwidth and irreversibility

Richard Davies Gill

As theories about the mind and consciousness are conducted through the medium of language, this must impose restrictions on what sorts of theories can be constructed. All the other tools of man have limitations, but are still useful and essential within their limited domains. In this paper I want to draw attention to the boundaries of language and theories of the mind that result from the very different data bandwidths of the eye and the ear, and the irreversibility of neural activity. These both have implications on the quest to understand the mind. Consideration of either physiology or the very different bandwidths needed to transmit telephone messages or television images shows that the bandwidth of the eye is more than 2000 times that of the ear. One immediate consequence is that the ear will not be able to reconstruct visual images, and that visual experiences cannot be reproduced by words. As irreversible processes take place when neurons fire, messages can only go from senses to the mind, and from the mind to the output organs of muscular control. Vision to action, but not, for example, touch to smell. However the unidirectionality is ingeniously broken by language and speech. A sentence can be heard, and spoken, and exact replicas can be made and experienced of the original. Replication can also be recreated by recirculation within the mind

2. “Neurocomplementarity” - A possible basis for our dualistic intuitions?

Johan Frederik Storm [1]

[1] Department of Physiology, IMB, University of Oslo

Humans seem to be inherent dualists. Even those of us holding monists views, find it almost impossible to grasp intuitively that physical brain processes can actually be identical to our conscious experiences, in the way that we can understand, say, how a machine works. This discrepancy may reflect different (types of) brain systems for understanding: (1) one type evolved to understand relatively simple physical phenomena by applying logic and simple, learned principles (“laws of nature”); (2) an entirely different type of system specialized for understanding mental phenomena. Because of the immense complexity of the underlying brain processes, these cannot be analyzed by brain systems used for representing simple physical phenomena. Instead, our brain understands mental phenomena (e.g. thoughts and feelings of others) in a fundamentally different way: by simulating them in the brain’s own systems for similar mental phenomena and “observing” the results. That these systems thus create radically different types of representations may underlie our inherent dualism: we perceive mental phenomena as being fundamentally different from non-mental (i.e. simpler, not brain-related) phenomena, although the underlying physical processes are fundamentally similar (but with very different degrees of complexity). By analogy, different sensory modalities, handled by distinct brain systems, evoke qualitatively different sensory experiences (colors, sounds, tastes, pain), despite similar underlying neural processes. Also: humans find it almost impossible to unify intuitively the dual particle-and-wave aspects of matter, which are therefore regarded as “complementary”. Hence, the inherent duality in our concepts of matter and mind may perhaps be ascribed to “neurocomplementarity”.

3. What is the contribution of conscious reflection to reliabilist justification?

Susannah Kate Devitt [1]

[1] Queensland University of Technology

This poster addresses the justificatory role of conscious reflection within a naturalized, reliabilist epistemology. Reliabilism is the view that implicit, mechanistic (System 1) processes can justify beliefs, e.g. perceptual beliefs formed after a history of consistent exposure to normal lighting conditions are justified in a given context with normal lighting. A popular variant of reliabilism is virtue epistemology where the cognitive circumstances and abilities of an agent play a justificatory role, e.g. the cooperation of the prefrontal cortex and primary visual cortex of the individual perceiving the Müller-Lyer illusion partly justify the belief that the lines are equi-length. While virtue epistemology is a well-endorsed reliabilism for implicit beliefs, its application to explicit, consciously reflective (System 2) processes is more controversial. Critics ask: How can iterations of dumb reliabilist processes produce higher order justification? To respond to this concern, I draw on another agent-centred, normative and reliabilist epistemology—Bayesian epistemology. A Bayesian virtue epistemology argues that reflective hypothesis-testing generated by (largely) implicit Bayesian mechanisms offers higher order reliabilist justification for beliefs. Iterative Bayesian

mechanisms (e.g. hierarchically nested probabilistic models) explain the development of higher order beliefs about abstract concepts such as causation, natural laws and theoretical entities traditionally explained by recourse to vague concepts such as ‘the a priori’, ‘intuition’ or ‘the intellect’. A hybrid Bayesian virtue epistemology offers an iterative reliabilist framework to explain how conscious reflection justifies beliefs. However, I acknowledge limitations on Bayesian accounts of justification such as confirmational holism, commutativity, and the frame problem.

4. The Great Mind Shift: Three Scenarios

Marcus T Anthony [1,2]

[1] Swinburne University of Technology, [2] MindFutures

An increasing number of theorists have argued for the validity of the extended mind – consciousness which is not confined to the brain. This poster presentation provides a brief overview of the positive evidence for the extended mind and argues that a “Great Mind Shift” will occur within the next few decades. The focus of the presentation is the enormous implications if (and when) the extended mind becomes accepted by mainstream science and education. In particular, “the Great Mind Shift” will require major revisions in many domains including physics, psychology, neuroscience, biology, medicine; and in science and education in general. Finally, the very nature of human relations and social interaction will likely be affected. The presentation draws upon the tools and methods of Futures Studies to outline three scenarios for each domain. These are the “weak”, “moderate” and “strong” scenarios. Each scenario describes the implications according to the degree to which non-local consciousness is deemed to play a role in nature and in human behaviour.

5. On the evolution of conscious attention

Harry Haroutioun Haladjian [1], Carlos Montemayor [2]

[1] School of Social Sciences and Psychology, University of Western Sydney, Sydney, NSW, Australia, [2] Department of Philosophy, San Francisco State University, San Francisco, CA, USA

Consciousness has been a topic of intense debate in cognitive psychology and neuroscience for at least the past two decades, but with little improvement in our understanding of it. Unlike consciousness, visual attention has been a central topic in these disciplines for much longer and has produced robust empirical results and theoretical insights. Recently, questions have emerged concerning the relationship between consciousness and attention, creating a spectrum of views that range from fully identifying consciousness with attention, to full dissociation views that postulate complete independence between them. In this presentation, we aim to clarify the relationship between consciousness and attention through theoretical considerations about evolution. Specifically, we will argue that the empirical findings on attention and the basic considerations concerning the evolution of different types of attention demonstrate that there must be (at least) a moderate level of dissociation between consciousness and attention, regardless of how these terms are defined. To the best of our knowledge, no extant view on the relationship between consciousness and attention has this advantage. This characteristic presents a principled and neutral way to settle disputes concerning the relationship between consciousness and attention, while avoiding debates about the meaning of these terms. A decisive conclusion of this approach is that consciousness cannot be identical to attention, and therefore, we must reject identity theories. There are, however, areas of overlap within conscious attention, but developing a full understanding of this mechanism requires further empirical clarification and should be a focus of future research.

6. The Mood-Emotion Loop

Muk-Yan Wong [1]

[1] Hang Seng Management College

This paper aims to clarify and reformulate the conceptual relationship between emotions and moods in light of recent researches in philosophy, cognitive psychology, and neuroscience. I argue that emotion is an adaptive process that was set up to generate fitness-improving physiological and behavioral states in response to the appraisals of different adaptational encounters, whereas moods involve a mechanism monitoring our physical and mental energy levels in relation to the perceived energy demands of the environment, and biasing our cognitive architecture accordingly. The function of generating cognitive biases according to our energy levels is to restore equilibrium between the energy we possess and the energy our environment demands. Based on the theory of the mechanisms of emotion and mood above, I formulate the mood-emotion loop to explain how an emotion and a mood may affect each other. Specifically, one is more likely to be in a specific emotion when one is in specific mood if the cognitive biases generated by the mood affect the appraisals of adaptational encounters in the process of the emotion in a way such that a specific adaptational encounter is more likely to be represented. On the other hand, one is more likely to be in a specific mood when one is in a specific emotion if the appraisals and physiological responses associated with the emotion change one’s energy levels or one’s perceived energy demand of environment in a way such that the monitoring of which may lead to the arousal of a specific mood.

7. Phenomenal Properties as Nonconceptual Representations: A Defense from Autism

Chieh-Ling (Katherine) Cheng [1], Karen Yan [1]

[1] Institute of Philosophy of Mind and Cognition, National Yang Ming University, Taiwan

We argue that experiences can have (non-material) phenomenal properties as nonconceptual representations. We start with how David Papineau (2002, 2007) argues against Frank Jackson (1982) with his notion of phenomenal concepts. We will focus on Papineau's distinction between phenomenal concepts and perceptual concepts. Phenomenal concepts are the concepts for thinking about experiences, whereas perceptual concepts are the ones for thinking about the perceived objects or events, not experiences themselves. Papineau holds that the acquisition of phenomenal concepts requires the use of perceptual concepts, and that perceptual concepts can refer independently of phenomenal concepts. Based on these two claims, he infers that perceptual concepts do not refer via the "descriptions which invoke phenomenal properties" (Papineau, 2002, p. 111). We aim to undermine this claim from Papineau. We show that even if his distinction between phenomenal concepts and perceptual concepts is correct, the possibility that there are phenomenal properties is still open. We concretize this possibility based on nonconceptual representations. We show that perceptual concepts can refer via nonconceptual representations based on the case of autistic people (see Grandin, 2002). If this is the case, it implies that the existence of phenomenal properties is still compatible with Papineau's view. Having shown this, we then provide some reasons to suggest that it is better to identify phenomenal properties with nonconceptual representations.

8. The Non-trivial Subject Unity

Ting-An Lin [1], Allen Y. Hough [1]

[1] National Yang-Ming University

In Bayne's 2010 book, he claims that it is the phenomenal unity that provides us with the conception of the unity of consciousness that we are after. In this paper, I will argue that the unity that can provide us with what we are after is not the phenomenal unity but rather the subject unity, which is treated as trivial by Bayne. I argue that the subject unity captures an essential part of the unity of consciousness which is presupposed by the phenomenal unity and thus should not be treated as trivial. First, the phenomenal unity omits an essential part of the unity of consciousness, that is, the common subject who can experience this unity. What we concern about the unity of consciousness, is not only the jointly experienced of any set of conscious states, but also the jointly experienced by the common subject, me. There are two elements should be accounted for. One is the co-experience part, and the other is the common subject part. The phenomenal unity only explains the first part but omits the second one. The subject unity explains the second part. Second, the phenomenal unity presupposes the subject unity. The subject unity is the basis of the phenomenal unity. As Kant asserts, awareness of certain objects presupposes awareness of oneself as subject of the categories (Kant, 1781). In order to have awareness of jointly experiencing of a set of conscious states, there must be awareness of me as the common subject. The common subject part captures by the subject unity is the basis for the co-experience part describes by the phenomenal unity. In conclusion, the subject unity captures an essential part of the unity of consciousness and should not be treated as trivial. The question we are left with is what might be the cause of the subject unity. I suggest that it is related to the issue of self and spacetime structure.

Philosophical and Neuro Theories of Consciousness

9. The Extended Machinery of Consciousness

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The mind-body problem has traditionally been concerned with the relation between the brain and the mind. In my paper I consider whether the machinery responsible for conscious experiences can be constituted by processes external to the brain as well as processes internal to it. I argue that exploring the possibility of an extended machinery of consciousness is worthwhile insofar as it might open new perspectives upon two fundamental issues in the study of consciousness. Firstly, it might bridge the explanatory gap between brain states and conscious experiences. Secondly, focus on the machinery of consciousness might offer a new means for the naturalisation of the mind which does not require engaging in the traditional debate over reductionism. I then look at one possible formulation of the extended machinery of consciousness due to Alva Noë, identifying two main problems with it. One is that if the role of external processes is purely that of explaining why certain brain states give rise to particular conscious experiences, they cannot be considered constituents of the machinery of conscious experience. The other is that, insofar as this view is found to be committed to functionalism, it cannot provide such explanation. Hence the view considered fails either to provide a solution for the explanatory gap issue or to show that the machinery of consciousness is extended.

10. The Negative Neural Correlate of Consciousness

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Scientists and philosophers alike have been speculating about the neural correlates of consciousness (NCC). Most definitions conceptualize the NCC as minimal neural events whose realization is sufficient for a corresponding phenomenal experience. Here, we introduce the concept of a negative NCC (NNCC), which can be understood as neural events whose occurrence inversely correlates with a given phenomenal experience. We introduce the concept for two reasons. Firstly, it is an elegant solution to the problem of sufficiency. For a neural event N to be (minimally) sufficient for a corresponding conscious experience P, we would need to specify an open-ended *ceteris paribus* clause for each NCC to ensure the absence of potential 'content disrupters' that would prevent P. We suggest that this problem can be solved by pairing each NCC with a corresponding NNCC. Secondly, based on the Integrated Information Theory of Consciousness, we argue that scientists will only be able to predict conscious experience from brain data by pairing each NCC with a corresponding NNCC. If consciousness corresponds to integrated information, and if differentiating between potential conscious states generates information, then a complete account of the content of a given conscious state also needs to consider those states that are excluded for that conscious state. The content NNCC for a given experience can be defined as the nomological possibility space of content NCCs minus the content NCC of the given experience itself. We show how empirical evidence can be reinterpreted in view of the NNCC hypothesis and anticipate potential objections.

11. A Unified Model of Conscious and Unconscious processes

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Substance dualism is implicit in the assumption of a categorical distinction between consciousness and unconscious processes. For this reason, the search for the neural correlates of consciousness (NCC) recognizably embodies a Cartesian dichotomy. Approaches that seek to define the NCC, may then be considered to proceed from and thus reinforce implicit and unworkable philosophical biases. However, the continental philosophical traditions have in their earliest inceptions, questioned and provided alternatives to this fundamental dualism. Heidegger for example, critiqued not only the dualism present in Cartesian thinking, but more primarily, the underlying understanding of Being that implicitly informed Descartes's position in the first instance. For this reason Heidegger's critique of the ontological assumptions present in traditional Western thought, and the reinterpretation of Being that he offers, are here employed to re-inform the way in which we conceive consciousness to exist. Elements of Heideggerian thought are drawn on as a philosophical motivation for a characterization of consciousness as unable to be fully explicated or separated from a background of unconscious subliminal processes. According to the model presented here, conscious and non-conscious states co-determine each other and are therefore reciprocally constitutive of each other. On this basis we have argued that it is meaningless to construct an ontology of these states independently of each other. In this regard theories of collective neuronal activity together with the mathematical ideas of dynamical systems are drawn on to develop a unified model of consciousness and unconscious processes that has both philosophical relevance and empirical merit.

12. Natural dualism gives a molecular solution to the mind-body problem for psychiatry

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Modern psychiatry holds that biological reductionism will fully explain mental disorder with no questions unanswered. This position is now accepted as *de rigueur* but it has never been argued. While psychiatry pays lip service to the idea that mental factors may contribute to the causation of mental disorder (*sic*), its research program is overwhelmingly directed at finding a biological basis to the problem. Part of the problem arises because psychiatry has no working models of mental disorder or personality disorder. Attempts at formulating mentalist models invite contempt, an attitude adopted unthinkingly from the broader materialist approach which eschews unobservables. The idea of a different, mentalist model for psychiatry is dismissed as a "dualist magical thinking." The notion that dualism equals magic does not take account of informational theory. The concept of the mind as an informational space generated by the brain's switching capacities is both natural and dualist. It can be formalised using the computational approaches of Turing and of Shannon, and can thence be applied to neuroscience with dramatic effect. As an informational space, the mind is real, natural and immaterial but can interact with the body through standard neuronal mechanisms. This conceptual solution to the mind-body problem can be tested by application to different concepts in biology, including the Challenge Hypothesis of testosterone production. A natural dualist model of mind with a plausible molecular solution to the mind-body problem has profound consequences for understanding and treating mental disorder.

13. Inferential processing abnormalities in depression, and the antidepressant mechanisms of non-ordinary states

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Cognitive sense-making occurs through reciprocal loops between bottom-up perceptual processes and top-down inference to construct, refine and deploy cognitive models. The typical rigid and delusional cognitive features associated with Major Depressive Disorder, often cited as central vulnerability or maintenance factors, may be attributable to excessive top-down biasing or deficits in bottom-up processing. Various non-ordinary states – such as those generated through mindfulness and psychotropics – show antidepressant effects. States of consciousness may be considerably affected by changes in the balance between top-down or bottom-up processes. For example, reductions in higher order prefrontal cortical biasing (hypofrontal disinhibition) have been associated with attentional broadening, cognitive flexibility, hypersuggestibility and various non-ordinary states. However, the antidepressant mechanisms of non-ordinary states are poorly understood. I argue that certain non-ordinary states may have antidepressant value due to their associated reversal of excessive top-down or weak bottom-up processing, along with a panoply of downstream effects. My neuropsychological research, informed by states of consciousness research and predictive coding theory, aims to determine whether depression is linked to aberrant top-down or bottom-up inferential processes, towards an understanding of the antidepressant mechanisms of non-ordinary states and the development of new interventions.

14. Strange choice - approximate answer in dissociative disorder evaluated by a forced-choice test.

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Background: Approximate answer (so-called Ganser's symptom) is a symptom that patients give near-miss answers to simple questions, e.g. $3+6=7$ or a dog has 3 legs. Originally, this symptom has been reported among prisoners as dissociative symptom. Approximate answer has attracted attention in psychiatry for a long time, however, its etiology is still controversial. This is mainly due to lack of effective neuropsychological evaluation. In the current study, we evaluated approximate answer by a forced-choice test. Method: Participants were 6 patients with dissociative disorder (2 multiple personality disorder, 2 dissociative motor disorder, 1 dissociative amnesia, and 1 other specified dissociative disorder), who showed approximate answer without any external incentives. They performed a forced-choice test of simple calculation, e.g. $3+4=8$, correct or incorrect? They were asked to judge whether 20 easy math formulas were correct or incorrect each other. Result: Three patients showed below-chance level performance (correct rate was 1/20, 3/20, 4/20). Performance of other 3 patients was near chance level (9/20, 9/20, 11/20). The former suffered from severer type of dissociative disorder than the latter. Discussion: Their below-chance level performance suggests that their calculation capability is intact but they dare to choose incorrect answer. Considering the concept of dissociative disorder, unconscious process may lead to this strange choice. This forced-choice test can divide the patients with apparently same approximate answer into two groups, which implies the different pathological mechanism. It suggests that it could be an effective neuropsychological tool.

15. Mental causation in the course of neurorehabilitation: an argument for subjective agency?

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Usually, philosophers utilize neuroscientific findings for the purpose of reducing cognitive behavior to neural activity. The subsequent naturalistic stance towards consciousness shapes ongoing discussions to the extent that volition is supposed to be an illusionary capacity and lacks efficacy in terms of mental causation. However, assistive robotics yield strong empirical evidence that mental causation plays a distinct role in neurorehabilitation. As in the course of rehabilitation of the locomotor system, damaged neural functions are (partially) recovered if the patient at least tries to move impaired limbs voluntarily. Thus, voluntary control of bodily motion (subjective agency) significantly contributes to the effectiveness of neurorehabilitation. There seems to be a causal relation from voluntary control to the neural motor level. In my talk, I will introduce recent findings in assistive robotics and neurorehabilitation by means of a concrete case (rehabilitation of forward gait by use of HAL, an exoskeleton robot for the lower limbs). Then I will explain the philosophical implications of these findings and present an "argument from rehabilitation" which states that subjective agency is an efficacious mental capacity. According to this argument, philosophy is challenged to explain mental causation beyond mere naturalization. In particular, such an explanation has to integrate physical as well as cognitive aspects of subjective agency complementarily in order to show how voluntary control of bodily motion is possible.

16. Standing Wave Theory of Consciousness: A self-organizing neural reaction-diffusion model of (un)conscious neural dynamics

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Converging evidence from neural data suggests that particular states of consciousness and types of behaviour are associated with distinct spatio-temporal patterns of neural activity. Likewise, theoretical approaches propose that the degree of integration (functional connectivity) and complexity (number of possible patterns) of the neural activity might be directly related to the level of consciousness. However, despite substantial advances in empirical and theoretical work, the dynamic processes giving rise to such distinct and complex spatio-temporal patterns of neural activity remain unknown. Here we introduce a theoretical framework for the neural dynamics associated with consciousness based on the self-organizing wave patterns in reaction-diffusion systems. The mathematical models underlying this type of pattern formation predict the patterns experienced in visual hallucinations and various neuroanatomical properties of the visual cortex. We extend these self-organizing models to the 3D cortico-cortical network to demonstrate that the spatio-temporal patterns accompanying different states of consciousness emerge naturally from the dynamic interactions of excitatory and inhibitory neural activity. Further, we show that these reaction-diffusion models follow the dynamics of standing waves and thus can be easily assessed using the mathematical framework of harmonic analysis. This provides a testable theoretical model for the neural dynamics of consciousness, which accounts for both the distinct spatio-temporal patterns of neural activity and the theoretical predictions about the neural complexity and integration of consciousness. The ubiquity of standing wave patterns in nature, ranging from vibrations in solid objects to morphogenesis, provides a natural framework with simple, well-studied mathematics for a theoretical model of consciousness.

17. The neuro-integrative account of consciousness

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The science of consciousness is divided as to where we should look for consciousness in the brain (Tononi and Koch, 2008). I consider the role of the thalamo-cortical loops coupled with the integrative work performed by the thalamus as the substrates of consciousness. I will be defending a position that stresses integration between brain parts responsible for specific cognitive functions and their activities as opposed to specific brain regions or neural activities. Such accounts seem to fail in showing how specific brain regions or neural activities give rise to whole subjects of experience. On this account, I am tackling the 'binding problem' as it figures in neuroscience and cognitive science and the 'phenomenal binding problem,' which addresses the global unity of consciousness. Both of these problems need to be addressed for a robust account of the holistic nature of consciousness. My position is that it is the work of the thalamus, via the rich thalamo-cortical feedback loops, which performs the necessary integration of information at the neural and phenomenal levels. This way of addressing consciousness is not a way of tackling head on the 'hard problem' (Chalmers, 1995), but a way of locating unified contents of consciousness in a whole subject that is compatible with the science of consciousness. My aim is to address the holistic feature of consciousness by stressing integration of information. I call this position "the neuro-integrative account" of consciousness.

Coma, Anaesthesia, Sleep and Seizures

18. What is 'unconsciousness' in a fly or worm? Unpacking general anaesthesia endpoints in model organisms

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General anaesthesia is a drug-induced, reversible state of decreased responsiveness, capable of being induced in all animals. In humans, there are several key components of general anaesthesia, termed anaesthetic endpoints, which encompass the changes in perception or behaviour that are essential to general anaesthesia: immobility, amnesia, analgesia and loss of consciousness. These endpoints, particularly the perception of pain and loss of consciousness, are typically only associated with humans or higher mammals, so we asked how comparable are these endpoints across the animal kingdom? Particularly for simpler invertebrate model organisms, such as the fruit fly (*Drosophila melanogaster*), which has a small brain, or even the worm (*Caenorhabditis elegans*), which does not even have a brain, what does 'unconsciousness' look like in these animals? We have compared general anaesthesia endpoints in three model organisms: the mouse, fly and worm, showing what behaviours are reversibly abolished by general anaesthetics, paying particular attention to fly general anaesthesia endpoints. This examination reveals that the order in which behaviours are lost is related to behavioural complexity: with increasing anaesthetic dose, more complex behaviours, requiring coordination among multiple neuronal pathways, are lost first, and more simple behaviours require a higher anaesthetic

concentration to be attenuated. We propose that this pattern reflects a common presynaptic target of general anaesthetics, and that different anaesthetic endpoints reflect successive categories of synaptic coordination required for different behaviours.

19. Neural signatures of sleep in the fly brain

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Sleep in humans is characterised by distinctive electroencephalography (EEG) signals that are different from wake. However, the functional roles of these electrical signatures for sleep remain unclear. The fruit fly *Drosophila melanogaster*, with a tiny brain comprised of only 100,000 neurons, also requires sleep. The wide availability of genetic tools that provide fine temporal and spatial control of neuronal activity makes the fly an excellent model to understand the link between cellular activities and the brain electrical signals during sleep. The fly can be induced to sleep by genetically activating sleep-promoting neurons in the brain, or by exposure to sleep-promoting GABA agonists. We compared fly brain activity during spontaneous and induced-sleep. To record from the fly brain, we performed local field potential (LFP) and whole-cell patch-clamp recordings on tethered flies positioned on an air-supported ball. Overnight recordings revealed an overall decrease across all frequencies of the LFP activity during spontaneous sleep, although the LFP appeared to change dynamically within a sleep bout. Feeding flies the insomnia drug THIP was sleep promoting, and associated with decreased LFP activity resembling spontaneous sleep. In contrast, genetic activation of the dorsal fan-shaped body, which is a sleep-promoting structure in the fly brain, reliably produced an increase in LFP activity at lower frequencies (1-10 Hz), suggesting that the fly brain is capable of producing delta-like oscillations during sleep. Simultaneous LFP and single-cell recordings in these animals should uncover the relationship between intracellular activity in sleep-promoting neurons and extracellular activity across the brain during sleep.

20. Induced gamma-band activity signals awareness of change in a bistable percept during wakefulness but changes dynamics with sleep onset.

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Several neural markers of consciousness have been extensively studied by modifying different parameters of the stimuli in order to make them accessible or inaccessible to conscious report. Here we show a new approach to study conscious awareness by manipulating the level of wakefulness instead of the properties of the stimuli. Specifically, we propose to study whether traces of awareness can still be detected while participants fall asleep during an auditory bistability task using an electrophysiological marker of awareness. In this study, wake participants listening to a bistable auditory illusion are instructed to detect spontaneous changes in percepts by pressing a button with their left or right hand, while transitioning towards sleep. Using both electroencephalography (EEG) and direct cortical recordings (iEEG) we measured the induced oscillatory activity in two conditions: a condition where changes in the auditory stream were triggered externally by changing physical properties of sounds (exogenous condition) and a condition where stimuli were constant and the auditory stream alternated spontaneously (endogenous condition). Our results showed that wake participants exhibit a transient increase in the induced gamma oscillatory activity 500 milliseconds before the motor report in the endogenous but not during the exogenous condition. Here we propose to use this increase in gamma band activity as a neural marker of conscious awareness on an internal perceptual change while falling asleep. We hypothesize that induced gamma band activity will be diminished during drowsiness and the time in between spontaneous endogenous perceptual changes will be come longer.

21. Electroencephalogram approximate entropy influenced by both age and sleep

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The use of information-based measures to assess changes in conscious state has become increasingly popular. Though recent results have seemed to justify the merits of such methods, they have typically only been applied to adults. For our work, we used the approximate entropy (ApEn), a measure previously shown to correlate with changes in conscious state when applied to the electroencephalogram (EEG), and sought to confirm whether previously reported trends in adult ApEn values across wake and sleep were present in children (age: 10.6-12.6 years old). Besides validating prior findings that ApEn decreases from wake to sleep (including wake, rapid eye movement (REM) sleep, and non-REM sleep) in adults, we found that previously reported ApEn decreases across vigilance states in adults were also present in children (ApEn trends for both age groups: wake > REM sleep > non-REM sleep). When comparing ApEn values between age groups, adults had significantly larger ApEn values than children during wakefulness. To assess the impact of low-frequency sleep-related oscillations, ApEn was recalculated following the

application of an 8 Hz high-pass filter. The number of electrodes with significant vigilance state effects decreased substantially, suggesting that these oscillations drive ApEn changes between vigilance states. Our results support the notion that ApEn can distinguish between vigilance states, and demonstrate its applicability to children. We suggest that the observed differences between adult and child ApEn values during wake may reflect changes in connectivity across development, a factor which may be important for the further development of EEG measures of consciousness.

22. Sleepy? Doing it worst without noticing: decrease in performance but not confidence in decision-making while falling asleep

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In order to investigate metacognitive performance in drowsiness we recorded high density EEG in fully awake, relaxed, drowsy states and on the verge of unconscious. Previous studies show that performance-related ERPs in decision-making, perceptual learning and go-no-go tasks are still present - albeit changed - in early sleep stages. In our experiment, participants decided between two auditory stimuli with parametrically varying levels of merging and indicated their confidence in every choice. Drowsiness levels for each trial were assessed via two independent EEG methods: alpha-theta ratio and sleep stages as defined by Hori (1994). Participants showed a decrease in discrimination abilities (d') with increasing both stimuli similarity and drowsiness. However, confidence in their decisions remained equally high in drowsy and alert states. The observed changes in behavioural measures may also be associated with differences in brain electrical potentials. Preliminary results suggest higher amplitude in late ERPs (P3) timed to stimuli depending on wakefulness changes, specifically, Hori stage H4 (drowsy) as compared to fully awake or mildly relaxed (H1, H2). Increase in amplitude with drowsiness also seems to occur for motor-related cortical potentials. The relationship between ERPs and changes in metacognitive abilities with increasing drowsiness is yet to be investigated. Overall, people seem to be able to match confidence ratings and performance reasonably well in higher drowsiness, though not as well as in alert. Understanding how metacognitive capacity is preserved and then lost when falling asleep may shed more light on the process of losing awareness in the transition to unconsciousness.

23. Left-handedness protects healthy participants from neglect-like effects induced at sleep onset.

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Continuous EEG was used to monitor alertness as 26 healthy right-handers and 26 healthy left-handers (Edinburgh Handedness Inventory) judged the location of auditory tones within 0-60° left and right of peripersonal space via button-press. During the task, participants were reclined with their eyes closed encouraging transition to sleep. Using theta: alpha ratios from the 4secs preceding the tone, trials were cut into upper (drowsy) and lower (alert) quartiles. An effect of handedness was found on error rates ($F(1,50) = 20.749$, $p < 0.001$; Cohen's $d = 1.2875$) with right-handers demonstrating an increase in left-errors from wakeful to drowsy periods (neglect-like effects) whilst, left-handers showed a slight increase in right-errors from alert to drowsy trials. This handedness effect was also found in the visual modality. Using a temporal order judgment task, left and right-eye LEDs mounted in a pair of goggles were flashed with the left/right light presented first with SOAs of 20, 40, 80, and 160ms. Twenty-eight right-handers and 25 non right-handers performed the task reclined with eyes closed. Using the same theta: alpha ratio method to index alertness, right-handers made significantly more left-first errors on 40ms SOA trials during drowsy periods, relative to alert, whilst the left-handers did not demonstrate a rightward shift $F(1, 50) = 4.347$, $p = 0.042$; Cohen's $d = 0.590$. These findings suggest that left-handers are less vulnerable to drowsiness induced rightward shifts in visual and auditory spatial attention. It is possible that differences in cerebral organization, associated with handedness, may underlie the effect.

24. Neurophysiological markers of sensory-motor expectations in human sleep

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During sleep, the brain is largely disconnected from its environment. However, under certain circumstances, some processing of external stimuli can be preserved. In particular, expectations about the stimuli heard can be maintained, sleepers showing Mismatch-Negativity and N400 responses. Nonetheless, these examples refer to rather automatic processes. In this study, we investigated the maintenance during sleep of learned expectations about arbitrary contingencies. Participants had to discriminate through lateralized hand-responses between 2 amplitude-modulated sounds (targets) preceded by a neutral cue. One target was more frequent than the other (ratio: 80/20) and should therefore be expected once the cue has been played. Subjects were comfortably lying in darkness while EEG was continuously recorded. They were explicitly instructed to respond while awake but

were allowed to fall asleep. Amplitude-modulated sounds entrained the Auditory Steady-State Response (ASSR) in both wake and sleep: we observed an increase in power corresponding to the modulation frequency. Interestingly, there was also a significant increase in power for the expected modulation frequency even when absent (rare tone played) showing participants' anticipation of the frequent stimulus. Behavioral results show that, while awake, participants learn to anticipate the most frequent sound (decrease in reaction times for the frequent target, increase in errors for the rare one). In parallel, we observed an early (prior to target onset) lateralization within the motor areas in accordance to the expected side of response. Such early lateralization was conserved in light sleep. Our results suggest that the sleeping brain can maintain learned expectations during sleep.

25. Meditation as a countermeasure for attention deficits and sleepiness following acute sleep restriction

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The impact of fatigue as a result of sleep restriction in society is significant, and highlights the importance of effective countermeasures to cope with the associated cognitive, behavioural and physiological consequences. Common countermeasures are not always feasibly employed or can lead to undesirable side-effects, and the need for alternative countermeasures remains. Meditation has been shown to benefit cognitive and affective states and may be an effective alternative countermeasure for fatigue. After a 3-week meditation training program, twelve participants completed assessments of attention, inhibition control, sleepiness, fatigue and mindfulness before and immediately after a single night of restricted sleep, and then again after an opportunity to either engage in 30 minutes of meditation practice or quiet reading intervention. Participants completed both conditions in a counterbalanced protocol. Attention, sleepiness and fatigue, but not inhibition control, were impaired following sleep restriction. Following engagement in meditation, attention and reported sleepiness improved to pre-sleep restriction levels. Deficits either remained or grew worse following quiet reading. These novel findings suggest meditation is an effective alternative method for dealing with the attention and mood deficits experienced following sleep restriction.

26. Mismatch Negativity in Disorders of Consciousness

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The neurological assessment of levels of consciousness relies mainly on behavioural observations. Diagnostic errors of such observations are reported to range from 30-40% and can have adverse effects on further clinical treatment. There have over the past years been attempts at finding a more objective assessment method with higher diagnostic accuracy (Andrews et al. 2013, Schnakers 2012, Schnakers et al. 2009.) The mismatch negativity (MMN) has been shown to correlate with levels of consciousness in previous studies (Wijnen et al. 2007). We investigated the relationship between the MMN response and the level of consciousness in different patients with disorders of consciousness. Patients were divided into three groups based on a priori defined diagnostic criteria according to the Glasgow Coma Scale (Teasdale & Jennett 1974): five coma patients, five vegetative state patients, four minimally conscious patients and 15 healthy participants. We recorded electroencephalography (EEG) while patients listened to an auditory oddball paradigm with five types of deviant tones (Näätänen et al. 2004). Using a general linear model, we first tested for a significant MMN within each group. When looking at each group separately, we found a significant activation in the control group, but no significant effect in the patient groups. We then tested the hypothesis that level of consciousness is expressed as a staircase effect with the MMN increasing with level of consciousness. Crucially, we found a significant effect of this staircase model and thus provide the first direct evidence that the MMN is related to the level of consciousness. References Andrews, K. et al., 2013. BMJ Publishing Group Misdiagnosis Of The Vegetative State : Retrospective Study In A Rehabilitation Unit All use subject to JSTOR Terms and Conditions rehabilitation unit in a. , 313(7048), pp.13–16. Näätänen, R. et al., 2004. The mismatch negativity (MMN): towards the optimal paradigm. *Clinical Neurophysiology*, 115(1), pp.140–144. Schnakers, C., 2012. Clinical assessment of patients with disorders of consciousness. , 16(direct 2362), pp.36–43. Schnakers, C. et al., 2009. Diagnostic accuracy of the vegetative and minimally conscious state : Clinical consensus versus standardized neurobehavioral assessment. , 5, pp.1–5. Teasdale, G. & Jennett, B., 1974. Assessment of coma and impaired consciousness. A practical scale. *The Lancet*, 304(7872), pp.81–84. Wijnen, V.J.M. et al., 2007. Mismatch negativity predicts recovery from the vegetative state. *Clinical neurophysiology : official journal of the International Federation of Clinical Neurophysiology*, 118(3), pp.597–605. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/17239656> [Accessed June 21, 2011].

27. Using semantic eyeblink conditioning as an index of conscious function and abstract rule processing in patients with disorders of consciousness

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Patients suffering from disorders of consciousness (DOC; vegetative state, minimally conscious state) are unable to overtly respond to external cues, posing difficulties in the assessment of their level of consciousness. A previous study by Bekinschtein et al. (2009) has shown that eyeblink trace conditioning with tones can be used to assess low-level awareness in DOC patients; that a subset of both vegetative and minimally conscious state patients showed muscle activity signalled by the tone and in anticipation to the airpuff to the eye. To test high-level awareness, including language and abstract rule implementation, we adapted the conditioning protocol by replacing the tones with semantic word categories (animals vs. objects). In healthy volunteers, acquiring the semantic conditioning requires attention and awareness, thereby making it a valuable tool to test consciousness without requiring an overt response (Peeters et al, under review). In this study we present the results for both tone and semantic eyeblink conditioning for 30 DOC patients. We signal the differences and similarities between the two tests, and argue that when learning is present, especially for the semantic conditioning, it means that in some of these patients new rules still can be learned and there is residual language capacity that requires conscious processing.

Neural Signatures of Consciousness

28. Balancing integration and segregation in brain dynamics.

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Assemblies of neurons in the brain display transient dynamic integration and segregation at multiple spatiotemporal scales. Transient dynamics characterise the ongoing complex activity which is observed in the cortex and is hypothesised to underlie its flexibility and sophisticated information processing capability. How the brain generates and controls these complex dynamics is not entirely understood. Integration of distant brain regions can be achieved through long-range excitatory projections, but the mechanisms supporting long-range segregation and the delicate dynamic balance between integration and segregation are not clear. We argue that the diffusely-projecting thalamocortical matrix connections, thought to support cortical integration, could play an equally-important role in long-range segregation and the integration/segregation balance of cortical activity. We present a computational model of the diffuse thalamocortical system, and show how different levels of input from the reticular activating system to the thalamus can control dynamical states in the cortex, including states with high dynamical complexity (wakefulness) and low (unconsciousness). The model also explains how mutually-exclusive activity across large portions of the cortex, such as between the default-mode and task-positive networks, can arise without long-range inhibition. The model is deterministic and does not require noise to produce ongoing autonomous complex activity, yet is robust to noise. Crucially, complex activity is sustained independently of the statistical properties of any input, while being simultaneously responsive to small input perturbations. We conclude that the thalamocortical matrix connections provide a mechanism for the segregation of cortical dynamics with roles to play in complex information processing, cognitive function and consciousness.

29. Direct electrical stimulation of the human default-network core produces no subjective change in consciousness

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The posteromedial cortex (PMC) has been consistently identified as a core node of the human default network. This region displays sensitive changes in activity across levels of conscious awareness (e.g. anesthesia), and is also activated during tasks requiring self-referential processing. The conjunction of these findings has promoted the hypothesis that the PMC plays some role in supporting 'conscious self-awareness'. As the PMC is positioned on the mesial surface, causally probing its function to test such claims is difficult. We address this challenge by studying the effects of electrical stimulation within the human PMC via

intracranial electrodes positioned over the mesial cortical surface in 16 human subjects. All stimulation procedures were part of standard clinical assessment in the surgical treatment of refractory epilepsy. From a total of 552 stimulations, we observed 277 reported effects (patient report, or observed behavior). Interestingly, 93% ($n = 257$) of these responses could be characterized as either sensory or motor in nature and observed outside of the PMC. Consequently, a large number of stimulations ($n = 128$) occurred within the PMC and produced no reported or observed changes in perception or behavior. Consistent with these observations a non-parametric test of association revealed a significant difference in the occurrence of responsive stimulations between PMC and non-PMC sites (Chi-square (2) = 48.6, $p < .001$). Although the PMC has been implicated in a host of higher order cognitive functions, including consciousness itself, direct causal perturbation of this region at rest produced no consistent changes in conscious state or content.

30. Could the worms have it?

Timothy Durbridge [1]

[1] Greenhill Research

My poster concerns the possibility that *Caenorhabditis elegans* experiences something as it goes about its daily business: grazing on its choice of soil bacteria, moving forward or back, taking naps, migrating, etc. Remarkably about 30% of its cells are neurones. By 1986 White et al. had traced its entire connectome, but much still remains to be discovered about this network's function. In 2013 Schrödel et al. devised a method of monitoring activity in the interneurons that ring the pharynx. They described neuronal population activity patterns teetering from one attractor to another. I comment that such activity is consistent with that of a Tononi complex, albeit modest. I wonder what integrated information nudges the network. In 2013, Katz et al. reported that a glia-like cell modulates a sleep related neuronal circuit, raising the possibility that 4 cells White called CEPsh could regulate behaviour. Glia-like cells ensheath the entire sensory-motor system. Glia have receptors finely sampling activity across neuropil, invoking transient glial cytosol calcium increases, amplified by calcium egress from the endoplasmic reticulum setting up eddies that I speculate result in an integrated code, a code applied through gliotransmitters to nudge neural activity. One might begin by testing whether any effect of CEPsh on the ALA AVE synapse (as described by Katz) varies with the pattern of CEPsh transient cytosol calcium changes. Further use of *C. elegans* in uncovering the fine grain physiology of correlates of consciousness could prove enlightening.

31. A dissociation of conceptualization processes from consciousness processes

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A long-standing controversy in the science of consciousness is whether visual consciousness is mainly dependent on activity and networks in the occipital lobe or in the frontal lobe (Lamme 2006; Dehaene et al. 2006). Block has argued that conceptualization of visual stimuli require attentional resources (2007) In turn, the recruitment of attentional resources draws on frontal sources and networks (Knudsen 2007), which makes it possible that frontal activations observed in earlier studies are related to conceptualization and not consciousness per se. We have designed a study suitable for teasing apart potential brain activations specifically related to conceptualization and brain activations specifically related to consciousness. We designed 2 tasks, both 2AFC with backward masking, with identical number stimuli. Subjects reported the clarity of their experiences on the Perceptual Awareness Scale (Ramsøy and Overgaard 2004). One task, (is x greater or lesser than 5?), requires conceptualizing the presented stimulus as a number, whereas the other, (is x written with a digital or an analogue font?), does not require conceptualization of the presented stimulus, since one can rely on discerning low-level perceptual features such as straight vs. curvy lines. The study will be done in a MEG-scanner. We hypothesize that occipital activations will be related to the conscious experience of the subject, whereas frontal activations will be related to conceptualization of number stimuli as numbers.

32. Predicting detection performance based on pre-stimulus EEG responses

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Even when the visual system receives identical physical inputs, resulting conscious percept can vary across trials. Can perceptual fluctuations be predicted from fluctuations of neural activities in the brain even before the stimulus is presented? To investigate the question, we recorded EEG from human subjects ($n = 8$) while the subjects performed a simple detection task, and we tried to predict whether or not the detection was going to be correct based on power of pre-stimulus EEG. In each trial, a Gabor patch was presented in one of four quadrants and weakly suppressed by low-contrast Continuous Flash Suppression. For this 4AFC localization task, we used the QUEST procedure to achieve ~50% correct detection rates at each quadrant. To predict the correctness of the detection, we constructed a multivariate decoder for each location. When the Gabor was going to appear in the lower right quadrant, the prediction was successful in ~60% of trials (with chance performance = 50%) even from 2.5 sec

before the trial onset. For the Gabor in the lower left quadrant, the prediction accuracy was ~60% from 1 sec before the stimulus onset. For other locations, the prediction was at chance. This location-dependent decoding accuracy seems difficult to explain by mere fluctuations in global arousal level. Our findings suggest that pre-stimulus power of EEG can be used to predict successful detection of a target in a location-dependent manner.

33. Initial EEG phase predicts the timing of perceptual switches in continuous flash suppression.

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Continuous flash suppression (CFS) offers a unique opportunity to study conscious perception. In CFS, a dynamic, random Mondrian pattern presented in one eye can perceptually suppress stimuli presented in the other. Dominance of the Mondrian pattern eventually gives way to the suppressed stimulus and perception switches. The perceptual switch times are stochastic and cannot be predicted from previous perceptual switch times (fast autocorrelation decay). Here, we investigated if, on a trial-by-trial basis, there are reliable electrophysiological markers that can predict future perceptual switch times. We collected EEG from 24 participants who viewed short trials of CFS, in which Mondrian patterns were presented to one eye and then 1-2 s later, a face to the other eye, with trials lasting 12-13 s. Using a multivariate linear kernel support vector machine we were able to predict whether the perceptual switch time was short or long in duration (~70% accuracy, chance is 50%), using the ongoing phase of EEG. The information that predicted perceptual switch times emerged 200 ms post onset of the Mondrian pattern but 1 sec before onset of the face. This predictive information was present in the low frequency band (5-10 Hz) and mainly in occipital channels. Crucially, prediction performance was at chance over all time points, frequencies and channels in a physically blended, face and Mondrian pattern, control condition. Our results imply that low-frequency neural activity that is evoked/induced by the initial frames of the Mondrian pattern helps determine the duration of perceptual suppression on a trial-by-trial basis.

34. Informational Structure of Perceptual Experiences

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In this study, we set out to measure the informational structure of neural activity corresponding to specific contents of visual consciousness. We employed a computationally tractable approximation to Φ based on channel covariances and mismatched decoding [Oizumi M, Takenaka K, Yanagawa T, Amari S, Tsuchiya N, Fujii N (2011) ASSC15, Kyoto, Japan], referred to as Φ^* . The Φ^* metric was applied to human electrocorticogram data that was collected in tandem with psychophysical measurements of visual perception, including continuous flash suppression. We observed informational structures that map directly onto phenomenal structure as reported by patients. These Φ^* -structures have two levels – at one level they are a power-set of Φ^* magnitudes over a specified range of recording channels, ostensibly describing the relative contribution to consciousness of different overlapping submechanisms; at a finer level, percept-specific structure appears in the causal structure of each mechanism that determines the magnitude of Φ^* . We propose that just as the magnitude of Φ is analogous to the degree of consciousness possessed by a system, the informational structures implied by Φ are analogous to the shape of the conscious experience, or qualia (Balduzzi & Tononi PLOS-CB 2009, Oizumi, Albantakis, Tononi PLOS-CB 2014).

35. Activity in the auditory cortex and the subject's awareness

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The nature of the neural correlates of conscious perception is one of the key issues in consciousness studies. In the literature, neural responses are typically analyzed with the assumption that they have their own time course characteristics (e.g. P100), irrespective of the actual duration of the auditory stimuli. We measured MEG during the presentation of 1000 [Hz] tone of 2.5, 3.5, 4.5, 5.5 seconds duration to 7 subjects. The intensity or frequency of each tone was changed in near-threshold differences during the last 0.5 [sec] of each presentation. The peak latency of the MEG response had no correlation to the moment of awareness (the timing of the subject's button presses). On the other hand, there was a small but significant increase of awareness-related MEG signals in the auditory cortex, which was widely distributed, and which changed slowly during the duration (about 60 [msec]) of filter window. Based on these results, we discuss the temporal and spatial constraints to be considered when analyzing the neural correlates of consciousness.

36. Stimulus-evoked neural activity and intrinsic variations in visual awareness: An EEG/fMRI study

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We undertook to study the neural correlates of visual awareness (VA) without any confounds of varying stimulus properties, so that changes in VA would be due solely to intrinsic factors. EEG and fMRI signals were recorded simultaneously while subjects performed visual detection task backward-masked images presented at the threshold of detection. On each trial, subjects were presented with an image of a face, a house, or an unrecognizable texture lasting 34 ms, followed by a dynamic mask (unrecognizable random-noise textures; total duration 200 ms). After a variable delay (1.25-2.5 s), subjects first made a two-alternative forced choice ("Face" or "House"; to assay "objective awareness"), then reported visibility on a pseudo-continuous scale ("Minimum visibility" to "Maximum visibility"; to assay "subjective awareness"). Preliminary analysis of the EEG data from midline electrodes Pz and Cz revealed a positive-going ERP component between 300-450ms (the P3b) that was larger in magnitude on high-awareness trials than on low-awareness trials. Intriguingly, the amplitude of the P3b component also scaled with subjective visibility on trials in which only an unrecognizable texture was shown. We also examined spectral power in the post-stimulus period, and found that two frequency bands, one centered on 9 Hz and one centered on 25 Hz, showed increased power in high-awareness trials from stimulus onset to 200 ms post-stimulus; this pattern was also present on texture-only trials. These results suggest that some neural correlates of VA may not depend on the presence of stimulus information.

37. Intracranial Markers of Conscious Face Perception in Humans

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The investigation of the neuronal basis of consciousness has greatly benefited from protocols that involve the presentation of stimuli at perceptual threshold. These protocols enabled the assessment of the patterns of brain activity that correlate with conscious perception, independently of changes in sensory input. However, the comparison between perceived and unperceived trials highlights not only the core neuronal activity necessary and sufficient for conscious perception, but also aspects of brain activity that facilitate conscious perception, such as attention, and aspects that tend to follow perception, such as memory formation. In this work, we provide a refinement of the threshold presentation approach, by combining an analysis of neuronal responses recorded intracranially from epilepsy subjects during the presentation of faces partially masked by Continuous Flash Suppression, and those responses observed during the unmasked presentation of faces and other categories. The comparison between seen and unseen trials in the masked condition revealed significantly different neuronal activity in several loci in the ventral and lateral temporal cortices. While some of the ventral areas showed selectivity to faces in the unmasked condition, the lateral areas did not, suggesting that the former are likely to constitute nodes of the core network underlying conscious perception, while the latter are probably involved with facilitating conscious perception or with subsequent processing. More generally, our results suggest that the comparative analysis of neuronal recordings obtained during different, but related, experimental protocols is a promising direction towards elucidating the functional specificities of the patterns of neuronal activation that accompany conscious experiences.

Attention and Perception

38. Unconscious Gestalt completion affects what we are aware of during Motion Induced Blindness

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The link between attention selecting a stimulus and that stimulus entering awareness is often disputed. One way to investigate this question is to examine whether attention can unconsciously influence the stimuli that are currently being perceived. The Motion Induced Blindness Paradigm (Bonneh, Cooperman & Sagi, 2001) offers an opportunity to investigate different states of awareness under different states of attention. Using this paradigm, Mitroff and Scholl (2005) demonstrated that stimuli enter or leave awareness synchronously more often when a gestalt is formed between the stimuli. However, this research was limited

by the fact that the conditions responsible for creating the gestalt were conscious and not prone to Motion Induced Blindness. Moreover, it is unclear whether forming a gestalt between stimuli at different levels of awareness will make them align in awareness. To resolve this, the experiment performed here examined what happens when two stimuli, differing in whether they are conscious or not, are connected by a line during Motion Induced Blindness. This line-gestalt is made by the transient and ignored distractor stimuli such that the effect is unconscious. Pertinently, it is shown whether a stimulus that is unconscious and forms a gestalt with a currently conscious stimulus is pulled into awareness or instead drags the conscious stimulus into the unconscious.

39. Cues triggering recovery from mind wandering

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The aim of this study is to explore the type of cues that trigger students' recovery from mind wandering in a university classroom. We asked undergraduate students to remember and describe the characteristics of their most recent episode of mind wandering in a classroom setting. We also asked them to report the internal or external triggers of the recovery from this state. An analysis of the triggers revealed that a large number of them were external events, while very few of them were internal ones. It was also shown that most of the external triggers were lecture-related, such as a change in the teacher's vocal tone. The results showed possible mechanisms underlying the onset and offset of mind wandering, and effective ways to control it.

40. Some distraction increases conscious awareness

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The notion of distraction typically has negative connotations, in that it refers to an additional stimulus or task that draws attention away one's primary task. Indeed a key function of attention is to filter out distracting stimuli in order to focus on a primary task. This provides a considerable challenge for attentional mechanisms: how and why are some stimuli "bounced" from early processing, while others reach conscious awareness? We used a dynamic inattention blindness paradigm to explore how distraction affects conscious recognition of unexpected objects. Participants were required to track moving objects over a number of sequential trials. During critical trials an unexpected stimulus moved horizontally across the screen. We have demonstrated that concurrently listening for tones embedded within music significantly increases awareness of unexpected visual stimuli, independently of cognitive load. Initial explanations for the results involved the distracting nature of music; however it could be the case that listening for an embedded tone constituted a trigger for detecting the stimulus. This was confirmed in a visual version of the task in which an unrelated visual 'flicker-distractor' significantly increased conscious awareness of the unexpected stimulus. These results suggest that task-irrelevant distractions, regardless of modality, have the potential to facilitate conscious processing of unexpected stimuli. We propose that distraction can optimise attentional capture of unexpected stimuli by disrupting attentional set and forcing the observer to distribute their attention more broadly. Thus these have important implications for models of attention and the role of distraction in attentional capture.

41. Examination of vague experiences during Kanizsa based illusions

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Over the last years, it has been debated whether unclear visual experiences should be viewed as generally degraded whole percepts or whether they are composed of clearly seen fragments. We investigated this using a novel paradigm: Two lines surrounded by elements that induced a Kanizsa figure on certain trials were presented briefly, thus creating a Ponzo illusion affecting the apparent length of two lines. The magnitude of the illusion was examined for each of the four levels of visual clarity reported on The Perceptual Awareness Scale (PAS - an introspective scale through which participants are asked to rate the clarity of their visual experience). Since all the individual parts of the Kanizsa figure must be present for the illusion to occur, this method could be used to examine weak experiences (when participants describe their experiences as weak on the PAS): If the influence of the illusion is measurable, then weak experiences can be interpreted as a generally degraded version of the whole stimulus. If the illusion had no effect, then weak experiences are either fragmentary or they have little influence on judgements. Preliminary analyses suggest that performance was influenced by the illusion when participants reported having experienced an 'Almost clear image' or 'Clear image' of the lines. When participants reported having experienced a 'Weak glimpse' or had 'Not seen' the lines, there was no significant difference between illusion and control. These results indicate that vague experiences are either fragmentary or that they have little influence on judgements.

42. Graphemes sharing phonetic properties tend to induce similar synesthetic colors.

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People with grapheme-color synesthesia experience idiosyncratic colors when viewing achromatic letters and digits. Despite large individual differences, researchers have suggested determinants of grapheme-color associations (Asano & Yokosawa, 2011; Brang et al., 2011). A work in our group, for example, showed that graphemes with similar sounds tend to induce analogous synesthetic colors (Shin & Kim, 2011). In the present study, we extended the previous finding and examined whether graphemes categorized the same based on the phonetic rules – i.e., the place and the manner of articulation – are associated with similar synesthetic colors. Four Korean multilingual synesthetes matched “colors” they experience while viewing achromatic graphemes in Korean, English and Japanese. The matched RGB values were converted into x y coordinates on the CIE xyY color space. The distance between each pair of graphemes was taken as an index for synesthetic color similarity. In terms of the place of articulation, graphemes in the alveolar category induce more similar synesthetic colors than others. In terms of the manner of articulation, graphemes which are categorized as stop sounds tend to be associated with similar synesthetic colors. These results are noticeable since graphemes that are not transliterated into each other (e.g., ‘s’ and ‘ㅅ’ (Korean grapheme sounded as /n/) in Alveola) belong to each phonetic category as well as graphemes that are. These results imply that the phonetic properties of graphemes across multiple languages, not just conceptual similarity based on their sounds, are what really matter in determination of their synesthetic colors. This work was supported by NRF-2013K2A1A2053850

43. Localizing category-selective BOLD signals in fMRI using SWIFT

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SWIFT (semantic wavelet-induced frequency-tagging) is a novel method, which periodically scrambles natural images in the wavelets domain, modulating the image’s semantic content at a fixed temporal frequency while conserving the image’s principal low-level properties (e.g., luminance, contrast and spatial frequency). As such, SWIFT is hypothesized to be able to isolate high-level visual representations by directly modulating neural activity at the tagging-frequency without using subtractive approaches (which have been criticized due to their propensity to generate spurious results). While SWIFT has been successfully applied using EEG (Koenig-Robert & VanRullen 2013 Neuroimage), it is unclear whether SWIFT can specifically engage high-level category-selective regions without contribution from low-level visual areas. To address the spatial specificity of SWIFT, we employed fMRI and localized brain areas selective for object categories (faces, scenes and objects) in humans (n=7) using slow tagging-frequencies (0.06, 0.08 and 0.1 Hz). We were able to frequency-tag the BOLD response using SWIFT and obtain category-specific responses. To compare sensitivity and selectivity of SWIFT and classic localizer in a criterion-free manner, we adopted an ROC approach, by defining sensitivity and 1-selectivity as the voxel percentage within canonical category-selective regions and V1/V2 activated above a certain threshold, respectively. We derived an ROC curve by changing thresholds. SWIFT showed area under the curve (AUC) values significantly higher than chance for faces and scenes categories, while AUC classic localizer values were not significantly different from chance for any category. We conclude that SWIFT is more sensitive/selective than classic localizer in finding category selective areas using fMRI.

44. SSVEP is modulated by dynamical change of object recognition state

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Steady state visually evoked potential (SSVEP) is used to investigate cognitive activity about the vision. It is known that SSVEP is evoked by flickered stimulus and recent studies suggest that it is modulated depending on various cognitive activities (ex. attention, working memory and object recognition). In this study, we investigated whether SSVEP is modulated dynamically by the transition of the recognition states. Meaningful and meaningless images were created by using nature images including animals or objects. In a trial, binary images of them are shown and morphed into the gray-scale images. At the same time, square noises flickering at 7.5Hz were superimposed upon the images. The trials were classified according to each image type (meaningful image and meaningless image). In addition, the trials for meaningful images were classified into 3 types of recognition transition (1:unrecognized to unrecognized, 2:unrecognized to recognized, and 3:recognized to recognized) according to participants’ behavioral responses. In this result, SSVEP amplitude for perceived target is higher than that for no target. Moreover, SSVEP amplitude while the state was changed into recognition increased during images morphed. In conclusion, this study suggests that SSVEP is modulated by the recognition state. Furthermore, it is modulated by the transition of the recognition state dynamically.

45. The Effect of Temporal Attention on Neural Oscillations, Discrimination Accuracy, and Subjective Visibility

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Allocating attention in time improves reaction times during discrimination tasks for stimuli that fall within the attended time window (Zanto, et al., 2011). Recent evidence suggests that bottom-up temporal attention (e.g., stimuli with rhythmic temporal sequences) improves processing at perceptual, rather than just response levels (Rohenkohl, et al., 2012). How temporal attention interacts with subjective visibility, however, is less clear. Nor is it clear if temporal attention can be deployed in a top-down manner to improve perceptual processing. Here we use symbolic cues to indicate whether a brief tilted Gabor patch will appear following a short (650 ms), long (1400 ms), or unpredictable delay (a delay randomly chosen from 650, 900, 1150, or 1400 ms). On each trial, participants had to judge the orientation of the Gabor and report subjective visibility thereafter. Behavioral results reveal that the effect of predictability on accuracy interacted with delay such that accuracy increased with predictive cueing but only at short cue-target delays. We observed a main effect of predictability on visibility ratings, suggesting that temporal attention can affect these two dimensions of perceptual processing differently, not unlike other forms of attention. Preliminary EEG data suggest that the effect of temporal cuing was associated with a shift in the phase of ongoing alpha oscillations preceding the Gabor, a mechanism known to influence visual awareness. These findings indicate that top-down temporal attention differentially affects subjective and objective measures of visibility, and that control of ongoing alpha phase may serve as a neural mechanism of temporal attention.

46. A Multi-factor Experimental Study on the Attention-orienting Triggered by Visual Subliminal Spatial Cue

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In the researches of unconsciousness and spatial cue, the process of attention-orientation triggered by subliminal spatial cue becomes the frontier question. On the basis of former researches, the present research recreates the experiment paradigm through the literature review and considers the effect of several factors in this process. In Experiment 1, we have designed a detection task to discuss whether the parameters under the threshold of subjects' perception are suitable in the novel paradigm. The results show that using the method of backward masking insures the stableness and reliability of subliminal spatial cue; the presenting time of cue and masking must be exactly controlled, namely, 16ms of cue stimulus with 80ms of masked stimulus; the subjective threshold is easily affected by the task difficulty, while the objective threshold is more stable in both difficult and simple tasks. Experiment 2 discusses effects of task type, task difficulty and SOA in the process of attention-orientation triggered by subliminal spatial cue and their interactions. The results show that in the conditions of double-task (color discrimination task and cross detection task) and multi-difficulty, subliminal spatial cue is able to trigger exogenous attention-orientation and the process is automatic. Subliminal spatial cue will not affect tasks with no relationship to it. But the effect of subliminal spatial cue is affected by time course. In different levels of SOA, facilitation effects and inhibition effects both appear consequently, which has a double-period effect. These effects are probably affected by task type and task difficulty, but subliminal spatial cue has regulatory effect on these effects.

47. Extraction of the covert divided attention by steady-state visual evoked potential

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Among the methods of extracting attention, steady state visual evoked potentials (SSVEPs) elicited by flickering stimuli have been noticed widely. SSVEPs reflect the attention and when the flickering stimulus of a frequency was paid attention to, SSVEPs amplitude of the same frequency is enhanced. Previous studies showed that SSVEPs reflect the various types of attention, spatial attention, selective attention, divided attention and so on. Our previous study suggested that the divided attention of multiple moving targets could be extracted using multi-frequency SSVEPs. However, it reflected the overt divided attention because of it permitted capturing multiple regularly moving objects. In this study, we investigated extracting the covert divided attention to multiple moving objects using SSVEPs rather than the overt attention. In the experiment, four round objects moving randomly were displayed with different flickering frequencies (7.5Hz, 8.57Hz, 10Hz, and 12Hz). Participants were instructed to track two moving targets among four (six attentional states) while gazing at the fixation point. We analyzed peak amplitude of elicited SSVEPs in each attentional state. The result showed that SSVEP amplitude was modulated depending on attentional state. In addition, the SSVEP modulation was caused by the covert divided attention since eye movement didn't occur. These results suggesting that it is possible to extract covert divided attention using SSVEPs. Our findings provide the first neural evidence of extracting the covert divided attention by SSVEPs.

48. By How Long does Visual Perception Lag the Physical World?

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Information takes approximately 100 ms to be transmitted along neural pathways from the eye to visual processing centres such as V1. Conscious awareness of neural representations of such information should also be delayed by at least this time. Such a delay can have significant implications – a car travelling at 160 km/hr covers 4.4 m in this time, as does a cricket- or base-ball. How then do we successfully perform interacting with such objects? Nijhawan (1994; 2008) advanced the attractive hypothesis that with a smoothly moving object the visual system uses past position and speed information to extrapolate the visual representation forwards, so that the discrepancy between an object's physical position in the world, and our perception of that position, is reduced. He advanced this hypothesis to explain the flash-lag illusion, which he rediscovered – when a smoothly moving stimulus is displayed adjacent to a briefly displayed flash, the flash is perceived to spatially lag. I review key findings from the subsequent two decades of work by myself and others investigating this and other visual phenomenon. I conclude that, despite claims to the contrary (e.g. Eagleman & Sejnowski, 2009), for a smoothly moving object Nijhawan's hypothesis has not been disproven. Although logic and our current understanding dictates that our perception of punctate stimuli must lag the physical world by about 100 ms, our perception of the position of smoothly moving objects may be substantially closer to their physical position than such a processing lag would suggest.

49. The Role of Monocular Dominance in Rivalry Onset Bias

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When an observer is presented with dissimilar images to each eye, the images will alternate every few seconds in a phenomenon known as binocular rivalry. Recent research has suggested that for the first conscious experience, or 'onset' period of rivalry, there is typically a bias towards one image. This bias varies between individuals and across the visual field, and does not appear to be related to average dominance in sustained viewing. To further characterize the role of monocular dominance in the onset bias, four trained observers were presented with orthogonal achromatic gratings for 1 sec and 1 min presentations at fixation and at 24 locations sampling the region within 1.5 degrees eccentricity from fixation. Results reveal individual differences in the contribution of eye dominance to the onset bias, with individuals displaying degrees of either right eye dominance or temporal hemifield dominance. Three out of four observers showed correlations between onset biases and biases in average dominance in sustained rivalry. These results demonstrate that monocular dominance plays a significant role in determining dominance at the onset of rivalry, though there are individual differences in the pattern of bias across the visual field. Monocular dominance can also affect dominance in ongoing rivalry in a way that correlates with the onset bias; however, this does not seem to be the case for all observers, suggesting that the neural mechanisms underlying onset and sustained rivalry may be distinct. In addition, some initial data assessing the relationship between onset bias and the stabilization seen with intermittent presentation will also be discussed.

50. The suppressive effects of phantom colour on conscious perception

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The constructive nature of sensory perception can be demonstrated by stimuli that induce experiences of phantom perception in the absence of direct input. Evidence suggests that such episodes of phantom perception rely on the same sensory representations as perception itself. The functional consequences of such an overlap for conscious perception and how phantom perception relates to voluntarily formed sensory representations such as mental imagery remains poorly understood. Here we created a phantom colour experience using the neon colour spreading illusion, in which four corner segments induce a vivid phantom colour experience in the centre. After passively viewing one of two phantom colours, participants reported the dominant colour in a brief binocular rivalry presentation, containing the same two colours. We found significant suppression effects on subsequent binocular rivalry, but not in a control condition in which each corner was presented in isolation for the same total duration. Further, these suppressive effects were stronger for longer presentation durations of the phantom colour. Finally we compared these suppressive effects of phantom perception to previously documented facilitative effects of voluntary mental imagery, prior to the same brief binocular rivalry presentation. Despite the generally opposite directions of these effects, where phantom colours were suppressive and voluntary colours facilitative, the two effects were significantly correlated. These data indicate that this form of involuntary phantom colour can bias subsequent colour rivalry in a suppressive, duration specific manner, and that involuntary phantom colour is related to voluntarily formed colour imagery, both in the absence of direct sensory input.

51. Visual field asymmetries in conscious identification

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Multiple stimuli in a scene compete for processing resources and access to conscious awareness. In patients with visual extinction following unilateral brain damage, this competition takes the extreme form that stimuli on the contralesional side are “extinguished” from awareness. Furthermore, extinction is more severe when the stimuli share perceptual or response features. A similar phenomenon, repetition blindness (RB), is demonstrated in healthy participants under conditions of brief serial visual presentation, whereby a repeated stimulus is harder to perceive than a non-repeated one. The dominant account of RB is that repeated stimuli activate the same memory representation (type), but they are not individuated as distinct episodic representations (tokens) of that type. Here, we used a spatial variant of the RB paradigm in which we presented two masked letter stimuli simultaneously in the left and right visual fields. The letters were either the same identity or different. We found an overall bias to report the left-sided (LVF) stimulus compared to the right-sided (RVF) one. In addition, the stimulus presented in the RVF suffered greater RB, which was more severe if the two letters were visually identical (i.e., same case). In a subsequent experiment, we presented both stimuli in either the LVF or RVF. Although in this case there was no longer an overall bias towards the LVF, RB only occurred when the stimuli were presented in the RVF. These results suggest a potential right hemisphere advantage in the ability to token-individuate visual stimuli.

52. Do you see what I see? Personality and perceptual suppression

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As a consequence of living in an ever-changing environment, our sensory systems have evolved to efficiently cope with large amounts of information: necessitating focus on one option and inhibition of less relevant details. A similar excess of options is faced in everyday life, requiring choices to be made to avoid endless distractions. We predicted that a highly efficient system, such as the human brain, might rely on similar mechanisms when facing comparable pressures from the environment. As personality is known to impact on individual's behavior when presented with conflicting options, Study 1 tested the relation between personality measures and an individual's perceptual experience, when presented conflicting visual stimuli using binocular rivalry. Participants (N.123) reported perceptual dominance during rivalry and completed The Big Five Aspect Scales (De Young et al. 2007). A significant correlation was found ($r = -.22$, $p < .05$), with individuals high in the trait “openness to experience” reporting a greater proportion of time when both rivalry images were simultaneously perceived (incomplete inhibition). In Study 2, we further explored the relation between openness and perceptual inhibition by assigning participants (N.60) either to a Positive-Pleasant or a Neutral mood induction. The relation between openness and perceptual inhibition was moderated by mood induction, $b = 5.65$, 95% CI [0.34, 10.96], $t = 2.13$, $p < .05$, with individuals high in openness reporting less complete perceptual suppression after the Positive-Pleasant condition. These results suggest that an individual's personality may impact low-level visual processing or be influenced by common biological factors.

53. The self through time: A neuroscientific investigation using twins

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Visual self-recognition may be an empirical marker for self-awareness. Neuroscientists have subsequently investigated the neural correlates of self-recognition to identify the neural correlates associated with self-awareness. Participants typically have been presented with pictures of themselves taken on the day of the experiment, the results of which are contrasted with recognizing pictures of another familiar face. Two problems arise with this approach. Firstly, there is no inclusion of self-images taken from different time periods across the lifespan (i.e., last year, 5 years ago, etc.). It is therefore unknown whether the neural correlates of self-recognition remain the same irrespective of the time period from which images originate. Secondly, researchers have not accounted for the differences that participants have between their exposure to images of self (i.e., the whole lifespan) and familiar others (i.e., usually less than the whole lifespan). It is possible that any reported differences in the neural correlates for recognizing self and others are simply an artefact of this differential exposure. We addressed these problems by asking our participants to recognize images of themselves and their non-identical twin taken from different periods of the lifespan. Event-related potentials recorded neural markers that reflect various stages of face processing. We found (i) no uniform neural signature for self-images across the lifespan; (ii) the neural signature associated with self-recognition is only unique (compared to twins) in relation to the stage reflecting the retrieval of mnemonic information about the person being recognized. The implications of our results and approach for investigating self-awareness are explored.

54. Intertwined coding of facial affects and odor hedonics

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Our behavioral response to a sensory stimulus depends in large on its intrinsic attractiveness or aversiveness, viz. valence. It is generally accepted that valence is encoded in the limbic system, yet how it is ascribed to inputs from various sensory channels has received little attention. Combining continuous odor exposure with a well-established paradigm termed interocular suppression, we show that the suppression time of an emotional face is modulated by the hedonic value of its accompanying odor, as if it assumes valence from the olfactory channel in the absence of visual awareness. BOLD responses in the amygdala mirror the behavioral results and exhibit an interaction between odor valence and invisible facial affect. Conversely, we find that initially indiscriminable neutral enantiomers gain different hedonic values through implicit pairings with fearful and happy faces, respectively. These findings point to intertwined valence codes between olfaction and vision, which are subserved by the amygdala and operate below awareness.

55. A functional MRI study on thought suppression

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The neural correlates of “thought suppression”, or at least the effort to suppress thought, has been searched for with brain mapping techniques, but a unified understanding is yet to be achieved. Recent studies demonstrating brain activity related to memory maintenance suggest the effect of total cognitive load that increases with task complexity. Since “thought suppression” can itself be an internal, non-demanding task recruiting only a weak activity in the healthy brain, such confound might have led to inconsistent findings across reports. In the present study, therefore, we created a very simple task paradigm that only requires subjects to shift between “imagery” and “suppression” conditions by a timing cue on the screen. Nineteen subjects were asked to imagine two famous architectures of Japan in order during the imagery blocks and stop imagining anything during suppression blocks. We used a relatively long block length of 48s to capture slow variations in the baseline activity. Using both conventional GLM and multistage independent component analyses, we found that bilateral supra marginal-gyri (SMG) were specifically activated during suppression, while most large-scale networks such as the frontoparietal or default mode networks (DMN) were suppressed at the baseline activity. Our finding is not only compatible with the known central role of the SMG in attention-orienting, but also provides an integrated model for thought suppression and cognitive control.

Memory

56. Attentional blink-like effect in working memory

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The Attentional Blink (AB) refers to an effect obtained in rapid serial visual presentation (RSVP) tasks. Identifying second of two targets (T2) is much more difficult if it is presented shortly (200-500ms) after the first target (T1). According to most of explanations limited-capacity attention needs to be allocated to the proces of identification of T1 so T2 often goes unnoticed and we are not aware of its appearance. In the study described below we wanted to check if similar effects can be observed in working memory (WM) functioning. WM is often described as a system consisting of limited capacity (1 to 4 elements) focus of attention (FoA) containing information ready for current processing and set of areas of different accessibility. We can be aware only of information that is in the FoA and information from other parts needs to be brought to FoA first. We presented subjects with a series of stimuli (letters) and then asked to recognize two targets presented one after another. As expected, accuracy was generally worse for T2 but the difference between T1 and T2 was the most significant in case of the most recent items (so the ones that should be in FoA). Also, it took longer to access information only from most recent positions. Results sugest that evaluation of T1 uses limited capacity of attention in similar way to AB and T2 fall outside FoA. We discuss results in light of current models of WM and accessibility/awarness of its different components.

57. The awareness of information in working memory: Time delay and confidence assesment.

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Still little is known about conscious and unconscious aspects of mechanisms underlying working memory. We used modified memory search task (Sternberg , 1969), to find how delayed presentation of target letter affects more or less conscious way of memory searching. Participants were asked to memorize set of 6 letters, and to recognize whether target letter had been shown before. In order to check conscious availability of material, we asked participants how confident they are of their recognition decisions. We interpret the results in context of WM embedded model (Cowan , 2005) and switching the search strategy from conscious sequential phase to the phase of parallel searching. When activation of information in WM decreases, the result should be increased difficulty of determining if the target was in the set. Therefore, the reaction time should be longer, and correctness and confidence of decision should decrease in the inconsistent condition (the correct answer was “no”) with delay increasing. However, this did not happen. Results showed that confidence was lower but the accuracy was better in inconsistent condition. Target delay did not affect the correctness, response time, and confidence in consistent condition. We discuss conscious aspects of access to content stored in working memory as indicators of recollection and familiarity (Jacoby , 1991).

58. Availability and consciousness of working memory content in serial recognition.

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The relationship between availability of material stored in working memory (WM) and consciousness seems to be close, but in fact it is not clear. The process of retrieval from WM seems to involve two mechanisms – recollection and familiarity. However, only the former is conscious, the latter is rather unconscious. One of many factors that affect the retrieval mechanism is the availability of memory content which fades in time. Low availability precludes recollection, but allows for the use of familiarity. In the present study we used a WM search task with multiple target stimuli in order to investigate availability of WM content in serial recognition, and we manipulated delay time between stimuli presentation and recognition (0, 1 and 3 sec). In order to check the availability of the material to consciousness, we asked participants how confident they are of their responses. The results show that the delay time does not affect accuracy (an indicator of availability) of the first target, and significantly reduces the availability of the second one, but exclusively in the consistent condition. Only in this condition, accuracy is accompanied by adequate evaluation of confidence. In the other conditions, subjects' confidence decreases with delay, while accuracy is constant and very high. Similar differences were found in accuracy level as a function of the target position: typical for first target and almost flat for second one when delay time was 3 sec. We discuss the obtained results in light of current models of WM and awareness.

59. Modeling access to working memory as a self-evaluation and decision process

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Working memory has been tightly linked to conscious access. It offers the unique possibility to maintain information for an arbitrary period of time. However, this ability comes at the cost of a limited information capacity. Hence, the decision to commit a piece of information to working memory or to relinquish it is a crucial one. Here, we propose to model access to working memory as an internal decision process, based on a self-evaluation of the relative values of maintaining or relinquishing information. We further propose that, even in the absence of an external task, the brain manages its memory updating according to some internal goals. We argue that one of these goals is optimization of the prediction of upcoming inputs. We show that using a value system that is sensitive to prediction accuracy, the brain can learn a successful policy to gate access to its working memory system. Specifically, we used a reinforcement learning approach to learn how to manage a working memory having a one slot capacity to discover which stimuli in a stream of events were improving the most predictions of future events. We showed that it could successfully identify long distance predictive dependencies up to at least 7 time steps, and learn the appropriate policy to exploit these dependencies. This model proved to be an excellent compromise between final predictive performance and speed of model estimation; pointing to an evolutive advantage of having small working memory capacity.

60. Processing of words related to a previously solved problem. Cognitive response to problem-relatedness depends on working memory capacity

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Earlier research by the author suggested that people in a special way process material related to demands of a divergent problem they recently solved, even though they do not consciously notice this relationship. For one thing, solving the problem before an incidental orienting task tended to negatively affect recall of problem-related words (PRW). According to one explanation, these words trigger previous-problem-related processing in the orienting task and get suppressed in defense against distraction this task-unrelated activity can cause. An alternative, proactive interference (PI) account ascribes the effect to a conflict or confusion at recall due to similarity of the critical words' designates and the items considered while solving the problem. Two studies addressed this controversy by exploring the relationship between recall of PRW and the participants' working memory capacity (WMC), which relates positively to the ability to control attention, and negatively to susceptibility to PI. In Study 1 (N=248), we found a curvilinear relationship between WMC and free recall of PRW in participants who solved the problem before the orienting task, and not in participants who didn't. Solving the problem improved recall of PRW in participants within an intermediate range of WMC scores, and worsened it in participants with the highest WMC scores. Study 2 (N=81), using cued recall, replicated the curvilinear relation between WMC and memory for PRW. These results support the hypothesis that people show special sensitivity to stimuli related to their previous strivings. Cognitive responses to such stimuli, which may involve inhibition, depend on the persons' WMC.

61. How Much Do We Consciously See And Remember Across Of Fixations During A Search Task?

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When viewing a scene, we form the impression of seeing every object within it. Despite its vividness, though, it remains unclear how much we consciously perceive and remember about the individual objects. We investigated this by recording eye-movements during a search task that employed a dual-task design. As a dummy task, subjects were instructed to search for a "target" face in a crowded natural scene. Upon completion of the search, subjects were presented with two faces. One was chosen from the faces that were fixated a few seconds prior to the search ending and served as the "probe". The other, non-fixated face, served as a distractor. We measured perception and memory of the probe face in a 2AFC+rating task, assessing objective performance (i.e., type-1 measure in the signal detection theory) and accuracy of metacognition (i.e., type-2 measure: correlation between subjective confidence and performance). We found that the longer subjects fixated on the probe, the better their objective performance and the higher their confidence. Interestingly, even for fixations lasting 150 – 250ms objective performance and metacognition were above chance level. Counter-intuitively, neither the number of fixations nor the time elapsed from fixation on the probe until the end of the trial affected performance. Our modeling analysis suggests that response selection and confidence are generated based on common signals mixed with independent noises and that they are, to some extent, processed by separate mechanisms.

62. Vividness of memory and post-coding events.

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Memory is an important element of human experience (Bergson 1896). The phenomenological properties of memories become important research issues within the context of consciousness studies. Flashbulb memories (Brown and Kulik 1977) are highly detailed and vivid autobiographical memories, typically related to the moment and circumstances in which a surprising event happened. The concept can be generalized to vivid memories, which meet the criteria of vividness, clarity, and detail of flashbulb memories, but are not necessarily caused by surprising or consequential events (Rubin and Kozin 1984). It is interesting to study the elements contributing to the nature of vivid memories. People with acquired blindness often report that the vividness of the memories of acquaintances' faces depend on post-blind interactions, with frequent encounter leading to diminished, rather than enhanced, vividness of the memory. Here we study how the frequency of post-coding encounters correlate with the vividness of autobiographical memory. The subjects answered questionnaires in which they rated the vividness of autobiographical memories, together with the frequency of encounter with similar situations. Based on the results, we discuss the effect of post-encoding events on the phenomenology of memory, and implications for the non-local temporal characters of consciousness. Bergson, H. (1896) *Matière et Mémoire*, Paris, PUF. Brown, R., & Kulik, J. (1977). Flashbulb memories. *Cognition*, 5(1), 73-99. Cole, J. (1999). *About face*. MIT Press. Rubin, D. C., & Kozin, M. (1984). Vivid memories. *Cognition*, 16(1), 81-95.

63. Recollection of episodic memory with feeling of nostalgia: Autonoetic consciousness of remembering

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When people remember their own past events, they sometimes feel nostalgia and have different kind of subjective consciousness of remembering. Especially when people feel strong nostalgia, they not only remember the content, time, and place of their event, but also can experience their past as if they re-experienced again. This kind of experience is called “mental time travel” or “autonoetic consciousness” and it is a key concept of the definition of episodic memory. Nostalgic experience can be considered as a typical situation of “mental time travel”. This study was done to examine what kind of subjective experience people have in remembering their past with nostalgia. Participants were asked to remember their most nostalgic event (nostalgia group) or a memory for their event last week (control group). Then, they were asked to respond to the questionnaire of 16 questionnaires, asking about strength of nostalgia, sensory characteristic, questions related to self, and so on. Results showed that nostalgia group felt nostalgia stronger than control group. Nostalgia group remembered an event of nine years ago and control group remembered an event of six days ago. Visual and auditory details of memory weren’t different between nostalgia and control group, but participants of nostalgia group had a stronger feeling of mental time travel. These results suggested that people have autonoetic consciousness (mental time travel) when remembering with nostalgia. Furthermore, nostalgia group felt social interaction greater than control group. This study suggested that nostalgia is closely related to autonoetic consciousness of remembering episodic memory.

Metacognition and Decision Processes

64. Lucid dreaming, introspection and awareness of mind-wandering: behavioural and brain bases

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Lucid dreaming is the ability to become aware that one is dreaming. This phenomenon is difficult to study, but two hypotheses have been put forward. First, lucid dreaming has been associated with metacognitive ability because lucidity requires access to one’s own mental states.¹ Second, lucid dreaming has been linked to the awareness of mind-wandering, because both phenomena are instances of regaining ‘mental autonomy’ (i.e., control of the course of one’s mind²). We explored the associations among three tasks: lucid dreaming, awareness of mind-wandering and thought monitoring. Lucid dreaming was assessed with a questionnaire completed repeatedly over several days.³ Awareness of mind-wandering was measured with a sustained attention task, adapted from previous research.⁴ Participants heard a fragment of Remembrance of Things Past⁵ by Proust, and were prompted periodically to report mind-wandering. Finally, a thought monitoring task was carried during functional MRI scanning. In addition, brain structure and function were measured using T1-weighted images. We report associations between lucid dreaming scores, grey matter volume in areas associated to metacognition, BOLD activity during thought monitoring processes and awareness of mind-wandering. [1] Hobson, JA (2009) Nature Reviews Neuroscience, 10(11), 803–813. [2] Metzinger, T (2013). Frontiers in Psychology, 4. [3] Voss, U et al (2013). Consciousness and Cognition, 22(1), 8–21. [4] Sayette, MA et al (2009). Psychological Science, 20(6), 747–752. [5] Proust, M. (1913). Remembrance of Things Past. France, Grasset and Gallimard.

65. Comparing subjective measures of awareness: implications for methodology and the nature of visual experience.

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Subjective scales have been an invaluable tool to measure unconscious versus conscious knowledge, the extent of stimulus perception, and the nature of visual experience. Here we present two experiments comparing a continuous scale consisting of 21 scale points (Sergent & Dehaene, 2004) with a recently developed 7 point scale (Nieuwenhuis & de Kleijn, 2011). Both experiments used the same simple masked color task and psychophysical design. Participants indicated the clarity of stimulus perception through one of the two subjective scales, by moving a cursor with the arrow keys. The first analyses reveal considerable inter-individual variability in scale use. With both scales we obtain evidence for graded awareness of the color stimuli, but a tendency appears with the 21 point scale for ratings to shift towards the extreme ends of the scale. We discuss important implications for the methodology of awareness measurement, and for the nature of visual awareness in general.

66. Confidence Measurement in the Light of Signal Detection Theory

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We compare three alternative methods for eliciting retrospective confidence in the context of a simple perceptual task: the Simple Confidence Rating (a direct report on a numerical scale), the Quadratic Scoring Rule (a post-wagering procedure) and the Matching Probability (a generalization of the no-loss gambling method). We systematically compare the results obtained with these three rules to the theoretical confidence levels that can be inferred from performance in the perceptual task using Signal Detection Theory. We find that the Matching Probability provides better results in that respect. We conclude that Matching Probability is particularly well suited for studies of confidence that use Signal Detection Theory as a theoretical framework.

67. Overflow as a strategy for the reduction of redundancy.

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There are ongoing debates whether visual overflow exists (Block 2011, Lau & Rosenthal 2011). Here I report empirical studies on the nature of overflow. Correlations between the subjects' metacognition of the overflow and the cognition/memory tasks in natural environments reveal heterogeneities in the subjects' strategy of sensory adaptation. In the first experiment, subjects participated in a "road" study on typical Tokyo backstreets, where they were asked, without prior notification, questions on factual details and gist impressions about the road. The confidence for gist impression questions was significantly higher than that for factual details ($p=0.035$). In the second experiment, subjects participated in a questionnaire on their perception of visual overflow. There was a significant heterogeneity in the subjects' perception of their own phenomenal experience as regards overflow. An earlier study (Mogi 2013) found a significant increase of feeling of qualia with age. There was no such increase of the feeling of overflow with age. In view of the results, I discuss dynamical filtering and accessing of information in sensory overflow from the point of view of redundancy reduction (Barlow 2001). The construction of phenomenal overflow emerges as one of the necessary conditions for dynamic and context-dependent redundancy reduction. References Block, N. (2011). Trends. Cog. Sci. 15, 567–575 Lau, H. & Rosenthal, D. (2011). Trends. Cog. Sci. 15, 365–373 Mogi, K. (2013). Scientific Reports, 3. Article number: 3354 Barlow, H. (2001). Network, 12, 241-253.

68. Fluency and difficulties in an "aha" experience

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The sudden cognition of figures hidden in a black and white pattern (e.g. "cow" (Dallenbach 1952) and "Dalmatian" (Gregory 1970)) is accompanied by a particular phenomenal experience, often referred to as an "aha" experience. The contrast between the difficulties preceding the cognition, and the apparent "fluency" in which the cognition occurs makes an "aha" experience an interesting subject in the context of consciousness studies. Earlier, we have developed a new method (Ishikawa and Mogi 2011), in which we analyzed this insightful experience with morphing black and white two-tone ("Mooney") images gradually into the original gray scale photo. Here we report new series of experiments. The subjects were asked to provide subjective ratings in six-point scale about ten aspects: suddenness, confidence, vividness, three-dimensional perception, gratifying, delight, surprise, misperception (false alarm), tip-of-the-tongue phenomena, and willingness to recommend. Exploratory factor analysis was performed on the data set of the participants' reaction time (RT) for perception, correct rate, and subjective judgments. Parallel analysis revealed that two factors were significant. The first factor (explaining 49% of variance) was interpreted as representing insight or "aha!" experience (Bowden, et al, 2005; Topolinski and Reber, 2010). The second factor (explaining 25% of variance) could be interpreted as "difficulty", or the characteristic state of experience before the subjects had a hunch. Based on the analysis, we discuss cognitive factors such as difficulty and fluency that lead to the vividness of "aha" experience.

69. Self-Awareness mediates Executive Functions and Conceptual Change Processes

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Research has showed the considerable conceptual changes that happen in science and mathematics are accompanied by ontological category shifts. Recently, scholars in the field acknowledged that the conceptual changes in science and math domains that occur during school years with development and learning implicate also Executive Functions. Many science and math concepts that are taught to children are counter-intuitive and require the inhibition of empirically supported everyday intuitive knowledge, and the shifting between different modes of thinking. We argue that in this process demands self-awareness of the processes involved in the task solving. One hundred-eleven schoolchildren participated in the study. Three sets of tasks

were addressed to our participants. The EFs tasks included tests for inhibition --3 Stroop type tasks -- shifting, 3 Number-Letter type tasks -- and updating -- 3 N-Back tasks. In order to measure the preadolescents' fluency in re-categorization in maths and science, the Re-Categorization Task (RECAT) is used. Thirty-five concepts were addressed from 4 different domains (physics, biology, mathematics, and epistemology). All the tasks were computerized and measured the participants' accuracy and reaction time. Finally, participants were asked to solve a set of verbal and maths tasks and were asked to explain verbally (thinking aloud) the way they followed for the processing of each one of them. Participants were tested individually. Results indicated that the self awareness mediates the effect of the Executive Functions to Conceptual Change. We speculate that these findings are important for a general theory about the functioning of the mind.

70. The evolution of metarepresentation: Preschool children, but not chimpanzees, spontaneously prepare for alternative future event outcomes

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The ability to reflect upon representations of the world and understand that they can be misleading is a remarkably adaptive feature of human consciousness. Nevertheless, how this capacity for 'metarepresentation' (representing representational relations) develops and whether it is uniquely human remains controversial. We tested preschool children (n = 90, aged 2 to 4 years) and adult chimpanzees (n = 3) on their ability to prepare for two potential versions of a single future event. Over several trials, a ball or grape was dropped into a forked tube with a single opening at the top but two openings at the bottom. The experimenter surreptitiously controlled which bottom opening the item would fall from, and after some observation trials the children and chimpanzees were given the opportunity to catch the item. Few 2-year-old children (8%), many 3-year-olds (47%), and most 4-year-olds (78%) spontaneously covered both bottom openings on the first trial, with performance gradually improving over trials across age groups. The chimpanzees, however, continued to cover only one bottom opening over many trials, with only one subject eventually covering both openings reliably in a manner consistent with simple operant conditioning. Our results suggest that older preschool children can reflect on their represented version of an undetermined event, understand that this representation could be incorrect, and prepare for an alternative version. No signs of such reflection were evident in the chimpanzees' responses, raising the possibility that the capacity for entertaining metarepresentations evolved exclusively in the hominin lineage within the last six million years.

Predictive Processes

71. The effect of expectations on visual processing reverses as stimulus presentation time increases

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Predictive coding models posit that visual representations result from the dynamic interaction between bottom-up sensory input and top-down predictions. However, the effect of predictions is ambiguous: while predicted sensory inputs are attenuated, they are also sharpened, hence it is not clear whether perceptual inference should be biased towards predicted or unpredicted signals. We hypothesized that the direction of this effect depends on processing depth: bottom-up prediction errors would have more influence when processing is partial, while sharpened predicted signals would bias inference when processing is thorough. We investigated this assumption using priming as a measure of processing. Participants were asked to make simple binary decisions on peripheral face and house targets (male vs female, two vs three stories), which were preceded by peripheral masked primes irrelevant to the task. Perceptual awareness was manipulated by varying prime duration (50 to 450ms), and target category probability was manipulated across blocks to induce expectations (e.g. 80% of face targets in 'face' blocks, 20% in 'house' blocks). Prime and target could either be identical or from opposite categories; priming size was defined as the difference between reaction times in those two equiprobable conditions. Results show that for intermediate durations, priming is greater for unexpected targets, while for longer durations, it is bigger for expected targets. This suggests that the direction of the effect of predictions on visual processing changes with stimulus duration, with a strong effect of 'surprise' signals when sensory information is partial and a bias towards predicted inputs as processing gets deeper.

72. Is perceptual presence perceptual? From a predictive coding point of view.

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Alva Noë (2002, 2004, 2006) popularized the notion of perceptual presence and used that as a support for his own enactivist theory of perception. Noë invokes perceptual presence in different places but one typical example is the perception of the back side of an object. However, the nature of perceptual presence as perceptual itself is sometimes cast over doubt (e.g. Prinz 2013). At least, it seems true that there are important differences: we only see the color and the shape of the front side of an object. I'll answer the question if it really is perceptual by exploring the neural mechanism responsible for the phenomenon under the predictive coding framework. Specifically, I'll try to spot the mechanisms of the representation of the front side of an object, the representation of the back side of an object, and the representation as of the whole object. My answer to the question given the mechanism is rather revisionistic. Perceptual presence doesn't fall within any sort of folkpsychological category; it is neither purely perceptual nor purely cognitive. It is not purely perception, because there is no direct causal interaction with the back side and the perceiver. It is not purely cognitive in the sense the representation of the back side and the representation as of the whole object are driven by the representation of the front side but there is "inference" element in the processings.

73. Subliminal enhancement of predictive effects during syntactic processing in the left inferior frontal gyrus: An MEG study

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Predictive syntactic processing plays an essential role in language comprehension. In our previous magnetoencephalography (MEG) study using Japanese object-verb (OV) sentences, we showed that cortical responses in the left inferior frontal gyrus (IFG) were enhanced at 120-140 ms after the verb onset, indicating predictive effects caused by the preceding object. In the present MEG study with a syntactic decision task, we hypothesize that the predictive effects represent early syntactic processes of determining verb transitivity and associated argument structures of the following verb ("target verb"). To further confirm the automaticity of the predictive effects, we examined whether a subliminally presented verb ("subliminal verb") unconsciously affected the predictive effects. In the contrast between OV and subject-verb (SV) sentences under the congruent condition, where the transitivity of the target verb matched that of the subliminal verb, we observed significantly enhanced left IFG responses at 150-170 ms after the target verb onset. In contrast, cortical responses in the midcingulate cortex (MCC) at 280-300 ms were significantly reduced for the OV sentences. Finally, by using partial Granger causality analyses under the congruent condition, we revealed a bidirectional interaction between the left IFG and MCC at 70-170 ms for the OV sentences. For the SV sentences, significant influences were detected from the left IFG to the MCC at 270-370 ms. Taken these results together, the present study highlights the dynamic interactions among these identified regions, such that the MCC shares its task-set information with the left IFG to achieve automatic and predictive processes of syntax.

Subliminal Processing

74. Rapid natural scene categorization of line drawings is less influenced by amplitude spectra: Evidence from a subliminal perception study

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It has been found that scene categorization accuracy suffers from normalized amplitude spectra, suggesting that the amplitude spectrum plays a crucial role in rapid natural scene categorization (Guyader et al., 2004). However, the role of amplitude might be dependent on the phase information (Joubert et al., 2009). This study aimed to explore the role of amplitude and phase information in rapid natural scene categorization by using a subliminal perception task. The experiment consisted of two blocks with amplitude spectrum normalized or unchanged stimuli. Each block consists of line drawings and gray photograph of natural scene as stimuli. Each trial started with a fixation cross for 500 ms, immediately followed by the stimulus for 20 ms, then followed by the mask for 100 ms. Participants were asked to report the scene category by pressing a key, and then report how clearly did s/he see the image with four possible responses (1. not seen; 2. brief glimpse; 3. almost clear experience; 4. clear experience) by pressing a key. The results showed that accuracy was higher for line-drawings than for gray photographs, and both suffered

from normalized amplitude spectra, but categorization of line drawings was less impaired. Meanwhile, for amplitude spectrum equalized stimuli, more gray photographs were reported as not seen, but more line drawings were reported as brief glimpse. These results suggested that rapid scene categorization is not only based on amplitude spectrum but also phase information which may determine most of the recognizable image structure in natural scenes.

75. Learning Human Faces Without Awareness

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Humans can learn and remember complex visual patterns: different faces, objects, places and printed words. It is generally assumed that consciousness is necessary for learning such complex patterns. Past studies have shown implicit learning for elementary visual stimuli (dots). Here we provide new evidence that learning can be achieved implicitly even for high-level visual stimuli (faces) by using a new kind of non-invasive brain stimulation based on fundamental cellular mechanisms of learning: reinforcing connections between neurons (synapsis). The enhancement of synaptic strength observed in animal learning studies can also be provoked by high-frequency neuronal stimulation (long-term potentiation [LTP]) and blocked by low-frequency stimulation (long-term depression [LTD]). Recent applications in humans have demonstrated selective learning through non-invasive brain stimulation (e.g. TMS) and even through sensorial input. We took advantage of this latter approach to test if implicit learning could be achieved for high-level vision. A face discrimination task was administered before and after applying passive stimulation protocols (LTP-like versus LTD-like) presenting flickering faces. The group undergoing LTP-like stimulation outperformed the LTD-like group, despite equivalent baseline performance. This outcome was replicated on each of three test blocks after stimulation and effects were even robust at the single-subject level. The present work has important theoretical implications by challenging the common assumption that consciousness is necessary for high-level visual learning. It also opens the way for testing the potential therapeutic value of implicit learning interventions (e.g., to improve face processing in autism), with the advantage of being non-invasive, selective, easy to set-up and effortless.

76. Unconscious decisional learning: improving unconscious information processing

Alexandra Vlassova [1], Joel Pearson [1]

[1] University of New South Wales

The idea that unconscious input can result in long-term learning or improvement on a task has been debated for decades, yet there is still little evidence to suggest that learning outside of awareness can produce meaningful changes to decision-making. Here we trained participants using noisy motion stimuli, which require the gradual accumulation of information until a decision can be reached. These stimuli were suppressed from conscious awareness during a training phase, by a simultaneous dichoptic mask. After ~45min of training, spread over 2 days, participants were tested on a partially suppressed decisional stimulus of perpendicular motion. While participants performed at chance throughout the unconscious training period, we found that performance on the partially suppressed test stimulus significantly improved post-training, despite a difference in motion direction. Moreover, we show that the unconscious learning period had a stronger effect on unconscious decisional accumulation than on conscious. Together, these data suggest that unconscious decisional processing can be improved via training.

77. Conscious Reflection of Unconscious Contingency Learning

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Humans can readily detect critical contingencies between objects or events in the environment. Here we report that contingency learning can take place in the absence of visual awareness and without external reinforcement (e.g., punishment or reward). In a modified cue-target paradigm, systematic contingency was arranged between the spatial layout of a pair of cues (faces with different expressions or Gabor patches with different orientations) that were rendered invisible by continuous flash suppression (CFS) and a subsequently presented target. Despite being completely unaware of the cues, observers could nonetheless detect the latent contingency and unconsciously capitalize it to facilitate the discrimination of the target. More importantly, the conscious visual representation was significantly enhanced through the unconscious learning, with the effect highly tuned to fearful-face rather than neutral-face or Gabor-orientation cues and possibly mediated by the subcortical pathway through the amygdala. Our findings shed new light on the mechanisms underlying contingency learning, and highlight the interactions between unconscious and conscious processing in the human visual system.

78. Unconscious decisional learning: improving unconscious information processing

Alexandra Vlassova [1], Joel Pearson [1]

[1] University of New South Wales

The idea that unconscious input can result in long-term learning or improvement on a task has been debated for decades, yet there is still little evidence to suggest that learning outside of awareness can produce meaningful changes to decision-making. Here we trained participants using noisy motion stimuli, which require the gradual accumulation of information until a decision can be reached. These stimuli were suppressed from conscious awareness during a training phase, by a simultaneous dichoptic mask. After ~45min of training, spread over 2 days, participants were tested on a partially suppressed decisional stimulus of perpendicular motion. While participants performed at chance throughout the unconscious training period, we found that performance on the partially suppressed test stimulus significantly improved post-training, despite a difference in motion direction. Moreover, we show that the unconscious learning period had a stronger effect on unconscious decisional accumulation than on conscious. Together, these data suggest that unconscious decisional processing can be improved via training.

79. A trial of Unconscious Hypermnnesia at 1 week intervals

Mitsuko Hayashi [1]

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This study investigated the possibility of Unconscious Hypermnnesia phenomenon to test the LEISURE (Lost Explicit memory Items are Stored as Unconscious memory's in order to REuse them someday) hypothesis by an experiment of a 3 times priming procedure at 1 week intervals. Hypermnnesia is phenomenon that memory scores improve between tests without re-learning phases. Hayashi, Fujioka & Honda(2008) showed that hypermnnesia happened on explicit memory, not on implicit memory. However, the result indicated that unconscious hypermnnesia would occur if the test intervals were longer (at least 1 week). 44 university students were participated in this study, but 19 people didn't do it to the last, so the data of 32 participants were analyzed. At first, a participant was told that this experiment investigated about a relationship between a game ability and a fluency of vocabulary, then he or she did a whack-a-mole game on PC. Writing down the score, he or she did the same game but this time 30 kinds of 5-letter Japanese words showed up instead of moles. The score was also jotted down and a whack-a-mole game again. After the score was noted, a vocabulary test was handed on as a 1st priming test. 1 week later, one whack-a-mole game and a second vocabulary test was hold and one more week later it was repeated. Finally a sheet of questionnaire was answered. Hypermnnesia didn't happen among 20 people with retrieval intentions, but it did among 12 without retrieval intentions. This meant the LEISURE hypothesis was supported.

80. Visuo-tactile interplay in conscious and unconscious numerosity encoding

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Over the last twenty years, while the quest for consciousness has made tremendous progress in the visual domain, its extension to other sensory modalities remains rather limited. Yet, if one wants to decipher the general mechanisms underlying consciousness, a multi-modal description of conscious vs. unconscious processing is needed. Here, we sought to extend the description of unconscious perception to the tactile modality, relying on experimental procedures that are widely recognized in vision. Based on previous work between visual and auditory systems (Faivre et al., under review) we developed a cross-modal procedure of numerosity priming (Dehaene et al., 1998), in which participants received one to three simultaneous tactile taps on their finger-tips (the primes), followed by one to three simultaneous visual flashes on both eyes (the targets). We measured reaction times for enumerating the visual targets as a function of their numerical distance with the tactile primes. When tactile taps were consciously felt, we found a classical numerical distance effect, revealing that tactile and visual numerosity signals are encoded with a similar format. When tactile taps were not consciously felt (i.e., peri-threshold stimulations and/or tactile masks), the pattern of results we found suggests that their global intensity, rather than numerosity was encoded. Similar results were obtained when tactile stimulations were spread across the two hands. Taken together, our results suggest that the encoding of supraliminal numerosity signals in the tactile domain shares some properties with the visual one. Yet, the encoding of subliminal numerosity signals, or the bi-manual integration of numerosity signals seem to be limited to lower levels of representations.

81. The perception of subliminal facial expressions in individuals with high and low autistic traits: An event-related potential study

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Autism is a neurodevelopmental disorder characterized by difficulties in reciprocal social interaction. Social difficulties observed in autism are partially explained by the amygdala dysfunction. The amygdala can be engaged subconsciously by presenting images of facial emotions, particularly threatening faces, very rapidly such that they fall outside conscious awareness. As autistic traits are thought to be continuously distributed through the general population, social difficulties in autism could also be detected in the broader autism phenotype as measured by the Autism Spectrum Quotient (AQ). In this study we examined subliminal and supraliminal facial emotion processing in subjects with low ($n = 15$, 7 females, $AQ < 12$), mid ($n = 9$; $AQ = 13-20$ AQ) and high ($n = 14$; $AQ > 21$) AQ. Neutral, fearful and happy facial expressions were presented subliminally (16 ms) and supraliminally (166 ms) and then masked by an abstract pattern. ERP components P1, N170, N2, P3a, P3b, N4 were examined. The most important group differences were found on the frontal N2 component, showing enhanced N2 amplitudes for subliminally presented happy faces in the low AQ group, but not in higher AQ groups. The earliest subliminal emotion effects were seen on the N170 regardless of autistic tendency, and marginally on the P1 in the low AQ group only. As the N2 represents an early orienting system to subliminal facial expressions, results are interpreted as group differences in orienting to subliminally present happy faces, and could be explained by a disruption in a “relevance detector network” in autism. Overall findings of the study suggest the importance of individual differences in subliminal face processing.

82. Unconscious Priming of Power by Words of Height-related Objects and Its Underlying Neural Mechanism

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Empirical studies demonstrated the perceptual simulation of vertical positions as a key role in thinking about power (Schubert, 2005). Specifically, people make faster power judgment when powerful groups were presented at the top of the screen and powerless groups at the bottom (metaphor-congruent effect), indicating power judgment could be influenced by perceived vertical position. It's left open, however, whether this metaphor-congruent effect could only occur when height information is provided saliently instead of subliminally. The current study aimed to investigate whether the unconscious activation of height could prime the concept of power automatically in a standard masked priming paradigm, and its underlying neural mechanism by using functional magnetic resonance imaging. Participants were asked to make powerful vs. powerless judgment at the present of target stimuli (e.g., King) after a 20-ms flash of a prime word (e.g., sky) while being scanned. Behavioral results revealed that participants responded more quickly in congruence condition than in incongruence condition. At the neural level, reduced activations were observed in supplementary motor area, precuneus, medial prefrontal gyrus and left inferior frontal gyrus in congruence condition compared with incongruence condition. Taken together, the results demonstrated the automatic and unconscious priming of the concept of power by spatial information and the specific neural circuit underlying it.

Self, Agency and Action

83. Dominance of the administrating hand in proprioceptive drifts of self-touch illusion is not applicable when hands are crossed

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In self-touch illusion (STI, originally called somatic rubber hand illusion by Ehrsson et al. in 2005), the feeling that one's hands are touching each other when they are actually separated is evoked by synchronously touching both hands. As STI involves an administrating hand and a receptive hand of the same person, two kinds of proprioceptive drifts (PDs) occur simultaneously causing the hands to move towards each other. It is known that PD is generally larger for the administrating hand than for the receptive hand (White et al., 2011). However, it remains unclear why such a bilateral asymmetry is universally observed. We conducted two experiments to induce STI under conditions where hands were uncrossed or crossed. The first experiment with 36 participants clarified that the uncrossed situation reproduced a trend of PD with a dominance of the administrating hand while the crossed situation drastically changed that tendency as well as magnifying the amount of PD by more than twice. The second experiment with seven “illusion-sensitive” participants selected from the first experiment examined the effect of a body midline

location on PD when hands are crossed, showing that the dominated hand in PD was completely different among subjects, but relatively stable over the midline location and time. A few participants showed quite a different pattern in the identical posture, suggesting the involvement of chaotic mechanisms in the process of inducing STI. How the dominated hand is determined in STI is discussed in detail.

84. The dorsal visual processing stream is critical for resolving biomechanical dilemmas in the selection of hand postures.

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A puzzle in cognition is how the brain selects an action to a visual stimulus when that stimulus ambiguously specifies multiple potential actions. For example, in the postural decision-making task that was the focus of this investigation, people used one of two possible wrist postures to grasp a dial presented at various orientations. The difficulty of the task increased as the dial orientation approached the limits of biomechanical flexibility for both postures, resulting in increased variability in wrist posture selection. Using fMRI in 15 participants, we found a network of cortical areas that were activated as a function of wrist-posture ambiguity. This network encompassed: areas in prefrontal cortex, the dorsal premotor area, and a dorsal-stream visual area in the posterior intraparietal sulcus (pIPS). Interestingly, we observed no engagement in the ventral stream, which is a grouping of pathways widely accepted as being important for visual perception. In addition, we also show evidence (from two patients) that when the pIPS is compromised, the selection of wrist postures with the contralateral arm is adversely affected. Taken together, our data suggest that the pIPS is critical in resolving ambiguities in the mapping between visual targets and multiple, equally afforded motor responses. Our findings touch upon the perpetually fascinating question: to what extent do we need a perceptual experience of the world to successfully interact with it – even in situations of ambiguity? In the case of selecting hand postures, there is no need for a perceptual analysis of an object's shape or orientation.

85. The “lingering alpha effect”: Baseline alpha-band spectral power differences correlate with susceptibility to the rubber hand illusion

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Those who undergo the rubber hand illusion (RHI) experience an imitation hand as belonging to self, but not every participant who sits for the induction procedure experiences the illusion. Because some research suggests that alpha activity correlates with internal focus and with inhibition of attention to external stimuli, and because anecdotal observations suggest significant inter-personal variation in the Berger Effect—decreased amplitude or disappearance of EEG oscillations in the alpha band when eyes open—we hypothesized that alpha band differences would correlate with differences in susceptibility to the RHI. On the assumption that alpha correlates with greater attention to internal and less to external stimuli, participants who evince a less pronounced Berger Effect—here dubbed a “lingering alpha effect” (LAE)—should be less susceptible to visual capture and, thereby, less susceptible to the RHI. To investigate differences between participants who are (RHI-S) and participants who are not (RHI-N) susceptible, we examined EEG baseline spectral power difference, comparing eyes-closed (EC) and eyes-open (EO) conditions. Frequency analysis showed alpha power difference between EC and EO to be significantly larger for RHI-S than for RHI-N participants. This finding suggests that the LAE might help explain the greater influence of internal vis-à-vis external stimuli for the RHI-N participants' experience of limb ownership—that is, RHI-N participants depend more upon proprioception and interoception than upon vision. The “lingering alpha effect” described in our study suggests fruitful lines of novel inquiry for cognitive-perceptual experiences that partially depend upon a contrastive weighting of internal and external signals.

86. The Sense of Agency during Verbal Action

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The Sense of Agency (SoA) is the experience of initiating actions to influence the external environment. Traditionally SoA has been investigated using experimental paradigms where a limb movement is required to initiate an action. However, verbal commands are also a prevalent mode of controlling our external environment. Examples of this are interacting with other agents in our environment or controlling technology via voice interfaces. Here we investigate SoA during verbal control of the external environment using intentional binding. Intentional binding is a phenomenon where the perceived action-outcome interval

for voluntary actions is shorter than for equivalent passive movements (e.g. Haggard, Clark & Kalogeras, 2002). Importantly, intentional binding is thought to offer a robust implicit measure of SoA (Moore & Obhi, 2012). Here, we developed a novel adaptation of the intentional binding paradigm where participants performed both verbal commands and limb movements that were followed by an outcome after a fixed 500ms interval. The so-called 'Libet Clock' intentional binding method was used whereby participants report the perceived time of actions and their effects. The results indicated that for limb movements, intentional binding was present which is consistent with the literature. However, intentional binding did not occur for verbal commands. Interestingly, further exploratory analyses of the speech data suggest that the action component of intentional binding was present but the outcome component was absent. We discuss the relevance of these findings for sense of agency.

87. Action awareness shapes motor memory consolidation

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Time and sleep benefit motor memory consolidation. Off-line consolidation is characterized by the reduction of retroactive interference induced by subsequent experience, and by the expression of delayed performance gains. Another important principle shaping off-line learning could be the individual's awareness of learning a new skill. While action awareness has recently been shown to promote short-term learning, here we examined whether one's own ability to be consciously aware of the evolving of task performance during training also influences the outcome of the consolidation process in terms of overnight memory stabilization and performance improvements. Sixty participants underwent a first training session requiring them to make performance-related (awareness groups) or performance-unrelated (yoked-control groups) judgments of a finger sequence-learning task. We strengthened conscious awareness of self-produced actions by way of asking participants to judge their performance in terms of subjective maximal performance and fluency after each trial. After a 10-min break, half of the participants underwent a second interfering task (learning a new finger sequence) in which only performance-unrelated judgments were made, irrespective of group assignment. All participants were re-tested the following day on the first finger sequence. Results revealed that the awareness groups expressed higher acquisition rates during the first training session and better 24-hr retention performance than the yoked-control groups. However, there were no additional benefits of action awareness during the off-line period. Instead, action awareness resulted in stronger retroactive interference. Current results highlight the distinct and action awareness-specific modulation of skill acquisition and system consolidation during motor learning.

88. Dissociating perception from action during conscious and unconscious conflict adaptation

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When a conflict is detected between relevant and irrelevant information, typically, a smaller conflict effect is observed on the following trial. This sequential effect has been interpreted as an expression of cognitive control implemented to resolve conflict. In this context, two different but related issues have received increasing attention in the literature. The first issue is whether motor conflict is necessary to induce cognitive control or, alternatively, whether perceptual conflict is sufficient. The second issue concerns whether awareness of the conflict is necessary to induce cognitive control. Here, we address both issues in a single design. Our results indicate that conflict-driven control is domain-specific. That is, the detection of perceptual conflict on the previous trial selectively reduces perceptual conflict on the next trial. Similarly, the detection of motor conflict on the previous trial selectively reduces motor conflict on the next trial. Furthermore, regardless of whether the conflict on the previous trial was at the perceptual or at the motor level, unconscious conflict appeared not be sufficient to induce cognitive control.

89. Positive bias in agency judgment

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The sense of agency refers to the sense that "I am causing my own action". Recent studies have shown that this subjective sense is biased by some cognitive factors such as context and predictability. Furthermore, when it comes to the decision making bias, sometimes we observe positive bias in agency judgment. Even when we detect a mismatch between the predicted and actual sensory feedback of our own action, we can attribute the action to ourselves. The current study examined the time course of agency judgment as well as mismatch detection in a motor control task (visually guided reaching). The results suggest that as participants were presented with more information (i.e., visual feedback) the mismatch detection became more accurate. However, when they judged agency, they attributed the visual feedback to themselves positively. Even if they detected the mismatch, they were still sticking to the self-agency judgment, suggesting our mechanism for adaptation to the external world where there is much sensory noise.

90. Voluntary Action and Time Perception

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Voluntary actions alter the perceived timing of events: In contrast to involuntary actions, voluntary actions are perceived as having occurred later, and their effects as having occurred earlier in time. According to a proposed explanation, voluntary actions temporarily slow down an internal clock, reducing subjective elapsed time between events. We tested the slowed clock hypothesis by showing subjects stimuli that could result in perceived apparent motion. Subjects either initiated the display by a voluntary action, or passively observed the display, and then reported whether they saw motion, or estimated the inter-stimulus interval. According to the slowed clock hypothesis, voluntary actions should lead to decreased subjective elapsed time between the visual stimuli, and therefore increase the frequency of observed motion. Although the voluntary action condition led to shorter interval estimates, motion responses did not change between conditions. These results argue against the slowed clock hypothesis and suggest that voluntary actions influence retrospective timing judgments, but not visual perceptual processing.

91. Distortions in the perceived time of actions and their effects as a marker of disturbed sense of agency

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When we repeatedly perform an action that results in an effect (e.g. a tone), we learn an association between the action and its effect. Interestingly, this association is reflected in conscious experience as a distortion in the perceived time at which the action and effect occur. Specifically, the action and its effect appear closer together in time than they are in reality. This robust effect is referred to as 'intentional binding' or 'temporal binding'. It has generated considerable interest as it has been suggested that it may be an implicit, quantitative measure for assessing the 'sense of agency'. The sense of agency is the sense that one is the 'author' (i.e. the initiator and controller) of one's own actions. This sense is normally an unremarkable accompaniment to our everyday actions, but in certain psychiatric disorders – notably schizophrenia - actions can be performed without the normal associated sense of agency (e.g. "the devil entered my body and made me do it"). Some studies have shown that intentional binding is altered in schizophrenia, but the relationship between abnormal agency and temporal binding remains unclear, and there is additionally debate about whether self-initiated action is necessary for temporal binding. Along with schizophrenia, high schizotypy is also associated with unusual agency experiences. Here we investigate the relationship between schizotypy scores and the magnitude of temporal binding between actions and auditory effects for self- and other-initiated actions using the Libet clock method to assess the perceived timing of events.

92. Abnormal Imagined Walking in High-Schizotypal Individuals

Naohide Yamamoto [1], Lucinda V. Rohde [1], Saliha Qadir [1]

[1] Department of Psychology, Cleveland State University

Efference copy has been considered as a component of nonvisual spatial navigation, but empirical data that support this notion have been sparse. The present study was designed to find evidence for the role of efference copy in whole-body locomotion by capitalizing on the idea that dysfunctional efference copy may underlie schizotypal traits. In an experiment, participants with varying degrees of schizotypy viewed a target on the floor and either walked or imagined walking to it without vision. Real walking evoked both afferent and efferent signals, while imagined walking presumably involved efferent signals only. Results showed that although all participants reached the target accurately in real walking, high-schizotypal participants exhibited abnormality in imagined walking. Specifically, in contrast to low-schizotypal participants who underestimated the time to walk to the target in imagined walking (which is a normal pattern of performance in this task), high-schizotypal participants spent an equivalent amount of time to get to the target in real and imagined walking. These findings suggest that aberrant efferent signals in high-schizotypal individuals gave rise to the performance difference between the two groups of participants, supporting the view that efference copy is an integral part of the human locomotor navigation system.

93. Neural responses to heartbeats dissociate the self as the subject and the self as the object during spontaneous thoughts

Mariana Babo-Rebelo [1], Craig Richter [1], Catherine Tallon-Baudry [1]

[1] Cognitive Neuroscience Laboratory, Institut National de la Sante et de la Recherche Medicale (INSERM) - Ecole Normale Supérieure (ENS), 29 Rue d'Ulm, Paris, France

The most fundamental sense of self is represented in first-person perspective situations. This sense of self known as the 'I' is distinct from the 'Me', the most often studied form of self which relates to explicit reflection about oneself. Here, we propose and test the hypothesis that the neural implementation of the 'I' is rooted in bodily signal monitoring by the central nervous system. We developed a new thought sampling paradigm in which subjects evaluated how much they were thinking as the subject ('I') and as the object ('Me'). 20 subjects fixated the screen and mind-wandered until a warning stimulus occurred at random intervals. Subjects would then rate the thought that was interrupted by the warning according to 4 continuous scales: self-as-subject, self-as-object, time and valence. Magnetoencephalographic data and cardiac activity were recorded simultaneously. We measured neural responses to heartbeats preceding warning onset to test whether the amplitude of neural responses to heartbeats could predict subjects' ratings on the 'I' scale. The heartbeat-evoked response differed for high and low scores in the 'I' dimension (significant cluster over posterior magnetometers between 300 and 328ms after the T-peak, Monte-Carlo $p=0.024$). The 'Me' dimension was associated with a significant frontal cluster, between 120 and 155ms after the T-peak ($p=0.026$). A General Linear Model approach is currently being developed to test to what extent activity in these clusters is specific to each dimension of the self. This would confirm that heartbeat-evoked responses reference thoughts to the self and distinguish between 'I' and 'Me'.

94. The Neural Dissociation of Rule-Based and similarity-Based Processing in Implicit Learning

Xiaoli Ling [1], Xiuyan Guo [2,3], Zoltan Dienes[4]

[1]School of Psychology and Cognitive Science, East China Normal University, Shanghai, China, [2]Shanghai Key Laboratory of Magnetic Resonance and School of Psychology and Cognitive Science, East China Normal University, Shanghai, China, [3]Key Laboratory of Brain Functional Genomics, Ministry of Education, Shanghai Key Laboratory of Brain Functional Genomics, East China Normal University, Shanghai, China, [4]School of Psychology, University of Sussex, Sussex House, Brighton BN1 9RH, United Kingdom

People can implicitly learn both abstract rules and chunks but the neural regions involved in processing rules and chunks during implicit learning are not well established. Previous studies using finite state grammars make it difficult to isolate the contributions of knowledge of rules and chunks, as the structure in the grammars is largely captured by allowable chunks, leaving open the questions as to which brain systems mediate the processing of either source of information during implicit learning. The present fMRI study investigated neural regions involved in rule-based versus similarity-based implicit learning using the artificial Chinese poetry paradigm developed by Jiang et al. (2012), which allows independent manipulation of grammaticality and chunk strength across test items. Participants were scanned during both the training and test phases. In the test phase, the participants were asked to classify strings into grammatical or ungrammatical and provide attributions of the basis of their judgments. Results showed that, at the behavioral level, participants were able to discriminate grammatical from nongrammatical items and high chunk strength items from low chunk strength items without awareness. At the neural level, the Broca's area was activated more in the grammatical condition (vs. ungrammatical condition) (cf Freiderici et al, 2006, for conscious rule learning), whereas putamen was activated more with high chunk strength items (vs. low chunk strength items). Together, there is a Neural Dissociation of Rule-Based and similarity-Based Processing in Implicit Learning: the Broca's area engages more in abstract rule processing, whereas the putamen associates with similarity-based learning.



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Transport

General Information

TransLink runs nearly all public transport in Brisbane. Their website contains complete information for timetables and fares, as well as a journey planner to find the best way to get from A to B.

translink.com.au

GoCards are the primary method of public transport payment and are similar to London's Oyster card and other smart card transport systems. Cards can be preloaded with credit and simply swiped at designated readers when entering and exiting public transport. These are available for purchase at most 711's and newsagents, including Campus News at UQ (see UQ Campus Map).

translink.com.au/tickets-and-fares/go-card

Two major taxi companies in Brisbane are **Black and White Cabs** (131 008) and **Yellow Cabs** (131 924).

blackandwhitecabs.com.au

yellowcab.com.au

AirTrain is a train service connecting Brisbane airport with inner-city Brisbane and the Gold Coast. The easiest way to UQ from the airport using public transport is to catch the AirTrain (which will read 'Gold Coast') and get off at Park Road train station. The Park Road bus station is located next to the train station, and every bus from platform 6 goes to UQ Lakes, which is a 3-5 minute walk from the conference and colleges.

airtrain.com.au

Transport at UQ

The two main bus stations are UQ Lakes and Chancellors Place (see UQ Campus Map). The conference bag contains timetables for the major routes to and from UQ, and these can also be found online at the translink website.

The easiest way to and from the city is on **bus 66** from Stop D at UQ lakes. This will take you via the busway and stops at The Cultural Centre, where Stanislas Dehaene's public lecture will be held.

Buses 412 and **411** leave from Chancellors Place and travel along Coronation Drive to get to the city. These are the best buses for travelling to the Regatta Hotel for the student social.

Ferries (City Cat) leave from the UQ ferry terminal near the north end of campus (see UQ Campus Map). These travel down the Brisbane River stopping at the Regatta Hotel, North Quay (the city), & South Bank.

Conference Dinner

The conference dinner for ASSC18 will be held on Friday 18th July at Lone Pine Koala Sanctuary. This will be a uniquely Australian experience allowing you to interact with a variety of native Australian animals in a beautiful location.

Each dinner ticket will include

- An Australian BBQ dinner
- Access to most of the Koala Sanctuary
- A night-time guided tour and animal encounters
- A koala cuddle and professional photo

Getting there

- For early registrants The River Cruise will depart from the UQ boat terminal (see campus map page 97) at 5:30pm. This will take an hour to reach Lone Pine
- Alternatively, buses will leave from Chancellor's Place (campus map page 97) at 6pm.

Getting back

- Buses will return depart from Lone Pine at 10pm (2 buses), 11pm (1 bus) and 11:30pm (1 bus). These will return to UQ via Indooroopilly, where public transport can be caught for those wanting to continue onto the city or somewhere else.

The 'Poor Man's' Dinner Alternative

For those not attending the main dinner, a cheaper BBQ dinner will be held at Lone Pine at a café outside the sanctuary. The cost for this will be \$17, including transport to and from Lone Pine on the same buses departing at 6pm. For an additional \$20, you will also have the option to access and explore the sanctuary. Please see the main reception desk at AEB for payment.



The Student Social Party

Where?

The Regatta Hotel
543 Coronation Drive, Toowong

When?

Thursday 17th July, 8pm onwards

What?

Cocktail party, with fingerfood & drinks provided. The party is organised by the ASSC Student Committee, and is an all-inclusive event for students and non-students provided by the conference.

How to get there: Taxis will leave from outside the Women's College (see map p97) at 6:30pm and 8:15pm (subsidised by the conference)

There is also the option of catching a ferry from the UQ Ferry Terminal (see map p97). Ferries travel to and from UQ and the Regatta (10minute journey) every 20mins before 7pm, and every 30mins after 7pm. The Regatta Hotel is situated directly opposite the Regatta Ferry Terminal. One way adult fare is approximately \$4.

Public Lecture & ASSC Afterparty

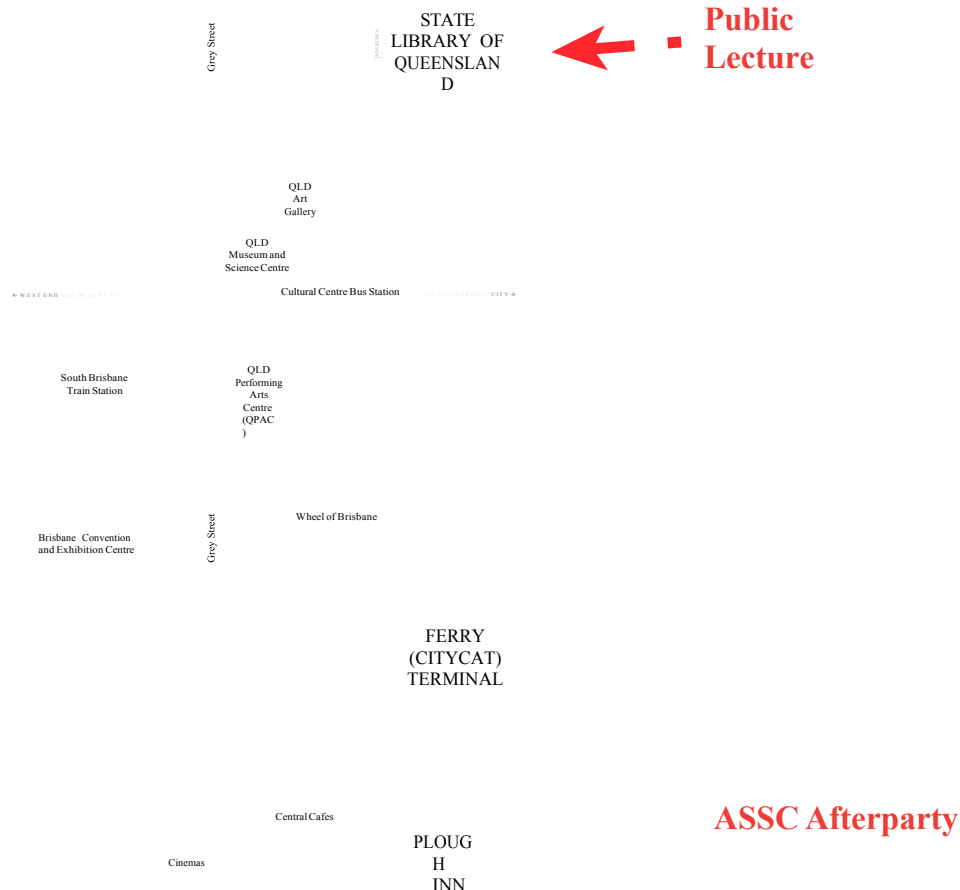


A public lecture from Stanislas Dehaene will be given at the Queensland State Library (auditorium 1) at South Bank on Saturday July 19, the final night of the conference. Please see page 24 for the abstract for this talk 'Understanding Consciousness: from the lab to the clinic'.

The ASSC Afterparty will also be at South Bank from around 8pm onwards on Saturday 19th July at The Plough Inn Tavern.

Address: Building 29, Stanley Street Plaza, South Bank Parklands, South Brisbane

The Plough Inn Tavern is a 13 minute walk from the State Library. Note that this is simply a common venue for everyone to meet and catch up before heading home. Both food and drink can be purchased here, and there are also many other restaurants in South Bank for those looking for other alternatives for dinner.





Stanley St Plaza

Streets
Beach



ASSC18 Associated Event

Panpsychism workshop (July 20-21, Byron Bay)

Info

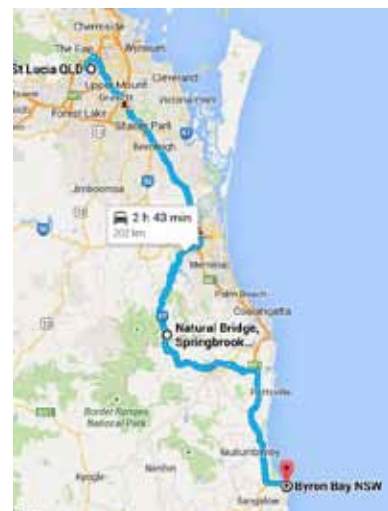
Panpsychism is a meta-theoretical framework, which assumes consciousness is a fundamental aspect of the universe. There are many variants of panpsychism, but all admit that organisms can be conscious to variable degrees.

In this workshop, we will re-consider panpsychism from historical, philosophical, and neuroscientific viewpoints. In so doing, we will revisit many fundamental questions that can potentially be addressed with a rigorous theoretical approach and empirical investigations.



Speakers:

- David Chalmers (philosophy, ANU, NYU)
- Monica Gagliano (evolutionary biology, U of Western Australia)
- Yasuo Kuniyoshi (robotics, U of Tokyo)
- Larisa Albantakis (neuroscience, U of Wisconsin)
- Mandyam Srinivasan (neuroscience, U of Queensland)
- Giulio Tononi (neuroscience, U of Wisconsin)
- Janet Wiles (engineering/computer science, U of Queensland)



Schedule:

Sunday, July 20:

A bus will leave from the Women's College at 10:00 (cost included in registration)

There will be a lunch/lecture stop at Natural Bridge, Springbrook National Park.

Arrival in Byron Bay will be around 15:00, at The Byron at Byron Resort:

<http://thebyronatbyron.com.au/>

Informal dinner at Byron Bay Beach Hotel, 19:00: <http://beachhotel.com.au/>

Monday, July 21:

A full day of talks and discussions is planned, including:

9:00- Mandyam Srinivasan: consciousness in insects?

10:00- Monica Gagliano: consciousness in plants?

11:00- Yasuo Kuniyoshi: consciousness in robots?

15:00- Janet Wiles: consciousness in artificial lives?

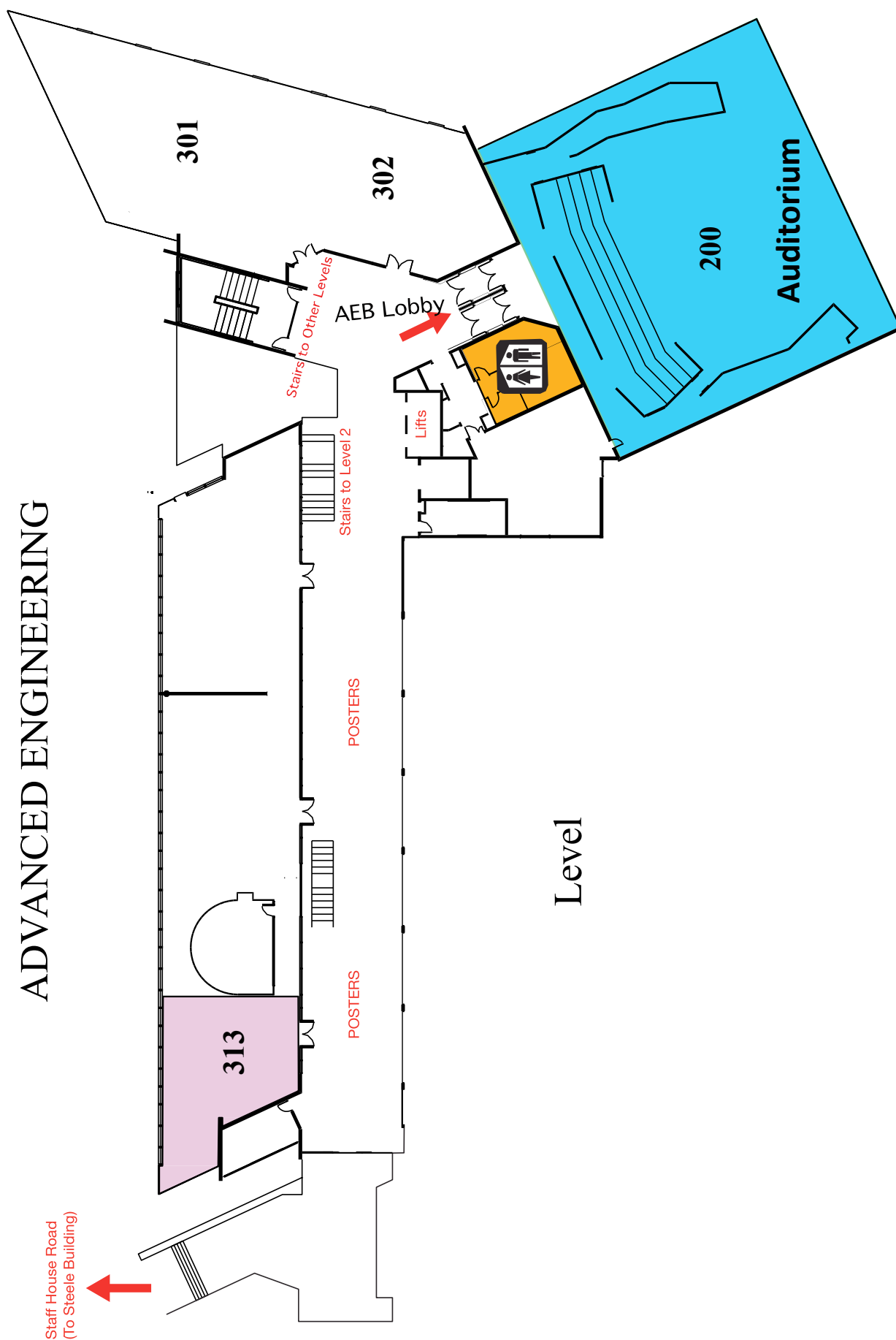
16:00- Giulio Tononi/Larisa Albantakis: panpsychism and integrated information theory

BBQ at 19:00 (cost included in registration).

The Byron Bay area offers a variety of attraction for interested guests staying beyond the 21st.

Advanced Engineering Building (AEB) level 3

(Tutorials, Keynotes, Symposia, Special Talks, Posters)



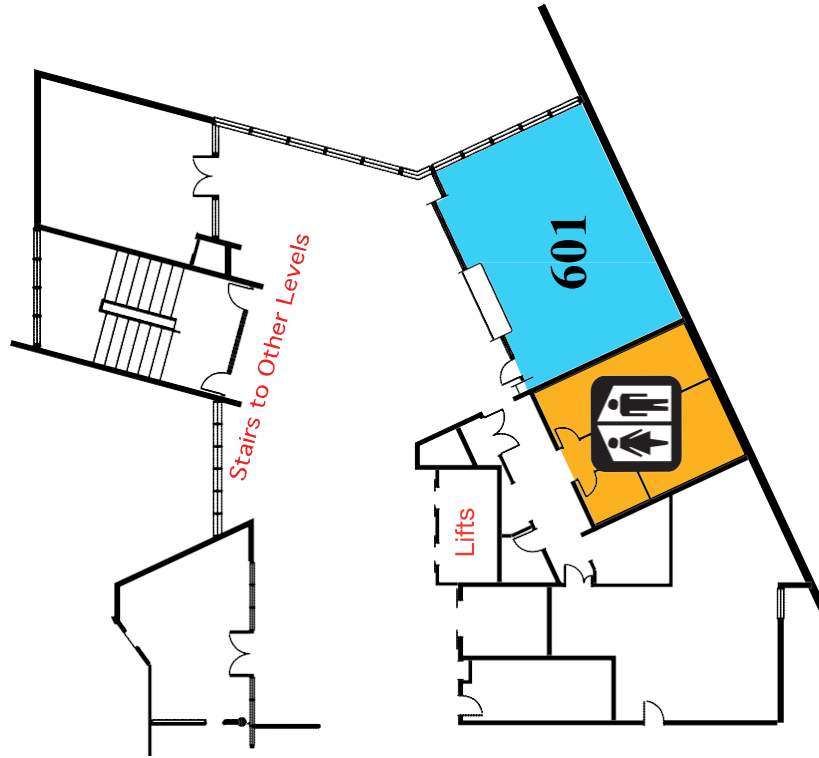
ADVANCED ENGINEERING

Advanced Engineering Building (AEB) level 2 & 6

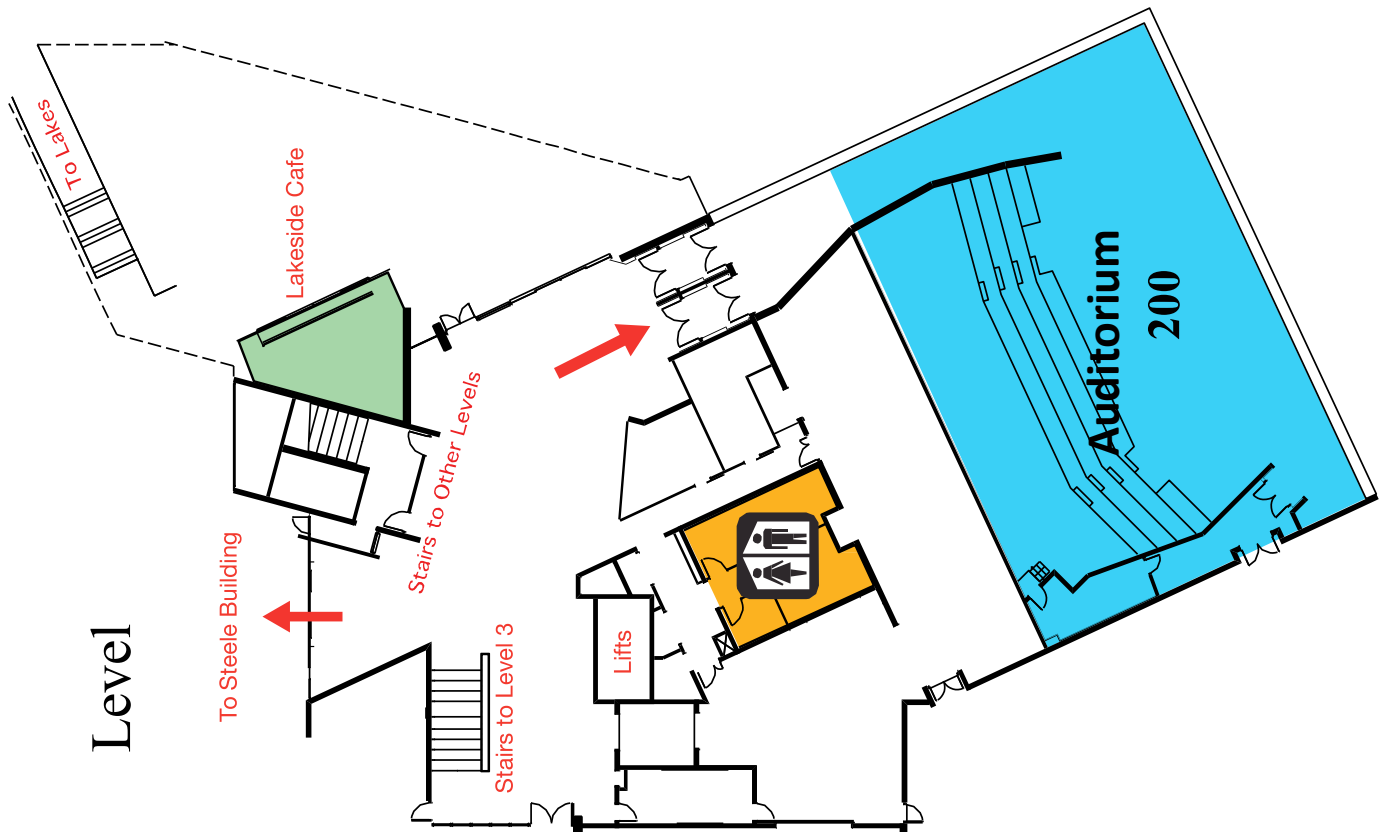
(Tutorials, Keynotes, Special Talks, Symposia)

ADVANCED ENGINEERING

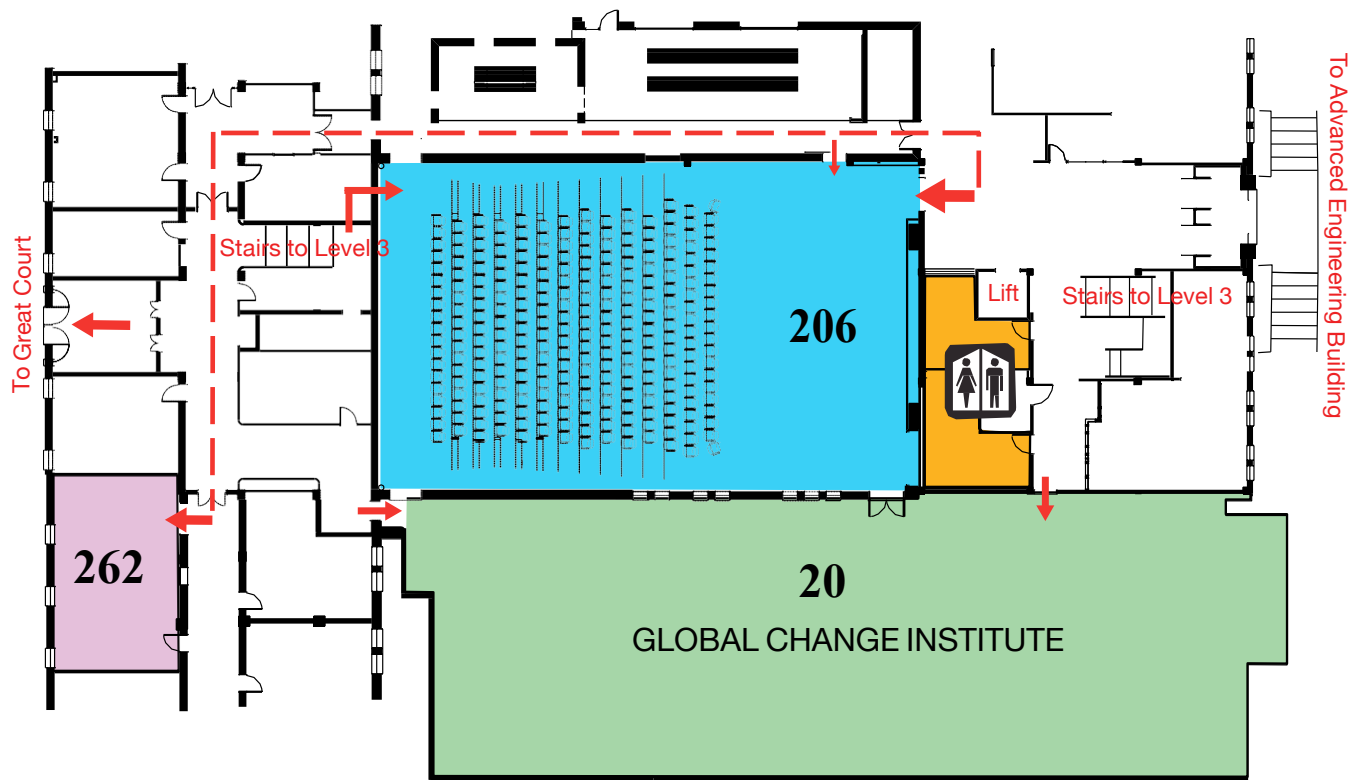
Level



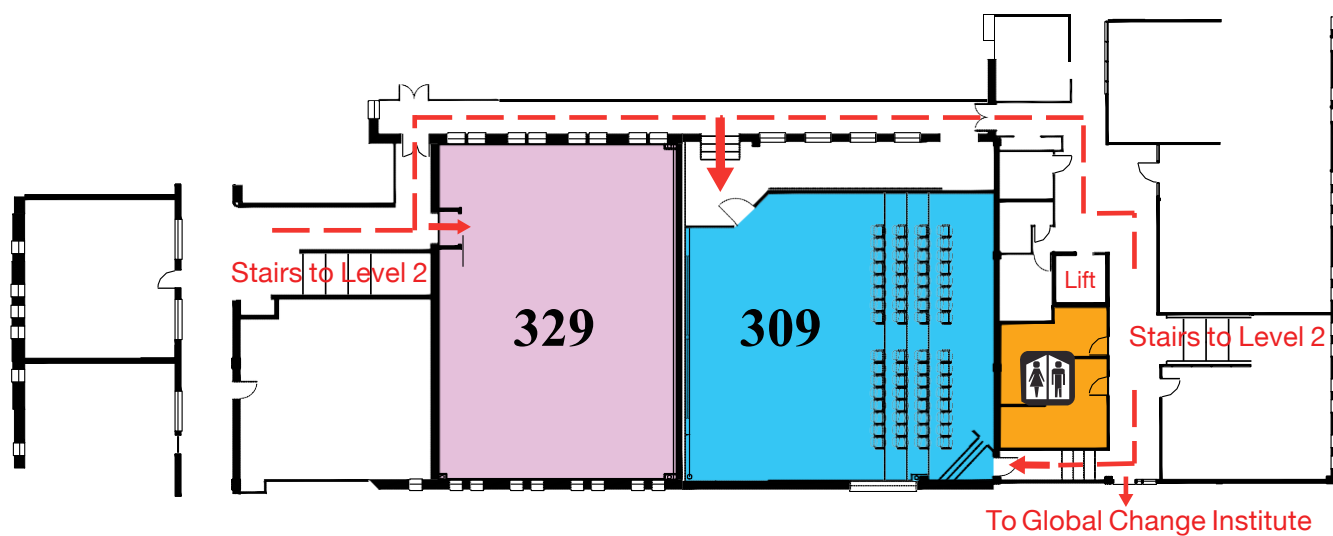
Level



Steele Building Level 2&3 **(Concurrent Sessions)**



Level 2 (Ground)

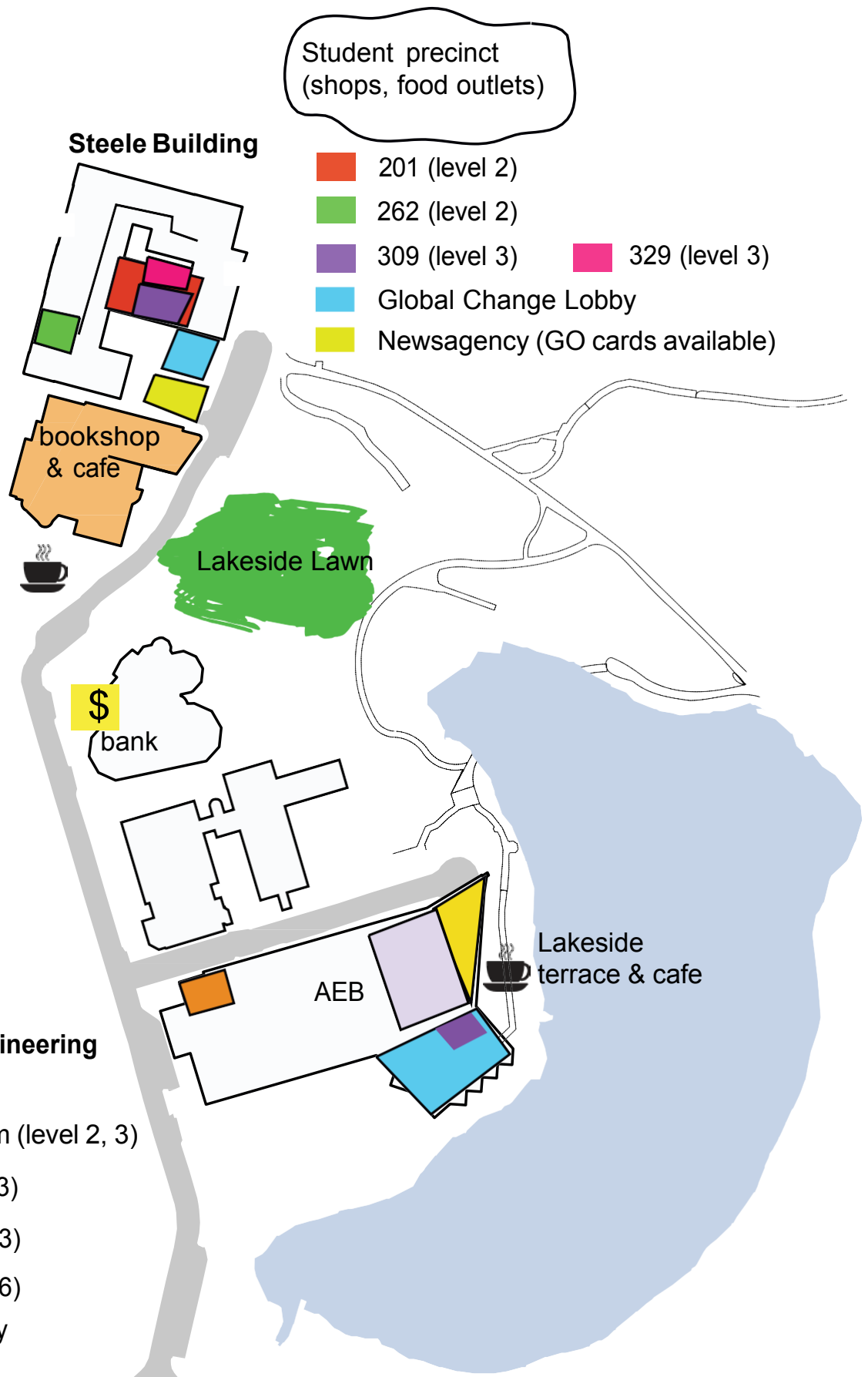


Level 3

UQ Campus Map



Map of the Conference Area



Other Information

Poster Printing

Posters can be printed by BlueStarGo at the UQ Printery on campus. The UQ Printery is located at Building 85, on corner of Hood St and Services Rd (see campus map, p97). For an A0 poster, they offer printing on fabric (\$99.00 inc GST), gloss paper (\$60.50 inc GST) or matt paper (\$35.20 inc GST). They can also print A1 and A2 sizes. For further enquiries, or to make an order, please email Nicola Stavar : nicola.stavar@bluestargroup.com.au

How to connect to UQ WiFi

UQ's wireless network for visitors can be accessed through '**Visitor-UQConnect**'.



Step 1. Select '**Visitor-UQConnect**' from your available networks

Step 2. Open a new page in your web browser

Step 3. A terms and condition page should appear on your first ever access to the wireless. You will need to read through the conditions and click '**Agree**' at the bottom of the page.

You should now be connected to the '**Visitor-UQconnect**' wireless.

