Toronto, Canada
June 24th - 27th 2010

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Contents

LOCAL ORGANIZERS: Randy McIntosh, Mel Goodale, Maria Tassopoulos & Michel Ferrari

SCIENTIFIC PROGRAM COMITTEE: Mel Goodale (Chair), Mitsuo Kawato, Sean Kelly, Su-Ling Yeh, Petra Stoerig, Evan Thompson, Victor Lamme & Olivia Carter

UNIVERSITY OF TORONTO
FACULTY OF MEDICINE

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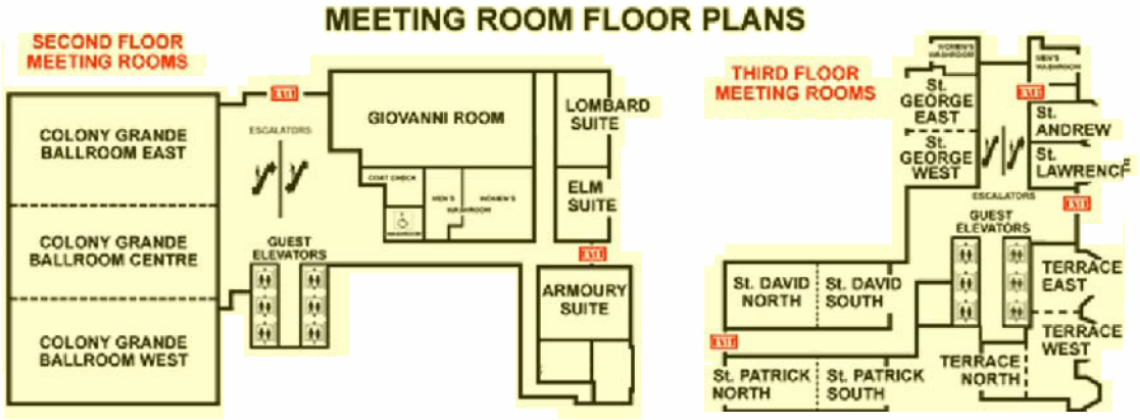
ASSC14 Program and Venue Overview
June 24th - June 27th

	Thurs. Jun 24	Fri. Jun 25	Sat. Jun 26		Sun. Jun 27	
9:00 AM	Morning Tutorials	Keynote 1	Keynote 2	Poster	Keynote 3	Poster
9:30 AM	1 - Snodgrass & Lau	Nicky Clayton	Mohan Matthen	Exhibits	Morris Moscovitch	Exhibits
10:00 AM	2 - Tong	Coffee	Coffee		Coffee	
10:30 AM	3 - Berlin & Anderson	Symposium 1	Symposium 2	Poster	Symposium 3	Poster
11:00 AM	4 - Droege	Hakwan Lau,	John Dunne,	Exhibits	Rama Chakravarthi	Exhibits
11:30 AM		Stanislas Dehaene,	Antoine Lutz,	up	Tim Vickery, David Whitney	up
12:00 PM		Imogen Dickie & Ned Block	& Heleen Slagter	all day	& Mark Neuwenstein	all day
12:30 PM	LUNCH					
1:00 PM	Afternoon Tutorials	LUNCH & Student mentor event	LUNCH & Posters		LUNCH & Posters	
1:30 PM	5 - Tsuchiya & Maier	Concurrent Session 1	Posters Session	Poster	Symposium 4	Poster
2:00 PM	6 - Cancelled		Posters Session	Exhibits	Naotsugu Tsuchia,	Exhibits
2:30 PM	7 - Aleksander & Gamez	A - C in Schedule	Posters Session	up	Alex Maier,	up
3:00 PM	8 - Hoedlmoser & Schabus		Posters Session	all day	& Melanie Wilke	all day
3:30 PM		Coffee	Coffee & posters		Coffee & posters	
4:00 PM	Welcome &	Concurrent Session 2	Concurrent Session 3	Poster	Posters Session	Poster
4:30 PM	James Prize			Exhibits	Posters Session	Exhibits
5:00 PM	Presidential Address	A - C in Schedule	A - C in Schedule	up	Posters Session	up
5:30 PM	Thomas Metzinger			all day	Keynote 4	all day
6:00 PM					Bob Knight	
6:30 PM	Opening night reception					
7:00 PM						
7:30 PM		Student Social	Conference Dinner		ASSC14 After Party	

Session	Venue
Tutorial 1 & 5	Armoury Suite (2nd floor)
Tutorial 2 & 8	Lombard Suite (2nd floor)
Tutorial 3 & 7	Elm Suite (2nd floor)
Tutorial 4	St Lawrence (3rd floor)
Welcome & Presidential Address	Colony Ballroom (2nd floor)
Keynotes & symposium	Colony Ballroom (2nd floor)
Concurrent Sessions (A)	Colony Ballroom East (2nd floor)
Concurrent Sessions (B)	Colony Ballroom Center (2nd floor)
Concurrent Sessions (C)	Giovanni Room (2nd floor)
Poster Sessions	St. Patrick & St David (3rd floor)

MEETING ROOM FLOOR PLANS



ASSC14 Conference Schedule
Thursday, June 24th

MORNING TUTORIALS (9:00am – 12:00pm) * You must register for tutorials*

TUTORIAL 1: Signal detection theory and distinguishing conscious vs. unconscious
Michael Snodgrass (University of Michigan, USA)
Hakwan Lau (Columbia University, USA)
Venue: Armoury Suite (2nd Floor)

TUTORIAL 2: Decoding visual and mental content from human brain activity
Frank Tong (Vanderbilt University, USA)
Venue: Lombard Suite (2nd Floor)

TUTORIAL 3: Neural Basis of Suppression, Repression and Dissociation
Heather Berlin (Mount Sinai School of Medicine, NY, USA)
Michael C. Anderson (MRC Cognition and Brain Sciences Unit, Cambridge, UK)
Venue: Elm Suite (2nd Floor)

TUTORIAL 4: What are mental representations, and does the mind need them?
Paula Droege (Penn State, USA)
Venue: St Lawrence Suite (3rd Floor)

-- Lunch Break --

AFTERNOON TUTORIALS (1:00pm – 4:00pm) * You must register for tutorials*

TUTORIAL 5: Attention and Consciousness: Two Distinct Brain Processes
Naotsugu Tsuchiya (Caltech, USA and Tamagawa University, Japan)
Alex Maier (National Institute of Health, USA)
Venue: Armoury Suite (2nd Floor)

TUTORIAL 6 - Cancelled

TUTORIAL 7: Informational Measures of Consciousness: Integration, Causality and State Structures
Igor Aleksander (Imperial College, London, UK)
David Gamez (Imperial College, London, UK)
Venue: Elm Suite (2nd Floor)

TUTORIAL 8: Train your brain ! Understanding and applying the neurofeedback technique
Kerstin Hoedlmoser (University of Salzburg, AUSTRIA)
Manuel Schabus (University of Liège, Belgium)
Venue: Lombard Suite (2nd Floor)

ASSC14 Conference Schedule
Thursday, June 24th

-- Conference Begins 4:00pm Thursday June 24th --

OPENING WELCOME (4:00pm – 4:10pm)

Olivia Carter
Venue: Colony Ballroom (2nd Floor)

WILLIAM JAMES PRIZE (4:10pm – 5:00pm)

Winner to be announced
Venue: Colony Ballroom (2nd Floor)

Talk by the winner of the William James Prize for the best published contribution to the empirical or philosophical study of consciousness within 5 years of receiving a PhD.

PRESIDENTIAL ADDRESS (5:00pm – 6:00pm)

Venue: Colony Ballroom (2nd Floor)

What is a First-Person Perspective?

Thomas Metzinger
Johannes Gutenberg-Universität Mainz, metzinge@uni-mainz.de

In the last one or two decades we have all understood that the "problem of consciousness" is not a single problem, but a whole set of different epistemic targets - empirical, theoretical, philosophical. However, there is also something like a remaining “core question”, a central and unresolved issue: *Subjectivity*, the fact that our target phenomenon is almost always tied to an individual first-person perspective. No other object of scientific research has this property, and this fact creates all the well-known methodological and philosophical problems. I think the time is now ripe for a focused and coordinated attack on this core issue in consciousness research. In my Presidential Address I therefore want to encourage the scientific community to confront the core of the problem directly. I will clarify the concept of a first-person perspective, propose a positive model on the representationalist level of description, and draw the audience’s attention to a number of already existing empirical windows into the phenomenon, which we can use as experimental starting points - dropping first anchors in naturalizing the subjectivity of consciousness.

-- Opening Night Reception --

ASSC14 Conference Schedule
Friday, June 25th

KEYNOTE 1 (9:00am – 10:00am)

Venue: Colony Ballroom (2nd Floor)

Do Animals Make Shopping Lists? Prospection and Planning by Crows and Children

Nicola S. Clayton
University of Cambridge, UK. n.clayton@psychol.cam.ac.uk

As humans, we spend much of our time planning for the long-term future, from shopping lists to pension plans. Traditionally, it has been argued that only humans are capable of mental time travel, the ability to cast one's mind forwards and backwards in time to reminisce about the past and imagine future scenarios. I shall argue, however, that some non-human animals are also capable of anticipating the future, at least in a rudimentary form, and surprisingly, some of the most convincing evidence comes from a member of the crow family, the western scrub-jay. In this talk I shall also focus on the development of future planning in young children, and the distinction between episodic projection and semantic prospection.
http://www.youtube.com/watch?v=y_MnwNyX0Ds

-- Coffee Break --

SYMPOSIUM 1 (10:30am – 12:30pm)

Conscious Awareness, Perceptual Decision making and the Bayesian Brain

Chair: Hakwan Lau

Venue: Colony Ballroom (2nd Floor)

A dual-route theory of evidence accumulation during conscious access

Stanislas Dehaene[1] & Lucie Charles[1]
[1] INSERM-CEA Cognitive Neuroimaging unit Stanislas.Dehaene@cea.fr

Evidence accumulation is a highly successful framework for understanding elementary psychophysical decisions, but its relation to consciousness is unclear. My proposal is that evidence accumulation occurs at multiple levels in parallel. Many processors accumulate evidence towards the specialized categories that they code for. However, in the proposed dual-route theory of evidence accumulation, conscious access corresponds to the crossing of a threshold in evidence accumulated within a higher-level cognitive pathway, at the level of the global neuronal workspace (GNW), where multiple processors coordinate their activity and collectively "ignite" into a single coherent representation. During non-conscious processing, evidence is accumulated locally within specialized sub-circuits, thus explaining that forced-choice performance can be above chance, but it fails to reach the threshold needed for global ignition and therefore conscious reportability. I will propose a simple mathematical formulation of this theory, as recently published in Delcul et al (Brain 2009), then illustrate it with experiments drawn from the subliminal masking literature. The proposed framework can explain the existence of fast erroneous responses and their subsequent conscious correction. Its predictions are compatible with recent evidence for "changes of mind" in a motor task (Resulaj et al., Nature 2009) and are backed up by new evidence from MEG signals during a masked number comparison task.

Comparing different signal processing architectures that support conscious reports

Hakwan Lau
Columbia University USA hakwan@gmail.com

Possibility 1: conscious and unconscious perception are based respectively on two largely independent information processing channels (and presumably different brain areas). Possibility 2: conscious and unconscious perception are based on essentially the same channel, but a late stage of processing in the hierarchy distinguishes between the two. Whereas possibility 1 has intuitive appeal, I present computational modeling, brain stimulation and imaging data to support possibility 2. According to this Hierarchical model, a late stage of monitoring process estimates the reliability of the perceptual signal at the earlier stage. Conscious awareness arises when a perceptual signal is subjectively interpreted to be sufficiently reliable. This model is congenial with the philosophical notion of higher-order representationalism. Also, it draws distinction between attention and awareness, and thereby explains interesting phenomena such as why we seem to have conscious experience for more visual objects than we can attend to and report about.

Dual route vs. heirarchical models and the normative role of conscious perception

Imogen Dickie
University of Toronto imogen.dickie@utoronto.ca

I will discuss the significance of the distinction between 'dual route' (Dehaene/Charles) and 'heirarchical' (Lau) models of perceptual processing for central questions about the role of conscious perception in justifying basic cognition. I will motivate what I take to be the most plausible view of how this justification works. I will then argue that the dual route model is at least in tension with this plausible view. I will suggest that the heirarchical model does better, but only if we depart from Lau's preferred 'higher order representation' interpretation of it.

Models of perceptual decision and Tolstoy's principle of the nature of consciousness

Ned Block
New York University ned.block@nyu.edu

Even if, as Lau and Dehaene suppose, consciousness is a decision process, it does not follow that a higher order view of consciousness is correct. I will argue that even on a decisional view, the evidence supports better a first order theory of both the content of consciousness and what makes that content conscious. Lau supports a hierarchical decision account whereas Dehaene supports a dual route decision account. As Tolstoy almost said in the first sentence of Anna Karenina, "Conscious states are all alike; every unconscious state is unconscious in its own way." The application to this case is that both models have a role to play in explaining unconscious perception, but neither are very relevant to conscious perception.

-- Lunch Break --

CONCURRENT SESSION 1 (1:30pm – 3:30pm)

(A) - Blindsight, eye movements, and awareness

Chair: Melanie Wilke
Venue: Colony Ballroom East (2nd Floor)

1:30pm - Guidance of gaze based on color saliency in monkeys with blindsight.

Yoshida Masatoshi[1], Laurent Itti[2], David Berg[1], Takuro Ikeda[1], Rikako Kato[1], Kana Takaura[1], and Isa Tadashi[1].

[1] National Institute for Physiological Sciences myoshi@nips.ac.jp
[2] Computer Science Department, University of Southern California

We investigated residual visually-guided behavior in monkeys after unilateral ablation of primary visual cortex (V1), to unravel the contributions of V1 to salience computation. We analyzed eye movements of monkeys watching video stimuli and a computational model of saliency-based, bottom-up attention quantified the monkeys' propensity to attend to salient targets. All monkeys were attracted towards salient stimuli, significantly above chance, for saccades directed both into normal and affected hemifields. We also quantified the contribution of visual attributes (intensity, color, motion and so on) to the saliency-based eye movements and obtained evidence that the monkeys' guidance of gaze was influenced by color saliency. Here we directly examined residual visuomotor processing based on color saliency with color discrimination tasks. In two monkeys after unilateral ablation of V1, the isoluminant, chromatic stimuli was presented in one of the two positions in their affected hemifield. The monkeys were rewarded by making saccade to the target. The CRT monitor (Mitsubishi DZ21) was used for stimulus presentation and was calibrated with a colorimeter (PR650). The stimuli were defined by the DKL color space, that is, the luminance axis, the L-M axis and the S-(L+M) axis. In both monkeys, the correct ratio was significantly above chance for stimuli with the L-M component and the S-(L+M) component. Control experiments were done to exclude the possibility that a small luminance difference from background may contribute to the above-chance performance. When a small positive or negative luminance difference (<5%) was added to the chromatic stimuli, the correct ratio was not decreased. On the other hand, the correct ratio was near the chance level when the achromatic stimuli with the same luminance difference were used. Our results suggest that unilateral ablation of V1 does not abolish the computation of color saliency.

1:50pm - Task-irrelevant blindsight, attention, and a function of conscious sight.

Petra Stoerig[1]

[1]Institute of Experimental Psychology, Heinrich-Heine-university Düsseldorf
petra.stoerig@uni-duesseldorf.de

Even though stimuli presented within regions of absolute cortical blindness are subjectively invisible, patients with destruction of the primary visual cortex may localize, detect and discriminate them much better than chance permits. We here exploit this phenomenon of blindsight to learn whether task-irrelevant stimuli would affect performance in an attention-demanding rapid serial visual presentation task. Per trial, nine black letters and one white target-letter appeared briefly at fixation. On 50% of trials, a gray disc (5°, -.6 log contrast, 300ms) was presented prior to or simultaneous with the target-letter. This task-irrelevant disc was presented a) to the blind field, b) to the symmetric position in the sighted field, c) at low contrast to the same sighted-field position, and d) at no contrast, i.e. as a blank stimulus, in two patients. 900 trials were given for each distractor condition. Throughout, the three hemianopic participants named the white target-letter at the end of each trial. Analysis showed that, in one patient, overall performance was significantly affected by the high contrast sighted-field distractor. However, when trials with and without distractors were considered separately, the high contrast disc in the sighted field, like the blank disc, had no specific effect on letter identification. In contrast, blind-field discs increased error rates specifically on distractor trials. Rather than causing a null effect like the blank stimuli they perceptually resemble, the blind-field stimuli disrupted letter identification more effectively than did the sighted-field stimuli. Possibly, top-down attention fails to blend out the blind-seen distractors. Visual awareness, or the processes that generate it, may thus help rather than hinder effective suppression of distractors.

2:10pm - Gaze-cueing attention without awareness.

Robert Kentridge[1], Jo Mason[2], and Charles Heywood[1]

[1] University of Durham, robert.kentridge@durham.ac.uk
[2] University of Bangor

A prosopagnosic patient, MS, was tested in a Posner attentional cueing paradigm using photographs of the faces of two models as cues. The models were photographed directing their eye-gaze at one of three peripheral target locations and in a neutral, straight-ahead, direction. Targets appeared equally often at the three peripheral locations. There was no contingency between the direction of gaze and target location. As well as directing their gaze, the models directed their heads equally often at each target location for each gaze-direction. The task therefore tested how the gaze direction of another automatically directed attention to a

location independent of head direction. We found the gaze direction, but not head direction, was a highly effective attentional cue in MS. We tested a range of stimulus onset asynchronies between cue and target. The effectiveness of the gaze cue decayed as SOA increased beyond 400ms. This pattern differs from that of normal observers who persist in being affected by gaze cues at long SOAs in a manner typical of endogenous curing. Finally we showed that MS could not explicitly discriminate the gaze direction of the cue faces in a forced choice task, demonstrating that he was using the gaze cues without conscious experience and that these cues only drive an exogenous-like attentional process.

2:30pm - Paradoxical effects of fixational eye movements at the threshold of visual awareness.

Aaron Schurger[1], Kim Minsoo[2], Anne Treisman[1], and Jonathan Cohen[1].

[1] INSERM U992 / NeuroSpin aaron.schurger@gmail.com

[2] Princeton University

Fixational eye movements have been shown to play a critical role in conscious vision by counteracting neural adaptation. Here we show that fixational eye movements interact differently with first- and second-order perceptual judgements, at just below the threshold of subjective visibility. We presented visual stimuli using dichoptic color masking, varying the color contrast to manipulate awareness of structure in the images. We asked subjects to guess the stimulus category (face, house) and, after each guess, to wager on the accuracy of their guess. At a low level of color contrast subjects remained above chance in guessing the category of the stimulus, although sensitivity of high wagers to correct decisions was not different from zero. Using infrared eye tracking we discovered that this dissociation was tied to opposite effects of fixational eye movements on guessing and wagering behavior, suggesting that these two types of decisions may depend on independent processes in the brain.

2:50pm - Intimate Pacmen: Shrinkage of a Kanizsa triangle around the blind spot.

Nicole Pernat[1], Richard LeGrand[1], Wayne Podrouzek[1], André Aßfalg[1], and Dianne Crisp[1].

[1] Kwantlen Polytechnic University nicole.pernat@gmail.com

Despite over a century of research, there is still debate as to whether stimuli presented across the retinal blind spot is “filled-in” or simply not processed by the brain. Evidence from both perceptual (e.g., Ramachandran, 1992b) and neurophysiological (e.g., Fiorani, Rosa, Gattass, & Rocha-Miranda, 1992) research supports filling-in. In contrast, some research is not consistent with filling-in (Maertens & Pollman, 2007) or suggests that filling-in may occur only under certain conditions (Lou & Chen, 2003). Finally, some authors argue that evidence for filling-in is not actually evidence for filling-in. They suggest that the brain fails to notice anything missing in this region of the visual environment due to lack of representation of the blind spot in the cortex (Dennett, 1992; O’Regan, 1998). The present study examines whether the blind spot is filled-in or simply not processed by the brain. Ten subjects were tested. Psychophysical scaling was used to assess the relationships between the sizes of the stimuli presented and subjects’ perception of those stimuli (Kanizsa triangles). Kanizsa triangles were superimposed over either the blind spot or a corresponding eccentricity in the other hemiretina of the right eye. This methodology allowed for two possible results, each consistent with one theory of blind spot processing: (1) if the blind spot is filled-in, participants should perceive no difference in the size of the Kanizsa triangle whether superimposed over the blind spot or non-blind retinal area; (2) if the blind spot is ignored, the Kanizsa triangles should appear smaller over the blind spot location as opposed to the non-blind location. Participants perceived the Kanizsa triangles at the blind spot location to be smaller than they actually were, and smaller than the Kanizsa triangles presented at the non-blind retinal location. Our results indicate the hypothesis that filling-in at the blind spot does not occur. This has implications for research indicating that there is cortical representation for the blind spot in the primary visual cortex (e.g., Komatsu, Kinoshita, & Murakami, 2003).

3:10pm - An invisible signal can be made accessible to consciousness by training the perceptual system to use it for a novel purpose.

Massimiliano Di Luca[1], Marc O. Ernst[1], and Benjamin T. Backus[2].

[1] Max Planck Institute for Biological Cybernetics

[2] SUNY College of Optometry ben.backus@gmail.com

The perceptual appearance of a visual stimulus can be changed by presenting stimuli that are similar, but that differ along specific dimensions, to the observer in advance. Many negative adaptation aftereffects are familiar to students of perception, for example. A different example is "cue recruitment" (Haijiang et al., 2006): a visual signal that has no effect on some attribute of appearance can often be made to affect that attribute through the use of classical (Pavlovian) conditioning procedures. In that case, the signal has come to be treated as a new cue by the visual system, insofar as it now participates in the construction of some new aspect of appearance that it previously did not. We asked whether this learning requires that the signal be visible, i.e. whether it must have a consciously accessible perceptual consequence, of any sort, during training. To do this we employed an invisible visual signal, namely, a vertical gradient of vertical disparity obtained by slightly magnifying the image in one eye. This signal is measured by the visual system, but it had no influence on any of the perceptual attributes that observers' visual systems computed from the displays, in which horizontal lines depicted a rotating cylinder. During training we made the eye of vertical magnification (EVM) contingent on the rotation direction of the cylinder. After training we presented an ambiguous version of the cylinder and found that EVM influenced the perceived direction of rotation consistent with contingency during training. Thus, a signal need not be visible for the adult visual system to give it new use as a participant in the construction of visual appearances. Haijiang, Q., Saunders, J. A., Stone, R. W., & Backus, B. T. (2006). Demonstration of cue recruitment: Change in visual appearance by means of Pavlovian conditioning. *PNAS*, 103, 483–486.

(B) - Qualia, Phenomenology, and Sensation

Chair: Allen Houng

Venue: Colony Ballroom Center (2nd Floor)

1:30pm - Felt Agency and the Consistency Criterion.

George Seli.

Graduate Center, City University of New York gseli@gc.cuny.edu

D.M. Wegner takes perceived consistency between volition and act to explain a person's sense of causing her bodily movements, along with the other principles given in his Theory of Apparent Mental Causation: priority (that the agent perceive the volition to occur just before the movement) and exclusivity (that she perceive no other cause of the movement). The drawback to Wegner's conditions, however, is that they constitute a phenomenological ground for felt agency: If a person is to feel agentive in the course of action, she must (inter alia) judge her act to be consistent with her volition during that time. But as I argue, volitions are typically nonconscious during everyday action: we are simply aware of acting, and feel agentive in so doing. And even when volitions are conscious, they tend to be "phenomenologically indeterminate," as T. Metzinger has observed. Prima facie, these factors would prevent the person from assessing volition/act agreement. In this paper, I adapt Wegner's theory to address this problem, arguing that an act agrees with a volition based on the latter's representational content, which need not be conscious. Positing a nonconscious consistency judgment, one based on nonconscious volitional content, preserves Wegner's intuition that will/act consistency supports the feeling of causing a movement. Nonconscious volitions also have the theoretical advantages of J. Searle's intentions-in-action: they explain the difference between actions and mere movements, and why many actions subjectively appear spontaneous. But their imperative content and temporal priority to the movement makes them more suitable than intentions-in-action as causes of movement, as I will discuss. Furthermore, assuming that nonconscious consistency assessments regularly occur during action, the structure of mental processing can reflect -- and arguably supervene on -- a subpersonal mechanism of action-control, namely the "comparator" model proposed by several researchers. Thus, on my view, the sense of agency can serve the cognitive function of indicating operations at nonconscious levels of action-control, as the product of those operations.

1:50pm - The Phenomenology of Visual Self-Location.

John Schwenkler.

Department of Philosophy, Mount St. Mary's University schwenkler@msmary.edu

All perceptual experience is necessarily egocentric; that is, it locates objects according to a frame of reference centered on the body of the perceiver. But individuating locations with respect to oneself does not require an explicit representation of one's own location, as not all systems of egocentric spatial representation need be self-locating in the same sort of way as, say, my belief that I am at my desk. But can we do justice to the phenomenology of human visual experience if we regard it only as egocentric in the thin sense, and not as self-locating in the more robust one? I argue that we cannot: there are important aspects of visual experience that cannot be accounted for unless we take the location of the self to be among the things that vision represents. I go on to indicate some difficulties raised by this discovery for neurobiological models of visual perception that treat spatial distribution in the primary visual cortex as the fundamental source of visual spatial information; instead, it may be only via feedback from higher cortical areas that visual space is structured.

2:10pm - Toward a more perfect union - The prospects for integrating diverse theories of consciousness.

Robert Van Gulick.
Syracuse University rnvangul@syr.edu

There are at present many competing theories of consciousness: philosophical (higher-order, representational,..), cognitive (global workspace, information integration, attended mid-level representation....), and neurobiological (local reentrant, thalamo-cortical loop, synchronous oscillatory.....). Although most are developed in isolation and some combinations are obviously contradictory, others might be jointly accepted. Beyond mere joint consistency, some combinations might be complementary and mutually supportive. This might occur in at least three ways: 1. Different theories may describe consciousness at different levels, and a lower level theory may describe processes or mechanisms that implement those at a higher level: either within a domain (models at two cognitive levels) or across domains (cognitive and neurobiological). 2. Different theories may describe separate aspects of consciousness, each of which needs to be included in a comprehensive account. These parts or aspects of consciousness may divide at different scales: at the very macro level, e.g. the supposed distinction between access consciousness and phenomenal consciousness, or at more micro levels - e.g. the distinction between conscious and unconscious processing may apply differently with respect to memory than it does with respect to perception. 3. Two or more models of consciousness may describe what turn out to be mutually interdependent aspects of consciousness. Integrating the two theories may provide an important and useful re-conceptualization of each. The union of the two may transform our understanding of each in a way that allows us to better see how they together contribute to the nature of consciousness. I will provide a quick overview or "map" of some of the leading philosophical, cognitive and neurobiological theories/models of consciousness. I will then briefly survey some of the major prospects for each of the three types of integration among them. I will then focus on one particularly promising possibility for integration. That option aims to transformatively combine the reflexive view of consciousness as a form of self-awareness (whether higher-order or same-order) with global integration accounts. Both prior theories undergo a significant re-conceptualization in the process of integration. The integrated account also provides an explanatory link between access and phenomenal consciousness, and deepens the connections to various proposed neural substrates.

2:30pm - Experimental paradigms for studying the latency for conscious sensation.

Gilberto Gomes.
UENF ggomes@uenf.br

An important question about consciousness is how long it takes to become conscious of a sensory stimulus. Several experimental paradigms will be analyzed as possible ways to study this question. Simple reaction time (RT) is of no avail, since the reaction may occur before the stimulus becomes conscious. Choice RTs are subject to the same problem, but under some conditions (to be discussed) may indicate an upper limit for the latency for conscious sensation (LCS). Donder's (1868/1969) experimental situation c, which is the one that comes closer to what would be ideal for this purpose, has given a mean value of 237 ms for choice reaction time. Some backward masking experiments, by contrast, may give us an estimation of a minimum value for LCS. If a stimulus is masked from consciousness by a subsequent stimulus, this indicates that the subject was not yet conscious of the first at the time of presentation of the second. Available backward masking studies suggest

minimum values of about 200 ms for LCS. Libet's method of pairing a peripheral and a cerebral stimulus provides another way of estimating this minimum value. However, Libet et al.'s 1979 study presents methodological problems and was never replicated. Moreover, both its experimental design and the original interpretation of its results were biased by Libet's ill-founded adoption of the backward referral hypothesis. A reinterpretation of his results indicates a minimum value of 230 ms for LCS. In 1977, Geldard systematically studied the illusory spacial displacement of a cutaneous stimulus by the action of a subsequent stimulus. Rather than supporting the view that consciousness does not occur at a definite point in time, as Dan Dennett holds, I will argue that Geldard's results indicate a mean minimum value of about 210 ms for LCS.

2:50pm - Stinking consciousness!

Benjamin D. Young.

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Looking at the different theories of consciousness, one becomes aware that something does not smell right. Olfaction has been neglected. The olfactory system's anatomical structure, functional organization, and sensory states raise problems for the prevailing neuroscientific theories of consciousness, while providing a novel perspective for theorizing about consciousness. The anatomical structure of the olfactory system is problematic for the current neuroscientific theories of consciousness, which consider a thalamic relay or corticothalamic loops as a necessary condition for consciousness. A thalamic relay might be necessary for consciously analyzing odorants (Pially, et. al. 2007), but it is not required for consciously discriminating between odorants. Thus, providing reason to doubt Crick's (1984, 1994) theory (Smythies, 1997), Crick & Kock's (1998) theory (Shepherd, 2007), Koch's neurobiological t heory (2004), and the Information Integration Theory of Consciousness (Tononi & Edelman, 1998; Tononi, 2004). The functional organization of the olfactory system further aggravates the problem for these theories, since the necessary thalamic connections cannot be replaced with a functional equivalence within the olfactory system. Using research on the mitral cell's functional encodings of odorants in the olfactory bulb (Friedrich & Lauent, 2001), I argue that the aforementioned theories cannot reply that the olfactory bulb plays an equivalent functional role to that of the thalamus for vision (Kay & Sherman, 2006). Furthermore, the necessity of cortical connections without thalamic relays for our conscious sense of smell suggests studying phenomenal consciousness as a necessary condition for access consciousness. using evidence from Blind Smell (Schwartz, 1994, 2000; Sobel et. al. 1999).

3:10pm - The phenomenology of certainty: A reinterpretation of classical epistemological questions.

Jennifer Windt.

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A central question for epistemology is how to prove the reliability of our knowledge of the external world. Subjective feelings of certainty are central to this type of project in the classical literature. Examples include René Descartes' reliance on intuitive, self-evident propositions and clear and distinct ideas. Visual metaphors of certainty also abound in John Locke's Essay Concerning Human Understanding, where knowledge is defined as the perception of the agreement or disagreement of ideas. In the first part of the talk, I argue that in these classical examples, the transition from subjective feelings of certainty to objective knowledge hinges on the assumption that psychologically irresistible beliefs are also epistemically reliable (Loeb 1992). What makes these ideas psychologically irresistible, in turn, is that their occurrence gives rise to a distinct experiential property, the phenomenology of certainty. Whereas many agree that intentional states such as beliefs are not individuated by their phenomenal content (but see Horgan & Tienson 2002), increasing attention is being paid to feelings of knowing (Koriat 2000) and so-called noetic (Metcalfe 2000) or epistemic feelings (de Sousa 2009) as well as their neural basis (Maril et al. 2002). At the same time, the phenomenology of certainty says nothing about the epistemic justification of occurrent intentional states (or their corresponding verbal reports): Delusions can give rise to the phenomenology of certainty while be being profoundly misrepresentational. I claim that the phenomenology of certainty, including conscious theoretical intuitions, is not epistemically warranted. This suggests that a subset of questions traditionally conceived of as belonging to epistemology should be handed over to philosophy of mind as well as to interdisciplinary consciousness research. They require a reinterpretation in terms of the phenomenology of epistemic feelings as well as, ultimately, a functional and neurophysiological analysis. To the extent that epistemological theories rely on the

phenomenology of certainty to vindicate our epistemic access to the world without presenting a convincing argument for its trustworthiness, they must therefore be regarded as inconclusive, or incomplete. This presents a serious problem not just for classical epistemological arguments, but also for recent defenses of intuitionism (Goldman 2007; Chudnoff 2010).

(C)- Implicit Learning: Must we articulate what we (consciously) know?

Chair: Axel Cleeremans

Venue: Giovanni Room (2nd Floor)

1:30pm - Does unconscious knowledge of artificial grammars exist?

Zoltan Dienes.

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One of the key domains investigating the difference between conscious and unconscious processes is implicit learning. Within the implicit learning literature, the key papers defining the "believers'" position that unconscious learning exists, and its nature, were published by Arthur Reber in the 1960s and 1970s. The paper defining the sceptics' position, and still one of the most closely argued papers sceptical of implicit learning, is Dulany, Carlson and Dewey (1984) (DCD), the first response to Reber's papers. I will present fresh data which, for the first time in 25 years, attempts to replicate DCD, and test alternative interpretations of their results. I will argue that Reber's point of view is vindicated by DCD's procedure. Reber exposed people to strings of letters, unbeknownst to subjects generated by a finite state grammar, and then asked people to classify new strings as obeying the rules or not. People could do so at above chance levels despite being unable to describe the rules. Reber argued people had acquired unconscious knowledge. DCD repeated the procedure but asked people to underline the part of the string that made it grammatical or non-grammatical. Treating these underlinings as conscious rules, he showed rule validity predicted correct classification almost perfectly. Thus, DCD argued that all the knowledge was conscious. DCD assumed that forced underlining of part of a string amounted to asserting a rule. But, for example, wondering or completely guessing where to underline is not to assert anything. I repeated DCD's procedure but in addition asked people to report the basis of their underlining: They completely guessed, they relied on intuition, they used a rule, and they used recollection. People predominantly said they guessed (37%) or used intuition (30%). Further, DCD's method for calculating rule validity artifactually produced the results they wanted – the relation of rule validity to classification was largely a mathematical given, not an empirical discovery. When the artefact is corrected, underlinings are still shown to express knowledge to some degree. Importantly, they do so even when people felt they were guessing (or using intuition). That is, the underlinings largely expressed unconscious knowledge.

1:50pm - Is statistical learning exclusively implicit?

Julie Bertels[1], Ana Franco[2], and Arnaud Destrebecqz[1].

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To what extent does statistical learning occur implicitly? In visual statistical learning (VSL), participants learn the statistical regularities present in a sequence of different visual shapes. A recent study (Kim, Feenstra & Shams, 2009) suggests that visual statistical learning is not accompanied by conscious awareness of the statistical regularities between sequence elements. In a replication of this study, we challenge this interpretation by showing that participants are able to identify the nature of the statistical regularities in a 4-alternative forced-choice (4AFC) task in which each trial also involved a binary confidence judgment. We further observed a positive correlation between participants' performance in the 4AFC task and their confidence in their performance. Our results therefore suggest that the task used in the initial study may have been too difficult to elicit conscious knowledge but not that VSL was truly implicit. Participants indeed appear to be conscious of what they learned and when they applied this knowledge successfully. Our results will also be discussed in light of the ongoing methodological controversies in the field of implicit learning in which the interpretation of the empirical evidence has flipped between a strong endorsement of an unconscious learning system and the denial of non-conscious acquisition of new information. To our best knowledge, Kim et al's and our study are the first to address this issue in the burgeoning field of statistical learning.

2:10pm - Awareness in affective learning.

Robert Balas[1] and Joanna Sweklej[1].

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Evaluative conditioning (EC) is a process of changing the evaluation of initially neutral stimulus (conditioned stimulus – CS) due to its repeated pairing with either positive or negative stimulus (unconditioned stimulus – US). As such it is regarded as a basic learning process that results in forming attitudes and preferences. Conscious awareness impact on EC is now a question of considerable debate. Specifically, there is no consensus whether EC requires subject's awareness of CS-US contingencies as well as awareness of stimuli themselves. The presented research examines whether EC is possible without perceptual and contingency awareness. First two studies examined whether EC is possible with subliminal presentation of the stimuli. To assess contingency awareness a 4 Picture Recognition Test was used. This test requires participants to select an US that was presented together with a CS at the time of conditioning. The third study adopted dissociation logic in contingency awareness check. This time we asked participants to select the item that DID NOT accompany the CS. We found EC effects independent of awareness in all studies. This suggests that affective learning might proceed with no perceptual access to the stimuli and no intentional control over responses elicited by conditioned stimulus. We conclude that evaluative conditioning may shape our preferences and attitudes without awareness of what and how is being learned.

2:30pm - Flexible control over unconscious structural knowledge.

Elisabeth Norman[1], Mark Price[1], Ryan Scott[1], Emma Jones[1], and Zoltan Dienes[2].

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Flexible control over the application of knowledge is traditionally regarded as indicating conscious access to that knowledge (Baars, 1988). However the dichotomy between implicit/unconsicous and explicit/conscious knowledge is being softened by suggestions that consciousness might be graded (e.g., Cleeremans, 2008; Cleeremans & Jimenez, 2002) and the question of whether flexible control is always associated with conscious access to knowledge needs to be empirically addressed. In an artificial grammar learning experiment (N=72) we investigate whether people show flexible control over the use of acquired rule knowledge when detailed knowledge of the learned rules is not conscious. All participants were exposed to two sets of letter strings, each governed by a different artificial grammar. The nature of the grammar rules was disguised by random variation in irrelevant stimulus properties of each letter string. In a subsequent test, participants classified novel letter strings but were cued on a random trial-by-trial basis as to which grammar they were assessing. Participants' awareness of the nature of the grammar rule was assessed by a combination of free verbal report and a multiple choice questionnaire. Results showed that participants were able to flexibly control the application of the two grammars. This applied even to those participants who did not know which stimulus dimension the grammar rule was based on. These participants also showed better string classification on trials where they rated themselves as using "implicit" decision strategies, i.e., random choice, familiarity, or intuition. Results are discussed in relation to different theoretical viewpoints that could explain how flexibility can sometimes be seen as a property of unconscious knowledge. According to one such viewpoint unconscious knowledge can be reflected in conscious "fringe" feelings that can be used to guide behaviour flexibly (Norman, Price, Duff, & Mentzoni, 2007). Results can also be interpreted within a theoretical framework that distinguishes between the conscious status of judgement knowledge versus structural knowledge of the acquired knowledge (Dienes & Scott, 2005).

2:50pm - Subordinate categorization requires conscious awareness.

Ido Amihai[1], Leon Deouell[1], and Shlomo Bentin[1].

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Neuroimaging studies demonstrate that categorical processing of faces can occur even in the absence of conscious awareness. However, the extent to which information about subordinate properties such as gender, age, race or identity can be extracted without awareness of the perceived stimulus is still debated. Our present

experimental results suggest a need for conscious awareness in the processing of subordinate information. Using the FaceGen Modeller software, we generated faces that were ambiguous either with respect to gender or to race, and presented them immediately after prime faces that clearly belonged to a certain race or gender (an extremely male or extremely female face in the gender classification task and extremely Caucasian or extremely Asian face in the race classification task). As previously reported, when conscious vision was unhindered, the classification of the ambiguous faces was biased contrary to the category represented by the immediately preceding prime. In contrast, no bias was observed when the primes were rendered consciously invisible via continuous-flash-suppression. Moreover, we found a correlation between the bias strength and the exposure time of the prime only when it was consciously visible, indicating that the processing of subordinate information clearly depends on the amount of time that a stimulus is subjectively visible. Previous data show that affective images that are presented below the threshold of conscious awareness can both activate specific brain regions and influence the affective judgments of subsequent stimuli, possibly through a neural route that travels directly from the superior colliculus to the limbic system and bypasses the visual cortex. Our data shows that such routes are the exception, and are not available for subordinate categorization that is based on form aspects of the visual stimulus, such as a face's gender and race. Thus, despite the enthusiasm about evidence for residual categorical processing without awareness, conscious awareness is required for information extracted from faces to affect behavior.

3:10pm - Brain dynamics as music: analysis of musical properties in fMRI and its conscious correlates.

Dan Lloyd.

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Music, according to Edgard Varèse, is "organized sound." World music traditions organize sound according to common principles; the most basic is sparsity:detectable sound properties are continuous, but music restricts itself to discrete subsets of scales, timbres, and rhythms, subsets varying across musical niches. Moreover, music displays "1/f" power spectra, with greatest amplitude at low frequencies (Voss&Clark,1975). Functional MR signals from the brain display musical properties, a finding presented here for the first time. We show musicality through fMRI of 34 subjects, half with schizophrenia, performing simple tasks (Garrity et al.,2007). "fMusicality" (musical properties in fMR signals) is measured on six dimensions, and compared to 1000 iterations, same analysis, using randomly permuted surrogates of the original data (preserving autocorrelation). In fMRI, fundamental and mean harmonic frequencies are lower, harmonics are fewer, the pulse oscillates less, and instantaneous frequencies are lower and fewer, in 94% of healthy subjects and 83% of patients. Moreover, the analysis distinguishes healthy and ill subjects: patients are less fMusical than controls, but still unlike surrogate data. All these contrasts are highly significant, notwithstanding multiple-comparison thresholding. We argue that fMusicality arises through distributed dynamics essential to consciousness. Specifically, fMusicality reflects temporality, the structural awareness of persistence, change, and repetition over time (Husserl 1966, Lloyd 2002, 2010). The brain must encode these properties; fMusicality arises in large recurrent networks. Accordingly, purported NCCs may be not only multivariate but polyphonic.

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-- Coffee Break --

CONCURRENT SESSION 2 (4:00pm – 6:00pm)

(A)- Priming, Timing, and Neural Coding

Chair: Stanislas Dehaene

Venue: Colony Ballroom East (2nd Floor)

4:00pm - Neurocomputational modeling of the unmasked priming: Positive and negative congruency effects.

Ahmad Sohrabi[1], Robert West[2], and Andrew Brook[2].

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Briefly presented stimuli in a stream can affect each other. Specially, the first presented stimulus can affect the following one in terms of the ease and speed of the processing. An example is the priming effect where the first stimulus (the prime) can affect the second one (the target). Usually the prime can speed up the RT for the target when they are congruent (e.g., both require the same response) and vice versa when they are incongruent, a phenomenon known as Positive Congruency Effect (PCE). However, in some conditions the opposite effect can occur, i.e., the prime can speed up the RT for the target when they are incongruent and vice versa when they are congruent, a phenomenon known as Negative Congruency Effect (NCE). The PCE has been found with a short interval (e.g., shorter than 100ms) between the prime and target, i.e., short prime-target Stimuli Onset Asynchrony (SOA) while he NCE has been found with a long interval (e.g., longer than 100ms) between the prime and target, i.e., long prime-target Stimuli Onset Asynchrony (SOA). The NCE has been shown mainly using masked primes but recently it has also been found with unmasked primes. In this case, the NCE occurs especially when the prime-target SOA is quite long and the prime is relevant to the task i.e., carrying some meanings. Here we simulated our previous experimental data and others' on the unmasked stimuli using the same model that we have employed for masked stimuli only by removing the mask presentation and, in the case of irrelevant prime, also by putting the mode of the attentional response to the prime in a less phasic (slightly tonic) mode. The role of the attention in the model as well as its similar bases in the congruency effects and the attentional blink will be demonstrated using the dynamic behavior of the computational units in the model.

4:20pm - Conscious experience cannot be primed.

Dwayne Pare[1], Steve Joordens[1], Marc van Duijn[1], and Mina Atia[1].

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Studies involving stimulation of the somatosensory cortex suggest that electrical pulses at an intensity below some liminal threshold do not give rise to conscious perception even when trains of pulses were presented up to 5 s in length (Libet, Alberts, Wright, Delattre, Levin, & Feinstein, 1964; Pockett, 2002). These findings seem to imply that a stimulation that does not give rise to conscious experience simply can never give rise to conscious experience; that is, conscious experience cannot be primed. Previous studies have used the process-dissociation paradigm to quantify the probability of conscious awareness for some item as a result of a single masked presentation (e.g., Debner & Jacoby, 1994), but no studies prior to our work have examined the probability of conscious perception as a function of repetition priming. In our first experiment we describe a category/exemplar version of the inclusion/exclusion paradigm. Across two subsequent experiments we then estimate the conscious perception arising from a single presentation of an item, use that estimate to predict what would happen if multiple presentations simply led to an additive increase in the probability of awareness, then compare this prediction to the observed score. In these initial experiments we find that the additive model fits the data extremely well, again suggesting no priming of conscious experience. Given concerns with respect to the potential for ceiling effects affecting our data, two follow-up experiments were conducted with the intent of keeping the initial conscious perception of a single presented item to a minimum. This was achieved across experiments by using non-words in place of the pattern mask and decreasing the duration of item presentation. These experiments again provided clear support for an additive priming effect. This suggests that the probability that a given presentation will lead to conscious experience remains unaffected by repetition. Said another way, it appears as though conscious experience cannot be primed.

4:40pm - Game outcome retrospectively determines the time of action.

Eve Isham[1], William Banks[2], Arne Ekstrom[1], and Jessica Stern[1].

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[2] Pomona College

If an action is thought to be intentional, it is judged to be closer in time to its result than if it is not intentional. This compression between cause and effect is termed intentional binding (Haggard et.al., 2002). On the other hand, if an action is unintended, and instead is prompted by a stimulus, the action is judged to be temporally closer to the time of the stimulus than to a resultant effect (Waszak et al., 2005). Our study tested an alternative hypothesis that the perceived time of an action is not determined by the degree of intentionality, but by the saliency of the surrounding events. In Exp1, the participants performed a simple keypress in response to a visual cue, resulting in one of the two possible tones randomly selected by the computer. The perceived time of the keypress was the same in both cases (~241 ms before keypress), illustrating that non-salient, meaningless tones did not influence time perception. In Exp2, the participants performed the same keypress but in a competition-like environment where they competed against a confederate. Each player pressed her own button in response to the cue as in Exp1. To increase the saliency of the tones, the participants were told that if they were faster than the competitor, they would elicit a tone that indicated a win. If the competitor was faster, s/he would elicit a different tone, implying that the participants had lost. Deceptively, the participants elicited both tones, and the outcome was randomly selected by the computer and was not consistent with the actual outcome. The results showed that action time was perceived to be 21 ms earlier when the participants thought they had won as compared to when they thought they had lost, $p<.002$. Furthermore, the averaged perceived time was 124 ms later than that observed in Exp1 ($p<.013$), suggesting a temporal shift toward the tone. We attribute these results to the effect of game outcome, providing evidence that a meaningful post-action event can influence the direction of a temporal shift and retrospectively modulate the perceived time of a stimulus-based action.

5:00pm - The neural basis of self-monitoring attentional status.

Noriko Yamagishi[1], Eiichi Naito[2], Stephen Anderson[1], and Mitsuo Kawato[1].

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[2] NICT, ATR

High-level cognitive factors, such as states self-awareness, are believed to play an important role in human visual perception. The principal aim of this study was to investigate the neural basis of such processes. To do so we measured cortical activity using magnetoencephalography (MEG) and functional magnetic resonance imaging (fMRI) while participants were asked to self-monitor their internal attentional status, only initiating the presentation of a stimulus when they perceived their attentional focus to be maximal. Their task was to judge the orientation of a spatially localized Gabor patch. We employed a hierarchical Bayesian method that uses fMRI results as soft- constrained spatial information to solve the MEG inverse problem, allowing us to estimate cortical currents in the order of millimeters and milliseconds. Our results show that, during self-monitoring of internal attentional status, there was a sustained depression of alpha activity (7-13Hz) in the rostral cingulate motor area (rCMA), beginning approximately 450 msec after the trial start ($p < 0.05$, FDR corrected). We also show that gamma-band power (41-47 Hz) within this area was positively correlated with task performance from 150 – 640 msec after the trial start (average of correlation coefficients in this time range, $r = 0.71$). We conclude: (1) the rCMA is involved in processes governing self-monitoring of internal attentional status; and (2) the qualitative differences between alpha and gamma activity are reflective of their different roles in self-monitoring internal states. We suggest that alpha suppression may reflect a strengthening of top-down interareal connections, while a positive correlation between gamma activity and task performance indicates that gamma may play an important role in guiding visuomotor behavior.

5:20pm - One hand clapping, or: why silent units do matter.

Shimon Edelman[1] and Tomer Fekete[2].

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Many representational construals of brain function, including theories of qualia, identify their explananda with points in a representation space spanned by a set of units (e.g., spiking neurons), each of which is either active or not at any given instant of time (e.g., Smart, 2004). Under this model, the representational burden is carried by a typically sparse and ever-changing set of momentarily active units, raising the question of what is it that each silent unit contributes to one's ongoing experience. The problem of silent units is very general: it holds for any approach to cognition that attributes any kind of interpretation at all to the instantaneous state of the system in question. This includes, at the one extreme, the relatively uncontroversial notion that brain states represent world states (a standard working hypothesis in neuroscience) and, at the other extreme, the sophisticated Information Integration theory of qualia developed by Tononi (2008). While noting that "it does not make sense to ask about the quale generated by [...] a state (firing pattern) in isolation" and offering an intriguing prediction that cooling silent units would leave them inactive, yet alter the subject's experience, Tononi stops short of spelling out why this should be the case. According to IIT, "consciousness can be characterized extrinsically as a disposition or potentiality -- [...] as the potential discriminations that a complex can do on its possible states, through all combinations of its mechanisms." The need to invoke potentialities in explaining actual representational function or experience disappears if these are equated with portions of the system's state-space trajectory rather than with instantaneous states or reactive "mechanisms." By making dynamics matter (cf. Chalmers, 1994), our explanatory move (1) accounts for a range of neurobiological and behavioral characteristics of conscious experience, (2) gives voice to silent units, whose very silence is what makes the trajectory bend the way it does, and (3) points to a computational theory of mind that is both counterfactually sustainable and empirically grounded, thereby fixing the sense in which the mind is what the brain does.

5:40pm - Investigating intrinsic brain activity: a role for exploratory introspection.

Adrienne Prettyman.

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One standard strategy for investigating the cognitive function of a brain activity is to correlate that activity with task performance. A new area of research on intrinsic brain activity presents a challenge for this methodological strategy. Neuroimaging studies show that subjects who lay awake and still without being given a task nevertheless exhibit structured brain activity. Although non-task oriented activity is decoupled from external stimuli, researchers have identified networks of brain regions that spontaneously increase and decrease their activity together. This structure suggests that intrinsic activity might subserve a cognitive function. Since intrinsic activity is distinguished by decoupling from task performance, however, we cannot investigate its function directly using cognitive tasks. As a result, it remains unclear what cognitive function, if any, intrinsic activity performs. Among the proposed functions of intrinsic activity are background states of consciousness, such as the ongoing sense of self, experiences of the body, and the representation of time. While support for the hypothesis that intrinsic activity subserves background experience remains speculative, I argue that rigorous use of first-person data can advance our understanding. Expanding the methodological strategies of cognitive neuroscience to incorporate first-person data will enable researchers to test a new range of hypotheses surrounding the relationship between intrinsic activity and consciousness. I propose a particular type of introspection appropriate for investigating experiences outside selective attention: exploratory introspection. Exploratory introspection is unique in that it enables subjects to report on mental activities that occur in the absence of a task, without disrupting those activities. I align myself with the tradition of Neurophenomenology, a research program centered on the rigorous use of first-person data to identify a precise correlation between experience and its neurophysiological basis. I suggest that the development of skilled introspection is an important precursor to meeting what Chris Frith (2002) has called one of the major scientific projects of our century: “to discover how an experience can be translated into a report, thus enabling our experiences to be shared.” I end by showing how exploratory introspection using trained subjects can meet the problems raised by incorporating introspection into cognitive neuroscience more generally.

(B)- Theories of Consciousness

Chair: Anil Seth

Venue: Colony Ballroom Center (2nd Floor)

4:00pm - Identifying phenomenal subjectivity in machine consciousness.

Don Borrett[1], David Shih[1], Michael Tomko[1], Sarah Borrett[1], and Hon Kwan[1].

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The goal of synthesizing an agent with phenomenal experience presents a unique perspective to the study of consciousness that complements the more prevalent analytical approach. Rather than using the contents of our experience to serve as a framework to develop a synthetic phenomenology in a robot, we have suggested using the form of our experience to define a robot's phenomenal experience. We take as the fundamental form of experience a present sensible state that is framed by temporal horizons that confer meaning to that state. In a robot, these temporal horizons are identified with the time scales in the controller's dynamics to which the agent has access. The time scales are "carried" with the present sensible state in the controller's dynamics as the agent interacts with the environment. Data from evolutionary autonomous agent simulations will be presented and the idea that simple feedback of time horizons can lead to the evolution of an agent that can independently determine if its actions are appropriate to the situation will be discussed. It will also be proposed that the experience of a world of enduring objects can emerge as a content in the dynamics of an agent with this form of experience. Breakdown is the mechanism by which this alternative experience emerges. With this approach, two types of subjectivity are identified in the robot, the first person, phenomenal perspective identified with the proposed form of experience and the third person, cognitive perspective that emerges as an enduring self in the contents of the first person perspective. The application of evolutionary autonomous agent simulations to the problem of consciousness provides a unique and complementary perspective in the understanding of the mechanisms underlying phenomenal experience.

4:20pm - A Critique and Extension of Consciousness as Integrated Information.

Igor Aleksander[1] and David Gamez[1].

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In the Information Integration Theory of Consciousness (IITC), Tononi [1] claims that "…to the extent that a mechanism is capable of generating integrated information …. it will have consciousness", and he describes elsewhere how information integration can be measured in an arbitrary system. An algorithm that could predict consciousness in the brain has considerable appeal, but the IITC faces a number of difficulties. One problem is that the IITC is hard to verify because the calculation of information integration takes a large amount of computing power - a recent estimate suggested that it would take ten billion years to analyze a network of 30 neurons. A second issue is that the IITC claims to encompass not only the quantity of (conscious) information held in a network but also its quality, i.e. qualia. However, the IITC does not explain how networks' states can represent the external world. This paper introduces a method for assessing the information content of a neural area that obviates the above difficulties. Our approach treats the network as a state machine and bases the calculation of information-bearing states on 'liveliness', which measures the probability of a connection transmitting information when the network is in a particular state. This liveliness calculation scales linearly with the number of connections and takes less than a second to analyze a network of 30 neurons. To make the states of a neural complex meaningful we also introduce the notion of 'Iconic' training, which causes a network's states to represent sensory stimuli (some background in [2,3]). These adjustments to the IITC should make it more feasible to use the formalisms of information to develop a scientific theory of consciousness. [1] G. Tononi: "Consciousness as Integrated Information: a Provisional Manifesto", Biol. Bull. 215: 216–242. December 2008. [2] I. Aleksander: "Neural models: A Route to Cognitive Brain Theory" In Baars and Gage (eds), Cognition, Brain and Consciousness, Elsevier 2007, pp 453-476. [3] I. Aleksander and D. Gamez: "Iconic Training and Effective Information: Evaluating Meaning in Discrete Neural Networks" Proc. AAAI Symp. on Brain Inspired Cognitive Architectures Fall 2009.

4:40pm - Differential thalamocortical connections toward understanding consciousness from information and integration.

Xiaolin Liu[1], Jingsheng Zhou[2], Anthony Hudetz[1], and Shi-Jiang Li[1].
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[2] Xuanwu Hospital Capital Medical University

Converging evidence suggests that the thalamocortical system is essential in determining the formation of consciousness. A recent theoretical framework (the information integration theory) has proposed a compelling view toward understanding the neural mechanisms underlying consciousness. Specifically, "information and integration may be the very essence of consciousness." To the extent that consciousness has to do with information and integration, the important role of the thalamus to consciousness is exclusively signified by its rich and highly interdependent reciprocal connections with the cerebral cortex involving both functionally specific and nonspecific components. Here, using the resting-state functional imaging techniques, we examined the specific and nonspecific thalamic connections in the brain based on the neuroanatomical findings implicating their respective functional roles in sustaining information and integration. The participating subjects included seven healthy volunteers and seven age-matched patients diagnosed with vegetative state, which is characterized by wakefulness without awareness. The hypothesis we sought to substantiate is that the specific thalamocortical connections are responsible for functional specialization (information), which forms sensory representations from the content about the external world; in contrast, the nonspecific thalamocortical connections are responsible for information integration that eventually generate high-order conscious perceptions. Remarkably, our results demonstrated a consistent division of brain regions such that all the neural correlates that have been identified in association with high-order conscious perceptions are either predominantly (e.g., dorsal MPFC, AIC, IFG, ACC), or at least partially (e.g., PCC, retrosplenial cortex), connected with the nonspecific thalamic nuclei. Likewise, the specific thalamic connections were consistently revealed by brain regions presumably responsible for representing information about the external world. Of these, the nonspecific thalamic connections with the dorsal prefrontal cortex (PFC) and anterior cingulate cortex for information integration, and the specific connections with the ventral PFC and precuneus for gathering information together contribute primarily to the loss of consciousness in VS. Overall, our results not only endorse the view that the thalamocortical system is essential to consciousness, but also support the hypothesis that in line with the information integration theory of consciousness, brain networks that sustain and integrate information may be differentiated by the nature of their thalamic connectivity.

5:00pm - Consciousness: the radical plasticity thesis.

Axel Cleeremans.
Consciousness, Cognition & Computation Group, Université Libre de Bruxelles axcleer@ulb.ac.be

While numerous theories of consciousness have now been proposed, two big ideas dominate and subsume most other proposals. The first is that consciousness amounts to "fame in the brain" (e.g., Baars, Dehaene, Dennett, Lamme): We are conscious of whatever representations have, at some point in time, come to dominate information processing through processes of global competition and constraint satisfaction. The other idea is that consciousness specifically depends on the involvement of meta-representations (e.g., Rosenthal, Perner & Dienes): We are conscious of something in virtue of the fact that our first-order representations are the target of higher-order representations. In other words, it is because of the fact that one is conscious that one is conscious, that one is conscious! In this talk I explore the idea that consciousness is something that one learns rather than an intrinsic property of certain neural states, and suggest that this perspective offers a way of reconciling Global Workspace Theory with Higher-Order Thought Theory. Starting from the idea that neural activity is inherently unconscious, the question becomes: How does the brain learn to be conscious? I suggest that consciousness arises as a result of the brain's continuous attempts at predicting not only the consequences of its actions on the world and on other agents, but also the consequences of activity in one cerebral region on activity in other regions. By this account, the brain continuously and unconsciously redescribes its own activity to itself, so developing systems of meta-representations that characterize and qualify their target representations. Such re-representations form the basis of conscious experience, and also subtend successful control of action. In a sense thus, this is the enactive perspective, but turned both inwards and (further) outwards. Consciousness is "signal detection on the mind"; the mind is the brain's (non-conceptual, implicit) theory about itself. I subtend these ideas by exploring empirical evidence that conscious experience is shaped by learning and through neural network models that simulate the relationships between

performance and awareness in the different tasks explored by Persaud et al. (2007), which include blindsight, Artificial Grammar Learning, and the Iowa Gambling Task.

5:20pm - Forms of unity as a constraint on theories of consciousness.

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The scientific and philosophical investigation of consciousness has focused largely on the task of explaining what differentiates individual conscious states from unconscious ones, but, until recently, neglected the various forms of unity that characterize our conscious experience: Conscious experience is subjectively unified in the sense that, typically, one experiences oneself as a single subject of thought and action, and conscious experience is phenomenally unified in the sense that one's simultaneous experiences typically occur as modifications or components of a single global conscious state (Bayne & Chalmers 2003; Bayne 2010). The fact that consciousness is subjectively and phenomenally unified puts important constraints on any persuasive theory of consciousness. Moreover, in light of pathological conditions, the question of what differentiates unified conscious states from disunified conscious states is an important one. Despite these explananda, most current theories of consciousness tend to be atomistic both in methodology and scope; they take what Searle (2000) calls a building block approach to consciousness and attempt to explain particular conscious states individually. The task of this paper is to emphasize the unity of consciousness as an important yet neglected explanandum, and to put forward an account of consciousness that provides an answer to the question of what makes a conscious state conscious while at the same time respects subjective and phenomenal unity—that is, an account of what it is that unifies fine-grained conscious states into a single global conscious state. After introducing the forms of unity, the shortcomings of some popular theories of consciousness with regard to an explanation of these unities of consciousness are exposed. Finally, an alternative model is introduced that integrates philosophical theorizing with empirical models from the cognitive neurosciences.

5:40pm - The Quality-Space Theory of Mental Qualities.

David Rosenthal.
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Contemporary discussions of qualitative consciousness often assume without argument that mental qualities are always conscious—or if not that only first-person access can reveal their nature. These assumptions typically rest on the alleged conceivability of inverted qualities: If it's conceivable that your experiences of red objects exhibit the same mental quality as my experiences of green objects, only consciousness can tell us about such qualities. This leads to the hard problem and the conceivability of zombies, thereby threatening a scientific treatment of qualitative consciousness. But we needn't individuate mental qualities by way of consciousness; we can rely instead on the role those qualities play in perception. Each perceptual modality enables access to a range of perceptible properties, and we can construct a quality space that maps the just noticeable differences among the properties accessible by each modality. Since the ability to distinguish those perceptible properties rests on the distinct mental qualities they elicit, those mental qualities must themselves conform to a quality space homomorphic to that of the corresponding perceptible properties. So we can individuate mental qualities by their location in the relevant quality space. Quality inversion is precluded, since symmetry around any axis would collapse the quality space. This quality-space theory applies to bodily as well as perceptual sensations. Since location in a quality space depends solely on discriminative capacity independent of whether the relevant perceptual states are conscious, the theory accommodates nonconscious perceptual states, such as those in blindsight and masked priming. So additional theoretical resources are needed to explain how properties identified by location in a quality space lead to qualitative consciousness. I show that we can explain that with the higher-order theory of consciousness I've developed elsewhere; there being something qualitative that it's like for one is due to a higher-order awareness of mental qualities in respect of location in a quality space. The two theories together do justice to our pretheoretic intuitions about qualitative consciousness. And by individuating mental qualities independently of consciousness, it disposes of the hard problem and zombies, and so accommodates a science of qualitative consciousness.

(C)- Consciousness, Cognitive control, and Beliefs

Chair: Michel Ferrari

Venue: Giovanni Room (2nd Floor)

4:00pm - I know what you don't - a social affordance view on other minds and false belief tests.

Maria Brincker.

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Three year-olds cannot pass false belief tests but 18 month-old infants seem able to understand intentions behind clumsy unintended actions and predict actions of others based on attributions of false beliefs. How do we explain these seemingly contradictory findings? Due to the robust findings of 'Sally-Anne'-type false belief tests it is typically argued that children cannot understand and reason about other minds until the ripe age of 3 ½ and social cognition in smaller kids is accordingly dismissed as non-representational operant learning. Others argue that small children do have some understanding of mental states and that verbal difficulties rather than failure of perspective taking underlie the notorious inability to pass false belief test. Both interpretations seem unsatisfactory to me. The false belief tests indicate a radical cognitive development around the age of 3 ½-4, but I argue that it is not attributable to the sudden appearance of a 'Theory of Mind' module but rather the ability to 'decouple' from ones own pragmatic perspective or 'affordance structure'. Thus, I argue that smaller children do understand other minds but cannot reason or predict from the perspective of another other if that means disregarding their own affordance perspective. I point to developmental and neurological findings, which support the relation between performance on Sally-Anne-type tasks and the developmental timing and neural underpinnings of the ability to disengage ones own perspective. I then analyze the rather different social affordance structures of the difficult Sally-Anne type tasks and the infant looking time and action completions paradigms where small kids seem to show social understanding. I hypothesize that typically developing children and children with autism, who all are incapable of passing the Sally-Anne task show different patterns of social abilities such that the typically developing kids on my view should be able to understand others as along as they are not asked to leave their own perspective. I propose experimental paradigms that could test my proposals, and finally I point to some broader consequences for how we understand minds, mental states and their perceptual accessibility and inaccessibility.

4:20pm - The neural correlates of alien thoughts in the brain.

Simone Kuhn[1], Juergen Gallinat[2], Gottfried Vosgerau[1], Patrick Haggard[1], and Martin Voss[2].

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In our everyday phenomenal experience, it is seems indubitable that the thoughts we experience are our own thoughts. Accordingly, the claims that we are the authors of our own thoughts and exercise authority over them were taken as a priori truths (Descartes 1641). However, the phenomenon of thought insertion in schizophrenic patients has been considered an empirical proof that these claims are false (Campbell 1999) and its consequences for philosophy have been discussed (e.g. Vosgerau & Newen 2007). We have studied the brain basis of these processes in a unique instance of an individual who reported the exact onset of the alternation between thoughts that were identifiably his own, and thoughts that were not his. We compared differential brain activity in two different contrasts in a mixed blocked/event-related design: (a) periods with inserted thoughts present vs. (b) no inserted thoughts present. We show that the moment of intrusion of an alien thought (inserted>own thoughts) is associated with activation in the left supramarginal gyrus, while no activation was found for the reverse contrast (own>inserted thoughts). For sustained activity in the blockwise analysis, the state of thinking alien thoughts was associated with right angular gyrus activation, while the reverse contrast revealed activation in the cognitive control network, namely left dorsolateral prefrontal cortex and right superior parietal lobe. The brain network associated with thought insertion substantially overlaps with that for discriminating between external events and the consequences of one's own actions. We show that schizophrenic thought insertion involves a disturbed attribution process for linking thoughts to the self, and that this disturbance has a distinct neural basis. The results are discussed in the light of recent philosophical debates about the nature of thoughts and thinking processes. References: Campbell, J.

(1999), 'Schizophrenia, the Space of Reasons, and Thinking as a Motor Process', The Monist 82(4), 609-625. Descartes, R. (1641), Meditationes de prima philosophia, [1977] Meiner, Hamburg. Vosgerau, G. & Newen, A. (2007), 'Thoughts, Motor Actions, and the Self', Mind & Language 22(1), 22-43.

4:40pm - Awakening consciousness: discrepancy, binding and memory enhancement.

Steve Joordens[1] and Sarah Uzzaman[2].

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[2] University of Toronto

Whyte (1960) described consciousness as a self-defeating process similar to that of a fever; a process that is awakened when normal functioning is disrupted, and whose primary goal is to eliminate itself by correcting the disruption. This fascinating notion has received little scientific scrutiny to date. In the present paper we first describe how this notion fits well with recent findings attributed to memory binding, and then present three experiments that test the notion further. The experiments show that when discrepant (i.e., unexpected) events occur in an otherwise predictable context, other stimuli present at the time of the discrepancy are remembered better. These findings fit with the notion that discrepancies give rise to cognitive binding, a process by which all aspects of a stimulus array are bound together, including aspects that were assumed to be irrelevant to task performance. This binding process results in memory enhancement, but its core purpose is likely to provide more accurate predictions in the future, predictions that take into account background information in a way assumed to reduce discrepancy. To the extent that the accuracy of these predictions is increased, future discrepancies are reduced, which will then obviate the need to awaken consciousness in the future.

5:00pm - Re-thinking the active-passive distinction in attention.

Carolyn Suchy-Dicey.

Boston University carolynsd@gmail.com

Whether active and passive, top-down and bottom-up, or endogenous and exogenous, attention is typically divided into two types. This division has led to confusion about whether attention is necessary for conscious perception, memory, and perceptual learning. That is, when researchers attempt to show the relationship between attention and other functions, they need to show whether the type of attention they are researching is of the active or passive variety. However, the division between active and passive is not sharp in any area of consciousness research. In phenomenology, the experience of voluntariness is taken to indicate activity, but this experience is often confused with others. In psychology, task-dependent behavior is taken to indicate activity, but is often conflated with complex automatic behavior. In neuroscience, top-down processes are taken to exclusively indicate activity despite the fact that both top-down and bottom-up activations are always present in the brain. Moreover, work in attention has shown that the results of so-called passive and active processes are sometimes inseparable. Carrasco, et al., for example, show that active attention results in the same change in perceptual contrast that is enacted by bottom-up mechanisms. Likewise, Reynolds and Desimone show that top-down and bottom-up attention effect neural contrast in the same way. Thus, the passive-active distinction does not seem to neatly separate two types of attention. A more convincing model of attention combines active and passive processing into a single mechanism of control. One such potential model is what I call the Unitary Saliency Map Model, first suggested by Koch and Ullman and developed by Treue. In such a model, top-down and bottom-up processes each feed into the same saliency map, from which attention is controlled. Thus, active and passive processes are in a state of competition and balance, rather than run in parallel. I argue that this makes sense of the phenomenological, psychological, and neuroscientific data. Finally, the acceptance of such a model will force us to review some of our previous findings on attention and its relation to consciousness.

5:20pm - Prolonged internal control of awareness yields changes in the underlying mechanisms.

Kevin C. Dieter[1], Michael D. Melnick[1], and Duje Tadin[1].

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Binocular rivalry is a form of visual ambiguity that occurs when dissimilar images are presented to each of the two eyes. Despite unchanging visual stimulation, perception fluctuates between the two possible interpretations of the input, suggesting that the mechanisms involved in binocular rivalry may ultimately give rise to our visual awareness. Although these fluctuations in awareness are often described as uncontrollable, recent studies have established that attention can modulate rivalry dynamics, indicating some degree of internal control. Here, we examined whether prolonged internal control of rivalry alternations can have a lasting effect on fluctuations in awareness during rivalry. In our training experiment (12 30-minute sessions), subjects viewed a flickering bullseye stimulus presented to one eye (trained eye), and a rotating pinwheel stimulus presented to the other (untrained) eye. Whenever the bullseye was dominant, subjects were instructed to identify slight changes in its aspect ratio. We found that this attentionally demanding task increased dominance durations of the attended stimulus, replicating previous results. However, the strength of this effect was not stable, gradually increasing over the course of training. Additionally, training shortened dominance durations of the unattended stimulus, ultimately resulting in a strong predominance of the attended stimulus. Results from a battery of pre- and post-training conditions revealed that the observed training-induced changes in rivalry exhibited a considerable degree of eye-specificity: post-training predominance of the attended stimulus was the strongest when it was presented to the trained eye. We also measured the transfer of training to stimuli not used during the attentional task (horizontal and vertical gratings) and found increases in the predominance of the grating presented to the trained eye. In sum, we show that prolonged attentional control can have strong effects on low-level mechanisms involved in binocular rivalry. Importantly, the post-training changes in rivalry dynamics were observed even when attention was not biased toward one of the rival stimuli, demonstrating broad plasticity that also extended to untrained stimuli. These novel results indicate that internally guided control of binocular rivalry can lead to changes in the very mechanisms that give rise to experienced fluctuations in awareness.

5:40pm - Consciousness about cognitive processing, executive control and cognitive performance.

Nikolaos Makris[1] and Dimitris Pnevmatikos[2].

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Despite the explosion of scientific interest in both consciousness and executive control during the last decades, there is little research on the way these affect actual behavior. The present study, which aims to contribute to this limited body of research, examined (a) if children are consciously aware (CA) of the cognitive processes used to solve different types of problems, (b) which is the relation between this awareness and executive control (EC), and (c) how this awareness together with EC affect cognitive performance (CP). To this end, 138 participants, equally drawn among 9 –through 12-year-old were examined. They were asked to solve 8 cognitive tasks addressed, in pairs, to the spatial, verbal, quantitative, and causal domain of thought. Also, they were given descriptions of three different component skills for each of the domain of thought and were asked to specify whether each of these component skills was used during the processing of each of the tasks. For the determination of the level of their executive control, participants were tested with Visually Cued Color-Shape Task as well as with a series of Stoop like tasks. Participants were tested individually. Results indicated that there is an effect of age on the three parameters described above. Confirmatory factor analyses applied on the data showed that the model that had an excellent fit on the data was the one indicating the existence of three general factors. One of them represented the various measures of EC, the second represented CA about the processing of the various tasks, while the third one represented the actual CP. Interestingly, it was found that the CA factor was regressed on the EC factor, while there was a bidirectional relation between the CA factor and the CP factor. On the basis of these findings it is suggested that EC affects the CA with respect to the cognitive processing demonstrated at a given time and that CA affects and it is affected by the quality of CP. We speculate that these findings are important for a general theory about the functioning of the mind as well as for practical reasons.

ASSC14 Conference Schedule
Saturday, June 26th

KEYNOTE 2 (9:00am – 10:00am)

Venue: Colony Ballroom (2nd Floor)

Image and Message in Sensory States

Mohan Matthen
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The *content* of a mental state is the state of affairs that it envisages. A visual state, for instance, may inform us of the presence of a blue disc somewhere off to the left – this is its content. Sensory states carry content *imagistically* – the subject is presented with a spatiotemporally connected array of features and objects in which each feature is encoded by a characteristic experience. Thus, a subject who has a visual impression of a blue disc will see it as a part of an array in which this disc has location relative to everything else in the array. Further, the subject's experience of the disc will be experientially similar to that of every other blue thing she does or has experienced, and also similar (though in another respect) to every other presentation of a disc. Now, this imagistic mode of presenting content has certain formal limitations, which is illustrated by the following conundrum. Consider (a) a visual perception, (b) a memory, and (c) an imaging of a blue disc. All can involve the *same image*. Yet, the messages they convey are different: (a) carries the idea that the blue disc occurs *now*, (b) that it occurred *in the past*, and (c) that it is unreal. How do these states convey these differences? Not by the sensory image, because it is a common element. I propose to solve this problem in two complementary ways. From a psychological point of view, the problem just posed indicates that there has to be a significant component of sensory states different from the image they present. I propose that a sensory image is generated by a sensory system, but is then taken up and used by other systems. The signature of the user-system provides the additional component we are searching for: for instance, the fact that the memory system is using an image marks that image as past. From a logical point of view, I exploit the distinction between content and force. The fact that a particular system is using an image gives it a certain force that accounts for the extra element.

-- Coffee Break --

SYMPOSIUM 2 (10:30am – 12:30pm)

Possible Contributions of Research on Meditation to the Neuroscience of Consciousness

Chair: Antoine Lutz
Venue: Colony Ballroom (2nd Floor)

Focused Attention, Open Monitoring and Open Presence: Three Styles of Meditation and their Relevance for the Study of Consciousness

John D. Dunne
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Research on meditation offers a promising methodology to robustly align third-person and first-person accounts, and hence, to examine various features of human consciousness. The great diversity and complexity of meditation practices, however, crucially requires the formulation of rigorous constructs that highlight the commonalities within otherwise divergent styles of meditation. Drawing in part on Buddhist theories, this talk examines two especially useful constructs of this kind: Focused Attention (FA) and Open Monitoring (OM). In

OM styles of practice, one cultivates an awareness of the sense of subjectivity without requiring the selection of any particular object. Such training can culminate in states generalizable as "Open Presence" (OP). The talk will conclude by arguing that certain features of OP—including those which align with notions of reflexivity or "self-awareness" in the phenomenological tradition—may prove especially fruitful for inquiring into the nature of consciousness.

Impact of Meditation Training on Attention and Emotion Regulations: Implications for the Study of Consciousness.

Antoine Lutz
University of Wisconsin-Madison, alutz@wisc.edu

The first part of this talk will explore possible methodological motivations for the neuroscientific examination of meditative practices, such as the alleged increased ability of long-term practitioners to generate more stable and reproducible mental states and to describe these states. Using a 'neurophenomenological' approach, the practitioners' introspective skills may provide a way for experimenters to better control, identify and interpret large-scale integrative processes in relation to subjective experience. The second part of this talk will offer a neuroscientific framework for the phenomenological constructs of FA and OP meditations as presented by Dr. John Dunne (speaker 1). Key neuroimaging findings will be presented to illustrate how intensive training in meditation can affect mental processing and the brain.

Effects of intensive mental training on the temporal dynamics of access to consciousness in the attentional blink.

Heleen Slagter
University of Amsterdam, haslagter@gmail.com.

The main focus of this talk will be on findings from a study on the impact of three months of intensive meditation training on visual awareness as measured by electroencephalography and an attentional-blink task. Intensive meditation training resulted in a smaller attentional blink, reduced brain-resource allocation to the first target, as reflected by a smaller T1-elicited P3b and enhanced bottom-up attentional processes, as reflected by an enhanced phase-consistency of the second target over right ventral and midline frontal electrodes. These data increase our understanding of the conditions necessary for conscious stimulus perception and support the idea that meditation can significantly affect stimulus processing in the brain. This talk will also briefly discuss the methodological challenges that researchers face when attempting to control, or characterize, the multiple factors that may underlie meditation-training effects.

-- Lunch Break --

POSTER SESSION (1:30pm – 3:30pm)

Titles and Abstracts listed after the final talk sessions

Venue: St Patrick & St David rooms (3rd Floor)

-- Coffee Break --

CONCURRENT SESSION 3 (4:00pm – 6:00pm)

(A)- Attention, Rivalry, and Illusions

Chair: Hugh Wilson

Venue: Colony Ballroom East (2nd Floor)

4:00pm - An oblique illusion modulated by awareness: non monotonic sensory integration in orientation process.

Jérôme Sackur[1], Vincent de Gardelle[1], and Sid Kouider[1].

[1] LSCP jerome.sackur@gmail.com

Perception of orientations is known to be anisotropic: sensitivity is greater near the cardinal (horizontal and vertical) axes. This "oblique effect" results in the illusory perception of exaggerated tilts near the cardinal axes. Here, we quantified this illusion at various visibility levels, from subliminal to clearly perceived stimuli. We engaged participants in an orientation reproduction task on a Gabor stimulus whose visibility was manipulated by duration and masking. We found, first, that participants could reproduce the orientation of subliminal stimuli, a form of blindsight. Not surprisingly, precision of orientation reproduction was positively correlated to awareness. However, we also found that the magnitude of the oblique effect followed a non-monotonic pattern, being maximal for stimuli of intermediate visibility, and lower for subliminal and fully perceived stimuli. These results reveal that subliminal processing, although it is noisier, can be more faithful to the physical input than supraliminal processing. This counterintuitive result show that mechanisms of sensory integration depend on consciousness, and further suggest that categorical processing of sensory information may depend on stimulus visibility.

4:20pm - Binocular rivalry: mechanisms, genetics, applications and the scientific study of consciousness.

Steven Miller.

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The phenomenon of binocular rivalry is widely touted as a useful tool in the scientific study of consciousness. Binocular rivalry involves perceptual alternations of incongruous images presented separately, one to each eye, in the same retinal location. The mechanism underlying this remarkable feature of visual processing remains unknown, with relatively few models available for testing. I review one highly testable binocular rivalry model and the brain stimulation data on which it rests (1). In addition, I explain the link between this model and the finding of slow binocular rivalry in bipolar disorder, a highly heritable psychiatric condition (2). I also present recent findings from a large twin study, showing that the rate of binocular rivalry is substantially genetically determined (3). This finding supports the notion of using slow binocular rivalry as an endophenotype for bipolar disorder, and suggests new directions in the study of binocular rivalry. I conclude by outlining how the findings from binocular rivalry research do, and do not, inform the scientific study of consciousness (4). [1] Miller et al, (2000). Current Biology, 10 (7): 383–392. [2] Miller et al, (2003). Psychological Medicine, 33 (4): 683–692. [3] Miller et al, (2010). Proc Natl Acad Sci USA, 107 (6): 2664–2668. [4] Miller (2007). Acta Neuropsychiatrica, 19 (3): 159–176.

4:40pm - Mapping the time course of binocular rivalry and percept stabilization using MEG.

Kristian Sandberg[1], Bahador Bahrami[2], Ryota Kanai[1], Gareth Robert Barnes[1], Morten Overgaard[1], and Geraint Rees[1].

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[2] ICN, University College London, UK

Binocular rivalry has been widely used as a tool to determine neural correlates of conscious percepts that are independent of changes in physical stimulation. In the present study, we asked: (1) At which time point after the onset of rivalry stimuli do the rivaling neural signals start to diverge consistent with the contents of

conscious perception? (2) Can baseline neural activity before stimulus onset be used to predict the content of the subsequent percept after stimulus onset? We recorded neuromagnetic signals using a 275-channel MEG scanner, while human participants were presented with a face to one eye and a grating pattern to the other and indicated their percept via a button press. The stimuli were presented intermittently (800ms on and 1000ms off) to examine the signals triggered by stimulus onset and the baseline signals before stimulus onset. Behaviorally, our results replicated previous findings that the subjective percept remained highly stable across intermittent exposures to the bistable stimuli i.e. percept stabilization occurred. To determine the time points at which recorded neural activity was predictive of subjective conscious perception, we performed multivariate pattern classification analysis on multichannel neuromagnetic signals at each time point. The pattern of the evoked neuromagnetic activity at early time points reliably predicted the content of conscious percepts; we observed a large peak with 85-90% prediction accuracy at around 200ms after rivalry onset. The pattern of neural activity during the blank interval also predicted the subsequent conscious percept better than chance lending support to the idea that sustained, stimulus-specific activity in the blank period may be responsible for the perceptual memory known to persist across intermittent exposures to bistable stimuli. Taken together, our findings demonstrate that the contents of conscious percepts can be decoded from MEG signals on a trial-by-trial basis. This approach allows us to identify the temporal dynamics of the emergence of neural activity corresponding to conscious percepts with a high temporal precision.

5:00pm - Attention, surface and boundary signals in the perception of afterimages.

Jeroen van Boxtel[1] and Christof Koch[1].

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Currently, it is believed that a stimulus is visible as long as it has a surface signal (which is the signal that is perceived) surrounded by a strong-enough boundary signal (which itself is not visible). Without a strong boundary signal the surface signal dissipates and the stimulus fades from awareness. One problem with this hypothesis is that the border signal is experimentally (and conceptually) confounded with the visibility of the stimulus. Because the boundary signal has never been experimentally separated from the visibility of the stimulus, the core of the hypothesis has not been tested. To circumvent this problem, we simply physically present a ring on the screen surrounding the afterimage. This ring will provide a strong boundary signal. We show that the duration of the afterimage is lengthened by about 50% with a ring that exactly encompasses the afterimage. Rings of equal or smaller size than the afterimage increase afterimage duration relative to a condition without a ring, while boundaries larger than the afterimage do not increase afterimage duration. We find furthermore that maximum modulation occurs for intermediate contrasts of the ring, making attentional capture (by large luminance changes) an unlikely cause of the effect. Thirdly, placing a ring around the position of an already faded afterimage, revives the afterimage. Finally, we modulated the amount of attention paid to the adapting stimulus. We found that both boundary and surface signals were more adapted with increased amounts of attention. Interestingly, increased adaptation of the boundary signal led to decreased afterimage durations, while increased adaptation to the surface signals led to increased afterimage durations. Our data show that boundary signals (i.e. the ring) are crucial in the determination of afterimage perception. We also show that attention acts on both surface and boundary information, and that it has the capability to both increase and decrease afterimage duration.

5:20pm - Attentional load alters visual excitability.

David Carmel[1], Jeremy Thorne[2], Geraint Rees[1], and Nilli Lavie[1].

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[2] University Hospital Jena, Germany

Increasing attentional load has been shown to reduce processing and awareness of visual stimuli outside the focus of attention. The mechanism underlying these effects, however, remains unclear. Here we tested an account attributing the effects of attentional load to modulations of visual cortex excitability. Unlike stimulus competition accounts, which propose that effects of load should be found only when stimuli are presented simultaneously, the visual excitability account makes the novel behavioral prediction that attentional load should affect detection sensitivity when stimuli are presented sequentially as well as simultaneously. In four experiments, participants fixated a stimulus stream, responding to the appearance of occasional targets. In different blocks of trials, targets in the fixated stream were defined by either a color feature (low load) or color

and orientation conjunctions (high load). Additionally, participants responded to the critical stimulus – a second type of target, presented occasionally in the periphery (never at the same time as a target in the fixated stream). Increasing attentional load at fixation reduced detection sensitivity to critical stimuli, and this effect was similar regardless of whether critical stimuli were presented simultaneously with central stimuli or on their own, in an otherwise empty time interval. The effect of load was not apparent in a control condition where the critical stimulus was presented after processing of the fixated stimulus was over, ruling out effects of strategic task prioritization. These findings support a cortical excitability account for attentional load and challenge stimulus competition accounts.

5:40pm - Gustatory cortex activation with and without perceptual awareness of taste.

Noam Sagiv[1], Alireza Ilbeigi[1], Sean Williams[1], and Adrian Williams[1].

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The brain processes information coming from the different senses in a highly interactive manner. For example, silent lip-reading activates the auditory cortex (Calvert et al., 1997). Such cross-modal interactions are common and widespread, but only a minority of individuals (with synaesthesia) may exhibit sufficiently intense activation to warrant a vivid perceptual experience in a second modality when another is stimulated. The current study focuses on a sensory modality that received very little attention in the cognitive neuroscience literature - taste. First, we examined whether the gustatory cortex can be activated by visual stimuli. Using functional MRI we demonstrated gustatory cortex activation in normal perceivers viewing videos of people eating. Second, we documented a novel variant of synaesthesia that appears to represent a perceptual correlate of such cross activation from vision to taste. Such 'mirror-taste' synaesthetes automatically experience vivid taste imagery when viewing other people eating, analogous to 'mirror-touch' in which people have tactile experiences when viewing others being touched (Blakemore et al, 2005). We are currently investigating the extent to which this synaesthetic experience is associated with increased gustatory cortex activation and the mirror neuron system.

(B)- Body Perception, Cognitive Control, and Awareness

Chair: Mel Goodale

Venue: Colony Ballroom Center (2nd Floor)

4:00pm - Mental ownership constrains the rubber hand illusion.

Timothy J. Lane[1] and Caleb Liang[2].

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[2] Department of Philosophy, Chengchi University

We suggest that mental ownership and body ownership are distinct. The former concerns whether I represent myself as the unique subject of multiple experiences; the latter concerns whether a body part (e.g. a hand) belongs to me. This distinction is illustrated by cases of somatoparaphrenia wherein tactile sensations are experienced in a limb that is felt to be alien (Moro et al. 2004). Tsakiris (2009) proposes a neurocognitive model (NCM) of body ownership that attempts to accommodate research on the rubber hand illusion (RHI). He postulates a pre-existing, normative body model that contains a reference description of the body's visual, anatomical and structural properties. But he neglects mental ownership. According to NCM, during RHI induction, in addition to assessing visual-tactile sensory input, the body model also assesses visual form, as well as postural and anatomical features. Here we argue that: (1) Recent findings (Ehrsson 2009, Petkova and Ehrsson 2009, and Armel and Ramachandran 2003) suggest that NCM confronts several anomalies. (2) These anomalies suggest that Tsakiris seems to have overemphasized the influence of what we call a body-likeness principle (BLP), e.g. visual similarity in form and anatomy. (3) Successful induction of RHI requires that the subject represents himself as the unique subject of conflicting experiences. This, the mental ownership constraint (MOC), is needed to explain how RHI is induced by vision's trumping of proprioception and tactile sensation. (4) MOC provides greater flexibility, allowing a revised NCM to accommodate the three anomalies as well as to motivate new variants of RHI. Finally, (5) recognition of MOC will enhance our ability to investigate relationships among NCM, phantom limb (Giummarra et al. 2005), and full-body illusions (Blanke and Metzinger 2008).

4:20pm - The rubber hand and the bayesian body.

Jakob Hohwy[1] and Bryan Paton[1].

[1] Philosophy, SOPHIS, Monash University jakob.hohwy@arts.monash.edu.au

The rubber hand illusion, in which touch is experienced on a rubber hand, poses a puzzle for understanding the relationships between bodily self-awareness and perceptual inference. In this study, we use virtual reality goggles to develop a version of this illusion and use psychologically induced temperature changes of the experimental hand as objective evidence of presence of the illusion. We explore what happens to body image and causal inference as new stimuli are presented after onset of the basic illusion. We present data showing that people easily experience everyday objects, or even empty space, as loci of projected touch, and they report that it is as if there are supernatural causal relations between rubber hands and remote objects. These findings are interpreted in a probabilistic framework. By drawing on analogies from other areas of multimodal sensory integration, we show how this framework can explain crucial puzzles about why the illusion arises. We propose that bodily self-awareness in cognitive processes is fragile: its role is more subject to and in the service of perceptual inference, rather than exclusively the other way around. The notions of body schema and body image are discussed in the light of this proposed bayesian notion of bodily self-awareness.

4:40pm - Rubber hands, virtual bodies and bodily subjectivity.

Alisa Mandrigin.

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The rubber hand paradigm and globalizations of the illusion are used to probe our experience of our bodies. Some interpret the experiments as giving insight into bodily self-consciousness, self-specificity and embodied subjectivity through the manipulation of the sense of body ownership. I argue that these claims confuse the sense of body ownership and one's sense of bodily subjectivity, two different forms of self-experience that might both be manipulated in these illusions. In the RHI subjects report the feeling that a haptic sensation they experience is felt in a rubber hand, a sensation induced by synchronous stroking of their own unseen hand and the perceived rubber hand (Botvinick & Cohen 1998; Tsakiris & Haggard 2005). It is claimed that the manipulated sense of body ownership is a component of one's s self-specific subjective perspective (Tsakiris 2010). Global versions of the illusion involving either virtual representations (Lenggenhager et al. 2007) or real-time video images (Petkova & Ehrsson 2008) seem to indicate that one's sense of body ownership can also be distorted on a larger scale. The controversial claim is that the experiment probes bodily self-consciousness (Blanke & Metzinger 2009). I urge that we clarify the difference between the sense of ownership and one's sense of bodily subjectivity. The body is both something that is owned in our experience of it, and something that is lived-through. The relationship between body and subject is one of ownership, in perception of the body, and one of identity - the perceiving subject is bodily. One's sense of bodily subjectivity is a precondition of one having a sense of ownership of one's perceived body. This distinction is significant because of the possibility that the experiments manipulate, to different extents, both one's sense of body ownership and one's bodily subjectivity. Legrand (2006) and Legrand & Ruby (2009) suggest that bodily subjectivity results from sensorimotor integration, whilst it has been suggested (Tsakiris 2010; Leggenhager et al. 2007) that one's sense of body ownership depends on multisensory integration. Manipulation of sensory integration may therefore affect both the sense of body ownership and one's sense of bodily subjectivity.

5:00pm - Enhancing cognitive control through neurofeedback: A role of gamma-band activity in managing episodic retrieval.

Andre Keizer[1], Maurice Verschoor[2], Roland Verment[1], and Bernhard Hommel[1].

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Neural synchronization has been proposed to be the underlying mechanism for exchanging and integrating anatomically distributed information. Here we studied whether neurofeedback training designed either to increase gamma band activity (GBA), or beta band activity (BBA), would have an impact on performance of behavioral tasks measuring short-term and long-term episodic binding. Our results show that GBA-enhancing

neurofeedback training increased frontal-occipital GBA and BBA-enhancing neurofeedback increased frontal-occipital coherence in the beta band. Moreover, the increase of gamma band power was related to greater flexibility in handling episodic bindings. The long-term memory task revealed a double dissociation: GBA-targeted training improved recollection, whereas BBA-targeted training improved familiarity. We conclude that GBA is important for controlling and organizing memory traces of relational information in both short-term binding and long-term memory, while frontal-occipital coherence in the beta band may facilitate familiarity processes.

5:20pm - On the verge of consciousness: sedation impairs decision making.

Tristan Bekinschtein[1], Ram Adapa[2], David K. Menon[1], and Adrian M. Owen[1]

[1] MRC Cognition and Brain Sciences Unit tristan.bekinschtein@mrc-cbu.cam.ac.uk

[2] Division of Anaesthesia, University of Cambridge

When people receive anesthetics (propofol in this case) they enter the dynamic process of changing from fully aware (sedation level S0) to a relaxed state (sedation level S1) to drowsiness (sedation level S2). During this process, there is a point where volunteers cannot make decisions anymore. Where is this point? During sedation we measured high density EEG in 24 normal volunteers while performing an auditory go-nogo task or a simple go-left/go-right task. We've characterized the dynamics of losing the capacity to both, respond to the tones and, to make a decision during all three transitions (sedation S0 to S1, S1 to S2 and S2 to S0). For the same propofol concentration, some participants resisted the loss of consciousness and continued to respond to tones, but RTs were delayed (from ≈ 500 to ≈ 2000ms); while the rest of the participants also showed increased RTs but after a few minutes they stopped responding (unconscious phase). We discuss here evoked related potentials of decision making during these transitions and propose a model that may help to understand how we lose and regain consciousness.

5:40pm - The conscious mind in the still body: fMRI of the vegetative state.

Martin Monti[1] and Adrian Owen[1].

[1] MRC Cognition and Brain Sciences Unit martin.monti@mrc-cbu.cam.ac.uk

Disorders of consciousness such as coma, vegetative state and minimally conscious state are among the most complex and least understood conditions of the human brain. In particular, the assessment of residual cognitive function, as well as awareness, is very challenging in patients that have extremely limited (if any) capacity for motor output. Yet, correct assessment of the level of preserved cognition and consciousness is crucial for appropriate diagnosis, medical care and legal decision-making. With misdiagnosis rates above 40%, novel methods are required to tease apart vegetative and minimally conscious patients. Recent evidence has suggested that functional neuroimaging may play a crucial role in correctly evaluating cognitive capacity, as well as awareness, in brain injury survivors. In particular, this technique, by directly observing brain metabolic response, dispenses entirely with relying on the patients' motor capacity. For this tool to be diagnostically relevant and clinically useful, however, it must be possible to unambiguously distinguish automatic brain responses from willful mental effort. To address this problem we present a series of functional magnetic resonance imaging paradigms aimed at (i) assessing residual cognition and awareness in non-behavioral brain injury survivors, and (ii) providing a channel for these patients to communicate without relying on behavior. With respect to the first point, we developed a hierarchical approach to testing several sensory modalities, including vision and language processing, from basic sensory perception to high-level processing, and willful brain modulation. With respect to the second point, we show that, as demonstrated by a patient believed to be vegetative for 5 years, it is possible to use willful brain activity as a non-muscle dependent strategy to enable simple two-ways communication, sufficient to answer a set of 'yes/no' questions.

(C)- Non-human consciousness and Dreaming

Chair: Thomas Metzinger

Venue: Giovanni Room (2nd Floor)

4:00pm - Investigating consciousness outside the vertebrate lineage: theory, method, and progress.

David Edelman[1], Piero Amodio[2], Anna Maria Grimaldi[2], and Graziano Fiorito[2].

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Over its relatively brief history, the scientific study of consciousness has yielded some reliable neural correlates of conscious states in humans. Moreover, a variety of neuroanatomical, neurophysiological, and behavioral evidence is suggestive of conscious states in some non-human animals. However, confronting the question of consciousness in animals far removed from the primate, mammalian, or even vertebrate lineages presents serious methodological and theoretical issues, namely: 1) neural architectures that are poorly characterized or radically different from those of vertebrates; 2) smaller structural scales or other anatomical differences that require the development of new surgical and recording techniques to acquire critical neurophysiological data; and 3) establishment of benchmarks in well characterized animals that can be used to formulate hypotheses to test in distant phyla, i.e., what conscious states should 'look like' in such phyla. The first two issues are methodological and will require significant, albeit straightforward, effort to resolve. The third issue, which is theoretical, can be addressed by starting from the premise that there may be major functional properties common to all nervous systems capable of conscious states. Arguments based on rigid structural homology should therefore be avoided in favor of those based on broad functional analogy. Accordingly, in invertebrate species, we must identify neural structures that exhibit functions analogous to those of vertebrate structures implicated in consciousness, as well as neurophysiological signatures and behaviors resembling those observed in conscious vertebrates. Endowed with the most complex nervous system of any invertebrate and a sophisticated behavioral repertoire to match, the octopus provides an excellent test case for conscious states in animals well outside the vertebrate lineage. To explore aspects of visual perception and sensory integration in the common octopus (Octopus vulgaris), we have performed a variety of psychophysical experiments in which rapidly shifting sequences of visual stimuli are presented, via video projection, at rates and durations impossible to achieve through manual presentation. This methodology has allowed us to explore perceptual properties that may be associated with awareness in these animals. Here, we will discuss the development of the methodology and present our latest findings. *Supported by the Neurosciences Research Foundation.

4:20pm - Numerical Cognition in wild New Zealand Robins.

M Alexis Garland[1], Jason Low[1], and Kevin Burns[1].

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Numerosity is one of a handful of fundamental cognitive systems that create the framework for more complex cognitive function. An approximate number system is described as underpinning human and non-human animals' representations of numbers greater than four, where quantities of discrete objects are perceived on an approximated continuum of subjective magnitude. According to Weber's law, discrimination between two magnitudes or sets is a function of their ratio rather than absolute number. This mechanism is the key driver behind the approximate number system, and modulates numerical discrimination ability in humans and a range of primates and other species. It is widely believed that both human infants and animals cannot discriminate large numbers without deploying a number system that obeys Weber's law. As a natural extension of number comparison, simple arithmetic calculations such as addition and subtraction small numbers are a core feature of numerical cognition, and consequently understood as equally effected by both numerical size and distance. A series of experiments using paired number comparisons, multiple-set chunking and addition and subtraction of artificially cached items focused on examining large number perception in this songbird by investigating visuospatial memory of hidden food caches containing small and large numbers of mealworms (Tenebrio molitor), to construct an in-depth understanding of numerical abilities in this avian species. These trials were conducted within a wild population of the insectivorous food-hoarding New Zealand Robin (Petroica australis), and demonstrate that this songbird displays numerical discriminations independent of Weber's Law and

complex mathematical reasoning, suggesting a shift from the established primate-centric signature limitations that define both object and number perception. Robins' unusually sophisticated tracking of discrete number appears to be an evolutionary response to the social and ecological challenges of their daily lives. Overall results demonstrate that this scatter-hoarding songbird computes exact quantity representations over small and large numbers.

4:40pm - A comparative study in the perception of self-agency between human and chimpanzee.

Takaaki Kaneko[1] and Masaki Tomonaga[1].
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Humans perceive an event that they cause differently from other events that occur in their environment. Such unique experiences, accompanied by our voluntary actions, are called the sense of self-agency and allow us to establish the concept of self as being an independent agent. Here, we investigated possible differences in the perception of self-agency between humans and chimpanzees(Pan troglodytes), our evolutionary closest neighbors. It is known that chimpanzees have difficulties copying another individual's motor actions but they can reproduce the goal of the other's action. These differences may reflect variations in the perception of one's own voluntary actions. However, this issue has rarely been addressed from a comparative–cognitive perspective. In this study, we show that chimpanzees had monitored the goal of own action but was less attentive to one's own kinematic motion. In the experimental task, two cursors were shown on a computer monitor, one of which was the distractor cursor moved by the computer and the other was the self-cursor controlled by the participant. The participants were required to detect the self-cursor, and to hit either target shown on the monitor with that cursor. The chimpanzees spent more time detecting the self-cursor when the target, that a chimpanzee was trying to hit, was accidentally corresponded to the target which the distractor moved toward. Meanwhile they required less time when the distractor moved toward different targets. We did not observe such an effect in human participants. These results indicate that chimpanzees were more dependent on the representation of goal rather than kinematic motion for the self-other distinction and suggest a discontinuity between humans and chimpanzees in the perception of self-agency.

5:00pm - Evolutionary psychology, or how not to explain the human mind.

Alex Gamma.
ETH Zurich agamma@ethz.ch

Evolutionary Psychology (EP) is an ambitious enterprise to explain the structure of the human mind based on "evolutionary thinking". EP's basic idea is that the human mind consists of specialized mental modules that evolved in our hunter-gatherer ancestors as adaptations to their stone-age environments. Since (genetic) evolution operates too slowly to have significantly changed these psychological adaptations, modern man faces a particular predicament: while his mind is still largely adapted to living conditions prevalent 100,000 years ago, modern environments are so radically different from those ancient conditions that his mind will often fail to produce adaptive behavior. This explanation - while perhaps sometimes right - will often fail because it is systematically incomplete. This follows from two extensive blind spots in EP's theorizing: 1. EP completely ignores development (ontogeny) 2. EP has a radically impoverished view of evolutionary inheritance, and, a fortiori, of evolution itself. 1. Every trait of every organism develops. Individual development (ontogeny) is a complex process of multiple interacting causes that jointly determine both the bodily and the psychological traits of an organism. In modern human beings, this process alone could be able to create a mental architecture that adapts our behavior to our social and technological environments - beyond any consideration of evolution. 2. Inheritance of traits is one of the core mechanisms driving evolution by natural selection. However, nothing requires inheritance to be exclusively a matter of the physical transfer of genes. In fact, all that is required by "inheritance" in the Darwinian sense is an increased resemblance between parents and offspring. Thus, every causal factor internal and external to a child that makes it become similar to its parents will subserve evolution by natural selection. Cultural items that recur or are reconstructed in every generation meet the requirements for being heritable resources just as well as genes do. And they are able to affect the evolution of (e.g. mental) traits in fractions of the time needed by purely genetic evolution. Therefore, human mental structure may generally be much better adapted to current living conditions than EP would have us believe.

5:20pm - Primary consciousness in pill bugs (Armadillidium vulgare, Isopoda, Crustacea).

Tohru Moriyama.

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The 'primary consciousness' entails the ability to create a scene in the 'remembered present' (Edelman, G. M., 1989) in the absence of language and may be a basic biological process in both humans and animals lacking true language (Edelman, D. B. & Seth, 2009). The present paper reports on an experiment investigating the possibility of existence of primary consciousness in pill bugs. The antennae length of the subjects in the test group was extended by using either short Teflon tubes (approx. as long as the flagella of their own antenae) or with longer ones (approx. twice as long as the flagella) attached to the tips of the antennae, while nothing was attached to the individuals in the control group. They were each placed on the top tier of 14 stairs, in which the depth between the first and the second stairs was 5 mm, and the inter-step depth was increased by 1 mm for the rest of the stairs. They were all highly motivated to move down the stairs to run away from the experimenter. The maximum reachable stair and the body length for each individual were recorded, and the correlation between the maximum reachable stair and the tube length (none, short, and long) was calculated for each body-length class (in the range of 9.8 to 11.2 mm). A significant positive correlation was confirmed for the 11.2-mm body length class alone. This result suggests that matured pill bugs that were 11.2 mm long might use the Teflon tubes as tools to measure the inter-step depth with a 'sensation at the tips of invisible tools' as human beings feel the touch at the tip of the tool, rather than at the hand that holds the tool, when they touch something with a tool (Yamamoto & Kitazawa, 2001).

5:40pm - Dreamed movement elicits activation in the motor cortex.

Martin Dresler.

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Since the discovery of the close association between rapid eye movement (REM) sleep and dreaming, much effort has been devoted to link physiological signatures of REM sleep to the contents of associated dreams. Increased extrastriate and decreased prefrontal metabolism in REM sleep have been suggested as correlates of vivid dream imagery and the loss of volition in dreams. However, a direct demonstration of specific dream contents by neuroimaging methods is lacking, also because predefined protocols cannot be volitionally performed by the dreaming subject. By combining brain imaging with polysomnography and exploiting the state of 'lucid dreaming' we here show that a predefined motor task performed during dreaming elicits neuronal activation in the motor cortex. In lucid dreams the subject is aware that he is dreaming, with a wake-like access to memory, reflective thought and volitional capabilities while all standard polysomnographic data of REM sleep are fulfilled. Using eye signals as temporal markers, neural activity measured by functional magnetic resonance imaging (fMRI) and optical topography (OT) could be related to dreamed hand movements, while polysomnography verified that subjects were in REM-sleep. The cortical activation pattern during dreamed motor performance was highly similar to that during wakefulness. In summary, we provided first evidence that the content of REM-associated dreaming can be visualized by neuroimaging.

ASSC14 Conference Schedule
Sunday, June 27th

KEYNOTE 3 (9:00am – 10:00am)

Venue: Colony Ballroom (2nd Floor)

Varieties of Memory and Consciousness: A Cognitive Neuroscience Perspective

Morris Moscovitch
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The relation between memory and consciousness is central to many theories of memory. In particular, conscious awareness is a defining feature of memories that are explicit or declarative, and of one type of declarative memory (e.g., episodic) from another (e.g., semantic). I will question these views by drawing on behavioural and neuroimaging data from intact and brain-damaged people to show that there is more interaction than once was believed between these different types of memory and the neural structures that mediate them, and that consciousness may provide a clue about the nature of these interactions.

-- Coffee Break --

SYMPOSIUM 3 (10:30am – 12:30pm)

Crowding, blink and attention: what can they tell us about Consciousness?

Chair: Ramakrishna Chakravarthi
Venue: Colony Ballroom (2nd Floor)

Weak target masks and distant flankers interact to produce a catastrophic supercrowding effect

Timothy Vickery
Yale University, USA tim.vickery@gmail.com

In the typical crowding experiment, flankers degrade performance at identifying a peripheral object within a target-centered window of approximately half of the target's distance from eye fixation. While this "critical spacing" is not a strict limit, flankers rarely have a substantial effect on performance outside of this range. However, when a barely effective mask is applied only to the target item, flankers far outside of the typical critical spacing range have a catastrophic effect on performance (up to distances of at least 80% of the target's eccentricity). Further, while crowding has not been observed at the fovea under typical paradigms, the supercrowding paradigm consistently revealed interactions within at least 24 arcmin of a 16 arcmin stimulus. These findings suggest that seemingly ineffective masks and flankers actually have a profound, seldom-measured effect on perceptual mechanisms underlying identification.

The resolution of conscious vision: Visual crowding in infants and adults.

David Whitney
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Natural visual scenes are cluttered. In such scenes, objects in the periphery can be crowded – blocked from recognition and awareness – simply because of the dense array of clutter. Outside the fovea, crowding

constitutes the fundamental limitation on conscious object recognition. Here, we present three findings on the mechanism of crowding, the limits of crowding, and the development of crowding. First, we show that crowding occurs at multiple, distinct stages of visual processing, including selectively between high-level objects. Further, we show that crowding does not dismantle or destroy object-level information; an entire face can survive crowding and contribute its holistic attributes to subsequent texture processing, despite being blocked from recognition. Finally, we show the developmental trajectory of crowding from infancy; this reveals the spatial resolution of conscious perception in infants. Together, our results show that crowding is a dynamic and flexible process, modified with age and operating independently at multiple stages.

Pool party: Admit one

Ramakrishna Chakravarthi
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Crowding is a result of inappropriate pooling of target and flanker features. This pooling occurs over a very large area. It is thought that everything within this area is combined. However, one very well known exception is that flankers do not combine with the target unless they are similar to each other. Here, we describe another important exception. Using specially constructed stimuli, we show that flanker features interfere with the target only if they are both close to the target *and* belong to a unified object. Thus, the early visual system functions as a filter. It continuously attempts to prevent features of extraneous objects from combining with a target. When this fails, there is crowding. Our results are consistent with the idea that a top-down, perhaps iterative, process selects what features are pooled. This process constrains object representations, and ultimately what we consciously see.

On when, how, and why attention blinks

Mark Nieuwenstein
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While studies of selective attention examine how the human mind enables the selection of a target stimulus from amongst distractors, studies of divided attention examine the limits of attention by using tasks that involve multiple target stimuli. These limitations of attention can be observed both when multiple targets appear simultaneously in different locations (Duncan, 1980), or when targets appear in close temporal succession in the same location (Broadbent & Broadbent, 1987). In both cases, attending one target entails that another target is less likely to be seen, with studies using successive target presentation showing that it may take no less than 500 ms before attention can be switched from a first target to a second. In this talk, I will discuss work that examined when and how this attentional blink effect occurs and I will outline some ideas about the possible function of this effect in conscious visual experience.

-- Lunch Break --

SYMPOSIUM 4 (1:30am – 3:30pm)

Neurophysiological approaches within the scientific study of consciousness

Chair: Alexander Maier

Venue: Colony Ballroom (2nd Floor)

Backward masking and continuous flash suppression in human intracranial recordings

Naotsugu Tsuchiya
California Institute of Technology, USA & Tamagawa University, Japan naotsu@gmail.com

Intracranial recordings during epilepsy monitoring offer valuable experimental situations, where we can record direct neurophysiological responses from awake humans, with excellent spatiotemporal resolution from many brain sites simultaneously. With such an opportunity, we can investigate a specific hypothesis about the causal role of long-range, large-scale neuronal activity in producing subjective conscious feelings while subjects are performing a perceptual task (e.g., Varela, Dehaene). Here, we report the results of intracranial recording studies using two psychophysical techniques: backward masking and continuous flash suppression. In both tasks, we used faces as target stimuli. While subjects performed the tasks, we recorded intracranial EEG from 64-256 sites, including the primary visual cortex, the fusiform gyrus, the superior temporal sulcus, the amygdala. Applying a multivariate decoding techniques and Granger causality, we characterize those processing which are correlated with conscious visibility and those which are not available to consciousness, in terms of space (anatomical areas), time, and frequency bands.

Activity in the primary visual cortex related to visual awareness

Alexander Maier
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Whether or not activity in the primary visual cortex (V1) is related to the conscious experience of a stimulus is a long-standing debate. To investigate existing discrepancies in the literature, we measured the fMRI response, along with electrophysiological signals, in V1 of trained monkeys, and correlated responses there with the perceived visibility of a salient stimulus. We show that stimulus visibility can be reliably derived from the fMRI signal, but not from neural spiking activity. In contrast to the single neuron response, the local field potential (LFP) underwent substantial modulation with changes in visibility. LFP modulation was uneven between the cortical layers, thus hinting at awareness-related activity changes within the V1 microcircuitry. We conclude that stimulus visibility is represented in V1, but only minimally influences the spiking rate of feature selective neurons.

Role of thalamo-cortical interactions in spatial awareness

Melanie Wilke
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Due to devastating effects of lesions in the thalamus on conscious experience and its strategic anatomical location, thalamo-cortical interactions have long been hypothesized to play an important role in supporting consciousness (Edemann & Tonoi, 1991, 2001; Crick & Koch, 1998). However, few studies have directly investigated this hypothesis. Here we studied thalamo-cortical activity related to visual consciousness by combining behavioral measurements, electrophysiology, neuropharmacology and fMRI in monkeys.
We first applied a paradigm which renders salient visual stimuli perceptually invisible. Our neurophysiological recordings revealed widespread perceptual modulation of local field potentials (LFP) in cortical areas V1, V2, V4 and the thalamic LGN and pulvinar, accompanied by spiking rate changes in V4 and the pulvinar. Comparison of V4 and pulvinar latencies suggest that perceptual modulation of pulvinar neurons follows cortical input. Lastly, reversible inactivation of the pulvinar resulted in awareness and action-related behavioral deficits, and led to fMRI signal changes in cortical areas associated with spatial awareness disorders in humans. Based on these results, we conclude that a well coordinated thalamo-cortical interplay is a necessary condition for creating and maintaining visual consciousness.

-- Coffee Break --

POSTER SESSION (4:00pm – 5:30pm)

Titles and Abstracts listed after the final talk sessions

Venue: St Patrick & St David Rooms (3rd Floor)

KEYNOTE 4 (5:30pm – 6:30pm)

Venue: Colony Ballroom (2nd Floor)

Oscillatory Dynamics in the Human Cortex

Robert T. Knight

University of California at Berkeley rtknight@berkeley.edu

Since the discovery of the EEG in 1920's, neurophysiological dogma for the ensuing 80 years stated that the human cortex did not generate reliable rhythms above 50-60 Hz. However, findings over the last decade report neural activity up to 250 Hz in the human cortex. This activity appears to be the key neural response tracking cortical activation in humans. We record the human electrocorticogram (ECoG) from subdural electrodes implanted in neurosurgical patients. We have observed that every cognitive process examined including language, attention, memory and motor control generates high frequency oscillatory activity in the range of 70-250 Hz (high gamma, HG). Importantly, the HG band of the human ECoG has the most precise spatial localization and task specificity of any frequency observed. For instance, during linguistic processing, HG precisely tracks the spatio-temporal evolution from comprehension in posterior temporal areas to production structures in the left frontal region. HG a precisely tracks the time course of the behavior needed to comprehend the word, select a noun and articulate a response all occurring within a second. Similar findings of key HG activity are observed for working memory, contextual processing and a host of other human behaviors. Importantly the HG response can be reliably extracted at the single trial level. HG is also phase locked to the trough of theta rhythms in the human neocortex providing parallel findings of HG-theta coupling in animal hippocampus and cortex. HG-theta coupling occurs in a task specific manner with different cognitive tasks eliciting unique distributed spatial patterns of HG-theta coupling. These results indicate that transient coupling between low- and high-frequency brain rhythms provide a mechanism for effective communication in distributed neural networks engaged during cognitive processing in humans. Taken together the results indicate that HG activity provides a powerful new tool for understanding the real-time cortical dynamics subserving cognition in humans. The implications of HG and inter-frequency dynamic to consciousness will be discussed.

Closing Remarks & Presentation of Student Poster Prizes

Randy McIntosh & Mel Goodale

Venue: Colony Ballroom (2nd Floor)

Poster Session 1: Saturday, June 26th

Venue: St Patrick & St David rooms (3rd Floor)

1. Probing for functional sites of consciousness with anesthetics: the role of the cytoskeleton.

Travis Craddock[1], Holly Freedman[1], and Jack Tuszynski[1].
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While much of the neurobiological approach to understanding consciousness focuses on the level of the neuron, the nature of general anesthetics makes them a natural molecular probe. Studies on the mechanism of general anesthetic action tend to focus on the interaction of anesthetic agents with subcellular structures, such as GABAa and NMDA receptors, in the hopes of uncovering functional sites of consciousness. In recent years attention has been drawn to the cytoskeleton as a possible site of anesthetic action and functional site of consciousness. The cytoskeleton is essential to cell morphology, cargo trafficking, and cell division. The complex structure of the neuronal cytoskeleton has been implicated to play a role in memory, and a startling number of neurodevelopmental, neurological, and neuropsychiatric disorders show a disordering in its function. However, the role of the cytoskeleton in general anesthesia, and its link to consciousness, remain questionable. To investigate these possibilities we examine the interaction of volatile anesthetics with cytoskeletal microtubules via computational modeling and simulation. Results for putative binding sites of anesthetics to microtubules, with the relation to overall cytoskeleton function, are presented, providing insight on the role of the cytoskeleton in anesthetic action and consciousness.

2. Monitoring the depth of anesthesia using the time-varying spectral lines of EEG.

Eunji Kang[1], Hossam El Beheiry[2], Jean Wong[1], Peter Carlen[1], and Berj Bardakjian[1].
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[2] University Health network

The administration of the anesthetic agents is known to alter the electroencephalogram (EEG) signal significantly as the brain being their primary target. Thus incorporating some analysis of EEG in the assessment of the depth of anesthesia (DoA) have been an active research area for many years. Although there have been many promising results, their reliability and clinical utility are still debatable. In this study, we analyzed the EEG recorded from six ASA I/II patients undergoing 1-2 hour surgery. The EEG was collected before and during induction, maintenance and recovery of anesthesia using the 10/20 lead-system. A combination of fentanyl and propofol (+/- rocuronium) was the inducing agents and sevoflurane in air/O2 mixture was administered through an endotracheal tube to achieve the steady minimum alveolar concentration (MAC) to maintain haemodynamic responses during surgical stimulation within 25% of baseline. The collected time series EEG signals were decomposed into the time-frequency domain using the wavelet packet transformation. The power of the EEG signal varied both in time and frequency as the DoA was varied. In fact, there were a number of identifiable rhythms, some of which altered their peak frequency with the change of DoA. These changes in the frequency of the rhythms were tracked over time to produce the time-varying spectral line. The time-varying spectral line adds another dimension to the currently available monitoring techniques and it can improve the reliability and accuracy of the monitoring of DoA.

3. Potential confounds in region of interest studies of impaired states of consciousness.

David Jones[1], Brendon Boot[1], Kirk Welker[1], Jennifer E. Fugate[1], Daniel Drubach[1], Alejandro Rabinstein[1], and Eelco Wijdicks[1].
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Recently published investigations of impaired states of consciousness have used region of interest (ROI) functional magnetic imaging blood-oxygen level dependent analysis techniques (fMRI BOLD). However the use of ROI's preclude investigation of global brain networks such as the default mode network (DMN). Furthermore, using the BOLD signal from a single ROI (e.g. the supplementary motor area, SMA) to identify changes during a task versus resting state is potentially flawed: it does not account for neuronal and non-neuronal related

fluctuations in the BOLD signal that remains after bandpass filtering and standard preprocessing steps. To illustrate this point, we performed a comparable SMA ROI fMRI analysis on 10 healthy controls resting comfortably in a 3T MRI scanner. Preprocessing steps included: slice time correction, realignment, normalization (MNI space), smoothing (5 mm FWHM), linear detrending, and high and low bandpass filtering (0.01-0.08 Hz). The preprocessed data was then entered into a standard general linear model fMRI analysis utilizing an SMA mask to define the ROI. The SMA ROI showed considerable variability in the BOLD signal between subjects. One subject had resting BOLD signal fluctuations that mirrored a potential 30 second motor imagery task alternating with a 30 second rest block repeated for three cycles. This produced a statistically significant activation with typical fMRI analysis ($p < 0.05$, FDR corrected). This ROI based analysis identified task related brain activity in the BOLD signal from the SMA of a subject who was not performing any such task. Subsequent analysis of the entire brain revealed that this activation pattern was artifactual in nature. This exploratory analysis, of spontaneous fluctuations in the BOLD signal located within an ROI, highlights a potential confound when attempting to find task related activation in large numbers of subjects with impaired states of consciousness. Therefore, task-induced changes in large scale networks, such as the DMN, should also be examined to verify task specific BOLD changes. In addition, task-induced deactivations of the DMN would provide compelling evidence for the interruption of a stream of consciousness in subjects that clinically appear to have no stream of consciousness.

4. **Inverse correlation of fMRI default mode network connectivity in the persistent vegetative state.**

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Functional magnetic resonance imaging (fMRI) analysis techniques identify stable global brain networks termed intrinsic connectivity networks (ICN). Changes in connectivity in one of these networks, the default mode network (DMN), are associated with altered states of consciousness (e.g. coma, persistent vegetative state (PVS), and minimally conscious state). Studies suggest that there is a progressive decrease in DMN connectivity as the level of consciousness declines. However, it is unclear which connectivity factors serve as prognostic indicators. A 40 year old male developed acute demyelinating encephalomyelitis and generalized hypoxic-ischemic injury. He remained in a PVS for several months before and during fMRI scanning. His clinical status was determined by two neurologists specializing in neuro-intensive care prior to the scan and again several days later when his level of consciousness had improved markedly. One month later he follows with his eyes, says "Good Morning", and follows some one-stage midline commands. The patient and twelve age and gender matched controls underwent a typical resting state fMRI scanning session. Preprocessing steps included realignment, slice time correction, normalization, smoothing, linearly detrending, bandpass filtering, and correction for rigid body transformation motion effects, global mean signal, white matter and CSF. Node to node functional connectivity analysis was performed on a priori determined DMN seeds in the posterior cingulate (PCC) and medial prefrontal cortex (MPFC). Voxel-wise connectivity analysis was performed for each node and compared between groups using a two-sample t-test. The voxel-wise connectivity analysis of the patient's PCC seed showed a markedly reduced spatial extent of the DMN compared to controls. In addition, seed-seed analysis between the PCC and MPFC not only showed a lack of direct connectivity in the patient, but also showed a striking inverse correlation between the two nodes. This adds to the evidence that DMN activity may be useful in investigations of consciousness. In addition, we report for the first time a striking inverse correlation between the PCC and MPFC in a patient in a PVS who subsequently improved in his level of consciousness. More investigation is needed to determine whether PCC-MPFC inverse correlation is a sign of potential recovery from a PVS.

5. **Regional thalamic atrophy in vegetative and minimally conscious states.**

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The thalamus is known to play a key role in the regulation of arousal and the support of human consciousness. Based on its specific cytoarchitecture and anatomical specialization, it has been suggested that the central thalamus could be supporting large-scale cerebral dynamics associated with consciousness (Schiff, 2008). Neuropathological post-mortem studies in traumatic brain injury (TBI) patients have suggested that, along with widespread white matter damage, thalamic damage may be the basis of some disorders of consciousness (Jennet et al., 2001). Here we present results from our study that investigated thalamic regional atrophy in a sample of TBI patients in vegetative (n=4) and minimally conscious (n=8) states using high-resolution T1-weighted magnetic resonance images. We used the FIRST tool from FSL (http://www.fmrib.ox.ac.uk/fsl/) to perform vertex-based shape analysis to compare our patients group with 20 healthy control volunteers. Patients showed a bilateral inward deformation in the thalamic dorso-medial bodies, in contrast to partial preservation of other thalamic nuclei. These shape changes can be explained by atrophy in the dorso-medial nucleus and the internal medullar lamina. Our results confirm the importance of central thalamic regions in supporting human consciousness. Further, they suggest that specific damage to these areas might explain the impairment of consciousness in severely brain damaged patients. References: Jennett, B., Adams, J.H., Murray, L.S., Graham, D.I. (2001). Neuropathology in vegetative and severely disabled patients after head injury. Neurology 56, 486-490. Schiff, N.D. (2008) Central thalamic contributions to arousal regulation and neurological disorders of consciousness. Ann. N. Y. Acad. Sci. 1129, 105-118.

6. **Language comprehension in the vegetative and minimally conscious states.**

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The vegetative and minimally conscious states (VS; MCS) are characterised by an inability to consistently demonstrate awareness of self or environment. These diagnoses are currently made on the bases of responses, or lack thereof, to verbal commands to perform motor actions. It is becoming increasingly clear, however, that a lack of control over motor behaviours is not always accompanied by a lack of awareness on the part of the patient (Owen et al., 2006, Science; Monti et al., 2010, New England Journal of Medicine). While behavioural measures may indicate a lack of understanding of spoken language, measures of neural activity allow us to objectively determine the extent to which language abilities may be retained by these patients who cannot make a motor response. Functional magnetic resonance imaging (fMRI) has previously demonstrated comparable brain responses in a number of VS and MCS patients when listening to speech containing semantic ambiguities (Coleman et al., 2007, Brain). Crucially, this pattern of activity is not observed in fully sedated individuals (Davis et al., 2007, PNAS) suggesting a level of conscious awareness associated with this neural response. Due to the expense, and exclusion criteria associated with fMRI studies, however, the language comprehension abilities of a large number of VS and MCS patients can never be determined with this method. The current study is focused, therefore, on developing means of assessing language comprehension using the more portable and inexpensive method of electroencephalography (EEG). The EEG provides a well-documented component, the N400, which is tied to the semantic processing of linguistic stimuli. In the current study, verbal stimuli were employed which varied along dimensions of semantic relatedness, and ambiguity in the context of a sentence. A group of healthy controls demonstrated the previously reported modulation of the N400 component along these dimensions. Critically, however, this pattern was also observed in a number of patients who were behaviourally in the VS or MCS. These results highlight the efficacy of EEG in determining the extent to which language abilities are retained by these patients, and also bring into question the behavioural criteria used to make such diagnoses.

7. **Is anybody in there? Detecting consciousness without language comprehension or behavioural responses.**

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The assessment of consciousness in brain injured patients is essential for the differential diagnosis of vegetative state, minimally conscious state, and locked-in syndrome. Accurate diagnosis has important implications for prognosis, clinical management, and planning of long-term care and rehabilitation [1]. Current clinical practice relies heavily on behavioural evaluation and is therefore limited where either volitional motor responses or language comprehension are compromised [2]. These limitations contribute to rates of misdiagnosis, currently

estimated at 37-43% in patients diagnosed as vegetative state [3,4]. A novel learning-based procedure is proposed to overcome these limitations. We demonstrate a situation where only consciously detected violations of an expectation lead to changes in galvanic skin resistance (GSR). Thirty healthy volunteers listened to sequences of 3 piano notes that, without their being told, predicted either a pleasant fanfare or an aversive white noise according to a simple rule. Stimuli were presented either without distraction (attended condition) or while distracted by a visual task to simulate the absence of conscious awareness (unattended condition). A 5 min training phase preceded a 20 min test-phase that included violations of the rule – the white noise occasionally following a note pattern that would otherwise have predicted the fanfare. All participants in the attended condition and none in the unattended condition reported awareness of the rule and its subsequent violation. Thus, learning occurred without instruction and was reliant on conscious attention. Six participants did not show a robust sympathetic response to the white noise and were hence excluded from assessment. In the remaining participants (12 in each condition), GSR was contrasted for the white noise on trials violating the rule and trials conforming to the rule. Learning should be apparent as greater GSR when the rule is violated, making the noise unexpected. In the attended condition this difference was significant for 11 participants ($p<0.05$) and marginal for 1 ($p=.071$). In the unattended condition the difference was not significant for any participant (all $p>.13$). Thus, learning was detectable from GSR differences. This procedure may for the first time permit clinical assessment of conscious awareness that is neither reliant on language comprehension nor behavioural responses.

8. **An fMRI study of the default mode network connectivity in comatose patients.**

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Introduction: Functional connectivity within a resting state network, termed the default mode network (DMN), has been suggested to represent the neural correlate of the stream of consciousness. Areas encompassing the DMN include the posterior cingulate cortex/precuneus, the medial prefrontal cortex, and bilateral temporoparietal junctions. Altered states of consciousness where awareness is thought to be absent could provide insight into the function of the DMN. Here we examine the functional connectivity in the DMN in both reversible and irreversible coma. Methods: Twelve healthy control subjects (age: 28.4 ± 4.2) and thirteen comatose patients following cardiac arrest (age: 64.6 ± 10.1, 2 patients with reversible coma) were included in the study. Along with the clinical assessment, Glasgow Coma Scale ≤8 was used an indicator of coma. The functional MRI scans acquired 118 volumes at 1.5T. Independent component analysis (ICA) was used to decompose data into statistically independent spatial and temporal components using the GIFT software package (http://icatb.sourceforge.net). A spatial template-matching procedure was employed to select the DMN component in each individual. To compare the DMN of comatose patients who had irreversible coma to controls, each participant's DMN component was entered into a two-sample t-test ($p=0.01$). Results: Default mode network connectivity was observed in healthy controls and two patients who regained consciousness. Average spatial correlation of the DMN component of controls to the DMN template was 0.42 (SD=0.1) and 0.38 and 0.34 in the two cases of reversible coma. DMN connectivity was disrupted in the eleven patients who failed to regain consciousness with a spatial correlation to the template of 0.13 (SD=0.06). A two-sample t-test showing regions with significantly greater functional connectivity in controls versus patients who have irreversible coma include all areas of the DMN (posterior cingulate cortex/precuneus Zpeak= 5.63, medial prefrontal cortex Zpeak = 5.32, and L/R temporoparietal junctions Zpeak = 4.31, 4.10; $p=0.01$). Conclusions: In patients who do not recover consciousness there is a disruption of functional connectivity within the DMN network. However, functional connectivity in the DMN is intact in comatose patients who eventually regained consciousness indicating that potentially the DMN is necessary but not sufficient to support consciousness.

9. **Default mode network and impaired consciousness in epilepsy.**

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The "default mode" network, consisting of medial parietal along with medial frontal and lateral parietal cortex, is thought to participate in normal conscious introspection and unstructured rumination. Reduced activity has been observed in these regions when subjects engage in tasks, leading to the hypothesis that suspension of default mode activity occurs when subjects interact with the external world. Using a combination of

neuroimaging and electrophysiological methods, we recently found that reduced default mode network activity also occurs in three specific seizure types associated with impaired consciousness. In contrast to normal conditions, during these seizures there is reduced default mode activity while subjects are completely unable to interact with the external world. We found that rather than passive suspension of normal activity, seizure mechanisms actively reduce activity in default mode networks. 1. Using functional magnetic resonance imaging (fMRI) during childhood absence seizures, we observed that early abnormal increases in activity precede massive abnormal fMRI decreases in default mode networks during seizures. This pattern suggests that the observed decreases could represent an undershoot phenomenon of neuronal recovery following abnormal activation. 2. During generalized tonic-clonic seizures we found that decreased cerebral blood flow in default mode networks measured by single photon computed tomography (SPECT) was strongly correlated with cerebellar increases during and following seizures. Because the cerebellum consists largely of inhibitory Purkinje cells, and cerebellar activity was also found to correlate with the thalamus, these findings suggest that default mode decreases in tonic-clonic seizures are caused by active cerebellar inhibition of thalamocortical networks. 3. Through investigation of temporal lobe seizures in both human patients and animal models we found reduced cerebral blood flow and increased cortical slow oscillations in default mode regions, associated with abnormal activity in subcortical arousal systems. These findings support a "network inhibition hypothesis" by which active inhibition of subcortical arousal systems during limbic seizures causes cortical inactivation resembling coma or deep sleep. In summary, converging evidence from different seizure types shows abnormally decreased activity in default mode networks during epileptic unconsciousness. Further investigation may elucidate the role of default mode networks in both normal and impaired consciousness.

10. **Sleep patterns and their significance for disorders of consciousness.**

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INTRODUCTION: The sleep-wake system and consciousness are intimately connected. Therefore, a better characterization of sleep timing and architecture in patients suffering from clinical disorders of consciousness (DOC) might improve our understanding of neural correlates of consciousness. Consciousness consists of two components: arousal (wakefulness or level of consciousness) and awareness (content of consciousness). Previous studies in DOC have reported a wide spectrum of sleep disturbances ranging from almost normal patterns to severe loss and architecture disorganization. Furthermore it appears that the very existence of sleep is a challenging issue as these patients do not show the normal behavioural, physiological and regulatory signs of sleep. METHOD: Up to now we performed 24h polysomnographies in 28 patients being either in a vegetative (VS), or minimally conscious state (MCS) following a traumatic or non-traumatic brain injury. Coma state was classified using the Coma Recovery Scale-Revised (CRS-R). RESULTS/DISCUSSION: Cortical desynchronization arousals appeared to be the best marker for VS patients who showed later progression. Spindles on the other hand appeared predictive for emergence out of MCS. However, more patients are needed in order to evaluate the clinical value of the various sleep features.

11. **Higher order thoughts and hypnotisability.**

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The mechanisms underlying hypnotic susceptibility have remained elusive despite decades of research. The cold control theory of Dienes and Perner (2007)posits that inaccurate higher order thoughts (HOTs) about first order intentions may be responsible for the cardinal experience of involuntariness in hypnosis. Thus, individual differences in hypnotisability may be related to a person's habitual awareness and control of their mental states. Participants of high and low hypnotic susceptibility ('highs' and 'lows', respectively) performed a task designed to measure the relation between higher order thoughts and first order states (the "candle task"), and also completed a number of self-report measures concerning control and awareness of mental states and the world. In the candle task, participants were required to cultivate or avoid thoughts of a candle while looking directly at it. There was a trend for highs to have fewer candle related HOTS (weaker 'HOT coupling') and they showed less meta-awareness during the task, suggesting that highs are poorer at forming accurate HOTs. The self-report measures completed were: mindfulness (present awareness of the world), thought control, thought

suppression, cognitive failures, internal-external encoding, and absorption. Highs scored significantly higher on measures of cognitive failures, thought control, absorption and thought suppression than lows did, and their scores on the mindfulness scale were significantly lower. Significant positive correlations were seen among hypnotisability, cognitive failures, thought control, absorption, thought suppression, and internal encoding. All these measures correlated negatively with mindfulness and meta-awareness on the candle task. Hypnotic responding may be related to greater attempts to control thoughts, leading to reduced (externally directed) mindfulness and increased cognitive failures, together with increased absorption. The greater attempts at control of mental states go with a reduced awareness of mental states, and it is the latter that is responsible for the hypnotic experience.

12. **Conceptual requirements for state consciousness: HOT theory, autism, and a minimally sufficient TOM.**

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This paper brings together Philosophical theory and empirical evidence from Developmental Psychology to investigate the requirements for having conscious states of mind. Specifically, according to Rosenthal's Higher-Order Thought Theory of Consciousness, mental states become conscious if and only if they become the objects of higher-order thoughts (HOTs) and one requirement of forming such HOTs is that an individual have some way of conceptualizing the first-order states of her own mind. The exact level of conceptual sophistication required, however, is a point that remains unclear. While some have tried to gain traction on this issue by looking at theory of mind development in normally developing young children, I suggest that it may be more informative to look to the clinical population of people with Autism Spectrum Disorders (ASDs) instead, because many people with ASDs, despite demonstrating relative cognitive competency in other areas, seem to have a strikingly specific inability to understand the mind. If it can be shown that they have conscious states but do not have the requisite abilities to form HOTs, people with ASDs may be a counterexample to Rosenthal's theory. If, on the other hand, it can be shown that they have some minimally sufficient conception of the mind, this fact could shed light on questions arising both for Rosenthal's philosophical account of consciousness as well as for the empirical study of the development of a theory of mind. Thus the first part of the paper identifies some potential measures of an individual's possession of a minimally sufficient conception of the mind. The second part of the paper looks to the empirical research to see whether people with ASDs show evidence of having these abilities. Finally, the third part of the paper raises some new theoretical and empirical questions, which arise from the discovery that people with ASDs seem able to reason about desires despite showing no indication of understanding the representational nature of the mind.

13. **Detecting movement volition in a patient with vegetative state.**

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Recent functional neuroimaging paradigm can unequivocally demonstrate a level of preserved conscious awareness in patients meeting the clinical criteria for vegetative state, using tasks that tap "volitional" aspects of behavior (Owen et al., 2006). However, this volition paradigm, that requires patients to process mental imagery, is hard to perform for patients in such a difficult state (Monti et al., 2010). We conducted an fMRI study using a Hand Moving task in 12 patients with VS and one with MCS. During the scan, the patients were given spoken instructions to perform a task that required them to raise hand at specific time points. Only one of the 13 patients, who fulfilled the criteria for vegetative state by clinical CRS-R assessment, was observed significant activity in the supplementary motor cortex (SMA), primary motor cortex (M1), anterior cingulated cortex (ACC) and cerebellum during the "Hand Moving" period. Her neural responses were indistinguishable from those observed in 15-healthy volunteers performing the same tasks. The results confirm that, despite fulfilling the clinical criteria for a diagnosis of vegetative state, this patient retained the ability to understand instructions and to voluntarily perform the task through her brain activity, rather than through speech or actual movement. Our approach permits an easier and more direct way to assess whether behaviorally diagnosed patients in VS are truly conscious or not, and to further avoid diagnostic errors. Our paradigm seems more

propitious to apply and popularize in clinical situations as a supplementary tool to diagnose some patients who are aware but unable to produce an overt motor output.

14. **Consciousness at stake: perceptual and semantic decisions under sedation.**

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Auditory processing is susceptible to alterations in the level of consciousness. We used propofol (an anaesthetic agent acting mostly via the GABA-A receptor) to reversibly manipulate the level of consciousness in order to detect the neural correlates of semantic processing during sedation. Propofol administration was titrated to three plasma levels, and we tested perceptual and semantic processing at: baseline (S0, targeted plasma concentration: 0µg/ml), low (S1, targeted plasma concentration: 0.6 µg/ml) and moderate (S2, targeted plasma concentration: 1.2 µg/ml) levels of sedation. Participants were fully conscious at baseline, in a relaxed state (able to maintain a conversation with ease) at the lower level of sedation, and were drowsy (able to maintain a conversation only with difficulty) at the moderate level of sedation. 24 subjects decided whether the auditory stimuli presented was a noise or a buzz (perceptual decision), or a living or non-living entity (semantic decision) in all sedation levels and while connected to a high density EEG. Perceptual decisions were faster than semantic decisions in all sedation levels. The higher the sedation level the slower the responses for both conditions. In sedation level S2 reaction times were delayed (from approximately 700ms to 2500ms) and participants showed more errors in the semantic than in the perceptual decision condition. We discuss here the evoked related potentials of the perceptual and semantic decisions during these conditions and differentiate the neural correlates between concrete and abstract decisions in different levels of consciousness.

15. **Out-of-body experiences – is there need for a composite hypothesis?**

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During out-of-body experiences (OBEs) the unity of self and body appears to be disrupted, and the experiencing subject may perceive the world, and sometimes his or her own body, from a distant visuo-spatial perspective. OBEs are commonly reported by patients suffering from focal epilepsy or other localized pathologies affecting the cortex at the temporo-parietal junction (TPJ). Additionally, OBEs have been induced experimentally in humans by electrical stimulation at the (right) TPJ. Based on these observations it was hypothesized by Blanke and others that OBEs may result from a disintegration of multimodal body-related information at the TPJ. Notably, OBEs are also reported in the absence of any evident pathology: they may occur spontaneously, as a component of near-death experiences or lucid dreams, and can also be induced voluntarily using appropriate mental techniques. The “disintegration hypothesis” is very plausible for OBEs resulting from pathological neuronal information processing; however, at first glance, its implication for cases of OBEs arising in the absence of evident pathology seems less obvious. In these cases, the “dissociation model of OBEs” put forward by Irwin seems a promising account. Also, if the concepts of disintegration and dissociation overlap, I argue that both approaches need to be considered for an in depth understanding of OBEs. However, since the “dissociation model” is a psychological hypothesis it needs to be translated into a physiological-functional model in order to be integrated with the dissociation model. To this end, I consider the concepts of “top-down” vs “ bottom-up” neuronal processing to be useful. A “composite hypothesis” (disintegration and dissociation) may provide a better understanding of shared phenomenological aspects of OBEs as well as of more individual neurovirtual experiences during and after OBEs.

16. **Self-regulation in children with ADHD: Behavioral and fMRI data.**

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Self-regulation refers to the active evaluation of the cognitive processes implicated in goal-directed behavior. A dysfunction of the ventromedial prefrontal and anterior cingulate cortices, which affects executive function, could partly account for the problems observed in the ADHD. These regions are implicated in inhibition,

attention, planning and regulation. Objective: 1) Determine brain activations in children placed in a situation of self-regulation. Method: Forty-eight right-handed children (20 ADHD and 28 CONT) performed the task consisting of identifying the incoherent (INC) items among 56 pictorial stories presented in a block-design manner during two runs of fMRI. Results: Behavioral data showed difference between the groups in term of the error rate but no reaction time (RT) nor interaction. Time-per-target showed a significant interaction (ADHD are slower vs. CONT and faster in INC vs. CO). The fMRI analysis of the INC-COH contrast revealed activations in the dorsolateral prefrontal (DLPF) cortex in the ADHD group and orbitofrontal and anterior cingulate cortex (AAC) in the controls. There were additional activations in the temporal and parietal cortices in the ADHD children. The results imply that children with ADHD recruit different neural circuitry to arrive at a performance similar to healthy children on the self-regulation task.

17. **Prefrontal activation in performing on computerized maze problems: how cognitive consciousness works.**

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Planning, the internal processes of formulating an organized method about ones' future behavior, seems to form a crucial part of cognitive consciousness for both humans and non-human animals. The present study using near-infrared spectroscopy (NIRS) examined prefrontal activation associated with maze-solving performance in human adults. The participants were required to solve two maze tasks, comparable to the ones used for both pigeons and human children to behaviorally assess their planning processes, by moving a target square to a goal square presented on a touch-sensitive screen with their fingers. In Experiment 1, we used a plus-shaped maze and in some trials the goal jumped to the end of another arm when the target arrived at the center of the maze. The participants frequently made incorrect responses toward a previous goal, similarly to pigeons and human children but less frequently than these subjects, with shorter reaction times than when they correctly adjusted their responses. In these incorrect trials relatively larger hemodynamic changes having two peaks were observed, especially in channels of the right hemisphere, suggesting use of additional cognitive resources for adjustment of responses after making errors. In Experiment 2, we used a variation of the plus-shaped maze that had eight arms (i.e., a shuriken-shaped maze) and presented the maze for 10 seconds before the participants were allowed to solve them. In some trials the goal jumped to another end of the arm immediately after the color of the maze changed from the preview to the solution phase. In these goal-change trials the participants moved the target toward correct directions in almost all trials. In these trials as well as in baseline trials, two-peak waveforms were observed with the first peak during the preview phase and the second peak during the solution phase. The two-peak waveforms observed in both of these experiments seem to suggest that cognitive consciousness that was once activated for task solution/preparation can undergo an additional, even larger activation when some additional event occurs during the course of task solution. Also, similarity of the behavioral results across species may suggest an evolutionary convergence of such processes.

18. **Practical measures of integrated information for stationary, continuous systems.**

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Integrated information theory (IIT) has recently gained prominence as a theory of consciousness. IIT posits that any physical system has the potential to generate consciousness, and that the quantity of consciousness present corresponds to the integrated information generated [1]. Integrated information, PHI, is computed by quantifying the extent to which the system as a whole generates more information than the sum of its parts. However, in its present form [1], PHI cannot be measured for real neural systems, undermining its scientific utility. We present a new measure of integrated information, stationary PHI (SPHI), which is measurable for real neural systems. Defined for any system whose states are statistically stationary, SPHI measures information as reduction in uncertainty from the stationary distribution. By contrast, the formulation in Ref. [1] takes information as reduction in uncertainty from the maximum entropy distribution. Use of the stationary distribution, instead of the maximum entropy distribution, gives rise to two key features that enable SPHI to be measurable from time-series data. First, it is well-defined for systems whose states may vary continuously. Second, it can be measured purely through observation, without recourse to perturbation of system subsets. When states are Gaussian distributed, SPHI can be computed directly from empirical covariance matrices, and

can in fact be expressed in terms of linear regressions, which further enhances its practical application. The latter property also motivates a second measure, ARPHI (autoregressive PHI), defined directly from regression errors. ARPHI is equivalent to SPHI for Gaussian systems, whereas for non-Gaussian systems it provides a pragmatic alternative to SPHI. ARPHI (and SPHI for Gaussian systems) are state-independent. Therefore, to the extent that they are considered as measures of consciousness, they predict that (i) conscious level is constant during each stationary epoch in brain activity, and (ii) conscious level changes when functional connectivity changes, modifying the stationary statistics. To better understand the relations between structural connectivity, functional connectivity and integrated information, we present results from optimizing SPHI across a variety of simulation models, as well as comparisons with related measures such as 'causal density' and 'neural complexity'. [1] Balduzzi, Tononi 2008.

19. **Relating metacognitive sensitivity to human brain structure: a combined psychophysical-MRI study.**

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Humans have the ability to relate decision performance to awareness, but the neural basis for this ability remains unclear. Such reflective judgments of confidence or certainty may differ from objective performance. For example, a task can be performed poorly, yet the individual may believe his or her performance was good, or vice-versa. Metacognitive sensitivity has been proposed to underpin fundamental aspects of human consciousness (Lau, 2008; Rosenthal, 2000). We investigated this introspective mapping by using signal detection theory (Type II SDT) where high confidence correct judgments were assigned as introspective "hits", and high confidence incorrect judgments as "false alarms" (Kunimoto et al., 2001). We related SDT measures of metacognitive sensitivity for a simple psychophysical task to brain anatomy. A psychophysical staircase procedure coupled with post-decision confidence ratings was used to characterize inter-individual differences in a Type II ROC-based metacognitive measure (Aroc) in 31 healthy participants. All participants also underwent high-resolution anatomical and diffusion-weighted MRI scans. Substantial variation in Aroc was observed despite constant objective performance (d'). Variation in metacognitive sensitivity (Aroc) correlated with gray matter volume in frontopolar cortex (BA10; $P < 0.05$, whole-brain corrected) and posterior cingulate/precuneus ($P < 0.001$, uncorrected). In addition, white matter connectivity as indexed by fractional anisotropy (FA) was seen to be greater in the anterior corpus callosum (connecting opposite regions of prefrontal cortex) in high Aroc individuals. Together our results indicate a striking dependence of metacognitive sensitivity on underlying brain structure.

20. **An anatomical prerequisite of consciousness: Convergent - divergent transmission nets.**

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Geometry presents a seemingly impassable information bottleneck to justify brains larger than those of invertebrates. A brain's aperture surface limits how many neural pathways from the larger surrounding body can be connected. Since speed is as vital as precision, and conduction speed is proportional to fiber diameter; connecting pathways cannot be shrunk to squeeze more through the aperture. The problem increases as larger bodies involve longer transmission distances. A similar constraint on output pathways limits a brain's ability to control the surrounding body. A solution accompanied the arrival of vertebrates, making possible larger brains and bodies. Its nature was revealed in experiments on the organization of sensory pathways in the rabbit ear by Weddell, Taylor & Williams (1955). To map these pathways, they counted the number of hair-cell receptors in a certain area and the number of dendrites from that area. There were about 20X as many receptors as exiting dendrites. (Fortunate. otherwise there would be little room left in the rabbit brain.) Exquisite tactile localization ruled out simple summation. Further examination found that each hair-cell connected to more than one dendrite. Weddell, et al concluded that this convergent-divergent neural organization somehow maintained acuity. It has become recognized that most sensory systems are convergent-divergent, but how remained a mystery. To explain convergent-divergent sensory systems, I built some neural models. There was only one basic branching pattern that could transmit information from many inputs along a fractional number of pathways without losing acuity (Nilsson, 2008). A two-dimensional sensory array is limited to a 16-1

convergence - roughly what Weddell, et al found. Transmission of information within a brain faces similar geometric constraints since the surface of any region is proportional to its linear dimensions squared, but its volume is proportional to their cube. The problem worsens for larger brains because transmission delays must be reduced by larger fibers. Though not yet mapped within a vertebrate brain, convergent-divergent organization of intracortical pathways seems essential. Jerison's (1973) theory of consciousness requires a confluence of information from various senses. Only a convergent-divergent organization makes this possible.

21. **Human brain connectivity subserves the conscious condition.**

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In consciously-mediated behaviour, in contrast to automaticity, a significant subset of the resources of a person's brain can be brought to bear on the ongoing situation, including working memory processes and episodic memory processes as well as specialised motor processes. According to the present paper, this is made possible thanks to a connective infrastructure that allows the influence of individual brain processes to permeate the whole system while the system as a whole can influence individual brain processes. Under these conditions, the activity of massively many parallel processes can be orchestrated, creating unity out of multiplicity. Support for this idea comes from the growing body of evidence that human brain structural and functional connectivity forms a modular, small-world network with a pronounced connective core (Hagmann, et al., 2009). Such a network supports a dynamical milieu that 1) is characterised by episodes of broadcast punctuated with bursts of competition, which is the dynamical signature of a global neuronal workspace (Shanahan, 2008a; Doesburg, et al., 2009), and 2) promotes dynamical complexity (a balance of integrated and segregated activity), which facilitates an open-ended repertoire of coalitions of brain processes (Shanahan, 2008b; 2010a). Doesburg, S.M., Green, J.J., McDonald, J.J. & Ward, L.M. (2009). Rhythms of Consciousness: Binocular Rivalry Reveals Large-Scale Oscillatory Network Dynamics Mediating Visual Attention. PLoS ONE 4 (7), e6142. Hagmann, P., Cammoun, L., Gigandet, X., Meuli, R., Honey, C.J., Wedeen, C.J. & Sporns, O. (2008). Mapping the Structural Core of Human Cerebral Cortex. PLoS Biology 6 (7), e159. Shanahan, M.P. (2008a). A Spiking Neuron Model of Cortical Broadcast and Competition. Consciousness and Cognition 17, 288–303. Shanahan, M.P. (2008b). Dynamical Complexity in Small-World Networks of Spiking Neurons. Physical Review E 78, 041924. Shanahan, M.P. (2010a). Metastable Chimera States in Community-Structured Oscillator Networks. Chaos 20 (1). Shanahan, M.P (2010b). Embodiment and the Inner Life: Cogition and Consciousness in the Space of Possible Minds. Oxford University Press.

22. **A model of primitive consciousness on an autonomously adaptive system.**

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A model of primitive consciousness is proposed through investigation of a system that autonomously adapts, without a teacher, to its environment. This system is required not only to respond to the environment as fast as possible but also to provide a response of a quality that is appropriate to the situation based on its previous experiences. The system should grasp the situation, decide the action appropriately, and adapt by modifying its own configuration on the basis of its experience. To do these things as a single entity, the system has one evaluation mechanism, that is based on rewards or punishments. First, a main part of consciousness is modeled as a function to do an appropriate speedy action. For this, the system should quickly calculate a draft of a desired action based on a large amount of information, such as the results of recognition from sensory processing, recollections from the episodic memory, and states of the system itself. This calculation is done with neural loops, in which information is represented as a random pulse ratio. Each node relates to an imagery concept. Connections between nodes correspond to relations between imagery concepts. Each loop represents constraint conditions or equations. These loops operate as a solver that uses the iterative method of nonlinear simultaneous equations. The pattern of exciting nodes represents drafts of action at that time. The concept of "functional consciousness", including Baars's global workspace theory, is explained by using the above function. Second, to allow the system to control itself efficiently, only information needed to control the system is selected. The information selected, such as available alternatives or action space with relation to rewards and punishments, make up a compact space that corresponds to the everyday world that we feel consciously.

Additionally, the pair of the solver of simultaneous equations and the evaluation mechanism functions as a "self" of the system, and this self approximately corresponds to Koch's non-conscious homunculus. "Phenomenal consciousness" is simply modeled by using the compact space and the self.

23. **The network properties of conscious experience: 'small worlds' and functional connectivity.**

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Some consciousness researchers have hypothesized that "explanatory correlations" may hold between brain activity and subjectivity (Seth, 2009). For example, functional integration and differentiation within brain activity may account for the unity of consciousness and the extremely large number of possible conscious states, respectively (Tononi & Edelman, 2000). Graph theoretical measures that reflect these properties in whole-brain activity have been developed, and using these measures recent medical studies have found significant abnormalities in populations suffering from Alzheimer's disease (de Haan et al., 2009) and schizophrenia (Micheloyannis et al., 2006). However, few studies have looked for within-subject task effects using graph theoretical analysis, and none have used this analysis to investigate basic questions of consciousness research. Using synchronization likelihood (Stam, 2002) as a measure of electrode coupling in 64 channel EEG, we extracted functional brain networks to seek explanatory correlates of consciousness. Emulating Hakwan Lau's 2006 fMRI study, we induced relative blindsight in participants undergoing EEG recording. Relative blindsight was achieved when participants performed a task in which behavioral performance was matched between identical conditions but self-reported level of stimulus awareness differed significantly. Participants also performed a complementary working memory task in which they viewed identical stimuli while task difficulty was varied. This allowed us to disentangle and separately investigate functional and phenomenal views of consciousness. We assess mean path length (integration), coupling coefficient (differentiation), and 'small-worldness' (an optimal balance between path length and coupling coefficient; see Watts & Strogatz, 1998) between conditions and compare differences between tasks. Preliminary analysis shows that in the working memory task, task difficulty correlates with lower path length and higher 'small world' value, whereas in the relative blindsight task a higher level of perceptual consciousness correlates with higher path length and coupling coefficients and lower 'small world' value.

24. **EEG validation of a proposed regulatory definition of phenomenal experience.**

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Contemporary consciousness studies tend to give priority to the present in any analysis of the neural basis of conscious experience, a bias that does not correlate with our own phenomenal experience. The fundamental form that our phenomenal experience takes can be characterized as a " presence in absence", in which the present sensible experience acquires its significance through what is absent, the temporal horizons that frame or envelop the present. A regulative definition of phenomenal experience in a physical system is proposed based on this form that gives weighting to the past and future; a necessary condition for the present sensory state of a physical system to be experienced phenomenally is if the present sensory state can be related to the system's own time horizons. These time horizons are identified with the time scales that are recordable in the system's dynamic. Phenomenal experience corresponds to the present sensory state of a system framed by the time scales to which the system has access. We recorded the EEG in subjects performing two identical sensory-motor tasks that involved manual tracking of a target cursor on a computer screen with a joystick. In the first trial the pattern was predictable whereas during the second the pattern was random. Even though the sensory input and motor output were the same in the two conditions, changes were seen in the distribution of time scales in the EEG signals with the predictable pattern having a scale free distribution and the random pattern a bimodal or two peaked distribution. These distributions correspond to our phenomenal experience of a lack of subject object distinction with skilful coping (predictable pattern) and a phenomenal experience of a separation of subject and object during breakdown (random pattern). Since phenomenological accuracy is maintained with this proposed regulative definition, it deserves further study in establishing the physical basis of phenomenal experience.

25. **Magnetoencephalography (MEG) in Sudoku-puzzle solving task.**

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Creative thinking is the great gift for every human-being, which is surely under the control of the brain. Thus creativity is one of the brain functions. Creativity is related to wide-spread domain in the human culture such as academic field, art, literature, and so on. The common attributes of creativity are involvements to the solution, generative thinking, diversified thinking, and sudden-insight. It is expected that creativity is implemented by the brain activities related to such factors. To examine the creative brain functions, Sudoku-puzzle solving task was chosen in the present study. Many kinds of puzzles induce our Aha!-experience which contains involvements to the solution and sudden-insight. Originally Sudoku is a logic-based puzzle which is solved by sudden-insight based on logic rather than inspiration. The present study used 4x4 Sudoku which is a number placement puzzle. The objective of our modified version of Sudoku is to fill a 4×4 grid with digits so that each column, each row, and the center 2×2 sub-grid contain all of the digits from 1 to 4. It is known that Broca's area is activated by a number operation task. To prevent such linguistic area from being activated, we used corresponding colors to each number. In order to solve Sudoku, the first, we have to search/guess the solution, the second, to evaluate the possible solution, and then the third, to make us aware of the solution. Preliminary data from MEG in Sudoku solving task shows that activities in the left precuneus with a latency of -310 [ms](SE 13), L-PCG(the left posterior cingulate gyrus) with a latency of -178[ms](SE 22), then L-ACG(the left anterior cingulate gyrus) with a latency of -110[ms] (SE 26) appear preceded by the subject's button-press report for the solved moment of the puzzle. Subjects report that the introspective impression for our color-Sudoku is similar to the one for Aha!-moments. Such "Aha!-moment" can be restated by "moment of the awareness". We discuss the implications of our result for the neural mechanisms of a moment of the awareness.

26. **Propofol-induced changes of brain activation and thalamocortical connectivity - interpreted from information and integration.**

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The reduced level of consciousness during general anesthesia may be accompanied by altered neural activation and connectivity within brain networks. We assessed propofol-induced changes of brain activation and connectivity within different neural systems that are presumably responsible for information and integration, which are essential to consciousness. Based on a recent compelling view that the loss of consciousness in anesthesia may be best described as "information received but not perceived", we tested the hypothesis that with the administration of propofol, there would be relatively stable neural activations to the perceptual processing of verbal inputs, however, the neural substrates involved in comprehension and memory, which require high-order integrating processes, would exhibit significantly diminished. We also hypothesized that propofol would suppress consciousness by inhibiting the nonspecific thalamocortical system, which disrupts the integration of information; however, the specific thalamic network for representing raw sensory information would remain relatively intact. Eight healthy subjects listened to 200 high-frequency words during four conditions: alert, light sedation, deep sedation, and return to alert baseline during fMRI at 1.5T. Task-induced neural activations were extracted and thalamocortical connections were evaluated respectively by the cross-correlation of low-frequency filtered MRI time courses using seed voxels manually drawn from either the specific or nonspecific (Intralaminar) thalamic nuclei. We found that propofol significantly reduced BOLD activation in the left inferior frontal gyrus, middle frontal and posterior temporal regions, previously found involved in the encoding of sentences into memory or recognition of sentences containing ambiguities. In contrast, the auditory cortex demonstrated resilient activations across even under deep sedation wherein subjects showed no conversational responses. Propofol also reduced task activations in the medial parietal cortices that belong to the parietal default-mode-network (posterior cingulate and precuneus) which play an important role in memory and continuous monitoring of external and internal environments during resting-state. As hypothesized, the specific thalamic network exhibited relatively stable connections across both sedation conditions; whereas the nonspecific connections were significantly reduced. These results suggest that anesthesia impairs consciousness by primarily suppressing the neural systems involved in high-level integration and the parietal default mode network.

27. **Distinct oscillatory brain activity in disorders of consciousness.**

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Although bedside clinical evaluation of awareness in disorders of consciousness (DOC) is inherently difficult it still remains the clinical gold standard. We believe that the increasing use and refinement of EEG and advanced EEG analyses techniques would improve our clinical characterization of vegetative (VS), and minimally conscious state (MCS) patients, not only for re(de)fining their diagnosis, but also to better differentiate patients in terms of appropriate treatment (including administration of analgesics and access to neuro-rehabilitation programs), outcome and end-of-life decisions. In the present study we focus on (residual) cognitive processing in a sample of 12 control subjects, 8 VS, and 13 MCS patients using bedside EEG, and hope to provide new perspectives which might complement clinical diagnosis. We adopted an approach using an "active paradigm" which explicitly asks subjects to follow instructions, specifically to actively count own or other names as compared to passively listening to them. Paradigms of that kind allow to identify awareness in the complete absence of motor behavior. Bedside EEG data was then analyzed using an advanced EEG analysis technique termed event-related synchronization/desynchronization (ERS/ERD). Results reveal that MCS but not VS patients show enhanced theta responses when instructed to count as compared to passively listen to their own name. Interestingly, we also observed a systematic delay in theta ERS (controls responding earlier than MCS than VS) when participants were instructed to count their own name. We believe that this reflects the systematic processing decrements according to the underlying structural brain damage. Last but not least, alpha ERD – probably indicating long-term memory access – is only clearly evident in control subjects when instructed to actively count rather than merely listen to own names. Altogether data indicates that time-frequency analyses allows to focus on distinct cognitive processes in DOC and thereby contributes to a refined understanding of severely brain-injured patients. It has to be clarified whether this information is sufficient in order to guide diagnosis and to make statements regarding the further development of these patients.

28. **Brain oscillations underlying conscious perception.**

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Continuous sensory input provides a central representation of the many elementary features of the environment. However, we perceive an object in the world around us as an integrated entity. Thus, one key question in the neuroscience of brain function is how sensory elements are bound together for conscious perception. Neural oscillations at frequencies around 40 Hz (gamma band) have been discussed since long time as mediating such binding. Our model is that reciprocal thalamocortical connections form neural loops, in which intrinsic oscillations in inhibitory interneurons entrain synchronous oscillations in thalamic and cortical areas. Binding is established as interaction between specific and non-specific thalamocortical circuits. We performed a series of experiments in which we presented the subject with 40-Hz amplitude modulated sound and recorded the human magnetoencephalogram (MEG). The 40-Hz rhythm of amplitude modulation elicits synchronizes oscillations in thalamocortical networks, which can be detected in the MEG signal noninvasively. We introduced subtle changes in the sound stimulus, which were short temporal gaps, brief clicks to the opposite ear, or changes in sound location, respectively. A common observation in those experiments was that a stimulus modification resulted in a reset of the entrained brain oscillations. The reset of 40-Hz oscillations was characterized by a 200 ms time interval in which the response phase was delayed and the amplitude of oscillations build up to its steady-state amplitude. We interpret this phenomenon as indicating the process of resolving an existing binding when a new stimulus comes in and establishing dynamically a new synchronous network representing the perceived change in the stimulus configuration. With MEG we can localize and map the nodes in the brain network generating 40-Hz oscillations and can visualize the dynamics of activity with high temporal resolution. Observing stimulus entrained oscillations provides the advantage of a higher signal-to-noise ratio over the conventional approach of studying ongoing intrinsic brain activity and opens a new avenue to study the neural mechanism underlying conscious perception.

29. **Perception is a confidence game: Shared characteristics between consciousness and blackboard systems.**

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Global workspace theory posits that multiple unconscious processes update a conscious representation of the world that is shared between them. This is a biological embodiment of the computer science concept of a blackboard system. In a blackboard system multiple knowledge sources update a common blackboard database to collaboratively solve a problem. In robotics, blackboard systems are useful for solving the problem of sensor fusion where data from multiple noisy sensors must be combined to form a hypothesis about the state of the outside world. Since global workspace theory and blackboard systems are so closely related, it may be significant for validating global workspace theory that features of successful blackboard systems can be found in the awake brain. Neurophysiological evidence for specific shared characteristics between blackboard systems and consciousness will be presented. These common characteristics include maintaining hypotheses at different levels of abstraction simultaneously, tightly coupling the confidence in hypotheses with the hypothesis itself, a control system (attention) that directs the flow of problem solving, and a confidence-based model for updating uncertain hypotheses with new uncertain data. New psychophysical results will be presented demonstrating the role that perceptual confidence plays in the integration of noisy visual and auditory motion signals. The practical solutions that computer scientists have found to the problems of integrating noisy sensor data appear remarkably similar to the techniques the awake brain uses to address its own similar problem.

30. **The feeling of what happens in a game.**

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The interaction with others (e.g. family, friends, and colleagues) plays an important role in life, and has profound implications for the social construction of the self in its conscious and unconscious manifestations. The interaction between parents and child at the early stages of life has a long standing influence on the subsequent social adjustment abilities. Attachment is the affective bond of parent-child relation and supports the cognitive development of a child, with the attachment figure in adulthood generalizing to persons other than parents (Bowlby, J. 1991). Despite its importance in childhood and the suggested continuation into adulthood, there has not been an extensive study about attachment in adulthood, or the neural mechanism underling the affective bond. Studies on social reward provide important constraints on the nature of affective bond in adulthood. Eye gaze activates the striatum associated with reward prediction (Knut, K., et al. 2001), whereas social rewards activate the striatum in a manner similar to the monetary reward (Izuma, K., et al. 2008). The anterior cingulate cortex is activated by the distress of social exclusion (Eisenberger, NI., et al. 2003). Here we study the significance of the reliability and involvement of others as social rewards in a game where the subjects interact with others and exchange monetary reward. We examined the change in the actions and mental conditions of the subjects induced by the interaction. From the video recording, correlations between eye blinks and the subjects' reported mind states were analyzed. Our results show that the intentions of the counterparts as manifested in the monetary rewards affect the subject's state of mind, leading to various perceived feelings such as loneliness, sadness, and sleepiness. It is suggested that gaming can provide a tool not only for studying aspects of social behaviors such as altruism, but also for studying the nature of mental state (e.g. feeling of isolation) induced by the interaction. Finally, we discuss the potential of the current approach as a tool for studying the social construction of the self in its conscious and unconscious manifestations.

31. **Decision-making experiments under a philosophical perspective.**

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Decision-Making is an intricate subject in neuroscience. It is often argued that laboratorial research is not capable of dealing with the necessary complexity to study such issue. Whereas philosophers in general neglect the physiological features that constitute the main aspects of thought and behaviour, I advocate that a

philosophical analysis of cutting-edge experiments on decision-making can offer us a framework to explain human behaviour in its relationship with will, self-control, inhibition, emotion and reasoning. It s my contention that self-control mechanisms can modulate more basic stimuli. Assuming the aforementioned standpoints, I show the physiological mechanisms underlying social assessment and decision-making. I also establish a difference between veridical and adaptive decision-making useful to create experimental designs that can better mimic the complexity of our day-by-day decisions in more ecologically relevant laboratorial research. Veridical decision-making presupposes the idea that of one of the answers is the only correct. Although, the great majority of our choice is adaptive and don't have a unique transpersonal correct answer. Adaptive decision-making, is particularly dependent on the frontal lobes, differently from veridical decision-making. The ecological relevance of experiments dealing with adaptive decision-making is superior than of those dealing with veridical decision-making: Moreover, I analyse some experiments in order to develop an epistemological reflection about the necessary neural mechanisms to social assessment and decision-making. Philosophically and technically analysing experiments, I show that attention and inhibition are the key topics to understand how our choices are taken. I critically analyse experiments on decision-making and conscious and subliminal assessment aiming to show how inhibition and attention are related. I show that attention and inhibition are necessary capacities to conscious decision-making. The more semantically loaded and interpreted character of frontal lobes' information processing constitute my epistemic credentials to sustain that sheer determinism applied to living creatures, especially human beings is so nonsensical as the metaphysical freedom of the will. I present empirical evidence of how higher-cognitive functions could control more basic stimuli and interpret that as the underlying necessary conditions to decision-making.

32. **Does Buddhist meditation facilitate prediction?**

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According to Libet's experiment, the brain senses what happens before the mind. Generally, human cognition lags in sense perception, although individual's delay differs. If the mind delays the comprehension of phenomena, then it is questionable if controlling the mind by Buddhist meditation may prevent such time lag. Meditation requires attention and increases attentional network of neural circuit. [1] Given that attention modulates the speed of cognitive process [2], our cognitive process can be temporally modified with attention by meditation. According to Buddhist logic [3], there are two instruments of valid means of cognition: perception (pratyaksa) and inference (anumana). Perception implies the first moment of cognition, and is followed by inference in the process of conceptualization. Perception of meditating yogins is free from conceptual construction. Whereas most people experience a delay in recognizing the present conscious moment, yogins might reduce this temporal delay with lack of conceptual construction. Meditation is free from the past-present-future boundary, realizing temporality is merely an outcome of conceptualization. In considering temporality, the record is always 'past,' and the 'timeline' is recognized as a record of events first occurring in the 'present.' We can construct a 'timeline' that expands into the future by offering predictions based on probability algorithm. Supposing a Tibetan monk can foretell incoming events in advance of the present time, the meditation practitioner's present corresponds to the non-practitioners' future. This interpretation might increase plausibility in the idea of seeing the future as an action resulting from the conceptualization demarcating the three times that establishes the sequence of temporal progress. Given the alteration of attentional blink by meditation, the accurate detection of target stimuli is increased by optimizing the neuronal resources for stimuli. [4] Investigating meditation's effects on temporality in relation to neuroscience renders a new conceptualization of time, including the idea that predicting the future is not irrelevant to our ordinary experience and can be facilitated by meditation. I will discuss temporal latency of human cognition, using an epistemological approach of Buddhist meditation, based on the premise that consciousness creates time. [1] PNAS vol. 104, 2007. [2] Nature vol. 419 2002. [3] Hattori, Masaaki. Dignaga, On Perception, 1968. [5] PLoS Biology Vol. 5, 2007.

33. **Christian and Buddhist contemplative science: does either inform neuroscience?**

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Alan Wallace—founder and president of the Santa Barbara Institute for Consciousness Studies—has proposed that Buddhism and neuroscience can meet in a new discipline that he calls 'contemplative science.' Contemplation, from the Latin contemplatio refers to a total devotion to revealing, clarifying and manifesting the nature of reality. Wallace claims that certain Buddhist practice provides a method for empirically investigating human consciousness that provide a 'telescope for the mind.' The empirical results this practice generates about consciousness are said to be complementary to those obtained using 'hererophenomenological' method advocated by Dennett and others who deny the legitimacy of any first person science of consciousness. According to Wallace (2007), who follows William James in this, we must guard against confusing the rigor of the scientific method which gathers data through observation and experiment with materialism; their association is said to be merely a historical accident of 17th century mechanical science promoted by Bacon, Descartes and others. But can contemplative science provide information that is useful to neuroscience? An historical look at contemplative science that compares Buddhist contemplative practices advocated by Wallace today with those of historical and contemporary Christian contemplatives is very fruitful, especially since researchers like Mario Beauregard and Paquette (2006) have advocated a 'spiritual neuroscience' that seems very close to what Wallace proposes. That both draw on radically different metaphysical frameworks supports a point made by Ricoeur. Although Ricoeur (1992) agrees that contemplative reflection is essential to human experience and to developing personal identity, his blend of phenomenology and hermeneutic traditions lead him to claim that any contemplative reflection can never be entirely free of interpretations that frame our understanding of our own experience. What is more, various discourses about self, God, neurobiology and contemplation may never be reconciled (Changeaux & Ricoeur, 2000). However, all three approaches agree that first-person experience is not an illusion. Our first-person experience is itself testimony to our identity, and the refinement of that experience through contemplative practices can give an ever more refined and nuanced quality of the reality to which we testify.

34. **Stress-reduction and the cost of paying attention: focused attention vs. open awareness meditation.**

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Meditation has been described as a group of various attentional and emotional regulatory strategies (Lutz, Slagter, Dunne, & Davidson, 2008) and has also been defined as a state of consciousness where deep relaxation and increased internalized attention coexist (Murata, Takahashi, Hamada, Omori & Kosaka 2004). The present study investigated the relationship between focused attention and relaxation during a focused attention type of meditation and an open awareness type of meditation. Voluntary direction of one's attention may decrease stress, as measured by heart rate and heart rate variability (HRV). On the other hand, sustained attention may create mental fatigue and a narrow focus has been associated with stressful situations. To further explore the relationship between focused attention and stress, meditation instructions encouraging an open focus directed towards the background (e.g. the horizons) of a visualized scene were hypothesized to show more stress-reduction, as measured by HRV coherence, than narrow focused attention towards visualized objects in similar scenes. In a pilot study HRV data was collected from 19 subjects with none or little previous experience of meditation. A paired t-test showed no difference between the focused and the open meditation. In the main study 24 subjects who had some previous meditation experience participated. Among those who meditated more than 30 minutes per week (n=19) there was a significant difference, t(18) = -4,111, p = 0,001 for low coherence and t(18) = 2,332, p = 0.032 for high coherence. 20 of the 24 subjects also reported experiencing the open focus type of meditation as nicer or more calming, restful or relaxing. In conclusion this paper suggests that experienced meditators may reach a more harmonious state during an open focus emptiness meditation as compared to a focused attention type of meditation, while subjects with no previous meditation training may react differently to open meditation instructions. Clinical implications are discussed.

35. **Can subjectivity be explained away?**

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While the scientific frameworks are based on the third-person perspective without a subject, subjectivity is the realest and the most mysterious phenomenon in our consciousness. How do we explain subjectivity in a

physical world? Mechanistic explanations can provide a level-theory framework to explain a high-level phenomenon by lower-level and higher-level phenomena (Bechtel, 2009). For example, Metzinger's phenomenal self-model theory of subjectivity gives a lower mechanistic account of subjectivity by how representations operate to form a self-model. Moreover, in a level-theory framework, William Bechtel argues that we can accommodate both a reductionist's perspective from lower-level mechanistic explanations and an emergentist's perspective from higher-level mechanistic explanations, thus avoiding the commitment to mysterious high-level ontology. However, without a commitment to high-level ontology, the level-theory of explanations, I argue, is a kind of epistemic level-theory differing from ontological level-theories, and an epistemic level-theory is a reductionist's theory that can't account for downward causation. I argue that the mechanistic view of level-theory just provides a new version of bridge laws to theoretically reduce higher-level terms by a lower-level-theory, and the level-theory, without ontological commitment to high-level entities, is just a kind of reductive physicalism without emergent phenomena. In addition, ontological level-theories can solve the problem of downward causation, which is the most important aspect of subjectivity, by introducing lower-level entities with boundary conditions (Houng, 2009). So, based on the level-theory framework, we can't explain away the involvement of the ontology of subjectivity in a theory of subjectivity.

36. **A new way of explaining schizophrenia and the immunity to error through misidentification.**

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An important character of self-consciousness is that when we use the first-person pronoun in a self-referring way, it would be impossible for us to make a mistake. This character of self-reference is called the 'immunity to error through misidentification relative to the first-person pronoun' (IEM) (Shoemaker, 1968, 1996). Given that whether IEM is refuted by certain schizophrenic experiences (including thought insertion, auditory hallucination, and delusions of control) is yet to be decided, Gallagher (2000) suggests that this analysis implies that a scientific explanation of the mechanism of these schizophrenic phenomena may also account for how IEM works. Gallagher also suggests that Frith's model (1988, 1992) of the breakdown of self-monitoring in schizophrenia is a good candidate for explaining IEM. This presentation has two aims. First, I will argue against Gallagher's suggestion that Frith's model is a good candidate for explaining IEM. The main reason is that Frith's model of self-monitoring faces the infinite regress problem. If part of a system monitors the whole system, this monitoring part needs a sub-part to monitor the monitoring. Second, I will argue that the nested hierarchical view of the self (Feinberg and Keenan, 2005) provides a better explanation for schizophrenic phenomena and IEM because it avoids the infinite regress problem. According to the nested hierarchical view of the self, the brain is organized in an integrated multiple-level structure whose highest level is the self. Schizophrenic experiences happen when experiences fail to be integrated into the highest level of this structure. When an experience successfully integrates into the highest level, this experience becomes part of the self. Thus, the self cannot be wrong when referring to the subject of this experience. This new way of explaining IEM avoids the infinite regress problem because it does not presuppose a sub-system that performs the self-monitoring.

37. **An explanation of consciousness. What is the explanandum?**

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Consciousness is far from a clear and precisely defined phenomenon (see e.g. Ned Block 2007) and many different questions can be asked regarding consciousness. The explanandum – i.e. that to be explained – of an explanation of consciousness is therefore ambiguous. This ambiguity affects the explanandum as different events and phenomena require different explanations and have different explanandums. Therefore, a single explanation of consciousness will not be able to capture all the different aspects of consciousness. I will here oppose the idea of having one explanation of consciousness that explains every aspect. We should expect the explanation to be composed of different parts, in which each part explains a single event or phenomenon. However, we are not conscious of one aspect at a time. Rather, we have unified conscious experiences integrating multimodal aspects. I argue that we, therefore, need a framework able to integrate several explanations, i.e. the set of explanation, into a unified experience. I conclude that this approach provide the possibilities of capturing the different aspects and concepts connoted and denoted by consciousness. Thus,

different explanandums are possible and not a problem; they are a natural part of the overall explanation of consciousness.

38. **Explaining the experience of succession.**

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If one accepts that the succession of experiences is not the same as the experience of succession, there are two ways of explaining the difference. The primitivist strategy posits a relation between experiences that is itself experienced (Dainton 2005, Shoemaker 2003, James 1895). On this view, succession is a part of the content of an experience. The constructivist strategy posits a mechanism, which retains the just-had experiences in a sort of memory buffer (Gallagher 2003, Varela 1999, Husserl 1928). On this view, succession is interpolated from the contents of the buffer, but is never itself a part of the content of an experience. Primitivist views require that the subject be conscious of all the mental states bound by the relevant relation. This implies that at any given time at least two successive experiences are experienced simultaneously. Similarly, constructivism implies that just-had experienced continue to be experienced when they are in the memory buffer. This also implies that successive mental states are simultaneously conscious. These consequences are contrary to experience. Normally, subjects do not report seeing trails of moving objects, or hearing successive tones overlap into chords. I develop constructivist solution to this problem using David Rosenthal's higher-order thought theory of consciousness (Rosenthal 2005). On Rosenthal's view, a mental state is conscious only if the subject is conscious of it in virtue of having a thought about himself as being in that very mental state. On version of constructivism I present, the subject is normally not conscious of the just-had experiences in the memory buffer, and therefore never reports having them. Even though the subject is not conscious of them, the just-had experiences contribute to the construction of an experience of succession, about which the subject can report. I argue that only this kind of constructivist view can yield a workable solution to the problem. This is because, unlike primitivism, constructivism is not committed to the claim that a subject's reports about experiences are exhaustive of the reality of those experiences. Primitivism claims that succession is a basic feature of any experience, because that is how it appears to subjects.

39. **Do we need the environment to determine the content of consciousness?**

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In addition to our brain, what is sufficient for the content of consciousness? Thomas Metzinger, an internalist, argues that the stuff inside our body is sufficient to determine the content of consciousness. In contract, Alva Noë claims that our brain is not enough to do that. Alva Noë proposes that consciousness is constituted with the interaction between our body and the environment. In his view, the environment is one constituent of consciousness. The above two theories have different views when explaining our conscious experience. For instance they disagree on explaining our dream experiences. The internalists think that dream experience is like waking experience, since the brain is sufficient for consciousness. Dream experience is vivid and rich, so we can hardly distinguish dream experiences form the reality. However, the externalists emphasis the external environment is a constituted component of our experiences, so they argue that dream experience, which is condition without externally constituted components of consciousness, is fracture and not stable. In addition, they propose that dream is merely the byproduct of the mechanism of consciousness. In this presentation, I will use the research of REM sleep and dreaming, studied by Allan Hobson, to argue against externalism. First, Dream has its' own specific function because it provides a virtual reality model of the world. So, I argue that the mechanism of dream provides the fundamental elements to develop our consciousness experience, and consciousness is born from the closure box of body, rather than what externalist claim, consciousness is the product of interaction between the body and the environment.

40. **Extended consciousness.**

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The extended mind hypothesis holds that the cognitive system can extend beyond the brain and skin. In connection with this hypothesis, it is worth asking: How far can consciousness extend? Even among those who favour the extended mind hypothesis, some reject the idea that consciousness can extend beyond brain and skin, though some of these researchers argue for it. Interestingly, none of the moves that cut either for or against the extended mind hypothesis – not the parity principle (for), not the range of proprioception or of control by a basic action (against) – works for the issue of extended consciousness. If we look in a different place, at the unified phenomenal field that is central to unified consciousness, and ask what certain of its properties tell us about how far it extends, however, we can make some progress.

41. **Inattentional blindness exemplifies consciousness without attention.**

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One current debate in consciousness research concerns whether attention is necessary for consciousness. While some researchers have argued it is (Prinz 2000; O'Regan & Noe 2001), others have denied this (Lamme 2004; Koch 2007; Block 2007). Though experimental data have been brought to bear on this question (e.g., Sperling's experiments with iconic memory, or studies involving unilateral neglect), this has done little to settle the debate, since any given researcher seems able to accommodate the data in question within his theory of the relationship between consciousness and attention. In this paper, I argue that the phenomenon of inattentional blindness is most likely an instance of consciousness without attention. In an inattentional blindness paradigm (e.g., Simons & Chabris 1999), subjects often fail to notice an unexpected object as it passes through their visual field, even when the unexpected object is contextually bizarre (e.g., a man in a gorilla suit). In trials where the subject cannot report upon the unexpected object, it is clear that the subject is not attending to the object. (If she were, she could report upon it.) There is, however, reason for thinking that such a subject is nonetheless phenomenally conscious of at least some of the properties of the unexpected object. One reasonable assumption to make about the phenomenology of the subject is that she will be experiencing some color or another in the part of the visual field occupied by the unexpected object. It is natural to think that the color she experiences there will correspond to the color of the unexpected object. It appears, then, that part of the subject's experience is being determined by a representation of a property of the unexpected object (its color). We therefore should take subject to be, in some important sense, conscious of the unexpected object. Viewed in this way, instances of inattentional blindness appear to be instances of consciousness without attention. I will argue this conclusion can be denied only by holding that subjects lack color experiences in large parts of their foveal and parafoveal visual field. Introspection makes this view of visual experience seem implausible.

42. **Intentionalism and representational qualitative character.**

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Some mental states exhibit qualitative character, such as the bluish quality of a visual sensation. Other mental states exhibit intentional content, such as the content that it's raining of a belief. These properties are traditionally thought to be distinct mental properties. Intentionalists, however, maintain that a state's qualitative character is identical with or supervenes on that state's intentional content. Some intentionalists employ the Argument from Seeming (e.g., Byrne 2001, Thau 2002, Lycan 2006), according to which whenever qualitative character changes, things seem different to one. Since how things seem depends on how they're represented, it appears intentionalism follows. This argument succeeds only given the assumption that all representation is intentional. Though often assumed without argument, this premise is questionable. I argue that qualitative character is itself representational without thereby being intentional. A change in qualitative character may result in things' seeming different not because of a change in the way intentional content represents things, but because of a change in how qualitative character itself represents things. And if how things seem needn't be due to intentional content, the argument fails. Why think that qualitative character may be representational without being intentional? Intentional contents can be true or false, whereas mental qualities cannot be. Moreover, intentional states exhibit both intentional content and mental attitudes, such as belief and desire, toward that content; qualitative states, by contrast, exhibit nothing like mental attitude. These folk-psychological observations suggest that qualitative mentality is distinct from intentionality, but

they're compatible with qualitative character's being representational. A powerful theory of qualitative character shows how mental qualities can be representational, but in a nonintentional way. Quality-space theory (e.g., Sellars 1956, Rosenthal 2005) identifies and individuates mental qualities by their relative positions within quality spaces that match the quality spaces of corresponding perceptible properties. This suggests that mental qualities represent those perceptible properties. If undetectable quality inversion is conceivable, then qualitatively distinct states could be identical representationally and quality-space theory would fail. I argue, however, that such inversion isn't conceivable, since conceiving it requires assuming groundlessly that qualitative character is only known first personally.

43. **The interactive representation of the motor control.**

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Motor activities have been studied in terms of anticipatory systems and goal-directed systems. Do such activities bear content in any significant sense? This query seems hard to answer. On the one hand, such activities do not seem to be completely meaningless; they seem to be grounded on certain competence. Yet, on the other hand, the motor activities are clearly not managed by thought. Motor activities, are considered in Merleau-Ponty's (1962) notion of motor intentionality as activities that are between reflexes and deliberate actions (Kelly, 2000). Such activities, as Merleau-Ponty describes, are controlled by "a motor power, a 'motor project' (Bewegungsentwurf), a 'motor intentionality' in the absence of which the order remains a dead letter (Merleau-Ponty, 2006: 126-127)". But, the question remains as to what this "motor power" is. What sort of content do the motor activities bear and what is its bearer—representation? Grush (1997, 2004, 2007) and Pezzulo (2008)—two recent discussions on anticipatory behaviors—affirm the importance of representation on the basis of the standing-in-for relationship. The present paper does not deny this, but would argue that motor activities primarily bear the representational content that is not based on the standing-in-for relationship, but instead on the interactive relationship manifested in Bickhard's (1993, 2000) account of interactive representation. The present paper discusses the control structures of interactive representation and expounds them in the correction loops of the motor activities. As is argued, the interactive representation is genuine representation in the sense that orders of interactive systems tightly connect (via interactive, reciprocal, causal relationships) to orders of their performance. In addition, it is argued that some interactive systems (as manifested in motor systems) are cognitive because they maintain the accuracy of the goal-directed systems, and this is more implement for being cognitive then being a Popperian creature. Two examples of interactive systems—thermostat and the Watt Governor—are discussed with respect to the ways in which the interactive representation turns up in those two examples. The conclusion is that motor systems bear the representational content on the basis of the interactive representation.

44. **Consciousness and action control.**

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It is commonly held, both in folk psychology and in formal theorizing, that consciousness and action control are inextricably linked, in that the former is necessary for the latter. I'll call this the 'Conscious Control Principle' (CCP). More specifically, several theorists have argued that consciousness somehow enables the following functions associated with action control: response inhibition, action and target selection, and error correction. Evidence offered in support of CCP derives from studies using a variety of experimental paradigms, e.g., the exclusion task paradigm. Typically, these studies purport to show that participants can perform certain control tasks, e.g., response inhibition, only when task-relevant mental states, e.g., perceptions of task instructions, are conscious. The inference is then drawn that consciousness enables that type of control task. Further support for CCP relies heavily on the dual system visual processing model championed by Milner and Goodale (1995), which suggests that consciously available processing in the ventral stream is responsible for action and target selection. In light of all this, should we accept CCP? In this paper, I argue that we have no compelling reason to do so, at least in its present form. First, I critically review the main empirical results, and raise some conceptual and methodological worries. One concern is that it has not been established by proponents of CCP that it is the property of being conscious that is making the relevant difference, rather than a distinct property that merely co-occurs with being conscious. A second concern is that the central concepts of control and

consciousness are being used by some proponents of CCP in such a way that they presuppose the truth of the principle. I argue that both of these worries are worth taking seriously. Next, I offer an explanation of why many are pre-theoretically tempted to think that CCP is true. The explanation appeals to the mechanisms that generate the sense of control we typically have for our actions. Finally, despite my criticisms, I offer considerations in favor of accepting a weaker version of CCP, which claims that being in conscious mental states *facilitates* action control.

45. **The eyes as the gate to the mind: when consciousness wanders, does the gate slam shut?**

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Mindless reading occurs when a reader's consciousness drifts away from text comprehension but their eyes continue to move across the page. While the subjective experience of mindless reading is ubiquitous in real life, this phenomenon has received little attention in the scientific community, primarily because it is difficult to measure and manipulate in an objective empirical manner. Previous experiments have established the existence of mindless reading via subjective probing during reading periods. However, this method relies on participants to be aware of the contents of their experiences, realize that their mind have wandered away from the text, and then to report the episodes. Eye movements provide a good biological marker, and thus a potential objective indicator, that could be used to conduct empirically rigorous studies of mindless reading. Tracking eye movements creates a frame of reference for mindless reading, independent of the participant's subjective reports. In this presentation, we will describe our attempts to determine the best mathematical algorithm of eye movement indicators that distinguish normal reading from mindless reading. Our method involves first gathering data from the eyes in a task wherein participants are occasionally probed for mindless reading; thereby allowing us to compare the results of algorithms across trials where participants indicate their mind was or was not wandering. Effective algorithms are then further tested by using them to predict subjective reports "a priori" with the results of the algorithm determining when participants are probed.

46. **Double narrow content theory (DNC). Explaining phenomenal properties.**

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When I undergo a visual experience as of a red apple, there is something it is like for me to undergo it. A *redness* way to undergo it. We can distinguish two different aspects of the experience: the qualitative one (what it is like) and the subjective one (its for-meness). The theory I propose, the Double Narrow Content Theory (DNC), tries to explain these two interrelated aspects separately. The first part of the theory provides an account of the qualitative aspect. The qualitative aspect is what distinguishes among different experiences (for instance, an experience as of red from an experience as of green), what makes an experience the kind of experience it is. The theory I defend explains the qualitative aspect of an experience by its (narrow) content. The second part accounts for what makes of an experience a conscious one. A mental state is conscious iff it has a subjective aspect. I claim that, in order to explain the subjective aspect, we need to explain the kind of (pre-reflective) self involved in a conscious experience. This is not the elaborate sense of "self" we usually have in mind when we refer to a self. I am after some primitive processes that constitute the basis of this elaborated self. A proto-self (an antecedent of the self) can be identified, as the collection of neural patterns representing the internal activity of the organism. The interaction with the external world causes alterations in the internal states reflected in the proto-self. The subjective character or for-meness is, according to the DNC theory, explained by the representation of the interaction between the object and the proto-self and the phenomenal character of a mental state in virtue of its having a double intentional content: "redness for-me", With this theory I provide an unified account for two aspects that are seldom distinguished.

47. **Consciousness and the tribunal of experience.**

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Ned Block has recently renewed his attack on higher-order theories of consciousness. In one recent paper, "Consciousness and Cognitive Access," he has argued that empirical evidence suggests that it is false. The basic argument is as follows. We ought to evaluate theories of consciousness by how well they fit over-all with the body of empirical evidence that we have (the mesh argument). We have empirical evidence that seems to suggest that our phenomenology overflows our ability to report. The view that phenomenally conscious states can occur with cognitive access fits better with this data and so should be adopted. As evidence he cites Sperling's famous experiments. In that situation the subjects has a phenomenally conscious experience of all of the letters but is only able to report the letters in the row that they were cued. Block takes this to be an objection to the higher-order theory since he thinks it is a case of phenomenal consciousness without access. However, on a higher-order account like that of David Rosenthal, there is a ready response. One is conscious of one's own states in various respects. So in the Sperling case the subjects are conscious of the letters but just as letters not as determinate letters. The phenomenology does not overflow access if this is true. The phenomenology is just that it seems to the subjects that they are aware of all of the letters but not aware of each letter's identity and this is exactly what they report. So the higher-order view meshes just as well with the data. The same turns out to be true of Block's other overflow example in the Landman experiments. In that case the subjects are conscious of the array of objects and conscious of the shape that differs, but not conscious of it as the difference. Thus it doesn't seem to the subject that there is a difference. What does overflow in this case is information. So these results do show that there can be unconscious representations but not phenomenally conscious states that we cannot access. The methodological puzzle continues.

48. **The neuroanatomy of consciousness and the (multiple) boundaries of moral significance.**

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At ASSC13 I argued that if we are serious about our theories of the neural basis of consciousness, then we must take seriously their implications for assessing consciousness in non-human animals. In that talk, I focused on the question of how the most common theories might be combined with comparative neuroanatomy to draw conclusions about the mere presence of basic sensory consciousness, which is plausibly taken as a precondition for any sort of intrinsic moral status (e.g. possessing rights or being the subject of pleasure and suffering). In particular, I argued that animals such as fish, which demonstrably lack the sorts of neural structures that are required for dynamical cross-sensory feature binding, should be understood as lacking both consciousness and intrinsic moral status. Within the realm of conscious beings, however, both common sense and ethical theory routinely draw further distinctions; almost everyone agrees that it is worse to kill a human than to kill a mouse. In this talk I will explore what the neuroscience of consciousness can contribute to such further distinctions, focusing on two sub-types of consciousness which may mark off classes of animals with greater moral significance: (1) consciousness of self (2) social consciousness These hark back to approaches to consciousness which arguably peaked in the early 00s and have seen less attention of late (second-order/reflexive models and bodily self-representation; theory of mind and mirror neurons). While I believe the dynamic integration/GWT approach is superior as a foundational model, any such model will nevertheless be more useful if it can also account for these further distinctions. I will argue that this constitutes a prima facie reason to favor neuroanatomically rich approaches to consciousness (e.g. those which focus on thalamocortical dynamics) over those which abstract away the anatomy to focus on numerical measures such as Φ. In closing, I will consider whether comparative neuroanatomy can help to clarify the boundaries of these two narrower categories. I'm skeptical whether neuroanatomy is likely to tell us much more about (2) than we can already gather from ethological and experimental evidence, but the prospects for (1) seem somewhat better.

49. **Operationalising what?**

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Operationalising what? The problem of whether reports or behaviours are the best way of operationalising consciousness is particularly clear when they conflict, such as in change and inattentional blindness (see e.g. Block, 2007, Mack & Rock, 2000). Based on the idea of perception as hypothesis testing (see e.g. Friston, 2005),

it is argued that conflicting reports and behaviours are a natural product of a multi-stream perceptual system. None of these streams better reflect the real 'contents of experience', but the existence of 'default' reported levels of hypothesis generation may explain our intuitions about consciousness. Using the case study of partial report superiority (Sperling, 1960, Landman et al., 2003, Sligte et al., 2008), the different roles, informational input and time-frames of gist and item-specific processing are explored. This shows how hypotheses determining reports of scene gist (rich content) are produced in parallel to those that drive behavioural capacities (sparse content). In predictable environments, gist level hypotheses typically provide correct descriptions of scenes and constitute our 'default' description of experience, but in unpredictable environments gist level hypotheses may be incorrect (de Gardelle et al., 2009). Conflicts between rich reports and sparse behavioural capacity should not be seen in terms of the amount of content in experience, but how accurate hypotheses are. Gist hypotheses are not indicative of the 'illusion' of richness, but they can be wrong in certain contexts. This model of report generation and behavioural capacity in terms of multi-stream hypothesis generation suggests that there is no 'right' way to operationalise consciousness. Different operationalisations (including introspective techniques) access the products of different processing streams. In this case, consciousness is not a single stage or type of processing that can be better or worse accessed using reports or behavioural tasks, but refers to a shifting range of more or less detailed, and more or less accurate, hypotheses about the contents of an environment. Research into hypothesis generation in different perceptual streams can provide explanations of reports, behaviours, and our intuitions about consciousness, and avoids the problems of identifying the 'correct' operationalisation of consciousness.

50. **Empirically testing purported non-symbolic consciousness claims using standard psychological methods.**

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Alleged non-symbolic experiences have been reported for millennia. These experiences are often attributed to spiritual and religious contexts, however atheists and agnostics also report them. They go by many names, popular ones include: nondual awareness, enlightenment, mystical experiences, peak experiences, transcendental experience, unity consciousness, union with God, and so forth. Most non-symbolic experiences are temporary, but some are reported as persistent. Virtually all of the information about persistent forms comes from self report data. No comprehensive empirical investigation of persistent forms of these alleged experiences has been undertaken and completed. This presentation focuses on one that is underway, and includes preliminary data as well as an overview of the inquiry and what remains to be done. The overall inquiry focuses on three phases comprising many data collection efforts, each of which are quasi- or full experiments. The first phase involves obtaining comprehensive psychometric profiles of individuals who self report these experiences, as well as relevant qualitative data. Examples of measures used in this phase include those covering: psychopathology, big 5 personality, anxiety, absorption, and developmental levels. The second phase involves testing psychological claims made by people who self report these states using well validated psychological experiments. These claims are often considered untestable because they are put forth in a spiritual or religious context, and frequently used to refer to 'ultimate' truths. However, when viewed as psychological there are many empirical tests and measures that can be used to examine the scope of claims being made. For example, claims of 'loss of a personal self' and 'unity' can be tested from many angles. 'Self,' as these participants define it, contains racial and gender bias, so loss of this 'self' should lead to scoring low on covert tests for this type of bias. Claims of unbiased perception of the world and of seeing 'what is' much more accurately can likewise be tested in many ways, such as by using experiments involving visual inattentional blindness. A third phase will commence after the first two are completed and will focus on brain imaging based on the data collected in phases one and two.

51. **How 'epi' are phenomena? -- Philosophical vs psychological epiphenomenalism.**

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The word Phenomenon comes from philosophical Greek referring to the appearing to one, of sense data, mental images, or thoughts in the mind. Epi-phenomenon comes from more whimsical Greek for surface, superficial appearances. To argue that 'consciousness' has causal efficacy -- does something to something --

necessitates (a) defining what consciousness is and (b) specifying what consciousness does. Psychologist Max Velmans maintains that conscious experience creates a phenomenal world around us, and thus allows the universe to look in on itself, and that conscious experience is responsible for the development of science, but denies that conscious experience has causal efficacy, even in cognitive processing, citing Wegner, Libet, and others. Velmans appears to hold what I label a form of empirical epiphenomenalism, which I argue is contradicted by the bulk of modern consciousness science. Philosopher Bill Robinson presents a form of philosophical epiphenomenalism, in which phenomenalism and physicalism are given their due, but never the twain shall meet. For Robinson, the existence of tasks -- which can be done only through activation of brain processes that also cause conscious events -- is not an argument against epiphenomenalism. Dan Dennett helps me articulate my intuitive sense that Velmans and Robinson mean very different things by epiphenomenalism -- an empirical (psychological, physiological) epiphenomenalism versus a philosophical epiphenomenalism. I make a case against empirical epiphenomenalism, while remaining agnostic regarding philosophical epiphenomenalism -- presumably the opposite moves that Dennett makes!

52. **Implicit coherence detection – how emotions regulate unconscious bases for intuitive choice.**

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The presented research considers implicit processing of semantic coherence. Previous research has shown that semantically coherent word triads (i.e. three words that share a common associate) are detected without conscious access to the fourth word (a solution). Furthermore, this process can be facilitated or inhibited when the solution word induces positive or negative affective response, respectively. Current research examines to what extent semantic coherence detection is unconscious and automatic. In two experiments participants were shown semantically coherent and incoherent words triads and asked to judge their solvability either under dual or single task conditions. The secondary task required constant monitoring of a stimulus position on a computer screen and keeping it within limited space by pressing the spacebar. The results have shown that under dual task the overall accuracy of solutions decreased whereas the accuracy of solvability judgments was intact compared to single-task conditions. This suggests processing of semantic coherence to be indeed automatic and implicit. Detection of this coherence might (but not always) be followed by conscious access to the solution (insight), but this requires more effort and resources.

53. **The effect of intention-based and stimulus-based action in temporal reproduction.**

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Time perception is an essential aspect of human consciousness. Despite its significance in mental life, the detailed mechanisms of temporal processing are still unclear. States of intention (Haggard et al. 2002) and sensorimotor contingency (Moore & Haggard, 2008) are the key components in constructing the subjective sense of time. Studies on the effect of sensorimotor contingency on time perception often focused on the perceived timing of events. Here we focused on the perception of duration, an important aspect of temporal consciousness. Voluntary movements can be classified into two types based on the trigger of action initiation, i.e., stimulus-based and intention-based (Waszak et al. 2005). A stimulus-based action is triggered externally, where the subject generates a movement as a response to a sensory stimulus. In contrast, an intention-based action is driven internally without the trigger stimulus. The stimulus-based and intention-based movements are accompanied by differential senses of introspection. Waszak et al. (2005, 2006) suggested that different neural mechanisms were engaged in these movements. Based on the available neurophysiological evidences, we hypothesized that our perception of duration would be differentially affected by sensorimotor contingency in stimulus-based and intention-based movements. In the present experiment, we used the duration reproduction paradigm, in which the subjects reproduced the interval of reference durations (1,3 and 5[s]) by continuously pressing the key. In the stimulus-based condition, the timing of the initiation of key pressing was driven externally by a trigger stimulus. In the intention-based condition, the subjects started the key pressing at their own timing. Results showed that the subjects reproduced the reference duration significantly longer in the intention-based condition than in the stimulus-based condition for the durations of 3 and 5 [s]. There was no

significant difference for 1[s]. These results suggest that the perceived duration of time is affected by the nature of action trigger. The specific nature of neural processes leading to the initiation of action thus becomes an essential element of subjective time perception, to be incorporated into the broader context of sensorimotor contingency.

54. **The hidden observer effect, cognitive effort and involuntariness: a real-simulator investigation of streams of consciousness.**

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The notion of streams of consciousness is rooted in the history of hypnosis. Revived and rejuvenated by Hilgard in 1979 under the label of the Hidden Observer, the notion of dissociation and its latest embodiment, the Hidden Observer, has been hotly debated amongst hypnosis theorists and remains to this day controversial. According to Hilgard (1979), some subjects while hypnotized, are able to experience the Hidden Observer effect, a subjective experience of a "divided" consciousness . The present study explored the Hidden Observer effect during hypnotic items of low, medium and high difficulty index and assessed the role that demand characteristics play in shaping real and simulator participants' responses to this suggestion. Sixty subjects who were previously screened on the Harvard Group Scale of Hypnotic Susceptibility (HGSHS: A) participated in an individual hypnotic session using a modified version of the Stanford Hypnotic Susceptibility Scale (SHSS:C), with ten hypnotic suggestions and the introduction of the Hidden Observer phenomenon. Those who had passed nine or more suggestions on the HGSHS:A were classified as high hypnotizables (HiGroup), while those who passed three or fewer suggestions were classified as low hypnotizables (LoGroup). A third group of participants (simulators; SIMGroup) consisted of low hypnotizables asked to simulate being highly hypnotizable to a blind experimenter. Subjects' ratings of perceived effort and involuntariness in carrying out six of the hypnotic suggestions (3 ideo-motor suggestions; 2 challenge suggestions and a sour taste hallucination) were compared to ratings obtained during the Hidden Observer condition, as well as between groups. The results presented here have numerous implications both for the validity of the concept of the Hidden Observer, and for theories that support an altered state view of hypnosis. While the idea of diverse streams of consciousness may feed into a more romantic view of the mind, it may be more fruitful to view the Hidden Observer phenomenon as a temporary attentional shift triggered and guided by extrinsic cues and intrinsic abilities.

Poster Session 2: Sunday, June 27th

Venue: St Patrick & St David rooms (3rd Floor)

1. Unsupervised visual one-shot learning as restoration of degraded images: a novel morphing paradigm.

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Studying various aspects of visual perception provides a salient tool for clarifying the nature of awareness and consciousness. Considerable cognitive efforts are needed to perceive surroundings in scotopic vision, as color information is useless and spatial resolution is much lower than usual. The same holds true for seeing hidden figures such as the grayscale picture of a cow (Dallenbach 1951) and the tow-tone image of a dalmatian (Gregory 1970). The segregation of figure from ground is ambiguous in these degraded pictures. The dramatic transition from an unconscious impasse to a conscious epiphany is thought to be a special type of learning called visual one-shot learning. In the insightful moment when subjects perceive "Mooney" faces (Mooney 1957), neural synchronization spreads all over the brain which lasts for about 100 milliseconds (Rodoriguez et al. 1999). In general, when "Mooney" objects and their original grayscale photographs are presented alternately, activities of inferior temporal and parietal regions are enhanced (Dolan, et al. 1997), and the early retinotopic cortex is modulated by top-down interpretation (Hsieh, et al. 2010). The activation of left amygdala predicts memory performance one week later in a similar paradigm (Ludmer, et al. in prep.), suggesting the importance of emotional aspects of one-shot learning. The abrupt realization of the hidden figure provides a robust experimental tool to investigate the nature of conscious visual perception in its systematic and temporal richness. Here we present a novel procedure to clarify the behavioral characteristics of unsupervised visual one-shot learning involved in the perception of hidden figures. By morphing "Mooney" objects with the original grayscale images, figures of varied perceptual difficulties were produced. Through the variation of morphing and temporal transition parameters, we constructed an external means of controlling the perception of the figure in the conscious domain. Morphing provides a means of dynamically probing into the cognitive processes of one shot-learning, as opposed to the static approach of the conventional hidden figure. Based on the analysis of results, we shed light on the interaction of conscious and unconscious processes involved, and discuss the implications in the context of findings in the previous studies.

2. Physical delay but not subjective delay determines the learning rate in prism adaptation.

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Timing is critical in determining a causal relationship between 2 events. Particularly in motor adaptation, to determine the preceding control signals responsible for the subsequent error in a resultant movement, the timings of the action and the results are extremely important. In prism adaptation in humans and monkeys, an artificially induced temporal delay in error feedback (as short as 50 ms) reduces the learning rate. However, recent studies have shown that our sense of simultaneity is surprisingly flexible and plastic when a persistent delay is introduced into the visual feedback timing of our action. Therefore, judgment of 2 subjectively simultaneous events, or subjective simultaneity, does not necessarily correspond to the simultaneity of the physical events. Our study attempted to evaluate the effect of adaptation to a temporal shift of subjective simultaneity on prism adaptation by investigating whether prism adaptation depends on the physical timing or subjective timing. First, the participants conducted 60 trials of pointing movements in which the pointing location was shown after a short delay of 100 ms (delayed visual feedback). By measuring the points of subjective simultaneity, we confirmed that the subjective temporal difference between the time of pointing (when the participant touched the screen) and the time of delayed visual feedback was significantly reduced ($P < 0.01$; paired t-test). Thus, the participants' subjective simultaneity adapted to the delay. Then, while maintaining the temporal adaptation, the participants adapted to the spatial displacement caused by a prism with the same delayed visual feedback. We investigated the participants' learning rate during the displacement

and found that the rate was significantly lower than the rate without the delay and not significantly different from the rate with the delay (at $P < 0.05$ level after correction for multiple comparisons by Tukey's test). Therefore, our results indicated that the learning rate was consistently predicted by physical timing and not by subjective timing. Our result implies that prism adaptation is independent of subjective timing awareness and may be dominated by physiological processes in the primary motor areas that are considered to be associated with physical temporal relationships.

3. **Transfer of prior knowledge in implicit learning.**

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Our research project aim is to check whether natural-world rules acquired before implicit learning experience and then incorporated into implicit learning task and built into the learning material influence the way in which new rules are being learned implicitly. We also investigate whether the organization of material (intrinsic rules) facilitate or inhibit acquiring of new knowledge. Three experiments addressed the question whether implicit learning depends on rules associated with task material. All experiments used the same basic procedure consisting of acquisition and classification phase. The differences between experiments concern the structure of artificial grammar. We used Markovian artificial grammar proposed by Dienes (experiment 1), bicondicional grammar by Mathews (experiment 2), and our own non-sequential grammar (experiment 3). The last one was composed to avoid the sequential structure implemented in other grammars. The strongest conclusion from the results so far is that the more grammar is based on sequential rule the stronger learning effect is observed. Participants are unable to learn grammars that non-sequential rules. It suggests that similarity of natural-world rules built into the material to new rules learned in the implicit learning task facilitate learning. We conclude with proposals for further testing of this hypothesis.

4. **How do we find words in implicit artificial language learning?**

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Implicit learning is often viewed as a central mechanism in natural language learning. In line with this idea, recent studies have shown that infants and adults could identify the "words" of an artificial language in which the only cues available for word segmentation are the transitional probabilities between syllables. However, the exact nature of the learning mechanisms and of the computational models that can account for these results remains controversial. According to one class of models, statistical learning amounts to parse the speech stream by forming chunks between adjacent elements. In this view, the sensitivity to statistical regularities is an emergent property following from the acquisition of rigid, conscious, word-like representations. According to a second class of models (the Sequential Recurrent Network, SRN) learning is based on the computation of the statistical regularities present in the input. The ability to extract words out of the speech stream is then rooted in the processing of the basic statistical properties of the material. Learning occurs automatically and implicitly and the knowledge of the words follows from the flexible sensitivity to the transitional probabilities of the material. In order to contrast these two hypotheses, we ran experimental and simulation studies in which we studied, within the context of a Serial Reaction Time (SRT) task, the participants' and model's ability (1) to process statistical contingencies between non-adjacent elements and (2) to flexibly learn different artificial languages composed of a different set of words but sharing the same transitions between successive elements. These two kinds of linguistic regularities are indeed particularly challenging for models based on chunking processes. Our results show that the SRN can account for the essential features of human behavior suggesting that implicit statistical learning might be more powerful than previously anticipated and can indeed constitute a central mechanism of language processing.

5. **Measuring consciousness in implicit learning process.**

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The aim of the presented study is to establish what kind of procedure would be more sensitive in assessing nonconscious learning processes in a artificial grammar learning task (Manza, Bornstein, 1995). In AGL task subjects are asked to remember some set of letter strings which are built by using rule system. The main finding is above-chance level classification of novel letter strings which are generated from the same rule system with little, if any, conscious knowledge of the underlying rules of grammar. Lots of researchers assert that AGL may be mediated by explicit learning processes. The main problem is that subjects are informed of rule system existence prior to the classification task so they could use this explicit information to guide their subsequent classifications. Manza and Bornstein (1995) proposed to use method based on mere exposure effect paradigm. This effect occurs when exposure to unfamiliar stimuli lead to an increase in positive affect toward this stimuli. So they proposed using liking task in AGL as more sensitive measure of implicit learning process rather than rule-conformity task. In presented study participants were divided into four groups. Experimental groups had to memorize grammatical strings of letters as in standard artificial grammar learning procedure. Control groups did not learn anything. Next, one experimental group was asked for classification task – if letter string is grammar or not. The second one was asked for liking task – they decided about liking letter strings or not. The same classification task did both control groups. The results indicate that participants making rule-conformity judgments were more correct than participants who made liking decision. It means that subjects have some conscious knowledge of artificial grammar and information about rule system existence can lead to increase of correctness in AGL classification task.

6. **Semantic eye-blink conditioning; a paradigm to test abstract categorization and learning in DOC.**

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The presence of conscious processing relies on voluntary overt responses. Patients suffering from disorders of consciousness (DOC; vegetative state, minimally conscious state), however, do not overtly respond to external cues, thereby posing difficulties when assessing their residual cognition and awareness. Recent studies have focussed on two main aspects of consciousness in DOC - the understanding of language, and the ability to show trace conditioning. A well established language task, made up of several hierarchical aspects: (1) auditory processes, (2) speech-specific processing, and (3) semantic information, has already shown to be of great value in indicating the extent of residual language comprehension in DOC patients (Coleman et al., 2007, 2009). In addition race conditioning, known to rely on awareness, requiring explicit declarative knowledge of the temporal contingency of the stimuli, has been shown in a subset DOC (Bekinschtein et al., 2009). The current study brings these two aspects together into one paradigm. Rather than tones, words are used as the conditioning stimuli in a differential eye-blink trace paradigm in which the semantic category of the stimulus (animal/object) predicts a subsequent air-puff delivered to the eye. In order to decipher the predictive value of a stimulus the individual must rely on abstract features of the stimuli than simple tone discrimination. To our knowledge, there have been no previous studies of semantic conditioning. The purpose of the present study is to provide control data from healthy volunteers in order to establish the validity of this paradigm. Data from the control group will be presented, along with some preliminary data from DOC patients. We'll discuss the efficacy of this test as an affordable and simple bed-side test to establish aspects of residual cognition and awareness.

7. **EEG correlates of conscious versus unconscious knowledge in artificial grammar learning**.

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The current study investigated the neural correlates of knowledge and the conscious status of knowledge in artificial grammar learning. In the training stage, subjects were exposed to grammatical strings which were displayed one letter a time. Subjects were asked to type the string back. In the test stage, subjects classified strings as to whether they had the same structure as the training strings. Then they indicated the basis of that

judgment: guessing, intuition, familiarity, rules or memory. Tests strings violated repetition structure in the final (fifth) letter. In the test stage, the electroencephalogram was recorded while the fifth letter of each string was displayed. We were interested in two event-related potential (ERP) contrasts: 1) grammatical strings versus matching ungrammatical strings which violated repetition structure; 2) unconscious structural knowledge attributions (random, intuition, and familiarity) versus conscious structural knowledge attributions (rules and recollection) when subjects classified correctly. Ungrammatical rather than grammatical strings elicited greater N2 amplitude at the frontal electrode positions (Fpz/Fz/F4/F6), indicating that N2 amplitude is a useful marker of knowledge of grammaticality. Additionally, the P300 component was higher for conscious rather than unconscious attributions at frontal-central electrode positions (FCz/Cz C3/C5), indicating P300 is a useful marker of the conscious status of structural knowledge.

8. **Conscious and unconscious thought in implicit learning.**

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Unconscious Thought Theory has recently received considerable interest in the area of cognition. It posits a period of distraction after stimulus presentation leads to unconscious processing and can enhance decision making relative to conscious deliberation or immediate choice (Dijksterhuis, 2004; Dijksterhuis & Nordgren, 2006). Support thus far has been mixed. In the present study, intermediate phases were introduced into the artificial grammar learning paradigm between training and testing. Participants engaged in conscious deliberation of grammar rules, were distracted with an unrelated mathematical task for the same period of time, or else progressed immediately from training to testing. In the test phase, the conscious status of participant's structural knowledge was assessed using the method of Dienes and Scott (2005). There was a significant interaction between intermediate phase and structural knowledge type (conscious or unconscious). Immediate progression and distraction led to higher classification accuracy based on unconscious knowledge than rule discovery. Conversely, rule discovery and distraction yielded higher classification accuracy based on conscious knowledge than immediate progression. Thus, no evidence of unconscious thinking was found. Distracted participants performed as well as immediately progressing participants in terms of unconscious knowledge and as well as rule discoverers in terms of conscious knowledge. Results suggest both conscious deliberation and distraction promote conscious knowledge in a complex rule-based task. Furthermore, conscious deliberation deteriorates the quality of intuitive responses relative to distraction or immediate decision making. Hence, beneficial effects of a distraction condition cannot automatically be taken to indicate unconscious thought.

9. **Transient neglect: visual working memory mediates conscious visual perception.**

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What are the neural processes that support conscious visual perception? Evidence may come from visual neglect, a neurological disorder in which patients display profound impairments in conscious awareness for visual stimuli in the contralateral visual field. Visual neglect typically occurs following lesions around the right temporoparietal junction (TPJ), and is characterized by deficits in selective visual attention, and visual working memory (VWM) performance. Functional magnetic resonance imaging (fMRI) studies have identified brain areas that show VWM load-dependent activity: the bilateral intraparietal sulci (IPS), lateral occipital (LO) cortex, and anterior cingulate regions show an increase in activation with load, whereas the right TPJ becomes increasingly deactivated with increasing VWM load. In the current study, we tested whether increases in VWM load and the concurrent deactivation in the right TPJ may be associated with lateralized impairments in conscious visual perception. Our behavioural results demonstrate that conscious report for objects presented under a high-VWM load is impaired relative to a low-VWM load, and that recognition performance was worse for bilaterally presented objects. Interestingly object recognition performance was significantly impaired for items presented in the left visual field, but only under a high-VWM load. Thus, the behavioral results resemble the deficits observed in visual neglect, as conscious visual perception was impaired for objects presented in the left visual field under a high-VWM load. Using multivariate fMRI analyses techniques, we further demonstrated that activation in VWM regions increased with both VWM load and number of objects presented. Furthermore,

this activation was strongly correlated with object recognition performance. The timing of activity also suggested that the amount of information that reaches the levels of processing necessary for conscious object perception may be limited by capacity-limited VWM resources. Therefore, our results provide evidence that information must not only be attended, but must also be processed in VWM before it can be accessed at the conscious level. In other words, when cognitive and neural VWM resources are depleted, conscious object recognition is impaired. These findings provide insights into the cognitive and neural processes that support visual awareness of a given percept.

10. **Trade-off in the effect of attention for visual short term memory.**

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Failures of perception such as change blindness (Rensink et al. 1997) provide insights into the nature of visual consciousness. Visual short term memory is an important constituent of visual awareness in its temporal manifestations. Paying attention to a particular aspect of an object tend to reduce vulnerability in memory probes in that context (Makovski et al. 2008, Griffin and Nobre 2003). Paying attention to a particular feature, however, might also lead to failures in the perception of others. Even when selective attention is absent at the time of encoding, attending to a particular aspect at the time of recall might lead to the disruption of other features. Such a co-existence of enhancement and disruption would illuminate the nature of visual short term memory, and visual consciousness in general. Here we conducted a visual short term memory experiment using easily distinguishable and yet forgettable stimuli in a delayed matching task. The experiment consisted of the learning, recall and recognition phases. In the learning phase, the subjects viewed an array of four objects consisting of nonsensical line drawings, followed by blanks of multiple durations. During the recall phase, on the presentation of an arrow cue, the subjects were required to recall one of four objects corresponding to the cue. In the recognition phase, a memory probe object was presented, where subjects were required to answer whether the object was at the indicated location ("valid"), or at one of the other locations ("invalid"), or a novel one ("novel"). The results show that when the interval between learning and recall was sufficiently long, the probability of the subject incorrectly answering "novel" for an "invalid" stimulus was significantly higher, while the correct recognition of valid object was enhanced by a cue. Thus, focusing on a particular aspect in recall results in the enhancement of relevant information, while irrelevant information is degraded, even when there was no attentional asymmetry during encoding. Taking our results together with recent findings, we discuss the trade-off in the effect of attention for visual short term memory.

11. **Perceptual object priming in the absence of recognition memory.**

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Priming is a phenomenon whereby a previous encounter with a stimulus enhances the ability (e.g. faster reaction times (RTs)) to classify, identify or produce the same or a related stimulus. Although priming has been extensively studied, very little is known about when perceptual object priming can occur under conditions of inattention and with total absence of recognition memory. In experiment 1, participants studied line drawing pictures of objects in two encoding conditions: deep (animacy decision) and shallow (identifying the number of red dots presented within an image). At test, they engaged in an object decision task (ODT) in which pictures of real and unreal objects were presented very briefly (30 ms) followed by a recognition memory test. Significant priming, measured through RTs during the ODT, was observed for studied (deep + shallow) objects, indicating that participants were faster overall for studied than for unstudied/new objects. When the data were split into three conditions (deep, shallow and new) a strong trend to significant priming was obtained, but only shallowly encoded objects showed significantly faster RTs than new objects. Critically, both unrecognised deeply and shallowly encoded objects were judged significantly faster than new objects. However, an interaction between condition and memory approached significance, indicating that recognition memory awareness slowed participants down to a greater extent on deeply than on shallowly processed objects. In order to understand if this memory awareness could have been responsible for the lack of priming for deeply processed objects overall, experiment 2 was designed so that a group of participants performed the object decision task while another group was engaged in a recognition memory test. Here, significant priming was observed for both

deeply and shallowly processed objects, confirming that recognition memory awareness may have indeed affected RTs of deeply (but not shallowly) encoded objects in the first experiment. To our knowledge, these experiments have been the first to observe perceptual object priming in which, even under conditions of inattention (conscious processing of stimuli was not required in the shallow task), participants retained an unconscious perceptual record of objects which improved their performance in a subsequent perceptual test.

12. **Ouija and the ideomotor effect: when implicit memory turns explicit.**

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The ideomotor effect (Carpenter, 1852) is the production of actions that are unconsciously initiated, strongly associated with a loss of the sense of agency, and convey a thought rather than respond to sensory stimulation. A commonly known example of this is the Ouija game. Here, a movable indicator (planchette) is placed upon a flat board marked with letters, numbers, and the words “yes” and “no”. Players ask a question, position their fingers on the planchette and follow it as it moves about the board to spell out messages. Two important characteristics of Ouija are the absence of a sense of agency, and the meaningfulness of the answers. We propose using Ouija to explore the ideomotor effect--in particular, to determine if meaningful answers can be obtained in the absence of conscious thought. In this presentation we describe the results of a preliminary study comparing access to semantic long term memory with and without the use of a Ouija board. In the Non-Ouija condition participants answer questions by “yes” or “no” according to what they think, and rate the confidence level of their response. In the Ouija condition they are presented with the same questions but use the Ouija board, following the planchette when it moves toward the “yes” or “no” answer without interfering with its movement. A necessary condition for the ideomotor effect is that the player attributes the origin of the movement to an external source. To accomplish this, each participant is paired with an experimenter pretending to be another participant. The real participant is then blindfolded, so he cannot see that he is the only one touching the planchette. Performance is then analyzed as a function of the conditions (Ouija / Non-Ouija) and confidence level. Preliminary results indicate that in the Non-Ouija condition participants guess the percentage of correct answers at chance levels; when the same questions are answered with the Ouija board the percentage of correct answers significantly increases. This suggests that ideomotor effect may be useful in determining the contents of implicit memory.

13. **Recognition memory with or without subjective confidence: qualitative differences.**

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A variety of evidence suggests that recognition memory is not process pure. In light of this evidence, our goal is to establish the effectiveness of a variety of subjective measures at distinguishing between different components of recognition memory. Subjective, or “claimed awareness”, measures require the observer or the rememberer to report on their subjective phenomenal awareness while performing an experimental task. To establish the validity of these measures, we tested for qualitative dissociations between recognition memory judgments that were made in the presence versus the absence of subjective confidence. The experiments employed a generate read manipulation at encoding. At test, three main paradigms were used to assess participants’ subjective confidence at the time of retrieval. The first paradigm required participants to make a 2 alternative forced choice (2AFC) memory judgment concerning which of two words was old, and then to rate (on a scale from one to four) how confident they were in the accuracy of this decision. The second paradigm presented three words at test (one old, two new). Participants had to decide which of the three words was old, and then to make a second choice concerning which of the remaining two words was more likely to be old. The third paradigm was an adaptation of the unconscious perception paradigm developed by Merikle and Reingold (1990). On each trial during test, two words were presented (50% of trials = two new words, 50% = one new word, one old word). Participants answered 2 questions: 1. Is either word old? (response options in Experiment A: strong yes, weak yes, weak no, or strong no; response options in Experiment B: remember, know, or new) and 2. Which word is old? We examined question 2 performance contingent on whether the participant made an old or a new response during question 1. Overall, we report evidence that participants can be above chance on a 2AFC memory task in the absence of subjective confidence. Importantly, we also discuss evidence for

dissociations between memory performance in the presence versus the absence of subjective confidence at the time of retrieval.

14. **The duration of awareness during interocular suppression correlates with subsequent memory.**

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Presenting dynamic noise to one eye can completely suppress conscious perception of stimuli presented to the other eye for long periods of time. At particular stimuli contrasts, interocular suppression is occasionally interrupted, leading to periods of awareness. Here, we investigated the relationship between the duration of awareness of visual objects and the strength of subsequent memory. Subjects were exposed to visual objects under interocular suppression while they reported periods of object awareness. Memory for these objects was later tested with a 2-alternative forced choice discrimination task, followed by a confidence judgement of the response. We found that discrimination performance was at chance for objects that were never consciously perceived, but significantly above chance for objects that were perceived for at least a fraction of the presentation period. Moreover, discrimination performance for perceived objects increased with increasing duration of awareness, and resembled the performance obtained for control objects that were binocularly presented for periods that mimicked subjects' reports of awareness. For perceived objects, discrimination responses were more often correct when followed by a high-confidence judgement than by a low-confidence judgement. In contrast, for unperceived objects, the frequency of correct responses followed by high- and low-confidence judgements was equal, both at chance level. Thus, confidence judgements reflected memory performance for perceived objects but not for unperceived objects. Taken together, our results suggest that discrimination memory depends entirely on the access of visual objects to awareness, and thus support the use of discrimination memory performance as a reliable and objective measure of conscious perception.

15. **Anosognosia of memory impairment in dementia: a population-based study.**

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Objectives: This study investigated the prevalence of anosognosia of memory impairment in dementia in large surveys from different international regions. As a subsidiary aim it investigated socio-demographic and health correlates of anosognosia, and also the association of anosognosia with cognitive variables and behavioural and psychological symptoms of dementia (BPSD). Design: Cross-sectional population-based survey. Settings: Community samples (n=15,022) from three world regions (Latin America, China and India). Participants: 1189 people with dementia identified from standardized interviews and diagnostic algorithms. Measurements: Two variables were created to measure anosognosia of memory deficits: the first based on discrepancy between patient subjective report and objective results on memory tests and the second comparing patient and caregiver report about memory problems. The prevalence of anosognosia was calculated for each region and prevalence risks were calculated through Poisson regressions to assess the relationship between unawareness and demographic, behavioural and cognitive factors. Results: Regional differences in the prevalence of anosognosia of memory impairments in dementia were found, with less awareness in India. Some demographic variables, such as educational level and socioeconomic status, showed an association with unawareness of deficits in certain regions. The anosognosia variable based on caregiver report showed a greater relationship with behavioural and psychological symptoms, such as delusions, anxiety and mania, while the anosognosia variable based on comparison with performance was associated with cognitive variables such as memory, fluency and orientation impairments. Conclusions: Anosognosia of memory impairment is very common in dementia but varies across international regions. Anosognosia should be seen both as a common neurobiological feature of dementia, but also influenced by social and cultural factors.

16. **In and out of consciousness: The role of visual short-term memory.**

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What is involved in maintaining a visual percept in conscious awareness? We approached this question by using a typical shape-from-motion (SFM) display, in which fragmented line-drawings of an object move relative to a background of randomly oriented lines. When static, the fragmented line-drawings are indistinguishable from the noisy background, but when motion is added, observers become aware of the figure. The resulting percept of the object persists after the motion has stopped (stop condition), but only briefly, as it very quickly disintegrates into the noisy background. Despite one's continued effort to maintain the percept and in the absence of any change in the content of the perceptual array, the coherent figure is rendered inaccessible to awareness. Interestingly, when the lines are removed after motion off-set (vanish condition) the figure is no-longer perceived, suggesting that the persistence and fading of this visual percept is not merely a function of motion-induced neural activity. We wanted to examine whether visual short-term memory (VSTM) is involved in sustaining a coherent percept during the persistence period and whether VSTM may be a precondition for phenomenal consciousness. Participants observed SFM displays that were presented bilaterally and were asked to indicate, with a button press, how long the object percept persisted after the motion stopped. While participants performed this task, we measured their brain activity using electroencephalography (EEG). Specifically, we examined the contralateral delay activity (CDA) which is a negative ERP waveform computed as the difference between contralateral and ipsilateral activity and whose amplitude correlates with the maintenance of items in VSTM. In other words, we used a neural index of VSTM to test for its involvement in self-reported perceptual awareness. We observed a greater negativity (larger CDA amplitude) for the stop condition compared to the vanish condition, which correlated with subjective reports of persistence. This suggests that VSTM plays an important role in maintaining a visual percept and may be a necessary condition for phenomenal consciousness.

17. **The phenomenology of personal wisdom in younger and older Canadian adults.**

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Although wisdom has a wide range of historically specific meanings, the oldest and most common sense of wisdom refers to the human ability to personally cope with life by discerning patterns that lead to success. Scientifically, wisdom has been studied in several ways, but most naturalistically through implicit theories of wisdom held by people of different ages, religions, and nationalities (Clayton & Birren, 1980; Takahashi & Bordia, 2000) and through autobiographic accounts of moments of personal wisdom (Bluck & Glück, 2004). As part of a large-scale cross-cultural study of wisdom, 60 Canadian men and women (50 age 21-30 and 10 aged 65-85; half women) participated in this study, consisting of a single session lasting 1 to 3 hours. Participants first completed a demographic questionnaire. Second, they participated in a semi-structured interview that first asked about their life experience, and in particular their experience of wisdom: (1) a time when a personal acquaintance had demonstrated wisdom, (2) a time when the participant had demonstrated wisdom, and (3) an account of an historical figure had demonstrated wisdom. Finally, they were asked to define wisdom. Participants ended the session by completing psychometric assessments of wisdom and quality of life. All interviews were transcribed and content-coded according a coding manual inductively derived for the purpose of analysis based on the work of Ardelt (2003) and others using a phenomenological method. Each was then examined using a content-driven master narrative positioning analysis developed for this study (adapted from Thorne & McLean, 2003). Such an analysis assumes that the development and maintenance of personal narratives (in private discourse) is necessarily framed by overarching, prototypical stories found in public discourse (Harré et al., 2009). Preliminary results found that, as compared to younger participants, older participants show no statistical difference in Life Satisfaction, but greater Self-Transcendence, and greater General Well-Being, with no gender differences for either age group. But younger and older individuals of both genders who score higher on Ardelt's 3 dimensions of Wisdom Scale differed in their wisdom stories, suggesting that first-person experience of wisdom is not only a matter of age, but of perspective on life.

18. **Lessons from pain science: phenomenology and structure in the scientific study of consciousness.**

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Pain Science is paradigmatic as a scientific study of consciousness (SSC) due to its successful history of manipulating one specific phenomenal content: pain (Ayede and Güzeldere 2005). Then, however, SSC is necessarily dependent on phenomenological judgements (PJ), as I argue. First, due to the explication of "pain": To fragment the everyday notion of "Pain" into scientifically researchable subparts, one is relying on first-person accounts; e.g. Grahek (2007) established the distinction of "feeling pain" and "being in pain" by analysing phenomenological reports of pathological cases, thereby distinguishing clearly between pain asymbolia, analgesia and paradigmatic pains. Secondly, it is widely accepted among pain scientists that the experiencer has authority whether she feels pain or not (Thomm 2005; IASP 1986). Thirdly, among the diagnostic criteria of most pain phenomena are phenomenological as well as neurological symptoms (e.g. Freynhagen and Baron 2006, 39ff; IASP 1986; ICD-9, 330ff); and in those cases where pain serves as a perception, doctors rely on transindividual stabilities in PJs to diagnose the underlying cause: An ache refers to an intestinal cause, a stinging pain is nerval and a burning pain is reveals muscular damage (Tye 2006). Therefore, SSC depends on PJs. PJs can be data to be analysed, but also predictions, as demonstrated in Churchland's "Chimerical Colours" (2005). Thus, PJs are a necessary part of theories of consciousness. The specific stabilities in PJs inform about an abstract level of phenomenal structure, but not about intrinsic what-it-is-like-ness. Analysed as a claim for necessity, PJs can be falsified by phenomenological case studies, which is the underlying argumentative scheme of neurophenomenology. Given the additional premise that structural realism is true (Ladyman 1998; Ladyman and Ross 2007), knowledge about structures is the only scientific knowledge existing. As long as PJs are as falsifiable as any other scientific judgement and one analyses them as providing structural information, then their usage does not endanger SSC of becoming dogmatic or dualistic. Also, the structural properties of phenomenality can be seen as emergent from deeper neural structures, also without entailing a form of dualism. In the framework of ontic structural realism, then, nothing is left to explain.

19. **The detectable consciousness and the phenomenology.**

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Whether phenomenal consciousness includes the cognitive accessibility underlying reportability has long been a fray. Ned Block initiated the distinction between the phenomenal-consciousness and the access-consciousness among the mongrel concepts connoted and different phenomena denoted to avoid conflation in the research of consciousness. Per his definition, the phenomenal-consciousness is experience; the phenomenally conscious aspect of a state is what it is like to be in that state. The access-consciousness is availability for use in reasoning and rationally guiding speech and action. Phenomenal-consciousness remains a first-person datum which no objective measurement can immediately access. This makes reportability seemingly inevitable for verification of conscious states and thus leads in a circle which is called “the methodological puzzle of consciousness research” by Block. The debate over reportability of phenomenology would preclude concernful clinical evidence of patients with disorders of consciousness(DOC). Within the past decade, the rapid developments in the field of neuroimaging have played a substantial role in the assessment of patients diagnosed with DOC by providing new prognostic indicators from the residual functions examined among patients of such to reduce diagnostic errors between vegetative and minimally conscious state. Recent studies show that the self-referential stimulus (call subject’s own name) evokes residual brain activity by eliciting MMN in patients with DOC(Qin, 2008). These evidences imply their ability to create and utilize neuronal representations of the immediate sensory auditory environment (Näätänen et al., 2007). Some other studies using fMRI claim that patients with a diagnosis of being in a vegetative state were able to modulate their brain activity by generating voluntary, reliable and repeatable BOLD responses when prompted to perform imagery tasks (Monti, 2010). The states that seem unreportable, nevertheless can be detected by using “indirect” techniques and objective measurement redefines some conscious states further to the phenomenal-consciousness defined by Block. We posited “the detectable consciousness” as a distinctive category that helps clarify the phenomenology and the definition of conscious states related to this sort apart from the hard problems and provide a clearer scope on the related researches on comatose states, dream state, mental imagery and memory etc.

20. **The phenomenology of cognition: What is it like to be my thought?**

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I argue that occurrent cognitive activity does have a distinctive phenomenal character. Specifically, occurrent cognitive activity typically seems like our own cognitive activity, rather than some kind of alien intrusion. There is, in other words, a specific kind of phenomenal experience of "ownership" of mental states. When this phenomenal experience is absent, distressing symptoms of mental illness occur—witness the schizophrenic subject's complaint that someone else is inserting thoughts into his mind against his will. I also argue that certain specific types of occurrent cognitive state, such as the experience of suddenly seeing the solution to a problem, are also clearly phenomenally endowed, and the phenomenal character of such an experience is the experience of a change in the character of our cognition, not simply the experience of a "flash in the dark." Once it is established that there is a phenomenology of occurrent cognition, the question is then what this fact means for psychology. I argue that it is possible that the kinds of sub-personal cognition appealed to in cognitive science could very easily be phenomenally conscious states, though clearly not the conscious states of the subject in question. If this is possible, then we must rethink the explanatory nature of appeals to such sub-personal cognition, since evidently nothing explanatory is generated by the assumption that such cognition is the subject's own cognition. Furthermore, since plausibly the phenomenally conscious states of some other subject could be misunderstood by third-person observers, it is in principle possible that the content of sub-personal cognitive activity is quite different than cognitive scientists believe. But if this is possible, then it would seem that the attribution of particular contents to sub-personal cognition is also explanatorily otiose. Together, these points suggest that attributing sub-personal cognition to certain regions of the brain is not in and of itself explanatory of anything. The real explanatory work is instead accomplished simply by establishing regular correlations between certain types of brain activity and certain types of phenomenally conscious experience.

21. **Can there be a scientific explanation of consciousness without qualia?**

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ASSC is founded on the premise that the methods of science are the proper approach to a true understanding of the nature of consciousness. Science is rooted in materialism and physicalism. Few would question that human awareness supervenes on an intact brain. However, does it follow that all awareness supervenes on an intact mammalian brain? What about a starfish or a microbe? This talk will be about a little acknowledged \"chicken and egg\" problem. Which comes first - qualitative conscious awareness or scientific observation? To answer that preliminary questions need to be answered. What are qualia? What role do they play in consciousness studies? What role should they play in science? Should they be eliminated? I will argue that qualia are about neither \'the redness of red\' nor \'what it is like.\' Qualia are basically information theoretic having to do with detectable differences. They are fundamental for doing science. This also clarifies what consciousness is as a process, including scientific observation in particular. However, to fully appreciate the role of qualia in science, we have to acknowledge and reexamine some of our most basic presuppositions in science about mechanisms and laws. Mechanism is one of the most frequent words heard at any scientific meeting. Everyone is looking for them. But what are they, and what necessity do they carry? I will argue that our mechanistic world is a theoretical construct that results from how we habitually interpret qualitative sensations. There are alternatives to be considered. Conscious awareness as defined here is epistemologically prior to scientific observation. The upshot is that science has is limitations when practiced by individuals. Science can transcend those epistemological limitations through consensus as it has all along. However, consensus comes one conscious observer at a time. As Protagoras once said, "Man is the measure of all things." While I would argue that this was a great overstatement, qualia will always have their place enabling observation.

22. **On the selving self: a reappraisal of Kant's theory of consciousness and James' anti-Kantianism.**

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According to Kant, the "I think" or the synthesising self-consciousness is the supreme act of unification as well as the logical form of representation (Ameriks, 2000; Kitcher, 1990, 2006; Sturma, 1985). Its distinctive feature consists in «accompanying» (begleiten) necessarily all my representations, and thus it is the possibility of inner sense or self-perception despite remaining irreducible to it for the "I think" denotes a continuous unconscious

cognitive activity, on which relies not only the unification of my representations but also the unification of my mental operations. Contemporary theories of consciousness (e.g. Anscombe, Chalmers, Dennett, Dretske, Evans, Gallagher, Kripke, McDowell, Sellars, Siewert, etc.) comprise four main classes, that is, (1) higher-order theories explaining consciousness by means of metacognition or meta-representations, (2) same-order theories holding the hypothesis of self-(re)presenting states, (3) theories considering the conscious character a mere representational correlate of all mental content, and (4) zero-order theories describing phenomenal consciousness as pure appearing without reflexivity nor representability (Kriegel & Williford, 2006). By confronting Kant with this framework, new questions arise about the possibility of qualitative continuity in assigning a flux or stream of mental events to Myself (James, 1890). In line with Kant's Refutation of Idealism and in accordance with contemporary sensitivity, one should also ask whether and to what extent the mind is corporeal, given that the phenomenology of a unifying time-consciousness convokes the phenomenology of a unifying space-consciousness through the construction of a systemic unity of kinaesthetic intentions or endeavours as embodied activity in the world (Berthoz & Petit, 2006). The Self-Dynamics shows how accurately the motion of the mind responds to the motion of the body, and how deeply (meta)cognition is pervaded by bodily self-awareness and «ecological proprioception» (Merleau-Ponty, 1945; Damasio, 1995, 1999, 2003; Gallagher, 2006). This entails a final issue concerning the relationship between intersubjective cognition and inter-corporality.

24. **On self-awareness and being an objective particular in an objective space and time.**

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When I'm aware of being an I with a diachronic existence, am I then necessarily referring to myself as being an objective particular that is in principle traceable by others in an objective space and time? To probe this question I evaluate what Husserl says about the self-individuation and -unification of consciousness in his Ideas II. He claims that there could be a consciousness that individuates and unifies itself even if there were no nature. I conclude that Husserl's view is untenable. I raise questions that bring out how the constitution of our self-consciousness depends on our capacity to situate ourselves in an objective space and time. Two examples. (1) Isn't it a phenomenon that I in consciousness feel that I'm here, and does this not give my consciousness at least a ghostly body? (2) Husserl demonstrates how Erlebnisse reorganize themselves. What first belonged to the primal present becomes retained (but we can bring everything back to mind in principle), and memories of the same event will never be the same because they'll be tied to a new context. But would these Erlebnisse reorganize themselves in this way if we didn't have the idea of being one person with one particular history that stretches itself out through a time of days and years? We seem to need the idea of a person and a linearly unfolding time to conceive of the idea that we can trace back some of our experiences. Even when we understand that the time in which our memory-contents are presented to us doesn't match the objective time, a question remains. When past experiences come to mind, could this then be made possible by an awareness of the fact that one has one diachronically unfolding life? Could this be necessary to motivate us to turn to past experiences so as to make sense of current experiences? A consequence for the question of personal identity would be that my one identity is not so much constituted by the memories I have, as my memories may be constituted by the one identity I have.

25. **Self-consciousness and anosognosia in Alzheimer's dementia.**

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Anosognosia refers to a condition in which one lacks awareness or acknowledgment of one's own syndrome. Patients diagnosed with Alzheimer's Dementia (AD) typically suffer anosognosia, often leading to a thought that there is nothing wrong with them. It is a heated debate on whether anosognosia in AD is a form of faulty awareness or acknowledgment, but less attention has been paid to its relation to self-consciousness. What is the structure of the experiential life in which AD patients live and feel their own existence? How does it differ from non-demented people? Could this explain anosognosia in AD and help settle the debate? This paper aims to answer these questions by providing a model for understanding self-consciousness in the context of anosognosia in AD. Specifically, the model mechanistically differentiates three different senses of self-consciousness: Pre-reflective, reflective and narrative; however, they should be treated as three hierarchically

nested "entities" or "activities," integrating as a complex mechanism. Secondly, any exposition of AD patients' sense of existence must incorporate how the three interact and constrain each other. Finally, the temporal organization and intersubjective dimension of the hierarchically nested self-consciousness help explain why and how AD patients come to have anosognosia, whether it is faulty awareness or acknowledgment.

26. **Only time will tell: On the nature of free will.**

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The contingency between sensory inputs and motor outputs is one of the crucial aspects of the neural mechanism underlying the phenomenology of consciousness. For example, the nature of subjective time is known to be affected by the contingency between voluntary action and sensory feedback (Haggard et al. 2002). The perception of self body is affected by the contingency between actions and sensory feedbacks, as demonstrated in the mirror box treatment of phantom limbs (Ramachandran et al. 1995). Various empirical evidences suggest that sensori-motor contingency affects the construction of the phenomenal self in its temporal and embodied dimensions. One important and arguably ultimate question regarding human consciousness is that of free will. The question concerning the nature of free will is an essential one not only from theoretical point of view but also from the social implications involved (e.g. from the point of view of neuroethics, Gazzaniga 2005). In that free will concerns itself with the movement of the body in time, it is necessary to consider its nature in the context of sensori-motor contingency. From the phenomenological point of view, neural processes involved in action can be regarded as a subset of those involved in intentional processes in general. Here I argue that the nature of free will can be properly treated only by taking subjective time into consideration. Only a consideration of the nature of subjective time will tell us the origin of the feeling of free will, when it is taken to be compatible with determinism (Dennet 2003). I present a model of subjective time based on the interaction between sensory and intentional processes in the brain, in which two kinds of simultaneity ("sensory simultaneity" and "intentional simultaneity") are defined. Using the model, I analyze the differential nature of neural circuits involved in sensory and motor processes, based on the anatomical data on human brain (e.g., Van Essen 2004). Finally, I give an account of the neural correlates of free will in terms of the "open-ended" structures of intentional simultaneity in subjective time, in the context of the topology of connectivity in the cortical neural network.

27. **Reflections of the self: an fMRI investigation of links between animistic thought and self-processing.**

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The imbuing of objects and events with life and consciousness has been studied in psychology under the term 'animism'. Almost a century ago, Piaget (1929) made the conjecture that children's predisposition to display animistic modes of thinking is induced by their tendency to construct reality with the self as a model. To test this speculation empirically, we used functional magnetic resonance imaging (fMRI) to determine whether processes implemented in personification (a type of animistic thought) engage brain areas from the self-referential neuronal network. Nine naïve subjects were presented with a set of pictures of household objects. In half of these images one object was shown separated from the rest (intended to trigger experience of the social attribute of loneliness). Later the experiment was repeated after priming the participants to imagine how the excluded objects might feel. We demonstrate that brain areas associated with self-referential structures such as the insula, the precuneus, the inferior frontal cortex, the posterior cingulate, together with the temporal-parietal junction, the fusiform gyrus, and the lingual gyrus (brain regions linked with mentalising) are implementing processes involved in animistic thought. This supports the Piagetian conjecture that our social cognition is filtered through self-related concepts and experiences. Furthermore, the precuneus, temporo-parietal junction, and the posterior cingulate were also activated before priming (when participants had not considered a possible social interpretation of the stimuli). This suggests that personification may be an automatic, pre-reflective process.

28. **Quantifying the richness of phenomenal experience.**

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As arousal waxes and wanes, the richness of our experience varies profoundly from the near oblivion of dreamless sleep to the exquisite detail of full alertness. What systematic changes in the underlying brain activity bring about such changes in experience? We propose that the representational capacity of the underlying brain machinery – the degree to which the dynamics of a system is fit to embody information – is the delimiting factor in realizing phenomenal content. From the standpoint of implementation, the richness of experience must be provided for in the complexity of the structure of brain activity, which is the vehicle of experience. From the functional standpoint, the richness of experience supervenes on the ability to draw increasingly refined distinctions concerning the environment and the content of experience itself. These observations entail that the structure of the underlying neuronal activity space should match in its complexity the myriad of relations among the contents of experience. Thus, we define the representational capacity of a neuronal activity space in terms of the coupling between the complexity of its structure and the complexity of the activity it admits. If the richness of experience is to covary with arousal, it must remain unchanged if arousal is fixed at a given level. As it is the complexity of activity that sustains the richness of experience, this means that in a given state of arousal the complexity of activity is fixed as well. This suggests that representational capacity can be estimated by fitting an indicator function (classifier) parameterized by arousal to neuronal data, then using it to reconstruct the underlying neuronal activity spaces via the level set method. The complexity of the arousal-dependent activity spaces can now be estimated by computing their multi-scale homology, which measures not only the degree to which activity is inherently clustered but also the effective dimensionality of the configurations formed by the clusters. This approach to quantifying representational capacity was successfully applied to primate imaging data (Fekete et al., 2009). Our present research highlights its relevance to the development of a computational theory of phenomenal experience.

29. **Kant's theory of consciousness and self-representationalism.**

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The paper investigates whether Self-representationalism can be rooted in Kant's theory of consciousness. According to Self-representationalism, one's mental state does not only represent an object in the world, it can also represent one to oneself as the subject of that state. In his article "Kant: A Unified Representational Base for All Consciousness" (2006) and forthcoming book, co-authored with Paul Raymont, A Unified Theory of Consciousness (MIT Press), Brook suggests that Kant's theory of consciousness, anchored in the conception of transcendental apperception(TA), can provide an account of Self-representing representations that supports Self-representationlism. Following Strawson's steps in Bounds of Sense (1966),which implicitly maintains that for Kant's theory of consciousness to succeed, an empirical reference "I" for each subject of experience is required, I point out that Kant's original account cannot complete the task as Brook hopes. For the consciousness performed by TA lacks the empirical reference of the personal pronouns "I" for each subject of experience due to the fact that TA can only represent the manifold of representations in Kant's original design. In other words, TA cannot self-represent, meaning, representing one to oneself so that one would know one is the subject of experience. I argue that there is a distinction between the thematic activity and non-thematic activity for the operations of TA. The former is to represent the manifold representations; the latter, on the other hand, is to self-represent. For the distinction to work, however, one has to treat Kant's idea of "the self" as something single and complete with two kinds of properties, i.e. as a subject that has both empirical properties and transcendental ones, not a logical function "I" as some Kant scholars suggested. The paper shall explore scientific evidence in relating to the distinction in question. The thematic activity and the non-thematic activity have different but complementary abilities of TA. By making the above-mentioned distinction, we could know not only the nature of human cognition better, we may picture a scenario in which Self-representationalism can be contingent upon Kant's theory of consciousness as well.

30. **Deferential phenomenal concepts? Not for the zombie Mary.**

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The Knowledge Argument (KA) against physicalism relies on the intuition that without undergoing experiences, one cannot gain knowledge of their phenomenal characters, i.e. "what it is like" to undergo the experiences. Even with complete physical knowledge, Mary, the super-scientist, would still gain new knowledge when she experiences red for the first time. Phenomenal concept strategists counter-argue that Mary's new knowledge is constituted by new concepts referring to things she already knows, special concepts that are gained only when one undergoes phenomenal experience. Tye (2009) denies that there are such concepts. He argues that concepts about the phenomenal character of an experience are deferential, and since one can partially understand a deferential concept and one possesses a concept when it is partially understood, one can possess the concept without experience. I will argue that Tye's understanding of deferential concepts implies that one can partially understand a concept C without the relevant experiences only if one already possesses a more general categorical concept CC under which referents of C also fall. Thus, for one to possess a phenomenal concept PC prior to experience, one has to at least possess one particular non-deferential categorical phenomenal concept—the CC that this is a phenomenal character—which in turn, I shall argue, can be gained only via experience. That is, only if Mary has conceptualized her other experiences as phenomenal would Tye's conclusion follow, that she could possess PCs of new experiences. I've shown that Tye's argument rests on the assumption that Mary-in-the-room is not a philosophical zombie, however, Tye's, nor others' reconstructions of KA require this aspect of Mary. KA is traditionally thought to work with only premises about her complete knowledge, the first experience of red and our intuitions. Thus, this study shows that either KA should specify that Mary has to have other experiences prior to the new one or Tye's argument against the strategists only work against the versions that do. If the former, the effect of other experiences would affect counterarguments that employ Mary the ability to imagine new experiences a prior.

31. **Consciousness, access and phenomenal overflow: a reply to Block.**

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Ned Block claims that phenomenology "overflows" cognitive accessibility, that the capacity of phenomenal experience is greater than the capacity of the 'global workspace', and thus, that there are conscious experiences that are inaccessible. He thinks overflow is the best explanation of certain experimental results (e.g., Sperling (1960); Landman et.al., (2003)). Phenomenal overflow is only a good explanation of the experimental results if the subjects in these experiments have specific (as opposed to generic) phenomenal contents of the relevant kind for all or most of the items presented prior to the cue. Block must distinguish between two kinds of access in order for his view to be intelligible, but once he has done so, he cannot use subjects' reports as evidence of specific phenomenology in the phenomenal overflow experiments: this would require subjects to both have and not have *cognitive* access to a content C at t. This leaves Block with only neural evidence, and at least current neural evidence does not support the claim that subjects have specific phenomenology of the relevant kind. Given that there is no evidence that the subjects have specific phenomenology, phenomenal overflow is not even a good explanation of the experimental results. While these considerations do not show that there are no inaccessible phenomenal states, they do show that we have no reason to posit them. Further, if there were inaccessible phenomenal states, it would be impossible to specify phenomenal contents of any kind. Thus, if phenomenal contents or the theories that employ them are of any value, we have a reason not to posit inaccessible phenomenal contents. Finally, I speculate that Block's original claim that phenomenology overflows accessibility would be vindicated if there was contentless phenomenal experience. This would account for our intuition that infants and certain kinds of animals can be conscious despite lacking the capacity for certain kinds of higher order thought, and broadcasting to the global workspace (and a global workspace). It would also account for correlates of phenomenal consciousness that are not broadcast, if there are any, without requiring inaccessible phenomenal contents.

32. **Do dementia patients lose their self?**

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Dementia patients with the loss of some brain functions have altered consciousness. At their later stages, most patients cannot recognize their families or close friends and hold a story about themselves that is totally contradictory to what they really are. Due to their confabulation, dementia patients are often regarded as having no self. I argue here that dementia patients still have a self. First, I will introduce two concepts of self—the minimal self and the narrative self. The minimal self is the consciousness of oneself as an immediate subject of experience, unextended in time, which provides a point of view for experiencing and a framework for one's autobiography. The narrative self includes memories of the past and intentions toward the future to extend in time. With this distinction, I argue that dementia patients have both the minimal self and the narrative self, and the difference between healthy people and dementia patients is that healthy people can maintain one consistent story within a long period of time, while the dementia patients, due to the malfunction of their memory, cannot maintain their own autobiography. In addition, these patients make up stories about themselves all the time, in order to compensate their memories that are unable to be recalled. Whether the dementia patients have self or not is an important issue, which relates to many practical decisions such as whether they have moral or legal responsibilities or how they should be treated. Since dementia patients do have a self, we should reconsider these ethical issues.

33. **The context of stimulus association influences the perception of visual similarity.**

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The ability to discriminate stimuli that are perceptually similar to one another is crucial for identification and categorization of visual inputs. Multiple lines of evidence suggest that processing of visual inputs is amenable to top-down influences stemming from prior experience and knowledge. These previous findings lead to the suggestion that the perception of visual similarity is also susceptible to the memory of prior experience. Here, we investigated whether the context of previous stimulus association has an impact on the perception of stimulus similarity. In the present study, we introduced two different contexts in which two visual stimuli with slightly different orientations were each associated with an auditory stimulus. The nature of the associative context was determined by the relative degree of similarity between the two auditory stimuli: in the Divergent context, the difference in the frequency of the auditory stimuli was 800 Hz, whereas the difference between the auditory stimuli was 3 Hz in the Convergent context. The angular difference between the visual stimuli was constant across the two conditions. The measure of discrimination (D') of the two visual stimuli was significantly increased following the acquisition of the visual-auditory association in the Divergent context. However, no major increase in D' was found in the Convergent context. In order to determine the specificity of the observed changes in perceived similarity, we measured the discrimination performance of orientations that were adjacent to the two orientations presented during the visual-auditory association in a subsequent experiment. Again, the pattern of changes in discrimination of the nearby orientations was consistent with the context of the stimulus associations: In the Divergent context, learning of the stimulus association significantly improved discrimination of nearby orientations, whereas the context of the stimulus association in the Convergent condition resulted in a decrease in the discrimination performance. Together, our results suggest that the context of previous stimulus association can alter perceived similarity of basic visual stimuli, and that the observed changes are accompanied by overall changes in the perceptual space representing these stimuli in the visual cortex.

34. **Masked primes activate the frontal-parietal control system independent from prime visibility.**

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The cognitive control system is traditionally related to conscious processes. Previous research has shown, however, that unconscious visual stimuli can affect mental operations that are necessary to perform a discrimination task. Using functional magnetic resonance imaging, we investigated whether masked primes can access the frontal-parietal control system. Participants responded to visual target stimuli made of a human face and a superimposed scene in a speeded choice response task. A cue validly indicated whether they had to respond to the face (man vs. woman) or to the scene (indoor vs. outdoor) of the picture. In addition, the cue served as a metacontrast mask for a preceding prime which was either congruent or incongruent to the cue. On congruent trials participants responded faster than on incongruent trials. This behavioral priming effect did not depend on conscious perception of the effective stimulus because it was larger when prime visibility was reduced. Activity of parietal and frontal regions was increased on incongruent as compared to congruent trials. Importantly, this neuronal priming effect was especially pronounced when prime visibility was low. These results suggest that the cognitive control system is sensitive to visual stimuli irrespective of conscious awareness of these stimuli.

35. **Unconscious visual stimuli modulate endogenous orienting of covert spatial attention.**

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Subliminal stimuli can affect exogenous shifts of spatial attention, whereas endogenous orienting of attention is typically thought to require executive control. In this study we investigated effects of masked visual stimuli in an endogenous orienting task. Primes were followed by congruent or incongruent cues which served as metacontrast-masks for the prime. Cues validly indicated the position of subsequent targets. Subjects classified targets faster when prime and cue were congruent than when they were incongruent. This priming effect increased when the time between prime and cue increased, but it decreased when the time between cue and target increased. Additional research showed that this priming effect cannot be reduced to an effect of the perceptual similarity between prime and cue. Eye movements were controlled to rule out any occulomotor contribution to the priming effects. Results show that unconscious visual stimuli can modulate endogenous orienting of attention. Presumably, unconscious primes can initiate shifts of spatial attention if they share critical features with the cues. This finding contributes to the distinction between processes related to attention and consciousness.

36. **How features of the mask modulate inverse priming effects of unconscious visual stimuli.**

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An affirmative answer to the question whether there is a qualitative difference between conscious and unconscious processing has been suggested in recently by a counterintuitive phenomenon called “negative compatibility effect” or “inverse priming effect”. This effect results when a prime stimulus is followed by a mask and a subsequent target stimulus. It consists in slow and frequently incorrect responses when prime and target stimuli are congruent, and fast and accurate responses on incongruent trials. The magnitude of this effect is modulated by the structure of the mask: If the mask contains features of alternative target stimuli (relevant masks) the effect is larger than if it contains irrelevant features (irrelevant masks). However, the crucial features of task-relevant masks are unclear. Here we varied the structure of the mask in four levels between “irrelevant” and “relevant”. Instead of a gradual increase of the effect, we found the same effect for three variants of irrelevant masks and increased effects with a clearly relevant mask, which consisted of a superimposition of the two prime/target alternatives. With such a relevant mask, the size of inverse priming effects was the same irrespective of prime visibility. With all other masks, however, inverse priming occurred only in those subjects who were unable to recognize the primes. These findings suggest two independent mechanisms which generate inverse priming effects: one mechanism operates independent of prime visibility with relevant masks, whereas another mechanism operates only when the effective stimuli remain unconscious.

37. **The origins of synaesthesia: a direct comparison of pitch–luminance mapping in chimpanzees and humans.**

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In synaesthesia, input to one sensory modality leads to automatic and vivid secondary experiences. For example, sound–colour synaesthetes see colours when they hear sounds. Also non-synaesthetes experience synaesthesia-like correspondences to some extent, albeit more implicitly. Most prominently, humans – already as toddlers – associate high pitch sounds with light colours and low pitch sounds with dark colours. Sound–colour synaesthetes map in the same direction. It has been proposed that synaesthesia-like correspondences – such as pitch–luminance mapping – are innate rather than learned, and that they might have been a driving factor in the evolution of language. If this is true, they might have co-evolved with language late in evolutionary history and hence might exist uniquely in humans. Alternatively, they might have evolved earlier, either due to a function unrelated to language or as a by-product of the primate sensory system. To pin down the evolutionary origins of synaesthesia, cross-species comparisons are vital. However, so far no study has addressed the question whether non-human animals experience synaesthesia-like correspondences. Here we provide the first direct comparison between chimpanzees and humans concerning the mapping of high pitch to high luminance and of low pitch to low luminance. Participants from both species were required to classify squares as black or white while hearing irrelevant background sounds that were either high-pitched or low-pitched. Chimpanzees made more mistakes when the background sound was synaesthetically incongruent (low-pitched for white, high-pitched for black) than when it was synaesthetically congruent (high-pitched for white, low-pitched for black). In humans, the effect was evident through increased latencies in incongruent trials in line with previous research. These results suggest that the two species share pitch–luminance mappings and possibly other synaesthesia-like correspondences. Synaesthesia in humans hence partly reflects evolutionary old mechanisms in the primate brain.

38. **What Synaesthesia may tell us about the unity of consciousness.**

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The phenomenon of synaesthesia, in which a multitude of experiential levels is integrated under a unified phenomenal perspective, poses many pressing questions for multidisciplinary approaches to consciousness and cognition. However, its relevance and explanatory potential for theories of consciousness has not been fully realized in philosophy of mind. A related target phenomenon is the synchronic unity of consciousness. Sometimes it has evoked skepticism in the scientific study of consciousness. Especially in certain pathological states like: split-brain syndrome or DID, this unity has been claimed to be broken down (Nagel 1971, Dennett 1992). Nevertheless, such an apparent breach may only be one extreme on the continuum of the unity of consciousness. The continuum embraces various forms of unity, e.g. access, phenomenal, subject, object and spatial, which, depending on the neuropsychological condition, produce different degrees of coherence in unifying selected conscious states. This continuum should be understood as the domain of a qualitative universal (experiential coherence) – a general phenomenal property, instantiated and differentiated by particular conditions from neuropsychopathology, normal and extraordinary perception. In such a pluralistic framework for the unity of consciousness, the phenomenon of synaesthesia mirrors the other side of the continuum, where conscious experiences seem to be hypercoherent, i.e. more strongly unified than in ordinary situation, especially in the case of projectors binding perceptually a concurrent feature to its inducer (Dixon et al. 2004). Therefore, synaesthesia seems to be one of the best model phenomena to compare the varying distribution of phenomenal coherence between different neuropsychological phenomena. Neurophysiological mechanisms of binding, attention and multimodal integration associated with the relevant phenomenological feature of synaesthesia (Singer & Gray 1995; Treisman 1998, 2005), are posed here against the background on the traditional conceptual issues involved in a philosophical understanding the unity of consciousness, with the conclusion that the universal property of being unified, or experiential coherence for conscious states actually exists, but can only be empirically observed at its concrete psychological instantiation. The aim of the proposal

is to argue for the thesis that the phenomenal unity of consciousness can be seen as a highly specific functional, therefore multirealizable, but also graded, feature.

39. **Synaesthesia helps understanding consciousness: Concepts may be made of qualia.**

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Traditionally, we think of qualia differently than of concepts. The first phenomenon is about concrete perceptual experiences. The second one appears abstract; void of such sensations. But research on synaesthesia suggests another view. Recently, we learned that, in synaesthesia, concepts, rather than sensory inputs, activate perceptual experiences rich in qualia. For example, it is the concept of letter \"A\" that evokes perception-like experience of say, a red color. The classical, low-level view of synaesthesia, as cross-wiring between senses, is being abandoned on empirical grounds. The new insight into synaesthesia offers new implications for understanding the functional role of phenomenal conscious experiences. If, in synaesthesia, a quale is a part of a concept, in non-synaesthesia a similar close relation may exist; Concepts may be made of qualia. Traditionally, qualia are assigned to lower levels of sensory processing, i.e., the inputs. The assumption is that the presence of qualia is driven by the presence of physical inputs and that this sensory processing operates at a different level than the conceptual one. The new view, springing from the synaesthesia research, suggests that sensation and conception operate at the same processing level. In fact, the two may be inseparably intertwined. The simplest qualia, those evoked by pure colors or sounds, may define elementary concepts--blocks off which more complex ones are built. Thus, merger and rearrangement of the existing qualia (existing concepts) may be the process of constructing the new concepts (new qualia)--combining a red and a blue into purple; vanilla and sugar into a taste of a cake; a sequence of tones into a melody; social experiences into a concept of freedom. Our entire explicit knowledge and its cognitive manipulation may not be possible to detach from its fundamental phenomenal bases. Within the network of knowledge, activation of any concept may be tied to activation of private feelings and sensations--as it occurs so vividly, and in an exaggerated, empirically testable way, in synaesthesia. Phenomenal sensation may be the means of cognitive association. Qualia, rather than concepts, may be the main operational substrate of our semantical thinking minds.

40. **An fMRI study of auditory figure-ground segregation**.

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Figure-ground segregation – the process by which the brain extracts certain coherent patterns from a mixture of other patterns, is a fundamental aspect of scene analysis. So far, the investigation of these processes in the auditory modality has been limited by use of 'figure' and 'background' stimuli that are physically different (e.g. a tone in noise). In the present functional magnetic resonance imaging (fMRI) study we employ a new paradigm, similar to Julesz's visual pattern discrimination paradigm (Julesz, 1962) by which the figure and background span the same spectral space but differ in the statistics of fluctuation, allowing us to reliably identify brain areas that play a role in figure/ground segregation *per se* as opposed to those activated by different characteristic properties of sound.

Stimuli consisted of a sequence of 50 ms long chords containing a random set of pure tone components with frequencies ranging from 179 to 7246 Hz. This results in the percept of random tonal noise. Occasionally, a subset of tonal components repeated in frequency over several consecutive chords, resulting in the percept of a 'figure' popping out of the random noise. The duration of this repeating pattern and the number of fixed components (we refer to his as 'the coherence of the figure') were varied as parameters. To extract the figure, the brain must perform simultaneous (over different frequency components) and sequential (over time) grouping. Indeed, behavioral results demonstrate that listeners are remarkably sensitive to the emergence of such figures. In the scanner we presented listeners with figures constructed with parameters that span the behavioral detection range (from not- to highly- detectable) in order to identify the brain areas whose activity is correlated with increasing figure duration and/or coherence.

The study consisted of a passive and an active paradigm. In the passive study, subjects listened to the sound stimuli consisting of figures but were instructed to respond to unrelated decoy stimuli. Thereafter, the same subjects were trained and instructed to respond actively to the figures in the stimuli by pressing a keypad. The stimuli were presented in a continuous scanning paradigm in a 3T MRI scanner.

Previous studies suggested that auditory cortex plays a major role in figure ground segregation. Here we show that activity in the intraparietal sulcus (IPS), beyond the auditory cortex, is correlated with the perception of such auditory figures. These findings stand in good agreement with the reported role of IPS in auditory stream segregation (Cusack, 2005). IPS has also been implicated in binding in vision, touch and cross-modally suggesting it has a general role in perceptual binding and structuring sensory input.

41. **Unconscious semantic and repetition priming in the auditory modality.**

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Unconscious word priming has mostly been reported in the visual domain. With auditory stimulation, only one study has reported a repetition priming effect using distorted (time compressed) words. In the present study, pairs of words (semantically unrelated, related, or repeated) were randomly presented to adults who performed a lexical decision task (LDT). The participant's level of awareness of the prime was assessed with a categorization task showing close to chance performance (d'=0.10). Semantic and repetition priming were found in a sub-sample of the slowest participants at the LDT. The repetition priming was negative: a faster response to related compared to repeated pairs. This report is the first of unconscious semantic priming in the auditory modality. Furthermore, we were also able to show for the first time an unconscious auditory repetition priming with prime words that were not distorted.

42. **Electrical brain dissociation for consciously and unconsciously categorized auditory stimuli.**

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While a large number of studies have investigated the neural correlates of visual conscious perception, little is known about auditory conscious perception. In the present study, we have investigated the electroencephalographic (evoked and induced) responses to behaviorally categorized or uncategorized words, pseudo-words and sounds, and to silences. Results suggest that, like silences, uncategorized stimuli were not perceived : none of the two evoked potentials nor induced theta activity. Interestingly, uncategorized stimuli also shared neural mechanisms with those associated with consciously categorized stimuli, notably a decrease in the beta band, thus suggesting that uncategorized stimuli were partially processed. Hemispheric differences in the beta band between words and non-lexical sounds (pseudo-words and complex sounds), both for categorized and uncategorized stimuli, confirm that, while stimuli were behaviorally uncategorized they were unconsciously processed, probably at a lexical level.

43. **Conscious and unconscious spatial frequency processing during facial gender categorization.**

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It is generally agreed that some aspects of a visual scene are perceived consciously while others are perceived unconsciously. However, it is not yet known precisely which information is processed under different degrees of awareness in the adult human brain. Here, we address this question in the spatial frequency (SF) domain using the SF Bubbles technique (Gosselin & Schyns, 2001; Willenbockel et al., 2010) and a masked repetition priming paradigm similar to that employed by Dehaene et al. (2001). A “visible prime” condition was created by presenting the stimulus sequence mask-blank-prime-blank-mask-target (prime, blank, and mask durations <= 50 ms) and an “invisible prime” condition by reversing the temporal order of the masks and the blanks. Twenty grayscale face photographs (10 males) served as primes and as targets, and the primes were randomly SF sampled trial-by-trial. 12 observers were instructed to identify the gender of the target face accurately and as fast as possible over 25 blocks of 40 trials per condition. Our results revealed effects of SF filtering on observers’

response times for both conditions, confirming that conscious and unconscious priming occurred. A multiple linear regression was run on the filtering profiles and response times to obtain classification vectors: The classification vector for the visible prime condition peaked at 11.7 cycles per face width (cpf), revealing a significant SF range of 1.6 octaves ($p < .05$, Sr = 256, FWHM = 4.24, Zcrit = 2.7; see Chauvin et al., 2005). The classification vector for the invisible prime condition showed a pronounced dip within this SF range (significant for blocks 5-25). The difference reached significance for an SF range of 0.7 octaves, with a maximum Z-score at 11.2 cpf. No other SFs were significant. Our results suggest that the diagnostic SFs for conscious facial gender categorization (as well as conscious face identification; see Willenbockel et al., 2010) are suppressed relative to the other SFs during unconscious facial gender categorization. Possibly, many SFs prime to a small extent in the unconscious condition, whereas a more precisely defined, narrow SF range primes in the conscious condition, where top-down influences play a greater role.

44. **The objects behind the scenes: TMS to area LO disrupts object but not scene categorization.**

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Many influential theories of scene perception are object centered (Biederman, 1981) suggesting that scenes are processed by extension of object processing in a bottom-up fashion. However, an alternative approach to scene processing is that the global gist of a scene can be processed in a top-down manner without the need for first identifying its component objects (Oliva & Torralba, 2001). This suggests that global aspects of a scene may be processed prior to (or perhaps in parallel with) the identification of individual objects. Evidence from a patient with visual object agnosia and bilateral damage to lateral occipital (LO) cortex, an area associated with object processing (Grill-Spector et al., 2001), also suggests that scene categorization can operate independently of object perception (Steeves et al., 2004). Objectives: To determine whether temporary interruption to area LO in neurologically-intact controls with repetitive transcranial magnetic stimulation (rTMS) impairs object and scene processing. Materials and Methods: In an offline pre-post design, participants categorized greyscale images of objects and scenes as 'natural' or 'man-made'. Images were displayed for 100ms followed immediately by a mask which remained onscreen until participants responded. Subsequently, we stereotaxically targeted area LO, which had been functionally defined with fMRI, and participants underwent five minutes of rTMS. Immediately following rTMS, they completed another version of the object and scene categorization task. Test versions were counterbalanced across participants. Results: rTMS to area LO reduced accuracy of object but not scene categorization. Surprisingly, there was a trend for an improvement in scene categorization post rTMS. Conclusion: These findings demonstrate that the global gist used to rapidly categorize scenes remains intact despite an interruption to object processing brain regions. This suggests that scenes can be processed independently of objects and that these processes are not strictly hierarchical but rather they are dissociable. Further, the temporary suppression of object processing may actually facilitate scene processing, perhaps due to a release of inhibition.

45. **Preserved grip scaling for immediate but not delayed grasping in the absence of conscious vision.**

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When we reach out to grasp an object our grip automatically scales to the object's size. Previous work has shown that DF – a patient with visual form agnosia resulting from lesions to the ventro-lateral occipital cortex – can still accurately grasp objects even though she cannot discriminate between them on the basis of their shape. This suggests that the visual pathways mediating visuomotor control in her spared dorsal stream can operate independently from visual pathways controlling object recognition in her damaged ventral stream. Importantly, although DF can scale her grip to objects despite her inability to 'see' their shape, she still has access to several other aspects of conscious vision (e.g., colour and luminance). In the present study, we examined whether any conscious visual input from the ventral stream is necessary for grasping objects in SJ – a patient who has a complete right visual field hemianopia following damage to the left occipital cortex. We asked SJ to reach out and grasp objects of different sizes presented entirely within her sighted (left) or blind (right) visual field. In one experiment, SJ demonstrated a remarkable ability to scale her grip to the size of objects in both her sighted and her blind field. Although she was able to estimate the size of the same objects

when they were presented in her sighted field, she was unable to do so in her blind field. In an additional experiment we demonstrated that SJ's ability to scale her grip to objects in her blind field was completely abolished when a short 2-s delay (without vision) was introduced just prior to reach onset. Critically, she was still able to scale her grip to objects in her sighted field following the same 2-s delay. These results suggest that when the visuomotor system operates in real time it does not require conscious vision in order to scale the grasp to the size of the target object. Only in delay, where a visual memory of the object seen moments before needs to be accessed, is conscious vision critical.

46. **The effect of familiar size on simple reaction times.**

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It is usually reported that simple reaction time (RT) decreases as stimulus size increases. Recent studies have shown that this effect reflects perceived rather than retinal image size. Given this relationship between simple RT and perception, one wonders if RTs are affected by knowledge about object size. It is known that past experience provides important information about the size of an object and helps with judgments of size, but the effect on RT is unknown. We carried out two experiments: one with a training procedure designed to induce a strong association between colour and shape of a target and its physical size, the other with a presentation of familiar objects of known size. By presenting the objects with the same retinal size, it was possible to study the role of familiar size in speeded motor responses. We found that only in the second experiment were RTs affected by knowledge – but in an opposite way from what we expected. Objects known to be smaller were responded to faster than objects known to be larger (and vice versa). An analysis of perceptual judgments revealed a misperception of size: the images of smaller familiar objects were perceived as bigger than the images of larger familiar objects. A possible explanation of this result is the size-distance invariance hypothesis (SDIH). The SDIH argues that objects appear both as larger and nearer, or smaller and further. In the perception of size and distance, like in many other aspects of perception, observers are unaware which cues are being used to generate conscious experience. Given that the actual retinal size is not normally accessible to consciousness and that there are size constancy operations that take place at preconscious levels of processing, it is plausible that smaller objects that subtended the same retinal image size as larger objects are perceived as closer hence appear bigger. These results show that long- but not short-term familiarity affects RT, and that size-distance relations are processed in an invariant manner such that any misperception of distance necessarily involves a misperception of size and vice versa.

47. **Embodiment of positive and negative emotions does not affect visual spatial attention differently.**

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Emotions can affect cognitive performance in many tasks (Fredrickson, 2001; Levine and Burgess, 1997). Attention-plus-external-noise paradigm (Dosher & Lu, 2000) has been developed and employed to investigate the mechanisms of visual spatial attention and to quantify the attention effect size. Does the embodiment of positive and negative emotions affect visual cued attention differently? This study aims to quantify the embodiment effect of positive and negative emotions by visual spatial attention paradigm. Participants were asked to hold a chopstick between the teeth to create the embodiment of positive emotion and between the lips to negative emotion. In the formal experiments, 3 observers were asked to make 2-Alternative-Forced-Choice orientation judgments on oriented Gabor patches. The experiment design varied 7 contrast levels, 2 cueing conditions (5/8 valid & 3/8 invalid central cueing), 2 noise conditions, and 4 locations, which allowed fitting psychometric function curves for each observer. Each session consisted of two sub-sessions and each sub-session had 448 trials. Every observer participated in 5 experimental sessions. The first session was for practice and then discarded. The results showed the visual cued attention effect occurred for the embodiment of both positive and negative emotions in high noise conditions, but not in no-noise conditions. This confirmed that the major mechanism of visual spatial attention was external noise exclusion. The visual spatial attention effect did not differ between the embodiment of positive emotion and that of negative emotions.

48. **Gender differences in estimation of affective pictures.**

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Despite extensive investigation and increasing interest in gender differences of cognitive abilities and emotional processing, more questions than answers still remain. There is accumulating data that sex steroid hormones have strong effect on functioning of central nervous system. However, data concerning effects of these hormones on emotional processing in both genders and during different phases of women menstrual cycle are scarce and contradictory. The aim of our study was to investigate how gender and phase of menstrual cycle influence evaluation of affective pictures. Thirty university students (12 men and 18 women) 23,1 ± 2,4 years participated in this study. Thirty six images were selected from International affective picture system (IAPS) and grouped into four sets of nine photographs: three attractive, three neutral, three antipathetic. All subjects participated in four experimental sessions. Women were investigated during follicular, ovulatory, luteal and late luteal phases of menstrual cycle confirmed by salivary 17β-estradiol and progesterone assessment. Intervals between men experimental sessions correspond to women inter-session intervals determined by phases. The task for subjects was to rate pictures in valence and arousal dimensions using Self-Assessment Manikin instrument. Study revealed that estimation of affective pictures differs between men and women. Rating of affective images by men is stabile and independent of experimental day. Women rate pictures depending on the phases of menstrual cycle. Attractive pictures were rated as the most pleasant and arousing (statistically significant differences as compared to other phases and men) during ovulatory (high 17β-estradiol) phase. Rating of antipathetic pictures was less dependant on phase of menstrual cycle and in all cases (except luteal, high progesterone, phase) these pictures were rated as less pleasant and more arousing as compared to men. There is no published data about use of International affective picture system for research in Lithuania. Comparison of our data to normative data revealed that Lithuanian subjects generally assigned lower arousal ratings ($p<0,01$), but there are no significant differences ($p=0,46$) with respect to mean valence rating.

49. **Idiosyncratic spatial inhomogeneities in breakthrough to consciousness of suppressed visual stimuli.**

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Conscious experience incorporates only a portion of the information available to the visual system. A step toward understanding consciousness would be an improved understanding of the mechanisms whereby certain information becomes conscious while other information does not. Several stimulus presentation paradigms strongly bias the visual system toward awareness of some information and unawareness of other simultaneously available information. One such paradigm, continuous flash suppression (CFS), utilizes dynamic, high-contrast Mondrian patterns flashed sequentially to one eye while a static image is presented to the other eye. CFS presentation can render the static image perceptually invisible for long periods of time (Tsuchiya and Koch, 2005). The static, suppressed stimuli do sometimes overcome suppression, however, and they are then incorporated into conscious percepts. We demonstrate that the probability of CFS-suppressed stimuli becoming conscious varies substantially by location in the visual field. Method: We presented two-tone face stimuli at random locations equidistant from a central fixation point while an annulus of CFS Mondrians flashed at the same eccentricity in the other eye. Results: For each individual observer, we found a unique pattern of breakthrough probability. Though these patterns were dissimilar between observers, patterns remained stable over long time periods (< 1 week) within observers. We found that these idiosyncratic patterns of breakthrough probability were consistent for various levels of stimulus intensity (contrast) and types of stimuli. We review possible mechanisms which could account for such persistent spatial inhomogeneities in the incorporation of suppressed stimuli into conscious percepts and suggest an attentional explanation for the effect.

50. **The Ebbinghaus illusion requires consciousness of the inducers.**

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To what degree does information that is processed in the absence of consciousness influence the contents of consciousness? In the classic Ebbinghaus illusion, a target circle will be perceived as smaller than its veridical size when it is surrounded by larger "inducer" circles, and larger than veridical when it is surrounded by smaller circles. The illusion is a striking example of the effect of context on visual phenomenology. Here we demonstrate that this effect is dependent upon conscious awareness of the inducing stimuli. We applied a modified version of continuous flash suppression (CSF) to the Ebbinghaus illusion. In CFS, dynamic, high-contrast Mondrian patterns are flashed sequentially to one eye while a static image is presented to the other eye, which can render the static image perceptually invisible for long periods of time (Tsuchiya and Koch, 2005). We presented naïve subjects with a display containing two Ebbinghaus targets, one on each side of fixation, each surrounded by inducers of a different size. In condition 1, the target circles were presented to one eye, on a background of dynamic high-contrast Mondrian patterns, while the inducing circles were presented to the other eye on a black background. This had the effect of suppressing the inducers from conscious awareness while the targets remained consciously visible. In condition 2, the targets were presented on a black background, so that targets and inducers were both consciously visible. In condition 3, targets and inducers were both presented to each eye, on the flashing Mondrian background, so that both were conscious. Subjects performed a two-alternative forced choice task indicating whether the left or right target looked larger. We found that suppressing the inducers from consciousness eliminated the Ebbinghaus illusion; i.e., in condition 1, targets did not appear to differ in size as a function of the size of the unconsciously presented inducers. In conditions 2 and 3, however, where inducing stimuli were consciously visible, the Ebbinghaus illusion was strong. These results demonstrate that the Ebbinghaus illusion is dependent upon conscious awareness of the inducing stimuli.

51. **The Contribution of Luminance, Contrast and Ocular Dominance to Conscious Perception in Onset Rivalry.**

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When an observer is presented with dissimilar images to the right and left eye, conscious awareness of each image will alternate every few seconds in a phenomenon known as binocular rivalry. In sustained viewing, the timing of these switches appears to be unpredictable, but recent research has suggested that the first conscious experience, or the 'onset' period of rivalry, is not random and may be different in its neural mechanism. Differences in luminance and contrast have a significant influence on average dominance during sustained rivalry, and perception of luminance can vary between individuals and across the visual field. We therefore investigated whether contrast also plays a role in onset rivalry. Observers viewed equiluminant rival targets for brief presentations in eight locations of the near periphery and reported the colour that was first perceived in each location. Results show that minimizing differences between luminance and contrast yields a stronger pattern of onset dominance bias and reveals evidence of monocular dominance. These findings are hard to reconcile with current models of sustained rivalry and suggest that different mechanisms may be responsible for determining the initial period of perceptual dominance.

52. **Conscious access to subliminal stimuli via sensory deprivation.**

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Background: Consciousness has a limited processing capacity, which is mostly absorbed by environmental demands. As a need for stimulation has been shown, reduction of external stimulation might lead individuals to process smaller inner stimuli to fulfill this need. Therefore, we investigated whether subliminal stimuli may enter into consciousness in case of sensory deprivation. Method: This hypothesis was tested with 72 participants who were randomly assigned in one of three groups depending on the level of environmental stimulation. A first group performed the experiment in a completely dark and silent environment. A second group of participants was in a reduced stimulation environment, where random noise could be heard in darkness. A last group was in a sensory stimulation environment with regular lighting and random noise. All participants were exposed to pre- and post-masked words displayed for 16ms. Then, participants had to identify the masked word in a list of two words, similar in length and spelling. Participants provided their answers either

immediately after the presentation of the word or after a 15s delay. Results: A forced-choice task performed on the kind of font that was used confirmed that masked words were really imperceptible (d'=.02). No differences in words visibility were found across the environmental conditions (F<1). A GLM performed with identification rates of masked words as the criterion revealed a marginal effect of the delay before answering (p=.051), which interacted with the environmental stimulation conditions (p=.023). While there was no effect when answers were immediate, participants who were in the sensory deprivation conditions identified the words better when their answers were delayed. Their identification rates were above the chance level in this case (M = .57). Discussion: Subliminal stimuli have been traditionally described to be too weak to reach consciousness and to decrease in time. Our result contrasts this view as we show that subliminal stimuli can still enter in consciousness after some time when this delay is free of external stimulation. This may be explained by the need for stimulation that may orient individuals toward smaller inputs in case of sensory deprivation.

53. **A common brain network underlying the attentional blink and the psychological refractory period.**

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Doing two things at once is difficult. When people are asked to perform two tasks (T1 and T2) in close succession, their response time for T2 is typically slower, the so-called psychological refractory period (PRP). The central interference model of the PRP proposes that only a central decision stage is strictly serial while sensory and motor processing occur in parallel. In the present experiment, we tested the hypothesis that depending on the duration of task 1, the conscious perception of T2 should be either delayed or T2 might be completely missed (the Attentional Blink effect, AB). We used magnetoencephalography to record the brain activity during a dual-task in which T1 was a sound and T2 a letter embedded in a series of distractors. We found that T2 sensory processing was unaffected by task overlap, but late T2 central components were delayed until T1 processing was completed and completely absent when participants missed T2. In addition, when the response time to T1 was slow, T1 central components were larger, T2 central components were further delayed and the proportion of missed T2 increased. Our data support the hypothesis that the central decision stage is strictly serial. In addition, when tasks overlap in time, T2 central access is delayed (the PRP effect) and can even fail if T1 processing is too long (the AB effect).

54. **Error-related brain activity under subliminal versus conscious conditions.**

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Cognitive control and metacognitive processes have been the object of intense research in neuroscience for many years. However the question of how conscious perception influences this type of processes remains unsolved. Nieuwenhuis et al. (2001) investigated the influence of error awareness on two event-related brain potentials, the error-related negativity (ERN) and the error positivity (Pe) which occur respectively 100 and 300 ms after an erroneous response. They observed an ERN even when subjects were unaware of making errors, suggesting that one could detect brain activity linked to cognitive control in a non-conscious situation. However this study focused exclusively on error awareness. By contrast, we investigated how error-related brain activity is modulated by awareness of visual stimuli presented below or above the threshold for conscious access. Our study addressed this question by simultaneously using magneto- and electroencephalography techniques. We used a continuous backward masking paradigm identical to Del Cul et al. (2007), with a variable target-mask stimulus-onset asynchrony (SOA). On each trial, subjects reported both their visibility of the target, and their evaluation of their performance (correct or incorrect). These subjective measures allowed us to study the modulation of the ERN component in various conditions of visibility and metacognitive report. No ERN was observed in the shorter SOA conditions (high-masking condition) whereas it was present in the longer SOA conditions. Indeed, the ERN varied in parallel to stimulus visibility showing a very similar threshold-like profile as a function of SOA. These results suggest that the ERN is drastically reduced under complete subliminal conditions, i.e. when subjects report not having seen the stimulus. This is consistent with the hypothesis that subliminal visual stimuli, compared to consciously accessed stimuli, fail to reach higher-order cognitive control stages. Although these results seem at odds with Nieuwenhuis et al. (2001) conclusion, we suggest that several

factors differ importantly between our two experiments that could explain these dissimilarities: (a) the study of visual versus action awareness; (b) the fact that, in their experiment error unawareness was not under experimenter control and might relate to a different mode of conscious access disruption such as inattention.

55. **Can syntax be processed subliminally?**

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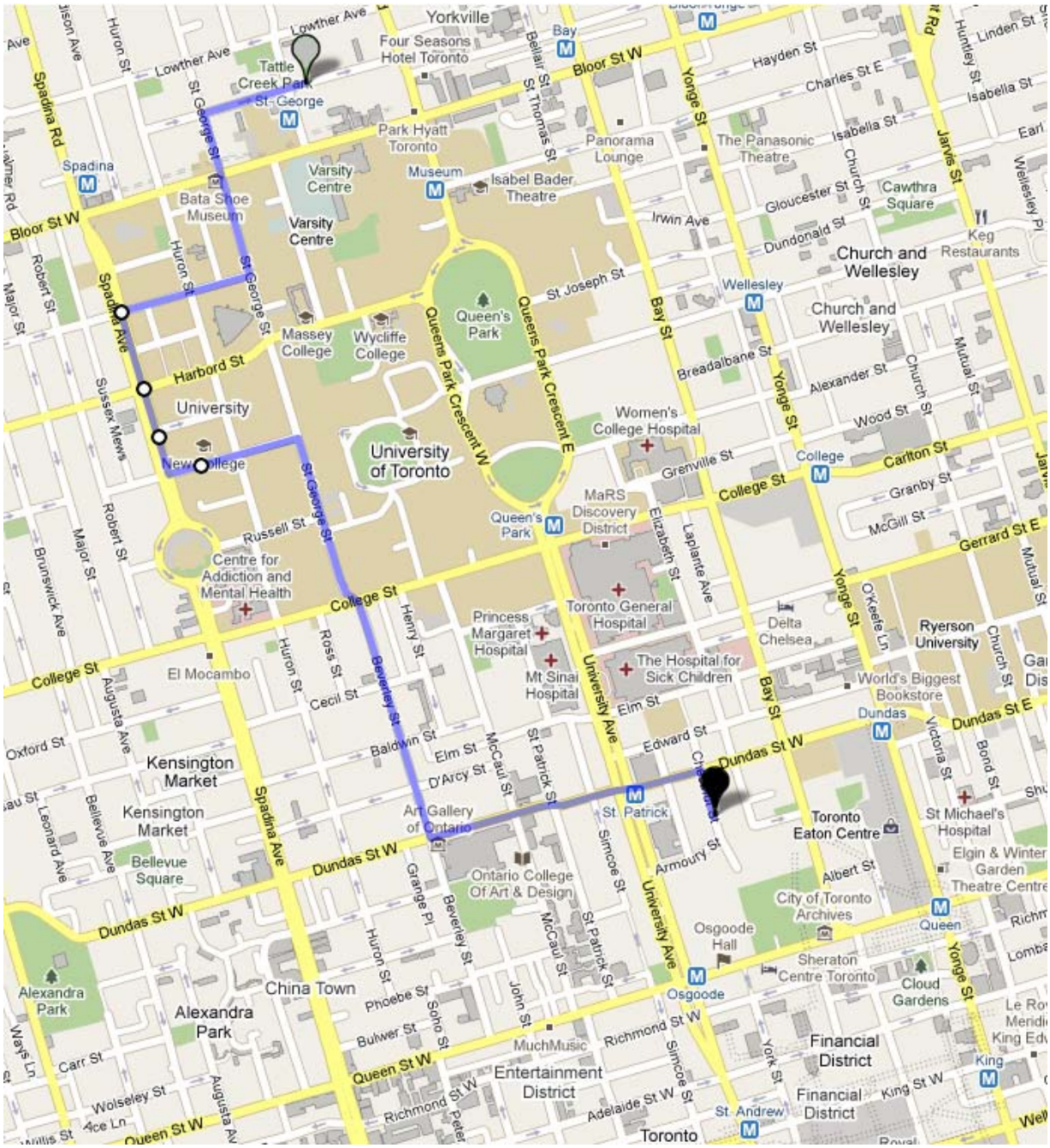
While it is well established that the semantic properties of individual words can be processed subliminally, very little work has addressed whether one can use syntax to determine the overall meaning of a set of words. On the one hand, syntax operates almost entirely unconsciously in normal language production and comprehension. On the other, the processing of stimuli presented subliminally rather than consciously appears impoverished. However, many studies showing impoverished subliminal perception of meaning utilise objective thresholds: these investigations are not just testing unconscious cognition, but potentially degraded unconscious cognition (e.g. Lau & Passingham, 2006). Cheesman & Merikle (1984) first demonstrated that to determine the full extent of unconscious processing, it is necessary to use a subjective threshold. Two experiments were conducted to investigate whether subliminal priming is sensitive to the meaning of word combinations and sentence structure rather than just the meaning of individual words. The aim of experiment 1 was to determine whether unconscious processing is capable of comprehending the syntactic function of “not”, at an SOA just below the subjective threshold. Having been primed with the instruction to e.g. “pick cat” or “not cat”, participants were presented with the two words “cat” and “dog” and asked to indicate which word they had been instructed by the prime to choose. Experiment 2 aims to determine whether people can process word order in active and passive sentences, having been subliminally primed with one of e.g. “A attacks B”, “B attacks A”, “A is attacked by B” or “B is attacked by A”, participants were asked to judge which of two pictures best represents the meaning of the prime. If the participant is able to correctly identify the appropriate picture, this will provide evidence that the unconscious has understood both semantic meaning and word order. Whether the results are null or positive, there will be important implications for understanding the nature of unconscious processing.

Map and Directions to Student Social



CONFERENCE VENUE (89 Chestnut) - indicated by black dot.

Student Social (7pm Friday 25th June)

Where "Bradford Academy" - indicated by grey dot

Address: 36 Prince Arthur Avenue.

Directions: By public transit, take the Yonge-University-Spadina line to St.George. Exit the station and walk north; turn right at Prince Arthur Street. At the pub, you'll find us on the 2nd floor! Walking directions: Shown by blue line (3.4km from Conference Venue)