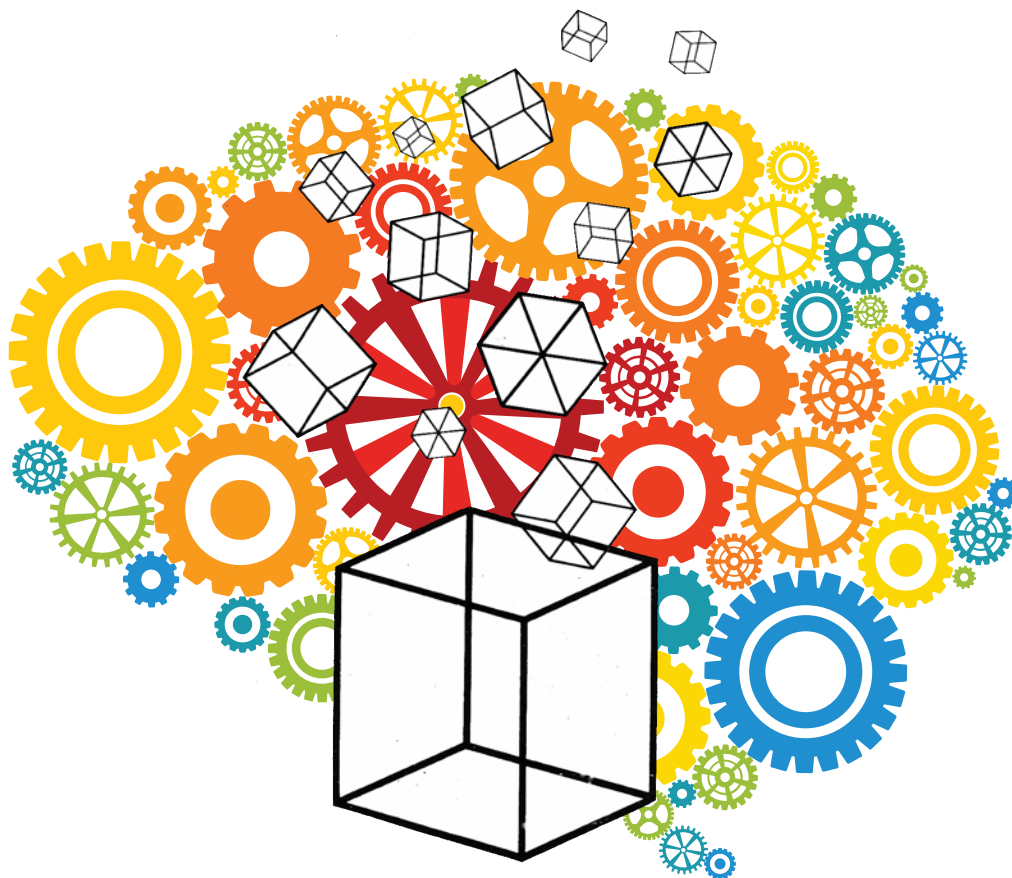


ASSC17

17TH MEETING OF THE
ASSOCIATION FOR THE SCIENTIFIC STUDY OF CONSCIOUSNESS

JULY 12-15 2013

SAN DIEGO SHERATON HOTEL AND MARINA
HOSTED BY THE NEUROSCIENCES INSTITUTE



CONFERENCE HANDBOOK



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A Warm Welcome to Southern California and America's Finest City!

And welcome to the 17th Annual Meeting of the Association for the Scientific Study of Consciousness (ASSC 17), hosted this year by The Neurosciences Institute. Although 2013 doesn't mark a singular benchmark in the history of either the ASSC or its annual meetings, it is significant that we find ourselves in Southern California, not far from Pomona and the Claremont Colleges, where the late, great Bill Banks and the indefatigable Patrick Wilken oversaw the first annual meeting and the idea of the ASSC was born. It is also notable that ASSC 17 is convening in San Diego: for many years, a rich and vibrant center for neurobiological research and a veritable 'hothouse' for ideas about the nature and seat of consciousness. These ideas have run the gamut, from the exciting, and groundbreaking terrain of neural correlates of consciousness (NCC) first charted by Francis Crick and a young Christof Koch at the Salk Institute, to the robust theoretical framework laid out by Gerald Edelman and his colleagues at The Neurosciences Institute in an attempt to place consciousness firmly back into nature; an ambition well in keeping with the long Darwinian arc that has traced the rise of all of modern biology.

Not surprisingly, work presented at the earliest annual ASSC meetings confronted the most fundamental issues in the nascent science of consciousness: namely, the anatomical and physiological underpinnings of consciousness (e.g., the NCC) and even the problem of how to apprehend and characterize those underpinnings experimentally. Needless to say, these issues are still at the core of our annual discourse. But, now, the combination of ever more sophisticated physiological techniques, imaging technologies, modeling paradigms, and robust theoretical frameworks (about which much will be offered and discussed during this meeting) is finally bearing fruit, and recent work certainly suggests a new and exciting phase of growth in the life of consciousness science. The study of consciousness is no longer an armchair enterprise. It has grown strong, muscular legs and is now treading down both basic and applied paths. From promising paradigms for assessing possible conscious states in non-human animals to the characterization of previously vexing neuropsychiatric disorders, to a profound reinterpretation of the diagnosis of a spectrum of coma states, serious inroads have been made. Given perhaps little more than three decades since consciousness gained respectability as a legitimate object of scientific inquiry, progress has been measureable and in many ways rather dramatic. And though few would argue that we're on the verge of unraveling one of the greatest of human mysteries, it now appears that our armamentarium is well stocked, and we're fighting the good fight and gaining the upper hand.

As in previous years, the breadth, depth, and overall quality of ASSC 17 will rest largely on the efforts and involvement of ASSC members from around the globe. This year, the Scientific Program Committee reviewed a total of 250 abstracts submitted by researchers and scholars from at least 24 countries and 146 colleges, universities, and public and private research institutions. Though this number doesn't even approach the stunning record set at last year's meeting, the breadth, depth, and richness of salient findings reported and scientific thought represented in this year's submissions nevertheless presented the Scientific Program Committee with a significant challenge, particularly in selecting the roster of concurrent talks. As in past years, neuroscience, psychology, and philosophy are equally well represented this year; moreover, research from the clinical arena is in evidence at ASSC 17, as this area takes its place as an established staple of the annual meetings.

The variety and substance of this year's keynote talks, symposia, and tutorials are testament to the conclusion that the scientific study of consciousness is a robust and growing enterprise. Moreover, the subject matter of this year's satellite symposium, 'Action and Perception in Immersive Worlds,' speaks to what will be possible in the future, as virtual, interactive systems are increasingly incorporated into both experimental research paradigms and everyday life. In particular, though, we must thank Professors Giulio Tononi, Christof Koch, Gary Marcus, and Stuart Firestein, and Ms. Jennifer Goldman, who gave freely of their time to participate in what promises to be a compelling, spirited, and fun roundtable discussion of the Integrated Information Theory of Consciousness.

And so, we owe a huge debt of gratitude to all of you—speakers and poster presenters alike—not only for your contributions to this and other ASSC meetings, but also for being the dynamic and sustaining force behind a robust science of consciousness.

As in previous ASSC meetings, student participation has been, and will be, critical to both the quality of scientific content and the overall flavor and functioning of ASSC 17. Student posters and talks this year account for a substantial number of high quality submissions. Under the chairmanship of Kingson Man, the Student Committee has been both deliberative and proactive in organizing such events as the Student Social, poster judging, and the Mentor Lunch, which affords students an important opportunity to interact with senior researchers representing a wide variety of fields and perspectives. Moreover, members of the Student Committee have been active in social media; their online journal clubs, in which the ideas and findings of a number of senior researchers presenting at ASSC 17 have been discussed, is a shining example of the involvement and earnest commitment of the Student Committee and, indeed, student members of the ASSC overall.

This year, ASSC 17 is convening on Harbor Island, situated across from the beautiful San Diego skyline and harbor. Noted for an unmistakable naval presence (three super carriers and a number of Los Angeles attack-class nuclear submarines are berthed minutes from our venue), as well as occasional America's Cup trials, San Diego Harbor is both a sailor's delight and a veritable playground for water sports of all types. But most notable for us is our proximity to greater San Diego County and easy access to the vibrant research community that resides along Torrey Pines Road; the laboratories of the Salk Institute, UCSD, The Scripps Research Institute, and The Burnham Institute are a mere 25 minutes away by car. In this vein, the *SouthCal Consciousness Research Map*, assembled by ASSC Communications Director, Lynn Chiu, highlights local research venues that have figured prominently in the scientific study of consciousness. So, what better time than now to explore the laboratories of colleagues engaged in the work that propels consciousness research forward?

ASSC 17 currently has a presence on both Facebook and Twitter. Apart from disseminating breaking news about the meeting, our Facebook page has highlighted the work of many among our current roster of speakers. As well, our Twitter page has been aflutter with tweets providing links to news and commentary about late-breaking work in consciousness studies, and will feature live, on-site tweets during ASSC 17. We thank Lynn Chiu and Jennifer Goldman in particular for their lively contributions to all ASSC 17-related social media.

For the past year, our Local Organizing Committee has been actively spreading the word about ASSC 17 throughout California. Members of the committee have been particularly proactive in securing the small army of volunteers needed to run the day-to-day operations of the meeting. So, our heartfelt thanks to Tom Albright, Gedeon Deak, Sergei Gepshtein, Jennifer Goldman, Ayşe Saygin and Ed Vul for their invaluable help in disseminating ASSC 17 and recruiting our hearty volunteer crew. We are especially grateful to Jennifer for her boundless enthusiasm and invaluable help in coordinating local arrangements for the meeting. Much of what you will enjoy in the way of meeting amenities are due in no small measure to Jennifer's efforts.

Needless to say, ASSC 17 owes its depth and breadth—indeed, its very soul—to the work and diligence of the Scientific Program Committee. Without the tough deliberations undertaken and hard decisions made by members of this committee, the program could not h

ave assumed its current form. We thank committee members Heather Berlin, Hal Blumenfeld, Olivia Carter, Shimon Edelman, Andreas Engel, Hakwan Lau, David Rosenthal, Corrado Sinigaglia, and Masatoshi Yoshida for their dedication and for a job well done.

Without an enthusiastic and hardworking crew of volunteers to run day-to-day operations, it would be impossible to realize a meeting of this scale. We're therefore immensely grateful all those who have given freely of their time to provide ASSC 17 with a functioning infrastructure. We're particularly grateful to Amira Hankin and Evan Braun for their help in assembling the graphics for the meeting poster, Maggie Ammons for her work on building the ASSC 17 attendee spreadsheet, and Eve Isham for her careful proofreading of the meeting program book.

Major organizational efforts at all scales require significant financial support and, of course, patrons with the imagination, vision, and generosity to provide that support. ASSC 17 is no exception, and would never have become a reality without such support. First and foremost, for its steadfast commitment to seeing ASSC 17 to full fruition, we are deeply grateful to our host institution, The Neurosciences Institute (NSI). In particular, Dr. W. Einar Gall, Vice President and Research Director of the NSI unflinchingly provided the initial support that allowed us to secure as our venue the beautifully and conveniently situated San Diego Sheraton Hotel and Marina. Upon hearing about our plan to bring ASSC 17 to San Diego, Dr. Gall immediately responded with words to the effect of, "Let's figure out a way to make this happen." And so, we thank Dr. Gall for his broad vision and generosity, the benefits of which now redound to you, not only as ASSC 17 attendees, but also as scholars and researchers of consciousness who will gain insights from what you learn here today. Such insights will drive your work far into the future.

Finally, we owe a deep and enduring debt of gratitude to The Mind-Science Foundation (www.mindscience.org) and Joseph Dial, Scientific Chair of the Aspen Brain Forum (<http://aspenbrainforum.com>), not just for their generosity this year, but for the many years of committed support they have provided for our annual meeting.

This year, the Mind Science Foundation (MSF) gave \$8,500.00 to sponsor two ASSC 17 special events: the evening of talks and music in honor of Dr. Gerald Edelman and the satellite symposium, 'Perception and Action in Immersive Worlds.' Needless to say, it would not have been possible to present such important and engaging fare without the generosity of the MSF and its Board of Directors. We are grateful beyond words to MSF Executive Director, Meriam Good, and Vice Chair and Chief Science Officer, Dr. Paul Ingmundson, for their attention, care, and unwavering support throughout the planning and execution of ASSC 17. Continuing the ambitious vision of philanthropist and entrepreneur, Tom Slick, the MSF has been "...dedicated to solving one of the major questions of modern science - the puzzle of human consciousness" (<http://www.mindscience.org/about/about-msf>). Clearly, the mission of the MSF has never been more critical than it is today, particularly when federal funding for basic science in the United States has been on the wane for so long. And so, Meriam and Paul: for your dedication to Tom Slick's vision, your boundless energy, commitment to the 'care and feeding' of so many consciousness researchers, and your support of, ASSC 17, we think you seriously rock!

As many of you already know, Joseph Dial has been an unwavering supporter and booster of consciousness research, from his days as Executive Director of the Mind Science Foundation to the present, in his role as Chairman of the Aspen Brain Forum. This year, Joseph made a personal gift of \$5,000.00 to subsidize student attendance of the ASSC 17 Banquet, to be held at the legendary Del Coronado Hotel. The importance of fostering interactions between students and senior researchers cannot be overstated. The opportunity for both populations to mingle in a less formal and more intimate setting over a good meal is very precious indeed.

It can be said without irony or exaggeration that, just as Thomas Henry Huxley was 'Darwin's Bulldog,' so Joseph Dial has, for many years, been 'Consciousness Science's Bulldog' in the most practical and material sense of that moniker. Joseph has said that "...consciousness research is one of the most important endeavors of modern science and the ASSC students are the future of [that] research." Who are we to argue? Some months ago, Joseph told one of us, "I've got your back, brother!" His generosity and support of ASSC 17 is manifest proof of that sentiment. Thank you, Joseph.

We would be remiss if we did not mention a generous anonymous contribution of \$1,000.00 to support the musical performance by the Hutchins Consort during the special event honoring Dr. Gerald Edelman. We know that this concert will burnish the event and is particularly apropos of the breadth of Dr. Edelman's musical interests and talent. We hope you all enjoy this special musical offering.

Last but not least, we owe Olivia Carter a tremendous debt of gratitude for her sage advice, keen problem-solving from afar, and deep commitment to getting us across the finish line. We must add to this a sense of sadness we feel with the realization that this meeting will be Olivia's last as Executive Director of the ASSC. We know that all of you will wish her well in whatever endeavors she takes on, both as a member of the association and as an outstanding scientist 'toiling in the vineyards' of consciousness research.

To conclude, a heartfelt thanks to all of you for trekking to San Diego from far-flung parts of the world and joining us for this annual journey into, and celebration of, the heart of the science of consciousness.

Cheers/Prost!



David and Tobias
Co-Chairs, ASSC 17



Committees, Executive Board, and Volunteer Staff

ASSC 17 Local Organizing Committee

Co-Chairs	David Edelman – Science, Mathematics, and Computing, Bennington College, USA Tobias Schlicht – Institute of Philosophy II, Ruhr-Universität Bochum, Germany
Committee	Edward Vul – University of California, San Diego, USA Thomas Albright – The Salk Institute for Biological Studies, USA Gedeon O. Deak – University of California, San Diego, USA Sergei Gepshtein – The Salk Institute for Biological Studies, USA Ayse Saygin – University of California, San Diego, USA Jennifer Goldman – McGill University and Montreal Neurological Institute, Canada
Volunteer Staff	Maggie Ammons – Bennington College, USA Evan Braun – Bennington College '13, USA Phuonguyen Chu – Green Neuroscience Laboratory, USA Lauren Curley, University of California, USA Alice Gepshtein – University City High School, USA Noah Greifer – University of California, San Diego, USA Amira Hankin – Bennington College, '13, USA Max Henning – University of Southern California, USA Eve Isham, PhD – University of California, Davis, USA Akila kadambi - University of California, San Diego, USA Brittany Kleinschnitz – Bennington College, USA Kang (Matt) Liao – University of California, San Diego, USA Fauve Lybaert* - Catholic University of Leuven, Belgium Ting-An Lin- National Yang-Ming University, Taiwan Kingson Man** – University of Southern California, USA Alisa Munoz – Green Neuroscience Laboratory Edward Nguyen – University of California, San Diego, USA Angela Pham – University of California, San Diego, USA Ben Stillerman – University of California, San Diego, USA Aleah Stewart-Souris – Bennington College, USA Carol Thivierge – University City High School, USA Mateo Vargas – University of California, San Diego, USA Rebecca Warzer – Bennington College, USA Audre Wirtanen – Bennington College, USA David Zhou* - Carnegie Mellon University, USA

**ASSC Student Committee members*

***Chair, ASSC Student Committee*

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Committee	Heather Berlin – Icahn School of Medicine at Mount Sinai, USA Hal Blumenfeld – Yale University School of Medicine, USA Olivia Carter – University of Melbourne, Australia Shimon Edelman – Cornell University, USA Andreas K. Engel – University Medical Center, Hamburg-Eppendorf, Germany Hakwan Lau – Columbia University, Radboud University & University of California, Los Angeles, USA David Rosenthal – City University of New York, USA Corrado Sinigaglia – Università degli Studi di Milano, Italy Masatoshi Yoshida – National Institute for Physiological Sciences, Japan

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Past ASSC Meetings

ASSC 16

Chairs: Anil Seth and Zoltan Dienes, University of Sussex, July 2-6, 2012, Brighton, U.K.

ASSC 15

Chair: Tadashi Isa, June 9-12, 2011, Kyoto University, Japan

ASSC 14

Chair: Mel Goodale, June 24-27, 2010, University of Toronto, Canada

ASSC 13

Chairs: John-Dylan Haynes, Michael Pauen and Patrick Wilken, June 5-8, 2009, Humboldt-Universität, Germany

ASSC 12

Chairs: Allen Houng and Ralph Adolphs, June 19 – 22, 2008, National Taiwan University, Taipei

ASSC 11

Chairs: Stephen Macknik and Susana Martinez-Conde, June 22 – 25, 2007, The Imperial Palace Hotel, Las Vegas

ASSC 10

Chairs: Geraint Rees and Patrick Wilken, June 23 – 26, 2006, St. Anne's College, Oxford

ASSC 9

Chairs: Christof Koch and Patrick Wilken, June 24 – 27, 2005, California Institute of Technology, Pasadena

ASSC 8

Chair: Erik Myin, June 25 – 28, 2004, University of Antwerp, Antwerp

ASSC 7 Models and Mechanisms of Consciousness

Chair: Stan Franklin, May 30–June 2, 2003, University of Memphis, Memphis

ASSC 6 Consciousness and Language: Reportability and Representation in Humans and Animals

Chairs: Manuel Garc.a-Carpintero and Josep Maci, May 31–June 3, 2002, La Caixa Foundation Science Museum, Barcelona

ASSC 5 The Contents of Consciousness: Perception, Attention, and Phenomenology

Chairs: Güven Güzeldere and Ron Mangun, May 27 – 30, 2001, Duke University, Durham

ASSC 4 The Unity of Consciousness: Binding, Integration, and Dissociation

Chair: Axel Cleeremans, June 29 – July 2, 2000, Université Libre de Bruxelles, Brussels

ASSC 3 Consciousness and Self: Neural, Cognitive, and Philosophical Issues

Chair: Mel Goodale, June 4 – 7, 1999, University of Western Ontario, London

ASSC 2 Neural Correlates of Consciousness: Empirical and Conceptual Issues

Chair: Thomas Metzinger, June 19 – 22, 1998, Hanse Institute for Advanced Study, Bremen

ASSC 1 What Does Implicit Cognition Tell Us About Consciousness?

Chairs: William Banks and Patrick Wilken, June 13 – 16, 1997, The Claremont Colleges, Claremont

ASSC 17 Exhibitors

On Friday, July 12, exhibitor displays will be located in the Grande Foyer. From July 13-15, exhibitor displays will be located in the Harbor Island Foyer.

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The MIT Press publishes distinguished scholarly publications in the cognitive and brain sciences. New titles include: *Do Apes Read Minds?* by Kristen Andrews, *Mindvaults* by Radu Bogdan, *The Consciousness Paradox* by Rocco Gennaro, *Radicalizing Enactivism* by Daniel Hutto and Erik Myin, *Inner Experience and Neuroscience* by Donald Price and James Barrell, *Open Minds* by Wolfgang Prinz, *Mindshaping* by Tadeusz Zawidzki.

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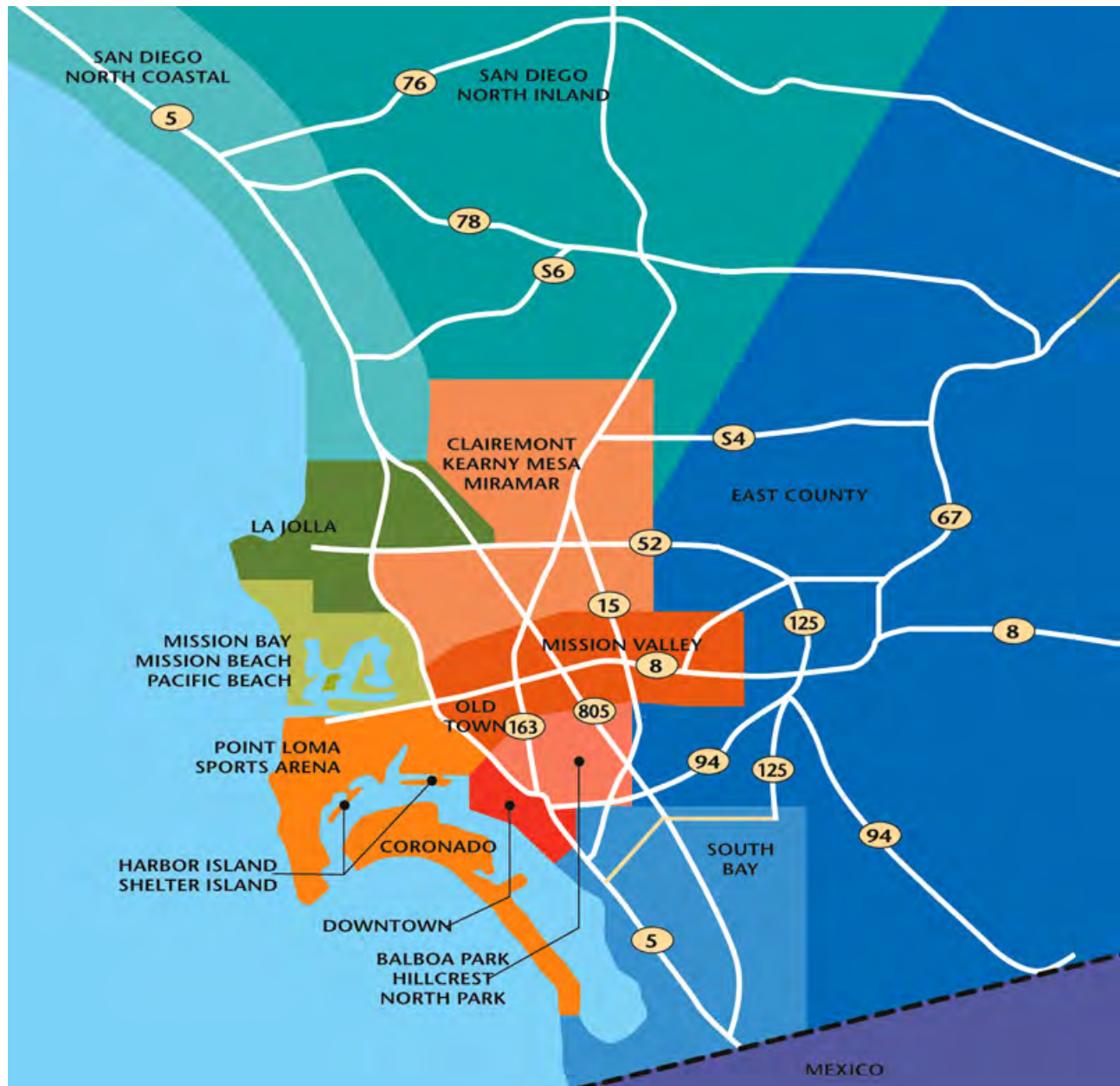
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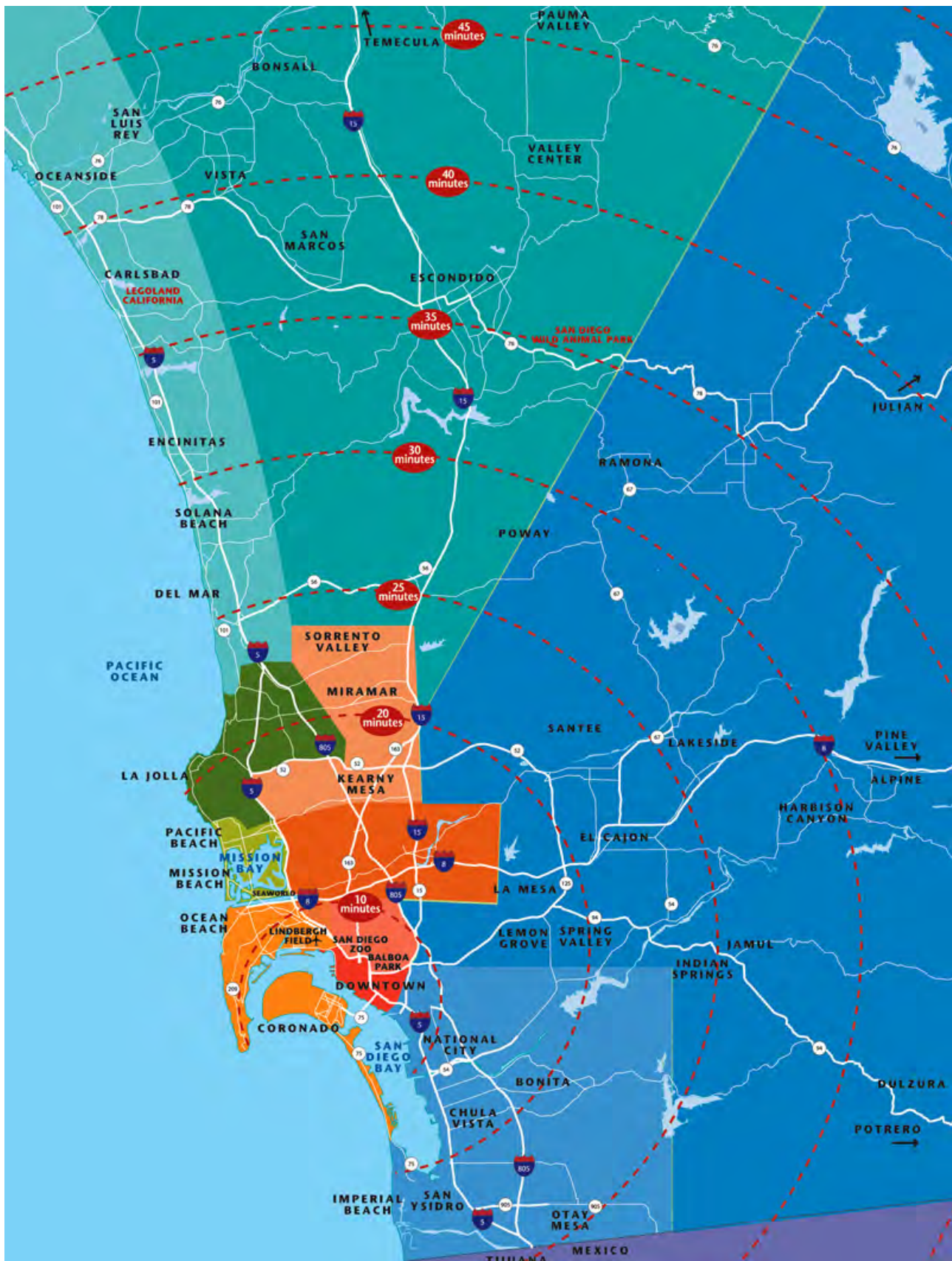
	FRIDAY, JULY 12	SATURDAY, JULY 13	SUNDAY, JULY 14	MONDAY, JULY 15	TUESDAY, JULY 16
	TUTORIALS 1-4				POST-MEETING SATELLITE
09:00		KEYNOTE I ITZHAK FRIED	KEYNOTE III SABINE KASTNER	COFFEE / TEA	COFFEE / TEA
09:30				SYMPOSIUM III	SATELLITE SYMPOSIUM:
10:00	Dienes: USING BAYES TO INTERPRET NON-SIGNIFICANT RESULTS SETH & KANAI: INTEGRATED INFORMATION, PREDICTIVE CODING, AND QUALIA WINDT & FINK: FIRST-PERSON READINGS: PHILOSOPHERS' DREAMS OR RESEARCHERS' NIGHTMARES? CARMEL & FLEMING: MEASURING UN/AWARENESS	COFFEE / TEA	COFFEE / TEA	BEYOND THE CONTRASTIVE METHOD	PERCEPTION AND ACTION IN IMMERSIVE WORLDS
10:30		SYMPOSIUM I ROLE OF THE PREFRONTAL CORTEX IN CONSCIOUS EXPERIENCE	SYMPOSIUM II BODILY CONSCIOUSNESS	MELLONI, DEHAENE, PITTS & BLOCK	S. GEPSSTEIN & A. MCDOWELL
11:00			BLANKE, METZINGER, SALOMON, SERINO & DE VIGNEMONT		CHAIRS
11:30		BROWN, MALACH, LEVINE & RAHNEV			
12:00		ASSC MENTOR LUNCH			
12:30	TUTORIALS 5-8			CONCURRENT 3.1	
13:00		SPECIAL ROUNDTABLE: DEBATING THE INTEGRATED INFORMATION THEORY (IIT) OF CONSCIOUSNESS G. TONONI, C. KOCH, G. MARCUS & J. GOLDMAN MODERATOR: S. FIRESTEIN	POSTER SESSION I	CONCURRENT 3.2	SATELLITE SYMPOSIUM (CONT'D):
13:30	DROEGE & BRAITHWAITE: INVESTIGATING ANIMAL PAIN AND CONSCIOUSNESS GENNARO: REPRESENTATIONAL THEORIES OF CONSCIOUSNESS TONONI, KOCH, TSUCHIYA, OIZUMI: THE INTEGRATED INFORMATION THEORY OF CONSCIOUSNESS TONG: DECODING THE INFORMATION CONTAINED IN HUMAN BRAIN ACTIVITY	COFFEE / TEA	COFFEE / TEA	CONCURRENT 3.3	PERCEPTION AND ACTION IN IMMERSIVE WORLDS
14:00		CONCURRENT 1.1	CONCURRENT 2.1	POSTER SESSION II	
14:30		CONCURRENT 1.2	CONCURRENT 2.2		
15:00		CONCURRENT 1.3	CONCURRENT 2.3	COFFEE / TEA	
15:30	COFFEE / TEA			SYMPOSIUM IV	
16:00	OPENING REMARKS			ETHICAL IMPLICATIONS OF DETECTING AWARENESS	
16:30	JAMES PRIZE LECTURE	KEYNOTE II SHAUN GALLAGHER	KEYNOTE IV PATRICK CAVANAGH	OWEN, NACI, BOR, YOUNG, PETERSON & WEIJER	
17:00				CLOSING REMARKS	
17:30	PRESIDENTIAL ADDRESS: ANDREAS K. ENGEL				
18:00					
18:30	RECEPTION: SAN DIEGO SHERATON HOTEL & MARINA (LIGHT DINNER AND CASH BAR)		TRANSPORT TO THE HOTEL DEL CORONADO		
19:00			SUNSET RECEPTION & BANQUET OCEAN VIEW BALLROOM, HOTEL DEL CORONADO	ASSC 17 AFTER-PARTY BEACH BAR (TBA)	
19:30		SPECIAL EVENT FROM MATTER TO MIND:			
20:00		TALKS AND MUSIC IN HONOR OF G.M. EDELMAN, MD, PhD			
20:30		POST-EVENT: RECEPTION (CASH BAR)	TRANSPORT BACK TO THE SAN DIEGO SHERATON HOTEL AND MARINA		
21:00					
21:30	ASSC STUDENT SOCIAL (21:15 START)				
22:00					
22:30					
23:00					

Venue Maps & Locations

San Diego Region Map

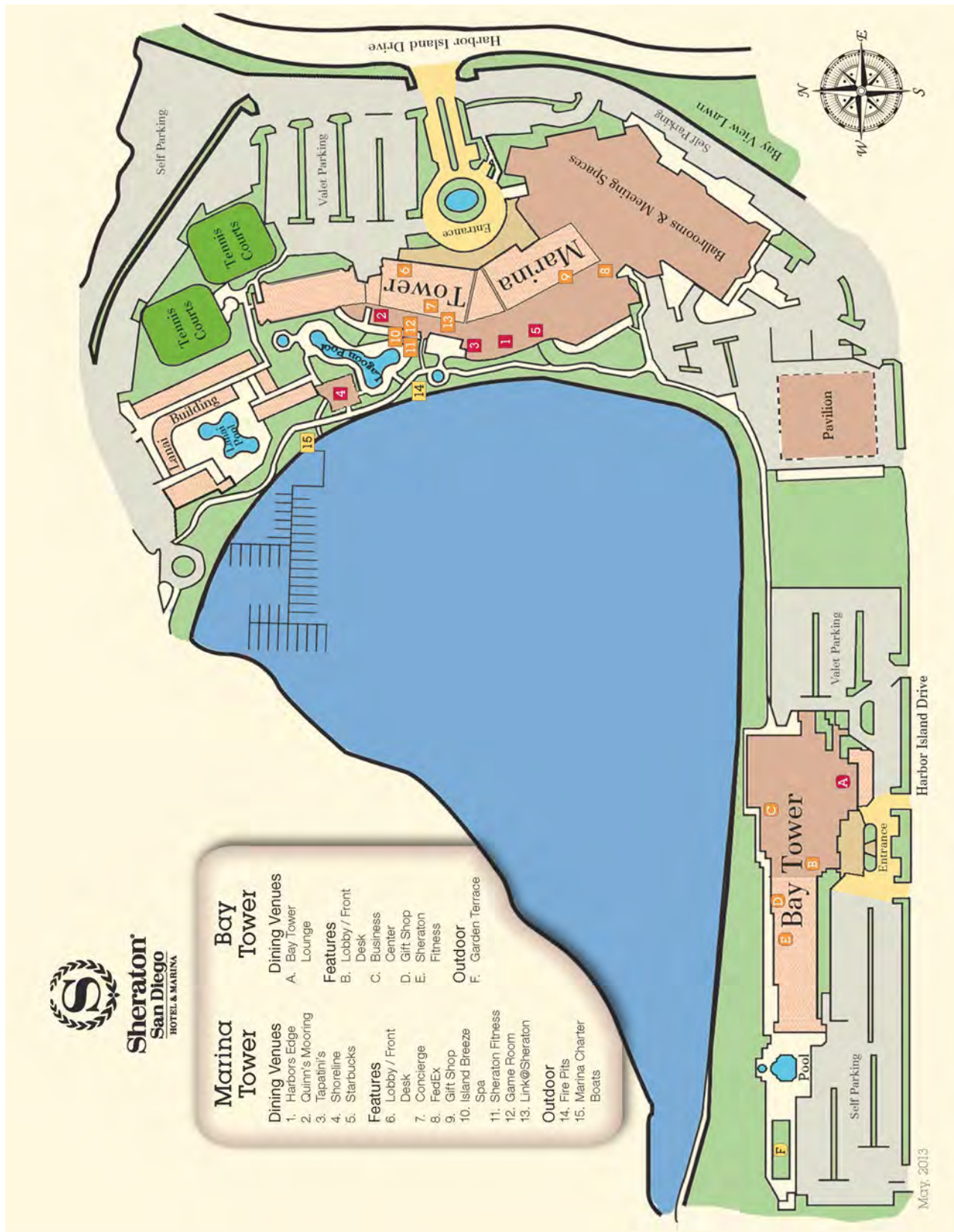


San Diego Distance Map





The San Diego Sheraton Hotel & Marina

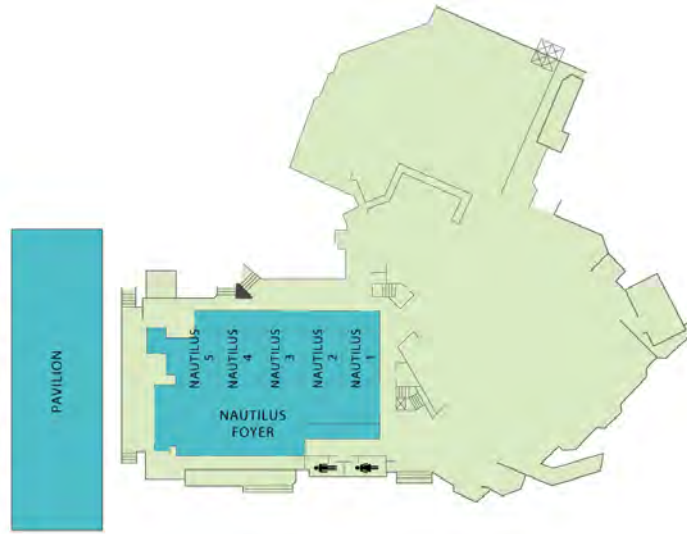


The San Diego Sheraton Hotel & Marina: Meeting Venue Floorplans



- BALLROOMS
- MEETING ROOMS
- PUBLIC AREAS
- SERVICE AREAS

LOWER LEVEL



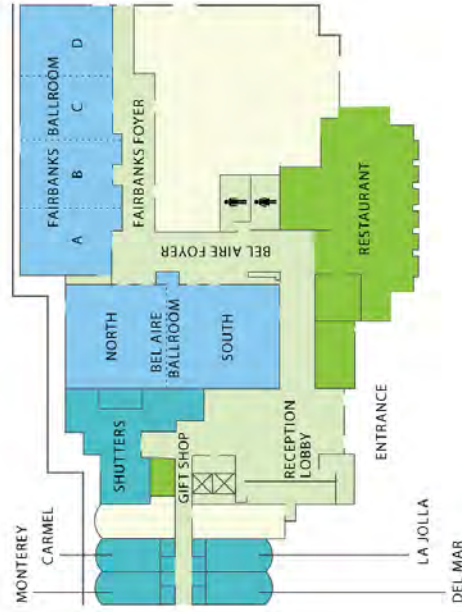
MARINA TOWER

LOBBY LEVEL

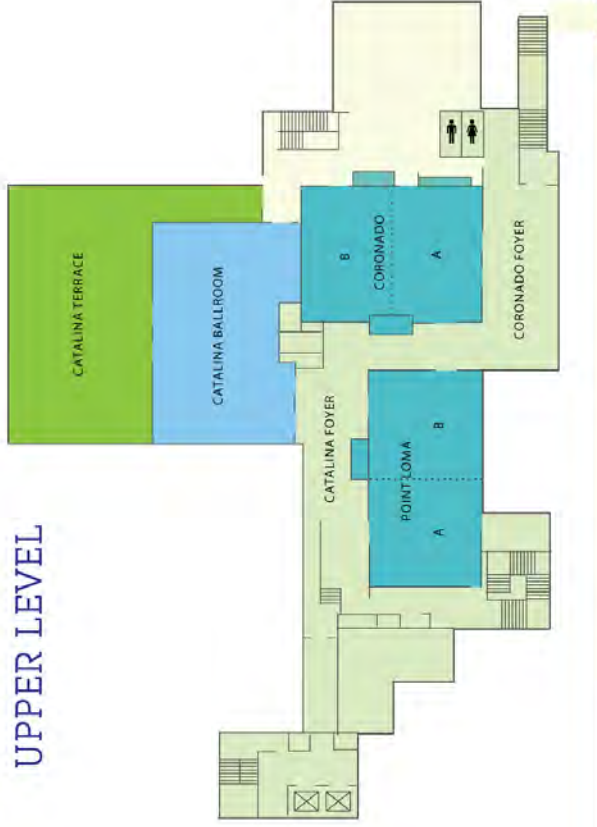


BAY TOWER

LOBBY LEVEL



UPPER LEVEL



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NOTE: Please remember that the password is case-sensitive; enter lowercase letters only.

Detailed Program

Friday, July 12th

Time	Event	Presenter(s)	Room	Page
9:00	Tutorial Workshops			
	M1 Using Bayesian Approaches to Interpret Non-significant results	Zoltan Dienes	Nautilus 1	21
	M2 Integrated Information, Predictive Coding and Qualia	Anil Seth & Ryota Kanai	Nautilus 2	21
	M3 First-Person Methods: Philosophers' Dreams or Researchers' Nightmares	Jennifer M. Windt Sascha B. Fink	Nautilus 3	21
	M4 Measuring (un)awareness	David Carmel & Stephen Fleming	Nautilus 4	22
12:00	Lunch			
13:00	Tutorial Workshops			
	A1 Investigating animal pain and consciousness	Paula Droege	Nautilus 1	22
	A2 Representational theories of consciousness	Rocco J. Gennaro	Nautilus 2	22
	A3 The Integrated Information theory of consciousness	Giulio Tononi, Christof Koch, Nao Tsuchiya, Masafumi Oizumi	Nautilus 3	23
	A4 Deciphering the information contained in patterns of human brain activity	Frank Tong	Nautilus 4	23
16:00	Coffee/Tea		Grande Foyer	
16:30	Opening Remarks & James Prize Lecture		Grande Ballroom C	
17:15	Presidential Address	Andreas K. Engel		14
18:30	Reception		Lobby Landing (Outdoor)	
21:15	ASSC Student Social		U.S. Grant Hotel	

Saturday, July 13th

Time	Event	Presenter(s)	Room	Page
9:00	Keynote Lecture I Memories and Volitions: Insights from Single Neuron Recordings in the Human Brain	Itzhak Fried	Harbor Island II & III	14
10:00	Coffee/Tea		Harbor Isl. Foyer	

10:30	Symposium 1: The role of the prefrontal cortex in conscious experience	Chair: Richard Brown	Harbor Island II & III	16
	Local neuronal “ignitions” and perceptual awareness	Rafi Malach		16
	Three Problems for Higher-Order Thought Theories	Joseph Levine		16
	Higher order attentional contributions to subjective perception	Dobromir Rahnev		16
	Consciousness without first-order representations	Richard Brown		16
12:30	ASSC Mentor Lunch		Spinnaker Room	
13:30	Special Roundtable Discussion: Debating the Integrated Information Theory (IIT) of Consciousness	Giulio Tononi, Christof Koch, Gary Marcus, Jennifer Goldman	Harbor Island II & III	24
		Moderator: Stuart Firestein		
15:00	Coffee/Tea		Harbor Island Foyer	
15:30	Concurrent Sessions:			
	C1.1: Attention & Time Consciousness		Nautilus 1	27
	Perceptual Load and the awareness of time	David James Robertson		27
	Quantifying Temporal Consciousness	Eve A. Isham		27
	Shutting down the world (in your mind): spontaneous mind-wandering associated with and predicted by threshold fluctuations in conscious perception.	Mikael Bastian		27
	Neural signatures of conscious face perception: The N170 is absent during inattention blindness	Juliet Shafro		28
	My future self and me: prospective memory and temporal discounting	Ying-Tung Lin		28
	Attentional attractors: Explaining the contrasting effects of different numbers of cues at attended and unattended locations	David Carmel		28
15:30	C1.2: Embodiment, Extended consciousness, and Higher-Order Theory		Nautilus 2	29
	Towards a Scientifically Tractable, Direct Realist, Sensorimotor Account of Experience	Mike Beaton		29
	Seeing Absence	Anya Farennikova		29
	Extended Cognition, Extended Consciousness?	Tobias Schlicht		30

	Tool use modulates both conscious and unconscious representations of body shape	Luke E. Miller		30
	Troubles with Higher-Order Thought Theories of Consciousness: an Objection from Hydranencephaly	Karen Yan		30
	Somatoparaphrenia and Higher-Order Thoughts	Rocco Gennaro		31
15:30	C 1.3: Consciousness & Unconsciousness		Nautilus 3	31
	Interaction between spontaneous fluctuation and auditory evoked activity during wakefulness and propofol-induced loss of consciousness: an EEG-fMRI study	Olivia Gosseries		31
	Signatures of consciousness and predictors of recovery in vegetative and minimally conscious patients	Jacobo D. Sitt		32
	The reach of the unconscious	Axel Cleeremans		32
	Threshold for subjective visibility is associated with striatal dopamine D2 receptor binding	Filip Van Opstal		33
	Neurodynamics of transitions between sleep and wakefulness revealed by Granger causality analysis of intracranial EEG data	Anil K. Seth		33
	Unconscious arithmetic –arithmetic problems are solved without conscious awareness	Asael Y. Sklar & Ran R. Hassin		33
17:30	Keynote Lecture II Consciousness in Outer Space	Shaun Gallagher	Harbor Island II & III	14
20:00	Special Event – From Matter to Mind: Talks and music* in honor of Gerald M. Edelman, MD, PhD	Anil K. Seth Oliver Sacks (video) Paul F.M.J. Verschure <i>*The Hutchins Consort</i>	Harbor Island II & III	25
22:00	Post-event: Open Bar Reception		Harbor Island Foyer	

Sunday, July 14th

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9:00	Keynote Lecture III Neural Network Dynamics for Attentional Selection	Sabine Kastner	Harbor Island II & III	14
10:00	Coffee/Tea		Harbor Island Foyer	
10:30	Symposium II: Projecting bodily consciousness: How the	Chairs: Olaf Blanke,	Harbor	17

	body affects consciousness in personal, peripersonal and interpersonal space	Thomas Metzinger	Island II & III	
	Body-building-awareness: Bodily factors shaping our consciousness	Roy Salomon		17
	Spatial boundaries of Body-self Consciousness	Andrea Serino		17
	Seeing other people's bodies	Frédérique de Vignemont		17
12:30	Lunch			
13:30	Poster Session I		Nautilus 4 & 5	
	Coffee/Tea		Harbor Island Foyer	
15:30	Concurrent Sessions:			
	C2.1: Feeling, Consciousness and decision-making		Nautilus 1	34
	Is consciousness involved in deliberate decision making? Evidence from intracranial recordings	Uri Maoz		34
	Prospects for an experimental philosophy of mind: experimental philosophy with or without intuitions?	Jennifer M. Windt		34
	Ventral Striatum but not Ventromedial Prefrontal Cortex Represents Stimulus Value without Perceptual Awareness	Leila M. Kouhsari		35
	The mechanism of choice blindness: clues from patterns of preference alteration	Ilya Farber		35
	Why has feeling not (yet) been selected against? Homeostasis, valence and biological value	Pietro (Cesare Andrea) Snider		36
	Decoding the dynamics of action, intention, and error-detection for conscious and subliminal stimuli	Lucie Charles		36
15.30	C2.2: Metacognition		Nautilus 2	36
	Metacognition versus Mindreading, Some Differences from Error Awareness Studies	Santiago Arango-Munoz		36
	Metacognition and two kinds of visual awareness	Hakwan Lau		37
	A New Method for Manipulating Metacognitive Awareness while Keeping Performance Constant	Man Song		37
	Metacognition and Cognitive Insight: Two sides of the same coin?	Emma C. Palmer		37
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15:30	C2.3: Perception		Nautilus 3	39
	Distinct MEG correlates of conscious experience, perceptual reversals and stabilization during binocular rivalry	Kristian Sandberg		39
	A cellular mechanism for perceptual binding	Matthew Larkum		39
	Causal role of gamma oscillations in bistable perception revealed by transcranial alternating current stimulation	Melanie Wilke		40
	Transient induced gamma-band responses in MEG during binocular rivalry: Do they reflect perceptual transitions or microsaccades?	Laila Hugrass		40
	Emergence of illusory shapes from invisible inducers	Marjan Persuh		40
	High-level contextual integration without awareness: evidence from unconscious processing in visual masking	Liad Mudrik		41
17.30	Keynote Lecture IV			
	Perceived Location: A New Measure of Attention	Patrick Cavanagh	Harbor Island II & III	15
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19:30	Sunset Reception & Banquet		Ocean View Ballroom	
22:00	Transport back to The San Diego Sheraton Hotel & Marina		Hotel Del Coronado Hotel Del Coronado Parking Lot	

Monday, July 15th

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9:30	Symposium III: Beyond the contrastive method: How to separate the neural correlates of consciousness from its precursors and consequences	Chair: Lucia Melloni	Harbor Island I & II	17
	Distilling the Neural Correlates of Consciousness	Lucia Melloni		18
	Using MEG to track conscious access and its non-conscious consequences	Stanislas Dehaene		18
	Isolating NCCs that are necessary and sufficient for visual awareness	Michael Pitts		18

	Core vs. Total NCC	Ned Block	18
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	Concurrent Sessions		
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	Expectations accelerate entry into awareness	Yair Pinto	41
	Generic Phenomenology and Partial Report Paradigms	Henry Shevlin	42
	Cross-modal prediction changes the timing of conscious access during the motion-induced blindness	Acer Yu-Chan Chang	42
	Subliminal oddball ERP effects: Psychophysiological evidence for complex unconscious processing	Brian Silverstein	43
	The effect of stimulus strength on subjective confidence	Stephen M. Fleming	43
12:30	C3.2: Consciousness, Self and Unity	Nautilus 2	43
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	Attention and the Problem of Unity	Carolyn Dicey Jennings	44
	From Darwin to Freud: Confabulation as an adaptive response to dysfunctions of self-consciousness	Paula Droege	44
	Intersection of perception and cognition & cross-modal experiences: New insights into unified consciousness	Aleksandra Mroczko-Wąsowicz	44
	I am what I am	Shimon Edelman	45
	Tracking Persons Over Time is Tracking What?	Andrew Brook	45
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	Using Training to Simulate Synaesthesia in Adulthood	Daniel Bor	45
	The cortical excitability and neurochemical markers of visual cognition in synaesthesia	Devin B. Terhune	46
	A neural marker of perceptual consciousness in infants	Sid Kouider	46
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	Do subjective, objective and indirect measures of perception reflect qualitatively different mechanisms?	Dominique Lamy	47
	Measuring the level of consciousness in flies with integrated information	Naotsugu Tsuchiya	47

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	Using multiple neuroimaging techniques to assess the quality of conscious awareness in DOC patients	Daniel Bor		20
	Obstacles at the interface between advances in cognitive neuroscience and clinical practice	Bryan Young		20
	Conceptual foundations for assessing decision-making capacity in disorders of consciousness	Andrew Peterson		20
	Navigating the transition between research and treatment when integrating novel neuroimaging techniques in medical practice	Charles Weijer		20
18:30	Closing Remarks		Harbor Island II & III	
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Posters

Poster Session 1, Sunday 14th, 13:30 – 15:30 (*Nautilus 4 & 5*)

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Keynote Lectures

Presidential Address

Andreas K Engel

Dept. of Neurophysiology and Pathophysiology, University Medical Center Hamburg-Eppendorf, 20246 Hamburg, Germany

Friday, July 12th, 17:30 – 18:30 (*Grande Ballroom C*)

Intrinsic Coupling Modes and Consciousness

It has been proposed that functional coupling of neural signals may be involved in several processes indispensable for consciousness, including integration, selection and routing of relevant information. Evidence is accumulating that these processes are strongly determined by the intrinsic dynamics of the brain, reflected in specific coupling patterns that can also be observed in the absence of stimuli or tasks. The presentation will discuss recent studies on changes of such intrinsic coupling modes under anesthesia and in bistable stimulus paradigms. While the former suggest that intrinsic coupling modes may be important in regulating levels of consciousness, the latter demonstrate that they also predict changes in the contents of conscious states.

Keynote Lecture I

Itzhak Fried

Professor of Neurosurgery, University of California, Los Angeles & Tel-Aviv Medical Center and Tel-Aviv University

Saturday, July 13th, 9:00 – 10:00 (*Harbor Island II & III*)

Memories and Volitions: Insights from Single Neuron Recordings in the Human Brain

Single neuron recordings in neurosurgical patients provide a rare opportunity to examine the inner workings of the human mind in conscious subjects who can report their memories and volitions. Neuronal mechanisms in the medial temporal lobe, explicit at the single neuron level, underlie the transformation of external information to mental constructs, which will later be available for conscious processing. At the same time, neuronal mechanisms in the medial frontal lobe underlie the transformation of action programs into consciously recognized volitions. Together then these neuronal networks, accessed by single neuron recordings, provide important components of the stream of consciousness connecting past and future.

Keynote Lecture II

Shaun Gallagher

Department of Philosophy, University of Memphis

Saturday, July 13th, 17:30 – 18:30 (*Harbor Island II & III*)

Consciousness in Outer Space

I'll report on a neurophenomenological, simulation-based investigation into the aesthetic and spiritual experiences had by astronauts during space flight. A team of researchers and I have conducted experiments in which we attempt to replicate such experiences using immersive mixed reality simulations. I will detail some methodological issues that arise in the study, and I'll define two different concepts of immersion. I will report preliminary results that correlate neurological (EEG and fNIR) and physiological (EKG) measures with events in the simulated environment, phenomenological reports defined across 38 categories of experience characterized broadly as feelings of awe and wonder, and psychological profiles measured by a battery of questionnaires. I'll conclude by exploring some philosophical issues connected with the specialized forms of consciousness under study.

Keynote Lecture III

Sabine Kastner

Department of Psychology, Princeton Neuroscience Institute
Director, Neuroimaging Facility, Princeton University

Sunday, July 14th, 09:00 – 10:00 (*Harbor Island II & III*)

Neural Network Dynamics for Attentional Selection

Natural scenes are cluttered and contain many objects that cannot all be processed simultaneously due to capacity limitations of the visual system. Selective attention refers to a set of mechanisms that route behaviorally relevant information through large-scale cortical networks. I will discuss studies performed in two primate brain models, the human and the macaque monkey, using a variety of different techniques including fMRI, ECoG and single-cell physiology. First, I will discuss how large-scale networks mediating perception and cognition can be identified using functional brain imaging. Second, I will discuss physiology studies revealing temporal dynamics in a distributed large-scale network that mediates the selection of behaviorally relevant information. Particularly, while there is evidence that populations of cortical neurons synchronize their activity to preferentially transmit information about attentional priorities, it is unclear how cortical synchrony across a network is accomplished. I will discuss the unique role of thalamo-cortical interactions in influencing cortical networks to optimize their communication. These studies are complemented by ECoG recordings from human epilepsy patients using identical behavioral paradigms providing a mechanistic understanding of the coding principles that best predict behavior in both primate species.

Keynote Lecture IV

Patrick Cavanagh

Laboratoire Psychologie de la Perception, Institut Neurosciences Cognition,
Université Paris Descartes

Sunday, July 14th, 17:30 – 18:30 (*Harbor Island II & III*)

Perceived Location: A New Measure of Attention

How do we know where things are? The standard explanation for perceived position has always been that each neuron responds only to a particular location on the retina so, after correcting for movements of our eyes and head, there should really be no problem. However, perceived location can deviate dramatically from retinal location, showing that this simple explanation cannot be true. These deviations arise when the visual system predicts where targets should be and in this case we see the predicted, not the retinal location. We have found behavioral evidence of attention benefits at these predicted locations and we now show that when targets are moving, they are seen ahead of their actual retinal location because they are seen at their predicted next location. These results suggest that a core function of visual attention is to provide the position code for attended targets and the errors of prediction then allow us to use position perception as a new tool for studying attention. Evidence suggests that underlying both the attention and position representations are saccade maps acting as the “master map of locations” – for eye movements, for attention, and for perception. Interestingly, if the saccade system specifies perceived location, it reverses the usual assumption that action is guided by perception and suggests instead that perception is determined by action.

Symposia

Symposium I

The role of prefrontal cortex in conscious experience

Chair: **Richard Brown** (Department of Philosophy, CUNY)

Friday, July 13th, 10:30 – 12:30 (*Harbor Island II & III*)

One major divide in consciousness theory is that between higher-order and first-order theories. Interpreted anatomically, first-order theories of consciousness maintain that consciousness will depend on the activity in the sensory cortices alone while higher-order theories deny that and maintain that consciousness will be reflected, at least in part, in activity of higher-order areas of the brain, most likely frontal-parietal regions.

Virtually all theories of consciousness have a stake in this debate. For instance, besides higher-order thought, and self-representational views, Global Workspace Theory, and Information Integration Theory can be seen as versions of higher-order theory in that they posit a role for prefrontal areas in conscious perception, at least in some cases. Also in addition to first-order representation views, recurrent feedback, and attention-based theories can all be seen as versions of the first-order view.

This symposium brings together two neuroscientists and two philosophers to present the empirical and philosophical case for and against the involvement of the prefrontal cortex in conscious experience.

Local neuronal “ignitions” and perceptual awareness

Rafi Malach (Department of Neurobiology, Weizmann Institute of Science, Tel Aviv, IL)

It is evident that visuo-motor behavior necessitates a global spread of neuronal signals from visual cortex to fronto-parietal networks. However, whether such spread is also an essential ingredient of human visual perception remains an open question. I will discuss experimental results supporting the notion that visual awareness is mediated by "ignition" like neuronal activity-localized in high order visual cortex. In contrast, activity of fronto-parietal networks likely sub-serves subsequent post-perceptual processes such as conceptualization, reflection and planning.

Three problems for higher-order thought theories

Joseph Levine (Dep't of Philosophy, U. Massachusetts, Amherst)

HOT makes two commitments that lead to awkward consequences. First, if being targeted by a higher-order thought is what makes a phenomenal state conscious, then it must be possible for there to be unconscious phenomenal states. But we have good reason to think that's not possible. Second, it must be possible for there to occur target-less higher-order thoughts, and it would seem that the best response for the HOT advocate is to say that these would constitute full-fledged conscious episodes. But then the relational aspect of the theory is lost, which undermines much of the motivation for it. These two problems, I claim, are symptoms of the third, fundamental one: namely, that representation cannot reconstruct the relation of conscious awareness.

Higher order attentional contributions to subjective perception

Dobromir Rahnev (Department of Philosophy, University of California, Berkeley)

Most theories of perceptual decision making assume that subjective perception (i.e., visibility ratings) tracks task accuracy such that the two increase or decrease together. Here we present evidence that attention breaks down this relationship: it appears that attention boosts accuracy while also decreases subjective ratings of visibility. This phenomenon is explained by a model in which attention decreases perceptual noise. Our findings suggest an explanation as to why our visual field appears uniform even though the representation in the visual cortex is much richer for the fovea and attended objects compared to the unattended periphery.

Consciousness without first-order representations

Richard Brown (Department of Philosophy, CUNY)

Higher-order theories of consciousness predict that we will find cases where there is a difference in conscious experience while there is no difference in first-order representations. Recent empirical work seems to bear this prediction out and provide some reason to prefer some kind of higher-order thought theory of consciousness. In addition reflection on the nature of phenomenal consciousness suggests that awareness is critically involved which further strengthens the case for the higher-order thought theory of consciousness.

Symposium II

Projecting bodily consciousness:

How the body affects consciousness in personal, peripersonal and interpersonal space

Chairs: **Olaf Blanke** (Cognitive Neuroscience, Ecole Polytechnique, Lausanne, CH),

Thomas Metzinger (Department of Philosophy, Universität Mainz, DE)

Sunday, July 14th, 10:30 – 12:30 (*Harbor Island II & III*)

Philosophy of mind, cognitive neuroscience, and neurology stress the importance of bodily input in forming of the experience of self and person. Such bodily aspects of self-consciousness have been shown to arise from the complex integration of interoceptive and exteroceptive body-related signals. An intriguing aspect of bodily self consciousness is that it is not limited to the body itself, but also depends on stimuli related to external objects and in turn influences the experience of the external world. In this sense, bodily self-consciousness extends beyond the limits of our body over the space around us (i.e. peripersonal space) and impacts the interaction with other humans.

The presentations of this symposium will highlight complementary findings from multisensory, motor, and affective approaches and discuss their relevance for self-consciousness. Roy Salomon will focus on how bodily information, that has been shown to alter self-consciousness, can also modulate visual consciousness. Andrea Serino will show how the boundaries of peripersonal space adapt when interacting with objects and others. Federique de Vignemont will extend the notion of embodiment to the study of social interactions and intersubjectivity.

Body-building-awareness: Bodily factors shaping our consciousness

Roy Salomon (Cognitive Neuroscience, Ecole Polytechnique, Lausanne, CH)

Of the multitude of stimuli bombarding our senses only a few are selected to become an object of our conscious awareness. The scientific study of conscious awareness has been dominated by the examination of visual consciousness while the effects of bodily senses and states, on consciousness have been frequently overlooked. Here I report on the interplay between visual conscious awareness and bodily processing that is of relevance for self-consciousness. I show that bodily input, i.e. proprioception influences the selection of information entering visual consciousness (using continuous flash suppression). We discuss how integration of sensory signals that modulate bodily self-consciousness interact with conscious awareness of the external environment.

Spatial boundaries of body-self consciousness

Andrea Serino (Cognitive Neuroscience, University of Bologna, IT)

Premotor and posterior-parietal brain regions responsible for Bodily-self consciousness integrate multisensory-motor signals related to our physical body and also related to a limited portion of space immediately surrounding the body, where the body directly interacts with external stimuli, i.e. the peripersonal space (PPS). Therefore, I propose that the space of bodily-self consciousness is not limited to boundaries of the skin, but extends into the PPS, which therefore constitutes the true psychological boundary of the Self. In a series of experiments, I will show how the limits of PPS adapt as a function of experience: they extend after that a tool is used to act upon the far space, they contract in case of amputation, and further accommodate after prosthesis implantation, they are sensitive to the presence and the behavior of others in the environment.

Seeing other people's bodies

Frédérique de Vignemont (Institut Jean Nicod/CNRS, Paris, FR)

Mirroring has been almost exclusively analyzed in motor terms with no reference to the body that carries the action. However, one does not only see movements, one also sees another individual's body. To what extent does one recruit one's body representation in social context? And does it imply that one has interpersonal body representations? This latter question is all the more legitimate that recent evidence indicates the existence of shared cortical networks for bodily sensations. Those shared representations have recently been interpreted in terms of embodied social cognition. The sense in which those states are embodied remains, however, often obscure. Here I will adopt the narrowest interpretation of the notion of embodiment according to which social understanding is embodied if it involves body representation. We will see that there are shared body representations, although they are not systematically recruited each time we are in a social context.

Symposium III

Beyond the contrastive method: How to separate the neural correlates of consciousness from its precursors and consequences

Chair: **Lucia Melloni** (Department of Neurophysiology, MPI Frankfurt, DE/Columbia University)

Monday, July 15th, 09:30 – 11:30 (*Harbor Island II & III*)

The most prevalent approach to study the neural correlates of consciousness (NCC) today is to contrast conditions in which conscious perception occurs with conditions in which it does not. Here, consciousness is treated as the dependent variable and then correlated with brain activity. This “contrastive method” has brought about important insights into the NCC. However, despite this apparently straight-forward approach, results are inconclusive and contradictory (e.g., it is still debated whether the NCC occurs early or late, or whether it is expressed in local or distributed brain activity). This discord can be understood when considering a methodological pitfall in the contrastive method: The contrast between conscious perception and unconscious processing confounds the NCC with processes that necessarily precede and follow conscious perception (pre-NCC and post-NCC, respectively) without directly contributing to subjective experience. It is not straightforward to arbitrate which previous results address the NCC-proper and which reflect other processes. In this symposium we will outline the shortcomings of the contrastive analysis, put forward a new taxonomy that differentiates the processes besetting the NCC-proper, and propose novel experimental approaches to dissociate the NCC-proper from its antecedents and consequences. We review M-EEG and ECOG studies that have employed these new approaches to probe which neural process directly correspond to the NCC. This evidence suggests that previous results may have indeed missed the NCC and reported pre-NCC/post-NCCs. Finally, we will discuss how this new taxonomy relates to prevalent theories of consciousness, arguing that some theories might be about post-NCCs instead of NCC.

Distilling the Neural Correlates of Consciousness

Lucia Melloni (Department of Neurophysiology, MPI Frankfurt/Columbia University)

We propose that contrasting conscious with non-conscious forms of information processing, i.e., the “contrastive method”, does not only reveal the NCC, but also prerequisites and consequences of conscious perception. To distill the NCC, we have developed new paradigms in which we manipulate how consciousness comes about, i.e., its antecedents (sensory evidence, expectations), or its consequences (encoding into memory). We use this methodology in M-EEG and ECOG studies to test major theories of the NCC (local sensory ignition, late wave of activation). We find that previous results likely reflect prerequisites or consequences instead of the NCC proper. Furthermore, the latency of the NCC varies depending on how consciousness comes about, posing major challenges for the search of the NCC. Finally, we propose that narrowing the search on neural mechanism instead of correlates and manipulating the ‘emergence’ of consciousness through plasticity may be a more fruitful venue to discover the neural processes underlying consciousness.

Using MEG to track conscious access and its non-conscious consequences

Stanislas Dehaene, Lucie Charles (Inserm-CEA Cognitive Neuroimaging Unit, Paris, FR)

The global workspace model predicts that, when a piece of information crosses the threshold for conscious access and is globally broadcasted, it becomes available to many additional cognitive processes. Thus, certain processing stages could be deployed only on conscious trials, merely as a late and possibly non-conscious consequence of conscious access. We tested this idea using MEG-EEG. In a number comparison task, a digit was presented at variable degrees of masking, and we examined its capacity to elicit conscious as well as unconscious action, intention, and error detection. The results indicate that the error-related negativity (ERN) indexes a process, which is only present when the digit is consciously seen. Multivariate decoding of brain activation patterns reveal the presence of stimulus and action codes on both conscious and unconscious trials, but of intention and error codes only on conscious trials. We argue that the ERN reflects a fast and automatic comparison of the subject’s conscious intention with his or her action -- a non-conscious consequence of conscious access.

Isolating NCCs that are necessary and sufficient for visual awareness

Michael Pitts (Department of Psychology, Reed College)

Novel experimental paradigms are required to isolate NCCs that are both necessary and sufficient for a particular visual percept. Most NCCs proposed so far have turned out to be either necessary but not sufficient (prerequisites) or sufficient but not necessary (consequences). In addition, separating neural correlates of attentional selection from those of conscious perception has been notoriously difficult. Here, I will introduce a novel paradigm in which potential NCCs can be distinguished from pre- and post-NCCs both temporally and functionally. Using a variant of Mack & Rock’s (1998) inattention paradigm, a bilateral-posterior ERP negativity (~200-300ms) was found to uniquely index awareness. Importantly, two previously-proposed NCCs, the P3 component and gamma oscillations, were found to be sufficient but not necessary for awareness. This experiment along with key follow-up experiments will be discussed

with special emphasis on the temporal variability of this potential NCC and its relationship to attentional selection.

Core vs. total NCC

Ned Block (Department of Philosophy, New York University)

Philosophers have made a distinction between the "total" NCC, which is a minimal sufficient condition for conscious experience and the "core" NCC, which is what makes the difference between one conscious content and another. This talk will argue that this reconceptualization of the usual categories used in psychology and neuroscience makes a real difference to the empirical research program that should be pursued.

Symposium IV

Ethical implications of detecting covert awareness in disorders of consciousness

Chairs: **Adrian M. Owen** (Cognitive Neuroscience and Imaging, Western University, Ontario, CA), **Andrew Peterson** (Rotman Institute of Philosophy, Western University, Ontario, CA)

Monday, July 15th, 16:30 – 18:30 (*Harbor Island II & III*)

Recent findings in cognitive neuroscience (Monti et al. 2010, Owen et al. 2006) suggest that functional magnetic resonance imaging (fMRI) may be a viable means for detecting covert awareness in the vegetative state (VS). This research opens a promising new avenue for developing brain-computer interfaces (Naci et al. 2012) that complement the current diagnostic criteria of disorders of consciousness (DOC), thereby increasing the effectiveness of diagnostic screening in this patient group. Given the high rate of misdiagnosis in this population (Andrews et al. 1996, Childs et al. 1993), actively seeking out patients, who retain conscious awareness despite a clinical diagnosis of VS, is of the highest importance. Moreover, this technique may also permit patients, who are consciously aware and have high levels of preserved cognition, to meaningfully engage in the decision making process related to their own medical care. To date, one patient, previously diagnosed as vegetative for approximately five years, was able to successfully answer a series of autobiographical 'yes' or 'no' questions correctly over repeated fMRI scanning sessions (Monti et al. 2010).

A natural step forward in this research program, therefore, is to apply similar neuroimaging methods to address medical questions relevant to individual DOC patients (Peterson et al. in preparation). Though these scientific findings appear highly promising in principle, incorporating any neuroimaging-based method into clinical setting will require satisfaction of established ethical and legal norms of medical practice. In particular, these concerns include: determining how information acquired from such techniques will be disclosed to patients' families, what the cost of running such tests will be, whether any individual DOC patient is capable of making medically relevant decisions with these techniques, and what type of questions we ought to be asking this patient population. We propose a symposium that brings together three different perspectives on this problem: neuroscience, neurology, and clinical ethics. The first perspective, offered by Drs. Lorina Naci PhD and Daniel Bor PhD, both neuroscientists working with these neuroimaging paradigms, will shed light on practical obstacles and ways forward focusing neuroimaging to assess residual cognition in DOC patients. The second perspective, offered by Dr. Bryan Young MD, a clinical neurologist working directly with this patient group, will highlight the difficulties as well as the potential that neuroimaging holds for DOC patients in the medical setting. Finally, Dr. Charles Weijer MD, PhD and Andrew Peterson MA, both medical ethicists and philosophers of science, will offer views on the overarching ethical standards relevant to this research. Dr. Adrian M. Owen, a neuroscientist working in this field, will chair the session. We hope that this interdisciplinary approach will facilitate a novel and productive conversation about the merits of this research and future directions for using it in the clinical setting.

Using fMRI to assess conscious awareness in patients with disorders of consciousness – practical considerations

Lorina Naci (Experimental Psychology, Western University, Ontario, CA)

Recent functional magnetic resonance imaging (fMRI) techniques have allowed behaviorally nonresponsive patients, previously clinically (mis) diagnosed as vegetative state (VS), to communicate (Monti et al., 2010). This work holds great promise for improving the standard of care for any patient with disorders of consciousness (DOC), who retains preserved cognition. Importantly, if any given patient is able to communicate via fMRI, it may be possible to involve him/her in the clinical decision-making related to their healthcare. Despite its promise, it is important to acknowledge the limitations of this work in order to set realistic expectations of family members, other proxy decision makers, clinicians/healthcare providers, and more generally, the wider public. Specifically, our ability to communicate with a proportion of DOC patients will be restricted by several factors, including: patient movement in the scanner, which renders the fMRI data unusable; inconsistent responses within the same or across different imaging sessions; the likelihood of a patient's mental exhaustion, which limits the number of questions we can address in a single fMRI session; and, finally, the high cost of the MRI technology, which will prohibit access for a number of patients.

Nevertheless, the utility of these fMRI methods is sticking when appreciated in the context of other assessment methods available, in particular, with regards to the unique opportunity for reassessing a patient's level of conscious

awareness, when all clinical bedside tests fail. fMRI remains the ‘gold standard’ neuroimaging method for DOC patients. MRI scanners constitute standard clinical equipment; thus, these techniques can be readily applied at numerous sites. Moreover, even a single fMRI-based communication session can be of the highest importance, as it may overturn a patient’s diagnosis. We are hopeful that, with further technical developments, these methods will yield effective and economically sustainable results, thereby mitigating the technical limitations discussed above.

Using multiple neuroimaging techniques to assess the quality of conscious awareness in DOC patients

Daniel Bor (Cognitive Neuroscience, Sackler Centre for Consciousness Science, University of Sussex, Brighton, U.K.)

This talk will describe the broader areas of research that are pertinent to ethical questions surrounding covert communication with patients with disorders of consciousness. First, making an accurate assessment of the level of residual awareness in these patients is of paramount importance for judging the extent to which the patient's decisions can be relied upon. Outside of covert communication itself as a marker of residual consciousness, various emerging indirect techniques have been developed, including diffusion tractography and measures of functional connectivity. I will discuss the reliability of these techniques, and how empirical studies and theoretical models in the neuroscience of consciousness can inform this assessment, and may increasingly do so in the future. Finally, I will discuss potential current and future treatments for this patient group, as an important ethical consideration for continued assessment and care.

Obstacles at the interface between advances in cognitive neuroscience and clinical practice

Bryan Young (Neurology and Critical Care Medicine, Western University, Ontario, CA)

It has been shown that a patient thought to be vegetative can potentially display evidence of cognitive awareness, by modulating brain activity in response to questions or commands. What does this imply for clinicians? For one, it suggests that we cannot rely solely on the clinical exam or anatomical imaging to conclude that a patient is vegetative. Indeed, use of neuroimaging techniques in the clinic may be yet another strategy to ensure a patient receives the most accurate diagnosis possible. But, clinicians tend to be skeptical. For example, it is often argued that fMRI evidence doesn’t entail the rich mental experience constitutive of healthy consciousness! However, this attitude may be overly paternalistic, assuming that the doctor knows best. The information gleaned from these tests has significant clinical relevance and should not be ignored. Whether we are interested in medically related information from the patient, or simply trying to determine how we can improve quality of life, the knowledge gained from communicating with this population, however different from our normal means of communication, is clinically invaluable. I take the position that in making prognostic and management decisions, it is vital to have the best information possible. This means that for many patients with severe brain injury it is necessary to go beyond the clinical exam and purely anatomical brain scans, to examine whether there is awareness or a potential for awareness in the future. “*Cogito ergo sum* by fMRI” could make a difference.

Conceptual foundations for assessing decision-making capacity in disorders of consciousness

Andrew Peterson (Rotman Institute of Philosophy, Western University, Ontario, CA)

A natural step in integrating these neuroimaging techniques in the clinical setting may be to allow DOC patients to partake in the decision-making process related to their own care. But, given the practical limitations of neuroimaging in this patient population, as well as the restricted form of binary (yes/no) communication, satisfying the received criteria of decision-making capacity may be an insurmountable obstacle. I offer a practical procedure for assessing decision-making capacity in the DOC population, which has been adapted to the neuroimaging techniques in question. If these techniques prove successful, modest dimensions of decision-making capacity may be assessed in this patient group, thereby allowing them to express certain medical preferences and reclaim elements of well-being lost to their initial injury.

Navigating the transition between research and treatment when integrating novel neuroimaging techniques in medical practice

Charles Weijer (Bioethics, Rotman Institute of Philosophy, Western University, Ontario, CA)

A central problem in research ethics is determining what conceptually distinguishes medical research from medical treatment. As the ethical standards that govern these respective domains of medical practice are often radically different, determining whether or not an investigator-clinician is, in fact, conducting research is valuable for understanding the exact ethical responsibilities she has for her patient-subjects. Given that this new work in cognitive neuroscience sits at the juncture of research and clinical service, it is important to reflect on the type of work that is being done, and the precise ethical framework this work should be governed by. Topics that will serve as points of departure for this talk will include the relationship clinician-researchers ought to have with patients’ families during fMRI trials, and the procedure for consent to use DOC patients in clinical research.

Tutorials

Friday, July 12th, 09:00 – 12:00

M1 (*Nautilus 1*)

Using Bayesian approaches to interpret non-significant results

Zoltan Dienes (School of Psychology, University of Sussex, Brighton, UK)

The purpose of the tutorial is to present simple tools for dealing with non-significant results. In particular, people will be taught how to apply Bayes Factors to draw meaningful inferences from non-significant data, using free easy-to-use on-line software: Software which allows one to determine whether there is strong evidence for the null and against one's theory, or if the data are just insensitive, a distinction p-values cannot make. These tools have greater flexibility than power calculations and allow null results to be interpreted over a wider range of situations. Such tools should allow the publication of null results to become easier.

While the tools will be of interest to all scientists, they are especially relevant to researchers interested in the conscious/unconscious distinction, because inferring a mental state is unconscious often rests on affirming a null result. For example, for perception to be below an objective threshold, discrimination about stimulus properties must be at chance. Similarly, for perception to be below a subjective threshold by the zero correlation criterion, ability to discriminate one's own accuracy must be at chance. To interpret a non-significant result, what is needed is a non-arbitrary specification of the distribution of discrimination abilities given conscious knowledge. Conventional statistics cannot solve this problem, but Bayes Factors provide an easy simple solution. The solution is vital for progress in the field, as so many conclusions of unconscious mental states rely on null results with no indication of whether the non-significant result is purely due to data insensitivity.

The tutorial will consist of lectures by me; after the first hour people will be able to use their internetted laptops to work through examples on the software, and thereby interactively follow the points I make, and also explore the tools for themselves.

M2 (*Nautilus 2*)

Integrated information, predictive coding and qualia

Anil Seth & Ryota Kanai (Sackler Centre for Consciousness Science and Department of Informatics, University of Sussex, Brighton, UK)

Current research in consciousness science must better integrate theory and experiment in developing our understanding of qualia [1]. Two classes of brain theory are now emerging as leading candidates. *Integrated information theory* (IIT), [2]) proposes that consciousness has to do with the amount of information generated by a neural system as a whole, compared to the sum of its parts. Integrated information ('phi') can be operationalized as a variant of dynamical complexity and compared with similar measures [3,4]. IIT thus highlights *information theory* and *complexity* as key tools for naturalizing consciousness and qualia. *Predictive coding* (PC) proposes that perception emerges via Bayesian inference: Perceptual content is determined top-down predictive signals arising from generative models of external causes, which are continually modified by bottom-up prediction-error signals [5]. PC thus highlights *re-entrant processing* and *probabilistic inference* as key concepts. While both frameworks are powerfully explanatory, IIT is underconstrained by current cognitive neuroscience and difficult to test, while for PC the relationship between conscious and unconscious perception is poorly specified.

In this tutorial, we will first provide basic introduction to IIT and PC with special emphasis on their relationship to understanding qualia. To facilitate interdisciplinary discussion, the tutorial does not assume any mathematical background and we will focus on conceptual understanding of the theories rather than mathematical details. In a later part of the tutorial, we will discuss how these different frameworks might be synthesized into a coherent computational framework.

M3 (*Nautilus 3*)

First-person methods: Philosophers' dreams or researchers' nightmares

Jennifer M. Windt (Department of Philosophy, University of Mainz, DE)

Sascha B. Fink (Department of Cognitive Science, University of Osnabrück, DE)

The best way to learn about the specific character of conscious experience is to study what people say about it. Fundamental features of consciousness (e.g. holistic integration, phenomenal embodiment, specious presence, etc.) were only established as targets for consciousness research through first-person methods. Most agree that such methods are indispensable for consciousness studies. At the same time, phenomena such as change blindness suggest that first-person access to phenomenality is not perfect. First-person reports can be confabulated, contradictory, or

incomplete. This calls the validity of first-person approaches into question. Apparently, we need first-person reports – but how far can we trust them?

Dreams illustrate the problem of first-person reports in a compelling manner. Because dreams are largely decoupled from sensory input and behavioral output, dream researchers rely almost exclusively on dream reports. At the same time, dream reports have often been taken to be particularly unreliable, occasionally leading to outright skepticism regarding the experiential character of dreaming. Despite these theoretical disagreements, however, dream research is a thriving field and can provide a fresh perspective on problems

The tutorial has four goals: (1) Provide an introduction to the basic problems raised by first-person reports using the example of dreaming, (2) suggest specific consequences from the philosophical debate on dreaming for the use of first-person reports in consciousness research, (3) discuss philosophical positions on the validity of first-person reports and the reliability of introspection, and (4) discuss the role and value of the researcher's own experience.

M4 (*Nautilus 4*)

Measuring (un)awareness

David Carmel (Dep't of Psychology, University of Edinburgh)

Stephen Fleming (Center for Neural Science, New York University)

Most research on perceptual awareness attempts to understand consciousness by investigating the twin themes of conscious and unconscious perception – i.e., what perceptual processes are associated with conscious experience and what can be accomplished in the absence of awareness. There is, however, a great deal of confusion regarding how to assess and measure each of these modes of perceptual processing. This tutorial will offer researchers at all levels an overview of pertinent methodological and conceptual issues, leaving participants with an understanding of the questions they need to consider when designing studies, and how the answers to these questions constrain the conclusions that can be drawn from research findings. For unconscious perception, the questions that will be discussed include how to ensure suppression of perceptual stimuli from awareness, how to decide which suppression technique is most appropriate for a specific research question, and whether different kinds of unconscious processing indicate similar neural underpinnings.

For conscious processing, the questions that will be addressed are how to measure the level and extent of subjective conscious experience, whether different ways of assessing reports of awareness (confidence, appearance, wagering) address equivalent constructs, and how detection and identification of perceptual stimuli differ. Several demonstrations will clarify the issues that will be discussed, and generous provision for discussion will be made to allow consideration of specific problems or issues arising in participants' own research.

Friday, July 12th, 13:00 – 16:00

A1 (*Nautilus 1*)

Investigating animal pain and consciousness

Paula Droege (Dep't of Philosophy, Pennsylvania State University)

Victoria Braithwaite (Dep't of Fisheries and Biology, Pennsylvania State University)

Neuroscientists have been making remarkable progress in identifying candidates for the neural correlates of consciousness (NCC) in humans. Through careful investigation of conscious and unconscious processes, the role of thalamocortical circuits and information integration in the production of consciousness is becoming clearer. But what about non-human animals? How can we apply the advances in consciousness research to animals (e.g. fish, cephalopods) that share few if any human physical and functional structures? The capacity to represent the current environment in contrast to the past and future is essential for consciousness and marks an important development in cognitive skill. We suggest this capacity for temporal representation can bring together physiological and behavioral evidence to help determine which animals are conscious and which are not.

The tutorial will begin with a discussion of the problems and prospects for research on animal consciousness, considering such questions as: Is nociception sufficient for pain? What is the relation between consciousness and self-consciousness? Then we will review several research paradigms designed to assess consciousness in animals. One important question here is: When is an explanation in terms of higher-level processes such as consciousness and cognition simpler than an explanation in terms of associative conditioning?

A2 (*Nautilus 2*)

Representational theories of consciousness

Rocco J. Gennaro (Dep't of Philosophy, University of Southern Indiana)

The notion of 'representation' is central to many philosophical theories of consciousness and also figures importantly

in psychology and neuroscience. Some questions raised by the role of representation in these fields are: What does it mean to say that a mental state is 'representational'? What is the difference between a first-order representation and a higher-order (or meta-) representation? This tutorial will begin with a discussion of how the concept 'representation' is used in the philosophical literature on consciousness. In addition, various senses of 'conscious' are distinguished and explained. The key question then becomes: What makes a mental state a conscious mental state? We shall survey a number of leading representational theories of consciousness found in the current literature: First-Order Representational Theory of Consciousness (Tye), Higher-Order Perception (HOP) Theory (Lycan), Higher-Order Thought (HOT) Theory (Rosenthal), Dual Content Theory (Carruthers), and Self-Representational Theory (Kriegel). After the main tenets of each approach are presented, we shall discuss the arguments for and against the theory in question. Significant attention will be paid to well-known objections to each theory, for example, the problem of misrepresentation, the question of animal consciousness, and how these theories might address the "hard problem" of consciousness. Finally, there will be some discussion of how these models might be realized in the brain. Also important is the reductionist motive of most representational theorists: Can any of these theories offer a viable reductionist account of consciousness?

A3 (Nautilus 3)

The Integrated Information theory of consciousness

Giulio Tononi (Dep't of Psychiatry, University of Wisconsin)

Christof Koch (Cognitive and Behavioral Biology, Cal Tech; CSO, Allen Institute for Brain Science)

Nao Tsuchiya (Monash University, Melbourne, AU)

Masafumi Oizumi (Dep't of Psychiatry, University of Wisconsin)

The Integrated Information theory of consciousness (IIT) has recently attracted attention among consciousness researchers. IIT stems from thought experiments that lead to phenomenological axioms and ontological postulates (information, integration, exclusion, and compositionality). According to IIT, an experience is an integrated information structure, which in principle can be completely characterized, both in quantity and quality, by determining to what extent a system of causal mechanisms is irreducible to its parts. Many observations concerning the neural substrate of consciousness fall naturally into place within the IIT framework. Among them are the association of consciousness with certain neural systems rather than with others; the fact that neural processes underlying consciousness can influence or be influenced by neural processes that remain unconscious; the reduction of consciousness during dreamless sleep and generalized epileptic seizures; and the distinct role of different cortical architectures in affecting the quality of experience. The tutorial will i) introduce the basic notions of IIT to a broad audience without requiring a mathematical background, and provide hands-on examples in which integrated information can be computed rigorously; ii) introduce measures of integrated information that can be applied to empirical data and discuss how they can be applied to evaluate the level of consciousness in wake, sleep, anesthesia, and disorders of consciousness; iii) demonstrate how integrated information grows in animals adapting to a complex environment, thereby shedding light on the evolution of consciousness; iv) consider theoretical and practical aspects of measures of integrated information, potential problems, and future developments.

Our intended audience is broad. We do not assume any prior knowledge of integrated information theory or information theory in general. In the first part of the tutorial, we start from the basics of the probability theory and information theory, which are key to understanding the theory. After the introduction of the basics, the contents of the tutorial will be at the level of a master class.

A4 (Nautilus 4)

Deciphering the information contained in patterns of human brain activity

Frank Tong (Dep't of Psychology, Vanderbilt University)

Surprisingly detailed information about visual and mental states can be decoded from non-invasive measures of human brain activity. Brain decoding approaches have successfully revealed what a person is seeing, perceiving, attending to, or remembering. Multidimensional models can further be used to investigate how the brain encodes complex visual scenes or abstract semantic information, and to reconstruct the stimulus that was viewed. Such feats of "brain reading" or "mind reading", though impressive, raise important conceptual, methodological, as well as ethical issues. What does successful decoding reveal about the sensory or cognitive functions performed by a brain region? How should brain signals be spatially selected and mathematically combined, to ensure that decoding reflects inherent computations of the brain rather than those performed by the decoder? What ethical considerations might emerge with the advancement of these methodologies? The tutorial will cover the fundamentals of "brain reading", and should be suitable for people from a broad range of backgrounds, with one component emphasizing the more technical and mathematical aspects of pattern classification. Questions and interactive discussion will be emphasized, especially when considering the strengths and limitations of fMRI pattern analysis methods.

Special Roundtable Discussion: Debating Integrated Information Theory

Giulio Tononi, MD, PhD (Dep't of Psychiatry, University of Wisconsin),

Christof Koch, PhD (Cognitive and Behavioral Biology, Cal Tech; CSO, Allen Institute for Brain Science)

Gary Marcus, PhD (Dep't of Psychology, New York University; Director NYU Center for Language and Music)

Jennifer Goldman (Dep't of Neurology and Neurosurgery, Montreal Neurological Institute, McGill University)

Moderator: Stuart Firestein, PhD (Dep't of Biology, Columbia University)

Saturday, July 13th, 13:30 – 15:00 (*Harbor Island II & III*)

Integrated Information Theory (IIT) was originally proposed by Giulio Tononi as a quantitative determinant of consciousness. The theory was updated and expanded in manuscripts in 2004, 2008 and 2012, and most recently in his new book, ϕ . Since its inception, IIT has created enormous discussion in various media including Christof Koch's book, *Consciousness: The New Yorker* by Gary Marcus, *The New York Review of Books* by John Searle, and *The New York Times* by Carl Zimmer. In addition to proposing a new and quantitative measure that can be applied to describing conscious states, IIT could provide important guidelines for the diagnosis of disorders of consciousness and yield important epistemic knowledge of 'what it is like' to be in a particular state of consciousness. Recent studies by Dr. Tononi and others indicate that during states associated with absent or reduced consciousness (e.g., NREM sleep, anesthesia, and Unresponsive Wakefulness Syndrome (Vegetative state)), thalamocortical networks, widely held, but not yet proven, to be the seat of mammalian consciousness, are less informationally integrated. This debate seeks to assess whether ϕ is the 'difference that makes a difference' for consciousness, addressing both the prowess and the problems of IIT, the questions that remain open, and the difficulties to be solved for extending experimental validation. Put simply, where do we go from here?

Special Event

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From Matter to Mind:

Talks and Music in Honor of Gerald M. Edelman, MD, PhD

Paul F.M.J. Verschure, PhD (SPECS, Universitat Pompeu Fabra)

Oliver Sacks, MD, FRCP (Dep't of Neurology, New York University School of Medicine & University of Warwick [Visiting]) – *A Video Tribute to Dr. Edelman*

Anil K. Seth, DPhil (Sackler Centre for Consciousness Science & Dep't of Informatics, University of Sussex)

Saturday, July 13th, 20:00 – 22:00 (*Harbor Island II & III*)

In a career that has spanned nearly six decades and more than 600 paper authorships, Gerald Edelman has made seminal contributions to immunology, developmental biology, and neuroscience. Though the 1972 Nobel Prize in Medicine or Physiology (shared with Rodney Porter of the U.K.) cited his work in elucidating the structure of the human antibody, Edelman is no mere dabbler in the mysteries of the brain. Since the publication of *The Mindful Brain* (co-edited and co-authored with Vernon Mountcastle) more than 35 years ago, Edelman has assiduously and singlemindedly elaborated a comprehensive theory of higher brain function that can make sense of the increasingly rich neuroanatomical, neurophysiological, and behavioral data confronting modern neuroscience. The theory of Neuronal Group Selection (TNGS) proposes that brain and behavioral states emerge from the selective strengthening of particular synaptic connections, among a vast and heterogeneous population of synapses, through ongoing interactions with a complex and unlabeled world. From the earliest instantiation of TNGS, two key predictions emerged from Edelman's theoretical framework: first, no two neuronal groups are the exactly same, either structurally or functionally; and 2) the populations of neuronal groups that comprise neural mappings of the world are never identical, even when similar, or effectively identical, stimuli are encountered. Given that degenerate neural mappings have been observed experimentally many times over nearly three decades, it is easy to forget that when Edelman first proposed TNGS in the late 1970s, there was scant evidence for such functional degeneracy in the nervous system.

For us as humans, the most profound implication of the foregoing is that each individual has an absolutely privileged history; that is, no two individuals evince the same neural mappings of the world, nor does any one individual ever evince the same maps on two different occasions. Fundamentally, starting from early in development, no two brains are wired in precisely the same manner, not even those of identical twins. As true as it was when Charles Darwin first published *On the Origin of Species* in 1859, the primacy of the individual in biological systems—from the immune system to the nervous system—can never be overstated. Edelman's work has thus followed essentially the same Darwinian principles that still constitute the bulwark of all of modern biology.

Twenty years after the publication of the *Mindful Brain*, Edelman expanded upon TNGS by proposing, with Giulio Tononi, the Dynamic Core hypothesis, which maintains that consciousness emerges from dynamic, reentrant (but not strictly recursive) higher-order neural maps that bind otherwise disparate sensory and motor neural maps. In mammals, such reentrant maps are believed to arise chiefly in thalamocortical and cortico-cortical circuitries of the brain. Notably, Edelman and Tononi have argued that; 1) every conscious episode is simultaneously integrated (i.e., unitary, of a piece) and differentiated (i.e., absolutely unique); and 2) such simultaneously integrated and differentiated episodes are richly informative discriminations—precisely those discriminations that we commonly refer to as 'qualia.'

While much can be said of Gerald Edelman's careers in three distinct (though related) areas of biology, the three talks that comprise this event honor and celebrate his important contributions to neuroscience generally and consciousness theory in particular. Many may disagree with Edelman's ideas, but few can dispute with any intellectual weight that, over 35 years, he has labored systematically and with committed passion to produce a comprehensive

global theory of higher brain function—indeed, one of a very few out there today that tethers faithfully to biological principles.

The three speakers for this event have more than a mere acquaintance with Gerald Edelman. Paul Verschure worked closely with him at The Neurosciences Institute (NSI) in its very earliest days as a full-blown research entity in San Diego. Anil Seth arrived at the NSI later—just as it had established its reputation as a place where young scientists could freely ply the most creative of research waters, unfettered by the formulaic structures and restrictions imposed by more traditional academic institutions. The distinguished neurologist and writer, Oliver Sacks, first met Edelman 25 years ago, and from early on, became increasingly convinced that TNGS and its extensions were in beautiful accord with all of the rich and varied observations he had made during a nearly 50-year career in neurology. All three speakers would certainly acknowledge that Edelman’s perspective on the nature of consciousness has much to offer to a young scientific enterprise still in search of its own core principles and mechanisms.

Concurrent Sessions

Concurrent Session C1.1: Attention & Time Consciousness

Saturday, July 13th, 15:30 – 17:30 (*Nautilus 1*)

1. Perceptual load and the awareness of time

David James Robertson, Nilli Lavie

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It is well established that conditions of high perceptual load in an attended task lead to reduced perception and awareness for unattended visual and auditory stimuli (see Lavie, 2010 for a review). Here we test the effects of perceptual load on people's awareness of time. We varied the level of perceptual load in a rapid serial visual presentation (RSVP) task, in which subjects searched a stream of coloured crosses for a feature target (red crosses) in the low load condition, or for a conjunction target (an upright yellow or an inverted green cross) in the high load condition. Time estimation was either obtained retrospectively with a surprise question at the end of the stream (prompting participants to reproduce the stream duration) or prospectively (informing the participants in advance that they would be asked to reproduce the stream duration). Higher perceptual load in the RSVP task led to shortening of the perceived durations, including streams in which there were no targets present, and when measured both prospectively and retrospectively. Our control over both stimulus and response demands as well as over eye movements allow us to rule out alternative accounts in terms of memory (e.g. with respect to the number of contextual changes) or in terms of temporal compression during saccades. These findings demonstrate the critical role of perceptual load in awareness of time and support a new hypothesis linking right posterior parietal cortex both in the effects of perceptual load and interval timing.

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2. Quantifying temporal consciousness

Eve A. Isham [1,2], Tiffany Wall [2], Farhan Sareshwala [2], Joseph Butler [2], Iain M. Harlow [2],

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Temporal awareness involves the detection and/or the ability to articulate the moment at which one becomes aware of an event or mental state. The precision of these time reports is crucial especially when forming a temporal relationship to reflect causality or intentionality. Past studies however suggested that participants often do not accurately express temporal judgments. For instance, studies using a variant of the Libet paradigm illustrated that the moments of intent (W) or action (M) are influenced by a post-action tone, implying that W and M reports are reconstructed rather than directly perceived. Motivated by these findings, the current research aims to 1) identify additional factors that modulate or influence temporal reports and to 2) explore alternative methods that may better quantify temporal awareness. In support of Aim 1, we found that post-event information (Exp.1), aging (Exp.2), deficiencies in movement-initiation (Exp.3), and perceptual biases facilitated by the timing devices (Exp.4) influence the perceived time of action-related events. These findings emphasize the perspective that multiple factors influence temporal consciousness such that participants do not accurately express them. These findings also argue for methods that can better quantify temporal awareness (Aim 2). To satisfy Aim 2, we explored alternative methods including confidence ratings and eye movement parameters. Although our results showed that confidence ratings were not sensitive to temporal judgments (Exp.5), our preliminary results suggested that eye-movements served as a more accurate measure of temporal intent than self-reports (Exp.6).

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3. Shutting down the world (in your mind): Spontaneous mind-wandering associated with and predicted by threshold fluctuations in conscious perception.

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When performing a demanding task, sustained attention often fades and drifts to personal concerns and thoughts. It has been suggested, primarily on the basis of neuroimaging studies, that such mind-wandering is detrimental to

conscious perception, leading to the notion that mind-wandering is associated with “perceptual decoupling”. Here, we addressed this issue in its most elementary form: we conceived of the threshold in a signal detection task as a direct measure of participants' decoupling from the environment. We devised a novel psychophysical task that allowed us to track continuously threshold fluctuations, and found that high threshold periods were associated, and even predictive, of incipient mind-wandering episodes. Then, in a second experiment, we extended our findings and tested whether we could entrain the spontaneous fluctuations in mind-wandering. To this effect we presented unpredictably highly-visible signals and found that they can reset these off-task fluctuations. To our knowledge, our data provide the first direct psychophysical test of the perceptual decoupling hypothesis. In addition, they constitute an original start in the elaboration of on-line detectors of mind-wandering based on behavioral indices. Furthermore, our data provide a link between low-level attentional fluctuations and high-level states that are subjectively reported as mind-wandering. This contributes to an integrated understanding of perceptual awareness and conscious streams of thoughts.

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4. Neural signatures of conscious face perception: The N170 is absent during inattentional blindness

Juliet Shafto, Michael Pitts

Reed College

The inattention paradigm was adapted for recording event-related potentials (ERPs) in order to examine the neural correlates of conscious face perception. In the first phase of the experiment, subjects engaged in a difficult tracking task overlaid on changing configurations of line segments. Unbeknownst to the subjects, on half of the trials these line segments formed a face for 300ms while on the other half of the trials the line segments were arranged randomly. An awareness assessment revealed that nearly half of all subjects did not see the faces and remained inattentionally blind for more than 300 presentations of the face during this first phase. In the second phase, participants engaged in the same tracking task, but due to the intervening awareness assessment, all participants reported seeing the faces during this phase. In a third phase, the stimuli remained the same, but the participants were instructed to forego the tracking task and to perform an explicit face discrimination task. Comparisons between ERPs time-locked to face and non-face stimuli revealed that the face-specific N170 was completely absent during inattentional blindness. The N170 was clearly evident in subjects who happened to notice the faces in phase 1, as well as in the inattentionally blind subjects once they noticed the faces in phase 2. Additionally, when the faces became task-relevant in phase 3, the amplitude of the N170 was significantly enhanced. These results suggest that the N170 is necessary for the conscious perception of faces.

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5. My future self and me: Prospective memory and temporal discounting

Ying-Tung Lin

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A recent study (Peters and Büchel, 2010) has shown that mental time travel involved in decision-making reduces temporal discounting. Temporal discounting refers to the phenomenon that human beings often discount the value of future rewards over time. In this paper, I argue that what accounts for the reduction is a sense of self-continuity, the phenomenal experience of extending temporally backwards into the past and forwards into the future. I propose that constructive episodic simulation, the common mechanism of retrospective and prospective memory (Schacter and Addis, 2007; Schacter et al., 2012), enables a sense of self-continuity, which allows our present self-model to identify the future self-model as the same temporally extended model. First, I will analyze the concept of self-continuity and discuss the “future self-continuity hypothesis” proposed by Ersner-Hershfield (2009). Next, I argue that self-continuity between a future/past self-model and the present one, created through mental simulation, is a matter of degree depending on the current state of the self-model. When two “intertemporal” self-models are more compatible, the future/past self-model can be simulated with a higher degree of specificity, and is easier to be identified by the present self-model. Finally, compared with Boyer’s (2008) explanation of the function of mental time travel with emotion, the role of memory in decision making is addressed. This model of self-continuity not only accounts for the reduction of temporal discounting by mental time travel, but also provides a new perspective on the traditional debate of personal identity and Schectman’s (1996) narrative identity.

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6. Attentional attractors: Explaining the contrasting effects of different numbers of cues at attended and unattended locations

David Carmel [1], Marisa Carrasco [2]

Spatial attention is often likened to a spotlight, but this metaphor is inadequate: It cannot account for the reduced sensitivity at unattended locations that accompanies facilitation at attended locations, nor for the flexibility of attention, which can be divided over several locations. Here we describe four experiments on exogenous (involuntary) attention, in which we systematically explored the effects of the validity and number of peripheral cues. On each trial, participants reported a grating's orientation. Gratings could appear at various locations and were preceded by one or more cues. If attention draws on limited processing resources, contrast sensitivity at cued locations should decline as the number of cues increases. For uncued locations the prediction is less straightforward: Modulation may only occur at attended locations, leaving sensitivity at unattended locations unchanged; alternatively, dividing attention may deplete resources across the visual field, reducing sensitivity at all locations, attended and unattended; finally, dividing attention may impair attentional specificity, leading to the counterintuitive prediction that unlike cued locations, sensitivity at uncued locations should improve as the number of cues increases. Indeed, dividing attention impaired sensitivity at the cued locations, but improved it at uncued locations. These findings are consistent with a model in which attentional cues act as attractors for spatially-tuned receptive channels: Cueing alters channels' spatial tuning, increasing their density near a cue and decreasing it elsewhere. Multiple cues pull in different directions, reducing both of these effects. Attentional attractors thus account for our results, and offer a viable mechanism for attention's effects.

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Concurrent Session 1.2: Embodiment, Extended Consciousness, and Higher-Order Theory

Saturday, July 13th, 15:30 – 17:30 (*Nautilus 2*)

1. Towards a scientifically tractable, direct realist, sensorimotor account of experience

Mike Beaton

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The sensorimotor account of experience has arguably not lived up to its early promise. I suggest that this is because a full-blown sensorimotor account needs to reject an assumption shared by most consciousness researchers, namely that first person experience corresponds to processes in the head. I argue instead that when we are experiencing an object or property in the world, the experienced object is literally part of the subjective experience. This is a form of direct realism. The sensorimotor account shows us (in ways which can be made highly analytic and mathematical) what objects are, such that we may enact them, and what experience is, such that it may directly, constitutively involve these external objects. This externalist account of experience matches our first-person phenomenology much better than the standard, internalist view; it also makes it much clearer how we can have genuine knowledge of the external world. Action-based views of perception, such as this one, should respond to apparently problematic cases such as locked-in syndrome, not by referring to covert action, but rather by referring to counterfactual links to overt action (this use of counterfactuals is completely normal in science). Direct realist views should respond to arguments from illusion by noting that the detailed flow of subjective experience is different when we are really encountering an object, and when we only seem to be. Brain dynamics remain a crucial enabling part of experience, but not the only part; experience itself is the ongoing, meaningful relationship between subject and world.

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2. Seeing absence

Anya Farennikova

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Intuitively, we often see absences. For example, if someone steals your laptop at a café, you may see its absence from your table. However, absence perception presents a paradox. On prevailing models of perception, we see only present objects and scenes (Marr, Gibson, Dretske). So, we cannot literally see something that is not present. This suggests that we never literally perceive absences; instead, we come to believe that something is absent cognitively on the basis of what we perceive. But this cognitive explanation does not do justice to the phenomenology. Many experiences of absence possess immediate, perceptual qualities. One may further argue that the ability to detect certain absences confers strong adaptive advantage and therefore must be as primitive and fundamental to humans as seeing positive things. I argue that we can literally see absences; in addition to representing objects, perception represents absences of objects. I present a model of seeing absence based on visual expectations and a visual matching process. The phenomenon of seeing absence can thus serve as an adequacy-test for a theory of perceptual

content. If experiences of absence are possible, then we have another reason (following Siegel) to reject the view that perceptual content is restricted to colors and shapes. Furthermore, if the proposed account is correct, then we have grounds for dissociating seeing absence from other imagery-based phenomena termed “perceptual presence-in-absence” (Noë, Macpherson).

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3. Extended cognition, extended consciousness?

Tobias Schlicht

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It is controversial whether the mind literally extends beyond the brain into the body and the physical and social environment (Clark & Chalmers 1998, Menary 2010). The strongest claim in this debate is that both cognition and consciousness are extended (Noë 2009); the weakest claim is that neither cognition nor consciousness is literally extended, while both are supported causally by these external factors (Adams & Aizawa 2008); finally, Clark (2009) defends a position in-between these extremes, arguing that while cognition is extended, consciousness is not (its supervenience base is firmly placed in the brain). In this talk it is argued that Clark’s middle position is not plausible. For one thing, it seems to rule out cognitive theories of consciousness a priori, while many well-argued philosophical theories contain cognitive elements. Moreover, it is demonstrated, based on the example of Otto, the patient suffering from Alzheimer’s disease, (1) that Otto’s cognitive process of remembering would not get off the ground if it weren’t for the ‘feeling of knowing’ (Koriat 2000) that the information he is looking for is contained in his notebook (this information itself cannot be in the notebook). It is then argued (2) that this epistemic feeling is a conscious phenomenal state and (3) that it is partly constitutive of the cognitive process of remembering that ensues once Otto consults his notebook. Since the cognitive process thus involves an essentially conscious element, Clark must admit that either are both cognition and consciousness extended or none of them is.

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4. Tool use modulates both conscious and unconscious representations of body shape

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Tool use can shape mental representations of users’ bodies. For example, using a long mechanical grabber can extend the length of the neural representation of the arm wielding the tool (Cardinali, et al. 2009). Surprisingly, most research has focused exclusively on changes to unconscious representations (e.g. body schema). Here, we investigated how tool use modulated both unconscious and conscious body representations. In Experiment 1, we measured unconscious hand representations using a tactile size perception task (Longo & Haggard, 2011). Participants judged the distance between pairs of tactile points before and after the brief use of a large hand-shaped tool (about 10 min of grasping and moving balloons). After tool use, we observed an increase in the width and a decrease in the length of the unconscious hand representation. In Experiment 2, we measured conscious perception of hand shape using a template-matching task (Longo & Haggard, 2012). We found significant modulation of this hand representation following tool use, which mirrored the results of Experiment 1. After tool use, we observed an increase in the width and a decrease in the length of the conscious hand representation. To our knowledge, these results are the first empirical evidence that tool use leads to changes in not only unconscious but also conscious self-representation. Further, we found that the change in the conscious representation mirrors that observed for the unconscious representation.

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5. Troubles with higher-order thought theories of consciousness: An objection from hydranencephaly

Karen Yan

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As a conscious human being, my conscious experience has some phenomenological structure. One putative aspect of this phenomenological structure concerns for-me-ness. For-me-ness is construed as the relation between some phenomenal character (what-it-is-like-ness) and the subject of consciousness, namely, the former is for the latter. Some philosophers argue that for-me-ness is constitutive of the phenomenological structure of consciousness. Among them, one prominent group of philosophers defends Higher-Order Thought (HOT) theories of consciousness, including David Rosenthal’s actualist HOT theory, Peter Carruthers’s dispositionalist HOT theory, and Uriah Kriegel’s Self-

Representational HOT theory. These philosophers employ different notions of HOT to explain for-me-ness. In this paper, I analyze the ways in which these HOT theorists explain for-me-ness. I argue that they make similar assumptions regarding the functions of HOTs. These assumptions commit them to the claim that some cortical mechanism is constitutive of consciousness. Having identified the assumptions, I present a case study of hydranencephaly (i.e., children born without a cortex) to challenge the assumptions. Finally, I present another representational approach to defend the claim that for-me-ness is constitutive of the phenomenological structure of consciousness. This view employs a set of body-mapping processes to ground for-me-ness. Having shown that, I argue that it can accommodate the challenge from the case study I have presented.

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6. Somatoparaphrenia and higher-order thoughts

Rocco Gennaro

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I defend the higher-order thought (HOT) theory of consciousness against the charge that it cannot account for the disorder known as somatoparaphrenia, where one denies ownership of a limb. Liang and Lane (2009) have argued that somatoparaphrenia threatens HOT theory because it contradicts the notion that when I am in a conscious state, I have the accompanying HOT that “I am in mental state M.” Indeed, it is difficult to understand how one can have a conscious state and not, at least implicitly, attribute it to oneself. In defense of HOT theory (and in addition to Rosenthal’s 2010 reply), I emphasize the following points (among others): (1) That somatoparaphrenia is often characterized as a delusion of belief under the broader category of anosognosia, a condition in which a person with a disability seems unaware of the existence of the disability. (2) That Lane and Liang do not properly recognize that the tactile sensation in question is still felt by often-cited patient FB as her own in one sense, even though she also attributes her limb to her niece and thus believes that the pain is her niece’s. (3) That Lane and Liang do not acknowledge that if some of FB’s problematic thoughts are not really even directed at mental states, then much of what they say is irrelevant with respect to any problem for HOT theory. I will also briefly discuss to what extent HOT theory can make sense of Shoemaker’s (1968) well-known “immunity to error through misidentification” (IEM) principle.

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Concurrent Session 1.3: Consciousness & Unconsciousness

Saturday, July 13th, 15:30 – 17:30 (*Nautilus 3*)

1. Interaction between spontaneous fluctuation and auditory evoked activity during wakefulness and propofol-induced loss of consciousness: An EEG-fMRI study

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Objectives: Functional MRI studies have identified spontaneous fluctuations in neural activity within auditory cortices. The functional significance of the preserved ongoing fluctuations during loss of consciousness remains however poorly understood. We here investigated the influence of spontaneous fluctuation in the auditory resting-state network on stimulus-evoked auditory responses under propofol anesthesia. **Methods:** Simultaneous functional MRI and EEG data were acquired in 13 subjects during wakefulness and under anesthesia where pure tones were presented. After obtaining an auditory network template from awake states, we identified a spontaneous auditory brain activity map in each condition for each subject. Sounds were then classified into two classes: ‘up’ if the tone onset occurred within the upper half spontaneous auditory activity, and ‘down’ otherwise. **Results:** During wakefulness, ‘up’ tones induced more widespread cerebral activation than the ‘down’ tones. During deep sedation, the effect was restricted to primary auditory cortices. A correlation was found between the influence of spontaneous fluctuations on the responses to sounds and the level of consciousness. A consciousness-dependent effect of spontaneous activity on the processing of stimuli was also found for stimulus-induced beta band synchronisation at a latency of 200 ms after the presentation of sounds. **Conclusion:** During wakefulness, spontaneous auditory cortices fluctuations elicits large differences

in brain activation and beta synchronization in late latencies. In contrast, the localized effect of spontaneous activity during loss of consciousness is unlikely to lead to changes in awareness of auditory stimuli. Our data suggest a correlation between the level of consciousness and the interaction between spontaneous and stimulus evoked activity.

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2. Signatures of consciousness and predictors of recovery in vegetative and minimally conscious patients

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In recent years, a large set of electrophysiological signatures of consciousness have been proposed. Here, we perform a systematic analysis of these EEG measures by quantifying their efficiency in differentiating vegetative state patients from those in a minimally conscious or in a conscious state. Based on a review of existing experiments and theories, we present a conceptual framework which organizes these measures along four dimensions: (1) event-related potentials versus ongoing EEG activity; (2) local dynamics versus inter-electrode information exchange; (3) spectral patterns versus information complexity; (4) average versus fluctuations over the testing period. We analyzed 181 high-density EEG recordings from a 30-minute paradigm designed to efficiently estimate a total of 94 measures. Results show that average and fluctuations of low-frequency power, measures of EEG complexity, and estimates of information sharing, particularly across distant sites, best index conscious states. This result is observed regardless of etiology and acuteness of the patients. When combined, these measures enable automatic classification of patients' state and even predict individual clinical outcome. Beyond its high clinical potential, a key element of this work consists in testing properties of cortical processing directly related to influential theories of consciousness (global workspace model; information integration theory; neural network recurrence theory) in a single empirical study.

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3. The reach of the unconscious

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A great conceptual pendulum oscillates, with a period of about 30 or 40 years, over our understanding of the relationships between conscious and unconscious information processing. Its path delineates the contours of the unconscious mind as well as its contents: Sometimes smart and defining the very fabric of the mind, the unconscious is at other times relegated to taking care of little more than our bodily functions. At this point in time, the pendulum finds itself hovering rather steadily on the side of those who think so many functions are served by the unconscious that they even question the very role that consciousness plays in shaping the human mind. Here I will suggest that the pendulum has swung a little too far, and illustrate the argument with recent experimental findings that document how challenging it may be to arrive at a satisfactory conception of the relationships between conscious and unconscious information processing. I will focus on three recent studies — one dedicated to perceptual awareness and the other two dedicated to social cognition. All are suggestive that the specific methods we use, as well as the manner in which we interpret the data, are of profound importance with respect to the conclusions we draw about the power of the unconscious. A few general principles emerge from this skeptical analysis. First, the unconscious is probably overrated today. Second, there is a pervasive and continuing confusion between information processing without awareness and information processing without attention. I suggest that considering how learning and plasticity mechanisms modify conscious contents can reduce this confusion.

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4. Threshold for subjective visibility is associated with striatal dopamine D2 receptor binding

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Research suggested that striatal dopamine (DA) activity affects corticostriatal information processing by disrupting or enhancing the transmission of input signals. This process is referred to as ‘sensory gating’ and is defined as a pre-attentive ability of the brain to modulate its sensitivity to an incoming stimulus. This indicates a strong relation between striatal DA and subjective visibility of a stimulus. We therefore hypothesized that individual differences in the threshold for subjective visual awareness would be related to dopaminergic binding in the striatum. The threshold for subjective visual awareness was measured in a behavioral masking (Del Cul et al., 2006). In a separate session, the uptake of dopamine in the striatum was measured with positron emission tomography (PET) and [¹¹C]Raclopride as a radioactive D2 receptor antagonist. Quantification of striatal binding was done by applying a partial volume- and resolution-independent method (Tossici-Bolt, et al. 2006; Goethals et al., 2007). Similar to previous work demonstrating a relation between striatal D2 binding potential and cognitive performance (e.g., human working memory, Cools et al., 2008) or personality traits (e.g., sensation seeking, Gjedde et al., 2010), results revealed a significant quadratic (U-curve) relation (corrected for linear trends) between striatal binding and the threshold for subjective awareness ($p = .0006$): Individuals with extreme values of striatal binding had higher thresholds for subjective visual awareness.

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5. Neurodynamics of transitions between sleep and wakefulness revealed by Granger causality analysis of intracranial EEG data

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An essential step towards revealing the neural basis of consciousness is to characterize directed functional interactions among diverse brain regions during different conscious levels. To address this challenge, we applied Granger causality analysis to intra-cranially recorded steady-state EEG data from 10 separate channels in a single human subject, obtained during both wakeful resting and deep (non rapid-eye-movement) sleep. The areas we recorded from included frontal, pre-central, cingulate, insular, and thalamic targets. We analysed Granger causality in the frequency domain, using pairwise and conditional implementations, and applying rigorous statistical controls. Results showed a dramatically increased Granger-causal influence during sleep from the thalamus to all other regions, concentrated in the low beta range (10-15 Hz), which was apparent in both pairwise and conditional analyses. This finding supports the notion of active thalamic regulation of sleep states. We also calculated network-level dynamical properties including “causal density” and “coalition entropy”. Causal density measures the overall level of causal interactivity in a network and has been related theoretically to conscious level, while coalition entropy measures the average entropy (over time) of the constitution of ensembles of synchronized channels. Both are in different senses measures of dynamical complexity of time-series data. Results showed that, surprisingly, these measures moved in opposite directions: while causal density increased during sleep, coalition entropy decreased. Our findings have implications both for the methodology of directed functional connectivity analysis of intracranial EEG data, and for complexity-based theories of conscious level.

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6. Unconscious arithmetic – arithmetic problems are solved without conscious awareness

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The modal view in the cognitive- and neurosciences holds that consciousness is necessary for abstract, symbolic and rule-following computations. Hence, mathematical thinking in general, and doing arithmetic more specifically, is widely believed to require consciousness. In the presented research we used continuous flash suppression to expose participants to extremely long-duration (up to 2000 milliseconds) subliminal primes, which were composed of arithmetic equations (e.g. $9-3-2=$). After prime presentation, participants saw conscious targets, either numbers (which participants had to read aloud; experiments 1 & 2) or statements (which participants had to verify by key

press; experiment 3). In all experiments targets were either congruent (the target was the equation's result) or incongruent. That primes were nonconscious was verified using both subjective and objective measures in each experiment. The results of the three experiments show an advantage for congruent targets, indicating that solutions to equations were activated even when the equations did not reach consciousness. In other words, they show that arithmetic can be done unconsciously. These findings imply that the modal views of the unconscious and consciousness need to be significantly updated – consciousness is not necessary for abstract, rule-based manipulation of information. Thus, the answer to the question what is the function of consciousness cannot be that consciousness is responsible for all “system 2” (Morewedge & Kahneman, 2010) processes.

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Concurrent Session 2.1: Feeling, Consciousness and Decision-Making

Sunday, July 14th, 15:30 – 17:30 (*Nautilus 1*)

1. Is consciousness involved in deliberate decision making? Evidence from intracranial recordings

Uri Maoz [1], Liad Mudrik [1], Shengxuan Ye [1], Dawn Eliashiv [2], Jeffrey Chung [3], Ian Ross [4], Adam Mamelak [3], Ralph Adolphs [1], Christof Koch [1,5]

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Introspectively, humans feel that they can consciously govern their decisions and actions. But the veracity of this experience was famously challenged by Libet's experiment and subsequent work, which suggested that it is unconscious processes that initiate action. This prompted claims that consciousness is not part of the causal chain leading to action. However, these studies focused on random actions, such as repetitively raising the left or right hand at will, while reasoned, deliberate actions are at the heart of the debate on free will and moral responsibility. Our subjects – 8 epilepsy patients intracranially implanted with electrodes for clinical purposes – played a matching pennies game where, at the go signal that followed a 5s countdown, they and their opponent raised one hand. Both starting the game with \$5, the subjects won \$0.10 off their opponents in trials where they raised the same hand, and lost that amount otherwise. Subjects kept the sum they scored at the end of the game if it was greater than their opponent's. So, importantly, our subjects' actions were reasoned and deliberate. In separate trials they reported when they consciously made up their mind. We constructed an online system that predicted which hand subjects would raise above chance starting 4s before action onset. Its accuracy rose to about 80% and plateaued, on average, together or after subjects reported having decided, 2.5s into the countdown. This suggests that consciousness may be more involved in deliberate actions than in random ones.

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2. Prospects for an experimental philosophy of mind: Experimental philosophy with or without intuitions?

Jennifer M. Windt, Thomas Metzinger

Johannes Gutenberg-Universität Mainz

The demand for interdisciplinarity has long been a buzzword in consciousness research. At the same time, experimental philosophy is currently a hot topic, claiming to revolutionize philosophical methodology itself. What, then, are the prospects for experimental philosophy of mind? Most existing studies have used questionnaires to investigate the intuitions of laypeople about consciousness. This is surprising for two reasons: One, philosophically relevant research results from cognitive neuroscience go far beyond questionnaire studies, so this methodological limitation seems exceedingly narrow. Two, intuitions, understood as a particular class of mental states, are themselves a target for philosophy of mind. Based on a brief analysis of the concepts of intuition and intuitiveness as a phenomenal signature of knowledge without epistemic justification, we argue that at best, intuition-based experimental philosophy investigates the phenomenology of intuitiveness in different subject groups, but has no consequences for questions concerning the nature of consciousness whatsoever. Intuition-free experimental philosophy of mind overcomes both limitations. Using a single example, we argue that intuition-free experimental philosophy is the outcome of an active collaboration between philosophers and cognitive neuroscientists, resulting from the attempt to operationalize conceptual distinctions from philosophy of mind and render them empirically investigable. As such, it is not purely philosophical, but when successful will rather be an example of genuine interdisciplinarity. Yet, its philosophical value is not limited to the philosophical relevance of specific research results, but includes the added

expertise and deeper understanding of the methods used in cognitive neuroscience that philosophers can gain through such collaborations.

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3. Ventral striatum but not ventromedial prefrontal cortex represents stimulus value without perceptual awareness **Leila M. Kouhsari [1], Christof Koch [2,3], Ralph Adolphs [1,2,3], Antonio Rangel [1,2]**

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Previous research has shown that activity in structures such as ventromedial prefrontal cortex (vmPFC) and ventral striatum (VStr) correlates with stimulus value at the time of choice when subjects are aware of the stimuli. However, we often make decisions without being fully aware of the details of the choice. The valuation mechanisms behind such ‘unconscious’ decisions are unknown. We used human fMRI to investigate the influence of perceptual awareness on value computation. Specifically, we asked if perceptual awareness is necessary for the neural computation of stimulus value, and if not, whether the same brain regions are involved in computing stimulus value in both the presence and absence of perceptual awareness. When a visual stimulus is preceded and followed by similar visual stimuli, it is experienced as indistinct or invisible, a phenomenon known as masking. Here, we used forward and backward masking to induce perceptual invisibility while observers viewed the names of appetitive and aversive food items. In the first part of the experiment, observers performed a 2AFC word, non-word discrimination task on masked food names and random letter strings. The discrimination performance measured by d' was not significantly different from chance, indicating that observers were not perceptually aware of the stimuli. In Part 2 of the experiment, we measured the participants’ preferences simply by asking them to view the names and indicate how much they would like to eat them. Finally, these same food names were presented with and without masking while the participants underwent fMRI, again rating how much they would like to eat each food. Consistent with previous research, we found that in unmasked trials neural activity both in vmPFC and VStr correlated with each participant’s subjective preferences collected in Part 2. In contrast, although observers’ behavioral ratings for masked trials were not significantly above chance, neural activity in VStr but not vmPFC reflected the participants’ subjective values from Part 2. In sum, we found that VStr is involved in computing the stimulus value at the time of decision-making both in the presence and absence of perceptual awareness.

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4. The mechanism of choice blindness: Clues from patterns of preference alteration

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Choice blindness challenges deep intuitions about intention, decision-making and self-knowledge. Recent studies have reproduced the phenomenon in a wide variety of decision domains, but the underlying mechanism remains nearly as obscure as when it was discovered. We here describe a study which closely replicates the original face-choice experiment (albeit computerized and using an Asian cohort), with a few key modifications: 1) more trials per subject, to make possible analysis of the effects of detection on subsequent trials; 2) additional psychometric evaluations, to support investigation of the role of individual differences; and 3) a post-test of attractiveness ratings ~2 weeks later, which allows us to use preference alteration data as a “wedge” for empirically distinguishing hypotheses about the underlying mechanism(s) of choice blindness. We find overall detection rates strikingly similar to the original study, but with more manipulation trials per subject some interesting within-subject patterns emerge; notably, even subjects who have explicitly reported concurrent detection of a manipulation will still miss about half of all subsequent manipulations. We find that the choice process alone produces a temporary exaggeration of preferences, choice + explanation does so more strongly, and non-detected manipulation trials do (with some caveats) reverse this effect. This suggests that subjects are genuinely “adopting” the reversed choice as their own, rather than merely producing surface-level confabulations in response to a question for which there is no true answer. Finally, we employ Bayesian model selection to investigate how detected and undetected manipulation trials modulate the preference-altering effects of choice and explanation.

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5. Why has feeling not (yet) been selected against? Homeostasis, valence and biological value

Pietro (Cesare Andrea) Snider

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Current scientific consciousness research aims at understanding the nature, function, and underlying mechanisms of consciousness. A central theoretical and empirical question regarding its causal function has however not received sufficient attention. Admitting that feeling (i.e., the qualitative aspect of experience) is a subjective biological phenomenon that has not been selected against, what is the best explanation for the persistence of feeling throughout evolution? The contingency of consistent correlations between neural activity and feeling, even if coupled with an evolutionary story about the fitness advantage of having a neural system, is not sufficient to exclude the possibility that the very fact of feeling has (or at least has had) some self-standing biological value too. I offer a novel theoretical perspective suggesting an alternative to Damasio's (2010) view on the subject. Drawing on interdisciplinary research, I claim that feeling is a cost-effective pattern-detection system assembling diverse information coming from a complex interrelated multi-modal sensory system onto a weighted, unified "rough" subjective experience which is informed well enough to drive selective behaviour. I suggest that variations in the rough valence of the qualitative aspect of feeling (feeling good or bad) have been tuned by natural selection to encode pre-conceptual information about how to react efficiently (quickly and with a better-than-chance success rate) to a countless number of potentially life-threatening situations. I claim that feeling is a biologically efficient phenomenon needed to prompt selective behaviour in beings having to deal with a multitude of multi-modal sensory information and living under demanding environmental constraints.

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6. Decoding the dynamics of action, intention, and error-detection for conscious and subliminal stimuli

Lucie Charles, Jean-Rémi King, Stanislas Dehaene

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How do we detect our errors? The comparison model proposes that to evaluate the accuracy of our decisions, we compare the motor response actually made to the response we believe we should have made. Such model therefore predicts that a cerebral representation of the correct response exists, even when making an error. Can we isolate it in brain activity? Does this representation need to be conscious to allow error-detection? In the present experiment we took advantage of decoding methods of linear classifiers applied on the high temporal-resolution magneto- (MEG) and encephalographic (EEG) recordings to contrast patterns of brain activity and track the neural dynamics of their associated cognitive processes. In particular, we examined correct and erroneous trials in conscious and non-conscious conditions to reveal brain activity related solely to the representation of the correct response and not to the actual motor response produced by the subject. We found that while low-level information on the stimulus and the response were available in non-conscious conditions, activity related to the computation of the correct/intended response could be decoded in brain activity only in conscious condition. Moreover, error could be detected by the decoder solely for conscious stimuli, at a time and with a certainty depending on the amount of evidence on the correct response. These results are in accordance with the dual-route model for conscious versus non-conscious evidence accumulation according to which error-detection results from the comparison of the outputs of a fast sensory-motor route and a slow route that computes intentions.

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Concurrent Session 2.2: Metacognition

Sunday, July 14th, 15:30 – 17:30 (*Nautilus 2*)

1. Metacognition versus mindreading: Some differences from error awareness studies

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Many psychologists and philosophers tend to identify metacognition with mindreading. They often claim that in order to monitoring cognitive activities (metacognition) subjects need to form self-ascriptions of mental states (mindreading); in doing so they identify metacognition with mindreading (e.g. Carruthers 2009, 2011). This view has two polemical implications: 1) our knowledge of our mind is grounded in the same capacity to know others' minds, and, therefore, 2) self-knowledge has not privileged status. The main aim of this talk will be to add some evidence for a functional dissociation between metacognition and mindreading to the burgeoning amount of evidence (see Proust 2012 for a review). This functional dissociation has been mainly unveiled by recent studies on error monitoring (e.g.

Logan & Crump 2010, and my own results). They have shown that although introspective reports often rely on environmental sensory information and, therefore, they could easily be manipulated to produce introspective illusions of rightness (as mindreading theorists of metacognition would expect), subjects' behavior remains unaffected by this sensory information showing an unaffected awareness of error through internal neural signals. In other words, although subjects' self-ascribe false propositions about their behavior, their metacognitive awareness of error remains unaffected. This suggests that our knowledge of our mental actions is not necessarily based on sensory information (at least not the same sensory information used for reading others' minds), and that this knowledge has at least some privileged status over our knowledge of others' minds (i.e. the knowledge produced by mindreading).

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2. Metacognition and two kinds of visual awareness

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What does it mean when an observer's perceptual capacity (d' , or accuracy rate in 2-choice discrimination) stays the same, but subjective confidence increases? We propose a framework to distinguish between two kinds of visual awareness – stimulus awareness and metacognitive awareness. The former is what most current studies are concerned with, i.e. keeping the physical stimulus constant while investigating the difference between effective and ineffective processing. But we argue that metacognitive awareness, that is the subjective realization that a visual process has been effective, is just as conceptually important and just as empirically tractable. We further distinguish metacognitive awareness from metacognitive capacity, and address the conceptual and computational relationship between the two. This taxonomy can help us resolve a number of confusions in the current literature. Like Ned Block's influential distinction between phenomenality and access, our distinction between stimulus and metacognitive awareness delineates the subjective and objective aspects of visual perception. However, the two distinctions are different as they led to opposing views regarding the plausible neural mechanisms. Most importantly, we argue that our distinction is superior because in our view the two kinds of awareness are operationally defined, i.e. they are determined by how we do the experiments. Whereas Block's distinction remains conceptually controversial, and has yielded little consensus on how do we measure phenomenal consciousness empirically. Major progress in neuroscience is often driven by careful conceptual taxonomy, but often such taxonomies are drawn by scientists who are actively engaged in the empirical work; it is our duty to engage in this kind of work.

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3. A new method for manipulating metacognitive awareness while keeping performance constant

Man Song [1], Brian Maniscalco [2], Ai Koizumi [2], Hakwan Lau [1,2]

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Metacognition, the ability to discriminate between one's confident and unconfident decisions, is an indicator of conscious experience. In the study of visual consciousness, when most methods manipulate the participants' metacognitive awareness levels, they also generate a change in a basic task performance. The confounding of awareness and task performance severely limits the interpretability of the results. Previous literatures have proposed methods such as metacontrast masking to dissociate the two factors. They manipulate subjective reports of confidence level/ visibility (i.e. metacognitive awareness) while keeping task performance constant. However it lacks the robustness in different experimental contexts. Here we propose a new behavioral paradigm that gives much more robust results. We manipulate the positive and negative evidence associated with a visual discrimination decision. Positive and negative evidence refer to the strengths of the stimulus component driving the correct and incorrect responses, respectively. We show that whereas performance is driven by the difference of magnitudes between positive and negative evidence, confidence is biased in favor of the absolute magnitude of the positive evidence; such that when we increase both positive and negative evidence we can increase subjectively reported levels of confidence/ awareness while keeping task performance constant. We present data to demonstrate the degree to which these results are robust under different kinds of performance feedback. We then discuss the potential applications of this new paradigm in addressing issues such as the functions of consciousness, and in the search of the neural correlates of consciousness using neuroimaging or electrophysiological methods.

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4. Metacognition and Cognitive Insight: Two sides of the same coin?

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Metacognition – the ability to think about thinking – is a central aspect of human consciousness. However, the link between more clinically based constructs in psychiatry such as insight (patients' understanding of their mental illness) and metacognition is unclear. Cognitive insight (CI) is a new concept from clinical insight research (Beck, 2004), which focuses on the habitual thinking styles involved in considering oneself. It can be split into two concepts; self-reflection (SR; ability to reflect on whether thoughts and beliefs about ourselves are correct, or could be changed by someone else's opinion) and self-certainty (SC; degree of overconfidence we have in our interpretations of experiences). CI may also be measured in healthy adults. Here we examine the relationship between CI (as measured on the Beck Cognitive Insight Scale; BCIS) and metacognition (using the task designed by Fleming et al (2010; *Science*, 329, 1541-43) in 30 healthy adults (mean age 40.5 years). We estimated metacognitive ability using the meta-d' measure developed by Maniscalco and Lau (2012; *Consciousness and Cognition*, 21, 422-43), which controls for response bias and type 1 sensitivity (task performance). A multiple regression analysis demonstrated a significant relationship between SC and metacognitive ability in healthy participants ($p=.012$). Further analysis indicated a gender*SC interaction ($p=.005$), driven by stronger association between SC and metacognition in male compared to female participants. There were no significant associations between SR and metacognition. Together our results indicate that CI and metacognition are inter-related constructs, but that this link is mediated by the self-certainty component of insight.

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5. The effects of metacognitive awareness on top-down cognitive control

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Our perceptual decisions are often accompanied by metacognitive awareness, expressed by the confidence in the fact that we have made the right perceptual decisions. What is the functional consequence of being metacognitively aware of the relevant visual information? Since cognitive control seems to require subjective effort, we wondered whether higher metacognitive awareness for the relevant visual stimuli enhances cognitive functions such as inhibitory control and task preparation. One difficulty here was to dissociate the effect of metacognitive awareness from that of perceptual accuracy, as they often co-vary. Here we used a new method based on superimposition of stimuli to create sets of gratings whose tilts were equivalent in discriminability, but differed in reported confidence levels. Experiment 1 assessed task preparation with a task-cuing paradigm. The tilts of gratings cued which of the two tasks (phonological/numerical) was to proceed. The results showed that although the cues perceived with higher confidence modulated the time course of the cued task preparation, it did not enhance preparation overall. Experiment 2 assessed inhibitory control with a Go/No-Go paradigm. The results showed that perceiving the signals with higher confidence did not improve inhibitory control capacity, although it led to more liberal responding criteria. Overall, these results suggest that metacognitive awareness may only give subtle effects on modulating cognitive control, despite common theories of consciousness predicting otherwise. We highlight several important advantages of our new approach to studying the functions of consciousness, in comparison with standard subliminal priming paradigms.

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6. Dissociable effects of attention and expectation on perceptual decision and metacognition

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Both attention and expectation facilitate sensory processing, however how they interact, especially with respect to metacognition, is poorly understood. We asked whether top-down expectation and attention act on stimulus detection and metacognitive performance differentially, by independently manipulating attention and expectation in a visual detection task. Participants reported, with or without a concurrent central visual search task (attention manipulation), the presence or absence of a Gabor patch presented at 70% contrast threshold. To equate objective sensitivity across conditions, contrast thresholds were estimated separately for the full and divided attention conditions using a staircase procedure. Top-down expectation was manipulated by informing participants of the probability of Gabor patch presentation in each block (25%, 50% or 75%). Expectation liberalised decision criteria yet

detection sensitivity d' was kept equal across levels of expectation and attention. This allowed us to examine metacognitive performance independently of objective performance. Metacognitive performance was only affected by expectation in full attention conditions, where it was improved when the reported percept (i.e. present or absent) was probable relative to when it was improbable. This interaction was driven by an effect on confidence ratings. Participants were reliably overconfident for improbable as compared to probable events. Interestingly, this effect was present under both full and divided attention. Taken together, our results suggest that top-down expectation modulates metacognitive performance by influencing confidence. Though confidence is adjusted independently from attention, the effect of expectation on metacognition is mediated by the availability of full attentional resource.

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Concurrent Session 2.3: Perception

Sunday, July 14th, 15:30 – 17:30 (*Nautilus 3*)

1. Distinct MEG correlates of conscious experience, perceptual reversals and stabilization during binocular rivalry **Kristian Sandberg [1,2], Gareth Robert Barnes [3], Bahador Bahrami [2,4], Ryota Kanai [2,5], Morten Overgaard [1,6], Geraint Rees [2,3]**

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During binocular rivalry, visual perception alternates spontaneously between two different monocular images. Such perceptual reversals are slowed or halted if stimuli are presented intermittently with inter-stimulus intervals larger than ~400ms – a phenomenon called stabilization. Often, the neural correlates of reversal and stabilization are studied separately, and both phenomena in turn are studied separately from the neural correlates of perception. To distinguish the neural correlates of perceptual content, stabilization and reversals, we recorded MEG signals associated with each in the same group of healthy humans observing repeated trials of intermittent presentation of a dichoptic stimulus. While perceptual content correlated mainly with inhibition of activity in extrastriate areas associated with the to-be-suppressed monocular image 140-280ms after stimulus onset, stability of perception reflected a gradual build-up of this inhibition across at least 10 trials and was associated with fronto-parietal activity 30-50ms after stimulus onset. Perceptual reversals, in contrast, were associated with temporal and parietal activity around 100-140ms on the trial before and after the reversal and a gradual decrease of inhibition of the suppressed image across at least 10 trials. Mechanistically, these findings suggest that stability of perception during rivalry is maintained by inhibition of competing interpretations, and gradual adaptation of inhibiting neuronal populations leads to instability that is eventually resolved by signals from late sensory and parietal cortices.

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2. A cellular mechanism for perceptual binding

Matthew Larkum

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Several lines of evidence suggest that conscious perception depends on recurrent connectivity in the cortex. While the importance of long-range feedback to lower cortical areas is clear from a great number of psychophysical experiments, there is at present no firm hypothesis about what specific effects feedback has on neuronal activity nor why it should be so crucial for perception. Here, a hypothesis is presented based on detailed intracellular recordings from neurons in mammalian cortex that the main cortical excitatory units (pyramidal neurons) contain an associative mechanism built in at the cellular level. This associative mechanism is robustly triggered by coincident input to opposite poles of the pyramidal neuron that perfectly match the anatomical location of feed forward and feedback inputs in the cortex. The associative mechanism depends on intrinsic properties due to voltage-sensitive ion channels found in the apical dendrites of pyramidal neurons. This mechanism can be robustly triggered and significantly affects both the number and pattern of action potentials generated. The hypothesis predicts that the binding process manifests as very tangible, plausible, experimentally reproducible and detectable events at the cellular level.

3. Causal role of gamma oscillations in bistable perception revealed by transcranial alternating current stimulation

Melanie Wilke [1,2], Yuranny Cabral-Calderin [1], Carsten Schmidt-Samoa [1]

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Alpha/beta (8–30 Hz) and gamma (>30 Hz)-band oscillations in the brain have found to be correlated with spontaneous perceptual reversals during ambiguous visual stimulation. However, whether these oscillations also play a causal role in determining the percept remains an open question. In the present study, we combined transcranial alternating current stimulation (tACS) with perceptual reports and functional MRI to test the causal role of oscillatory activity in bistable perception. Subjects were reporting their percepts in the context of a bistable structure-from-motion (SfM) stimulus while receiving tACS in different frequency bands. Behavioral results showed that tACS in the gamma range (60 Hz) increased the number of perceptual reversals. In contrast, tACS in the alpha (10 Hz) and beta (16 Hz) frequency ranges did not affect reversal rates. In order to evaluate the influence of tACS-stimulation on neural activity, we next combined the SfM stimulus with tACS and fMRI. Confirming earlier findings, the comparison between spontaneous reversals and physical replay revealed increased BOLD activity in visual cortex, superior parietal lobe, insula and anterior cingulate cortex during spontaneous reversals. Most importantly, perceptual reversals during 60 Hz tACS stimulation were primarily associated with an increase in BOLD signals bilaterally in the superior parietal lobe and the temporal occipital junction, while 10 Hz stimulation resulted in frontal deactivation. Taken together, our results provide evidence for a causal role of gamma, but not low frequency oscillations in visual perception and point to a critical involvement of gamma oscillations in temporo-parietal cortex in resolving perceptual ambiguity.

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4. Transient induced gamma-band responses in MEG during binocular rivalry: Do they reflect perceptual transitions or microsaccades?

Laila Hugrass, David Crewther

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During binocular rivalry, perceptual transitions are associated with synchronous neural activity in the gamma frequency band. Evidence from single-unit studies indicates that gamma-band oscillations are associated with conscious awareness, whereas evidence from scalp-recorded EEG studies suggests that transient gamma-bursts are associated with the initiation of perceptual transitions. In order to address this difference, we asked whether scalp recorded gamma bursts could be attributed to microsaccadic eye movements as opposed to perceptual transitions. We recorded MEG activity and eye movements while participants experienced binocular rivalry and reported their perceptual alternations. As expected, when time-frequency analyses were performed relative to the onset of microsaccades, we observed widespread bursts of high-frequency activity. Consistent with the existing literature, perceptual transitions were preceded by bursts of synchronous gamma-band activity. However, the timing of switch-induced gamma bursts matched peaks in the probability of microsaccade occurrence surrounding the switch. Separate analyses were performed for epochs that did and did not include microsaccades within 500ms prior to the subjective report. Bursts of gamma synchrony were more prominent for perceptual switches that were preceded by saccades than those that were not. Due to the relationship between microsaccade occurrence and perceptual transitions, switch-induced bursts of gamma synchrony are likely to be obscured microsaccades.

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5. Emergence of illusory shapes from invisible inducers

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Several studies have claimed that unconscious vision involves simpler forms of information processing compared to conscious perception. However, to render stimuli unconscious, experimenters often use brief stimulus presentation times and other manipulations that confound awareness with differences in physical stimulus attributes. In the current study, we developed a novel method to render visual stimuli invisible for extended duration to assess the evolution of unconscious processing over time. We demonstrate the validity of the method by showing that illusory contours are consciously perceived even when the inducing elements are rendered invisible, contrary to previous reports. In the first experiment we presented inducers, either alone or followed by a pattern mask. We varied the number of inducer-mask repetitions and showed that participants perceived stronger illusory contours with more

inducer-mask repetitions, even though they were completely unaware of the inducing elements in the masked conditions. In the second experiment we show that the perception of illusory contours is similar regardless of whether the inducers are masked or not, even though forced-choice discrimination of the direction of the inducers was at chance. These results demonstrate that with repeated presentations, the processing of stimuli presented below the threshold for awareness may be cumulative and more extensive than previously considered. Our study thus suggests that consciousness research should include methods that effectively block stimuli from awareness for extended periods of time while minimally interfering with their processing.

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6. High-level contextual integration without awareness: Evidence from unconscious processing in visual masking **Liad Mudrik [1], Christof Koch [1,2]**

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Integration is held to be a key feature of conscious awareness, and some even argue that the latter cannot occur without the former. We tested this claim by presenting masked scenes depicting a person performing an action with a congruent or an incongruent object (e.g., a man pouring coffee into a mug or into a roll of toilet paper). The masked scenes were then followed by congruent and incongruent targets, and subjects were asked to judge their congruency as fast as possible. Reaction times (RT) for targets preceded by incongruent but perceptually invisible scenes were longer than RT when the same targets were preceded by congruent ones. This implicit measure suggests that subjects had to compare the object with its background to detect whether or not the two were congruent, even in the absence of awareness of both. Subjective and objective measures ensured that subjects were indeed completely unaware of the masked scenes, ruling out influences of partial awareness. These results demonstrate that incongruency can be unconsciously detected even at impoverished presentation conditions, with reduced contrast and exposure durations as short as 33 ms, and provide further evidence for ongoing contextual influences of unseen stimuli on the processing of a subsequent target. Together with previous findings, they challenge prominent theories of consciousness, and call for an updated account for the relations between consciousness and integration.

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Concurrent Session 3.1: Consciousness, Access, and Subjective Confidence

Monday, July 15th, 12:30 – 14:30 (*Nautilus 1*)

1. Categorical judgments in visual overflow

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The overflow argument claims that the capacity of phenomenal consciousness exceeds that of cognitive access (Block 2011). Although the idea of phenomenological overflow is consistent with our (naïve) intuition, arguments against visual overflow have been claimed to be consistent with experimental data (Lau and Rosenthal 2011, Brown 2012). First-order representations of the visual information are not sufficient to give rise to phenomenal consciousness, and a second-order “representation” is necessary (Rosenthal 2005). Is the apparent richness of phenomenal visual experience only a “refrigerator light illusion” (O’Regan 2011)? The literature on binocular rivalry shows that in order for the subject to see something, the sensory representation arising from V1 should be “matched” with the top-down processes supported by higher order visual areas and prefrontal areas supporting subjectivity (e.g., Logothetis et al. 1996). Higher-order mechanisms that correlate with perpetual changes are not content-specific, but are of a more broad character. Here I explore the possibility that subjects are able to access generic information in the visual overflow, while being unable to register more specific information (Sperling 1970). Subjects were asked to walk through a typically constructed space, which were new to them. After the walk through, they were presented with a series of questions, including those about specific information as well as generic and categorical judgments about the space. I discuss how the apparent discrepancy between negative evidence on visual overflow and our (naïve) intuition that we see everything could be reconciled by a model of heterogeneous information spectrum handled by human cognition.

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2. Expectations accelerate entry into awareness

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Stimulus expectations can speed up subjects' responses to visual stimuli, but it is an open issue whether expectations speed up the process of perceptual awareness itself. Do we become aware of the visual world more quickly when we have an expectation about its contents? We investigated this basic question using a "breakthrough" paradigm. We employed a binocular rivalry set-up in which a mask (a meaningless mondrian pattern) started at full visibility, and a target-picture started at full invisibility. Gradually the visibility (contrast) of the mask was diminished, while the visibility of the picture was increased. Participants indicated when they saw the picture appear by pressing a key. We manipulated participants' stimulus expectation by showing a cue before the start of the trial. This cue predicted (with 70% validity) which image would likely appear. We found that expected images entered consciousness faster than unexpected or neutral images. In control experiments we confirmed that this effect is not due to response preparation, automatic priming or attention. Importantly, although previous studies have shown that top-down factors can influence dominance during binocular rivalry, and bottom-up factors can affect entry into consciousness, here we show clear evidence for top-down factors affecting entry into consciousness. These findings imply that awareness does not arise from sensory input at a fixed moment; rather, expectations change the time stamp of conscious awareness.

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3. Generic phenomenology and partial report paradigms

Henry Shevlin

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Ned Block (2007) has claimed that partial report procedures (e.g., Sperling 1960) present a serious challenge to those theories that make cognitive access a necessary condition of a representation's being conscious (see, e.g., Dehaene and Naccache 2001). Subjects in these experiments, Block claims, are best interpreted as being phenomenally conscious of more items than they cognitively access, hence demonstrating the overflow of cognitive access by the phenomenal. I provide an alternative interpretation of partial report paradigms that makes use of the notion of generic phenomenology (following Grush, 2007). In particular, I argue that subjects both have cognitive access to and are phenomenally conscious of most stimuli only in respect of relatively high-level generic features, such as being an alphanumeric character or being a rectangle at some orientation or another. This enables us to reconcile subjects' claim to have seen all presented items with their having been phenomenally conscious of no more than they cognitively accessed. Additionally, I argue that we have robust independent reason, both introspective and empirical, to think that such generic phenomenology is an important constituent of our ordinary conscious lives.

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4. Cross-modal prediction changes the timing of conscious access during the motion-induced blindness

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The ability to predict future events is crucial for survival. Previous studies have demonstrated perceptual facilitation by prediction. However, less is known about how prediction influences conscious awareness. In this study, we used motion-induced blindness (MIB) to examine this issue. Participants took part in a two-day experiment. On each day, both "training" and "MIB" sessions were performed. In the training session, participants detected change of colour of a dot (from blue to red or green), which was probabilistically cued by the pitch of a preceding tone (80% validity). The aim of this session was to have subjects learn the cross-modal probabilistic relation between the colour change and pitch. In the subsequent MIB session, a moving background induced unawareness of a target dot. Participants were asked to indicate the subjective disappearance (MIB onset) and reappearance of the target by pressing and releasing a key. During MIB, a tone was presented and the target colour gradually changed (from blue to red or green), either congruently (80%) or incongruently (20%) with respect to the pitch of the cue. We measured the duration between the tone onset and subjective target reappearance to evaluate the influence of cross-modal expectations on visual awareness. Results showed that the target gained access to consciousness faster in congruent trials than in incongruent trials, and this effect only appeared in the second-day experiment. Our findings establish that expectations learned through cross-modal training can facilitate conscious access to visual stimuli during MIB.

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5. Subliminal oddball ERP effects: Psychophysiological evidence for complex unconscious processing

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Unconscious processes are generally believed to be relatively unsophisticated, perhaps being limited to simple, rapidly decaying processes such as semantic priming (Greenwald, Draine, & Abrams, 1996; Dehaene & Naccache, 2001). Relatedly, many hold that subliminal stimuli should yield only early event-related potential (ERP) components (e.g., P1, N1) because later components (e.g., P3) reflect more complex stimulus evaluation which ostensibly requires conscious processing. Accordingly, some propose that late components may be a marker for consciousness (Del Cul, Baillet, & Dehaene, 2007). Oddball paradigms, in which larger P3 and even longer-latency late positivity (LP) components are routinely found to in response to supraliminal rare versus frequent stimuli (Spencer, Dien, & Donchin, 2001), provide a useful vehicle to test this hypothesis. Here, we demonstrate a clear P3 oddball effect using extremely subliminal stimuli. Moreover, this P3 effect is maximal parietally, suggesting it is a P3b component reflecting clearly complex unconscious processing (vs. less complex P3a components, which are maximal frontally). Furthermore, we found a strong LP effect, further indicating complex, long-lasting unconscious processing. Collectively, these findings closely resemble those found in corresponding supraliminal oddball paradigms, suggesting that unconscious processing can indeed be complex and durable, contrary to currently prevailing views. We then discuss possible reasons why some investigators obtain complex unconscious effects while others do not, including the counterintuitive hypothesis that these results may reflect the importance of achieving extremely stringent subliminal conditions (detection $d' = 0$) in order to successfully isolate and index unconscious responses to stimuli (Snodgrass, Bernat, & Shevrin, 2004).

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6. The effect of stimulus strength on subjective confidence

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Subjective confidence in seeing is a core feature of conscious vision. Intuitively, stronger stimuli produce subjectively greater confidence and greater clarity in perception. While psychophysics has developed a comprehensive theory of how stimulus strength affects behaviour (choice), how stimulus strength affects subjective confidence is still largely unknown. Prominent models of decision-making propose that confidence is proportional to the “balance of evidence” between chosen and unchosen decision options (Vickers, 1979). However, recent observations suggest that only the strength of the chosen stimulus affects confidence judgments (Zylberberg, Barttfeld, and Sigman, 2012). In a contrast-discrimination task, we tested this claim by manipulating the strength of multiple stimuli across a wider range than has been used previously. We found that the strength (contrast) of both chosen and unchosen stimuli affected confidence, but that the strength of chosen stimuli had a significantly stronger influence. In a second experiment we show that participants report lower confidence in three-choice compared to two-choice situations in which the contrast of the chosen stimulus was matched, consistent with the addition of an unchosen stimulus reducing the balance of evidence. Our findings demonstrate that evidence both for and against a choice affects subjective confidence, but contrary to a balance-of-evidence model, evidence in favor of a choice is given greater weight. We discuss how these regularities between stimulus strength and confidence are not accommodated by current theoretical accounts.

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Concurrent Session 3.2: Consciousness, Self and Unity

Monday, July 15th, 12:30 – 14:30 (*Nautilus 2*)

1. Re-thinking the unity of consciousness

Robert van Gulick

Philosophy and Cognitive Science, Syracuse University

In *The Unity of Consciousness*, Tim Bayne argues that phenomenal unity is a distinct form of conscious integration not reducible to representational unity. For Bayne the crucial notion is that of two or more experiences being experienced together by one and the same conscious self. Bayne denies that unity in this sense can be reduced to the representational integration of contents. However, at a deeper level Bayne's proposal may reveal that phenomenal

unity is ultimately grounded in representational integration, though of a special sort essential to consciousness. That deeper dependence derives from the nature of the self. Bayne (rightly) views the self as an intentional structure or virtual entity. It is not an independent thing (Cartesian substance or neural system) that has experiences, nor is the self a mere bundle of experiences. The self is an implicit perspective built into the structure of experience much like Dennett's notion of the self as the "center of narrative gravity". The link can now be spelled out. Phenomenal unity requires a unified self that experiences items together. To construct such a self one must integrate the relevant experiences and their contents as "being from the same perspective". In effect, the perspective is created or constituted by the fact that the experiences and their contents cohere "as from a single point of view." It is in that sense that phenomenal unity is ultimately grounded in a special form of representational integration. Moral: Models of consciousness as integration must include integration from the self-perspective.

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2. Attention and the problem of unity

Carolyn Dicey Jennings

University of Antwerp

This paper aims to explain the unity of conscious perception. The reader may be familiar with the concept of unity from other work in philosophy and cognitive science. In philosophy, Tim Bayne's work is responsible for considerable discussion on the unity of consciousness. In cognitive science, Anne Treisman's work is responsible for at least as much discussion on the unity of perceptual objects. The unity of conscious perception is a form of unity in between these: it is the unity of the perceptual field, discoverable through phenomenological reflection. This paper shows how attention can solve the so-called "problem of unity" for conscious perception. The problem of unity is that of explaining the origins of perceptual unity, given its absence at the level of early sensory processing. This problem is based on the presumption that conscious perception shares some structural correspondence with its physical underpinnings and that each instance of conscious perception depends for its existence on early sensory processing. Once one accepts these two claims, the problem of unity that motivates this paper can take hold. In sum, the problem of unity relies on evidence from phenomenological reflection and empirical science, both of which I review in this paper. I then propose and defend a unique solution to the problem of unity: attention provides the unity of conscious perception by prioritizing sensory processing with respect to the current interests of the subject.

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3. From Darwin to Freud: Confabulation as an adaptive response to dysfunctions of self-consciousness

Paula Droege

Pennsylvania State University

A puzzling feature of confabulation is its selectivity: only some people confabulate in response to illness, and only some people resist correction of their inventions. So-called two-factor theories of delusion account for the latter sort of selectivity in terms of the failure of a belief evaluator. The first factor in delusion is a dysfunction in perceptual or cognitive processing and includes such cases as amnesia, feelings of unfamiliarity toward loved ones, or auditory hallucinations. Since first factor deficits do not always cause delusions, a second factor is postulated to explain the failure of delusional patients to revise the faulty beliefs produced by first-factor deficits. For some reason – theories differ – delusional patients maintain false beliefs in the face of counter-evidence. I suggest that a Darwinian view of the mind can supplement two-factor theories by articulating the function of self-consciousness. If we suppose self-consciousness utilizes memories in order to maintain a sense of the self in time, then confabulation is an adaptive response to the absence of memories in order to maintain this function. Delusional forms of confabulation differ from the everyday sort of confabulation that many of us experience in that delusions are accompanied by a second deficit, unrelated to self-consciousness, in the capacity to reevaluate beliefs in light of contradictory evidence. By considering the function of rationality and the function of self-consciousness, the debate between explanationist and endorsement accounts can be resolved.

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4. Intersection of perception and cognition & cross-modal experiences: New insights into unified consciousness

Aleksandra Mroczko-Wąsowicz

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Traditionally cognition and conscious perception as well as its different sense modalities have been examined independently, as divided and different from each other. However, recent studies elucidating the impact of

perception on cognition, but also the various ways in which conscious perceptual experiences can be penetrated and modified by thoughts, beliefs, moods, desires, emotions, knowledge and memories, seem to support an alternative view. Investigations of cross-modal experiences and multimodal interactions, in which input in one modality modulates content in another, reveal that such perceptual experiences cannot be easily categorized as belonging to one of the traditional five senses. The existence of multisensory influences on perception or cross-domain integration going beyond the senses to the domains of abstract, conceptually represented entities, domains of bodily, motor and emotional states, provide challenges to standard methods individuating our epistemic abilities. This implies a need for a new methodology. A full understanding of how the mind works requires considering the complex and tight relations holding among these domains and their mutual impact. Our mental faculties should not be studied separately. They call for a more holistic approach in order to uncover their extensive capacity for interaction producing unified conscious experiences. Determining whether multisensory processing results in a multimodal state or rather a decomposable conjunction would provide the needed characterization of the basic units of consciousness.

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5. I am what I am

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A central, non-negotiable constraint on any account of phenomenal awareness or experience is that it must be intrinsic to the experiencer, rather than depending on an outside interpretation of its structure or function. When applied to computational accounts of phenomenal awareness that are based on dynamical systems theory, this constraint raises serious conceptual challenges, namely, the need for an intrinsic definition of "the" system in question and "the" computation that it realizes. We discuss a number of ideas that seem relevant in this context, including the notion of a maximal complex (in Tononi's IIT), extreme holism (extending Chalmers's remarks on the unity of consciousness), and an invariance principle based on relativistic considerations (Edelman & Fekete). More generally, we propose that a resolution of the system question with regard to phenomenality should be rooted in examples from more "mundane" physical domains such as mechanics and electrodynamics. Accordingly, we conclude by outlining a deflationary approach to the questions at hand.

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6. Tracking persons over time is tracking what?

Andrew Brook

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The topic of consciousness over time has not received a lot of attention in recent work on consciousness, despite the interest that philosopher/psychologists have taken in it over the past three centuries. Yet tracking persons, that is, determining that a person now is or is not a specific earlier person, is usually a matter of following the history of a current conscious being back in time to determine if the history ends up or does not end up at some earlier conscious being of interest. The lack of attention to this activity is not because it is not important. It is extremely widespread and important in our way of life. Nor is it because the techniques that we use are unproblematic. To the contrary, the main techniques, behavioural expression of memories, facial resemblance and, in more rigorous cases, fingerprints and DNA, are all in one way or another very problematic. So it would be a good idea to figure out what we are tracking when we track a person back in time, i.e., what it is to persist as the same conscious person over time, and to assess how well our current practices do so. Contributing to knowledge in these two areas is the aim of this paper. (The paper will introduce a 'theme', i.e., an interdisciplinary group of papers, on tracking persons in the journal, *Topics in Cognitive Science*.)

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Concurrent Session 3.3: Miscellaneous

Monday, July 15th, 12:30 – 14:30 (*Nautilus 3*)

1. Using training to simulate synaesthesia in adulthood

Daniel Bor [1,2], Nicolas Rothen [1,3], David Schwartzman [1,2], Stephanie Clayton [1], Jamie Ward [1,3], Anil Seth [1,2]

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Synaesthesia is a condition where presentation of one perceptual class consistently evokes additional experiences in one or more different modalities. Synaesthesia is widely considered a congenital condition, although an alternative view is that repeated exposure to multimodal associations at a key developmental stage may be the foundation for at least some forms of synaesthesia. Until now, only circumstantial evidence has supported this alternative position; for instance, specific letter-colour pairings for some adult synaesthetes is traceable to their childhood toys. Here we show for the first time that in non-synaesthetic adults learning alone is sufficient to create behavioural effects and phenomenology that are difficult to distinguish from actual grapheme-colour synaesthetes. Participants engaged in an eight-week training regime that involved a range of memory and reading tasks, designed to cement letter-colour associations in a similar manner to childhood experiences. Following training, subjects exhibited all the standard markers of synaesthesia, including Stroop interference effects, consistent letter-colour scores (Eagleman battery), decreased reaction times on the synaesthetic visual search task, and a conditioning effect of skin conductance response for letters when only the associated colours were paired with an aversive stimulus. In addition, 9 out of 14 participants described synaesthetic phenomenology, such as perceiving colours superimposed on achromatic letters, both within and outside the lab. This study shows that it is possible to train non-synaesthetes to display very similar characteristics to grapheme-colour synaesthetes, supporting developmental accounts of synaesthesia and illuminating a previously unsuspected potential for new learning to shape perceptual experience even in adults.

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2. The cortical excitability and neurochemical markers of visual cognition in synaesthesia

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Primary visual cortex has been repeatedly implicated in grapheme-colour synaesthesia but the role it plays in supporting different characteristics of this condition, and its connection with perceptual awareness, remain poorly understood. Here we will describe recent research measuring cortical excitability and neurochemical concentrations in primary visual cortex and their cognitive and phenomenological correlates in synaesthesia. By combining transcranial magnetic stimulation and transcranial electrical stimulation, we demonstrate that cortical excitability in primary visual cortex is selectively elevated in synaesthesia and that hyperexcitability covaries with the perceived visuospatial location of colour photisms in this condition. We further show that modulating cortical excitability in primary visual cortex modifies the synaesthetic experience and its behavioural consequences. Finally, we used magnetic resonance spectroscopy to measure neurochemical concentrations in synaesthetes and non-synaesthetes. This approach combined with proxy psychophysics measures highlights the differential roles of neurotransmitters that are involved in cortical inhibition and excitation (GABA and glutamate, respectively) in primary visual cortex in different characteristics of synaesthesia including enhanced visual working memory. This research sheds light on the role of primary visual cortex in synaesthesia and provides valuable information regarding the neural basis of individual differences in perceptual awareness and visual cognition.

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3. A neural marker of perceptual consciousness in infants

Sid Kouider [1,2], Carsten Stahlhut [2], Sofie V. Gelskov [1,3], Leonardo S. Barbosa [1], Michel Dutat [1], Vincent de Gardelle [1], Anne Christophe [1], Stanislas Dehaene [4-7], and Ghislaine Dehaene-Lambertz [5-7]

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Sleep is characterized by a lack of behavioural responses to the environment, but the extent to which the brain continues to process external stimuli remains largely unknown. Here, by combining a task induction strategy with electroencephalographic (EEG) measures of response preparation, we studied whether sleeping subjects can perform decisions on the meaning of spoken words. Awake subjects categorised words as either animals or objects while transitioning towards sleep and then continued being tested for covert response preparation towards the appropriate category during early non-REM sleep. Two brain markers of intention-to-act, lateralized readiness potentials and effector-specific desynchronisation in mu and beta bands, revealed that the participants continue to trigger category-

specific responses even after falling asleep. These findings show that despite the absence of awareness and behavioural responses, individuals can still extract task-relevant information from external stimuli and prepare to respond during sleep.

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4. Seeing with your heart: Can you feel what you consciously do not notice?

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Psychologists, philosophers as well as laypeople believe that subtle feelings or “hunches” can provide introspective access to emotional processes that otherwise elude consciousness. This notion of “seeing with your heart” finds support in phenomena such as affective blindsight, where neurological patients show physiological responses to emotional stimuli presented in a cortically blind visual field. Several psychological phenomena, such as subliminal affective priming and the use of “somatic markers”, also suggest that unconscious or implicit emotion elicitors can manifest themselves by biasing overt preference judgments and choices. Physiologically, unconscious emotional cues can activate a variety of responses that indicate the presence of an emotional state. However, the presence of an emotional response, as revealed in physiology or in judgment biases, does not mean that the emotion itself is directly (introspectively) available to awareness. This is the idea of “unconscious emotion”, as proposed by Winkielman and his colleagues (2004, 2011). In an update on this idea, I will describe several recent studies in which focusing participants on introspection of their fleeting emotional experience failed to improve the detection of briefly presented emotional stimuli, despite the clear presence of physiological responses indicating an emotional state (Bornemann, Winkielman, & van der Meer, 2012). I will also show that detection of subtle emotional cues (subliminal facial expressions) is influenced by the degree to which these cues invoke embodied processes, defined as activation of relevant facial muscles. This suggests that emotional awareness might be improved by tapping into those embodied outcomes.

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5. Do subjective, objective and indirect measures of perception reflect qualitatively different mechanisms?

Dominique Lamy

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Unconscious perception occurs when a stimulus that observers fail to perceive consciously is nonetheless capable of influencing their actions. There is currently no consensus regarding the measures that are most valid to dissociate conscious and unconscious perception or as to whether the reported dissociations reflect qualitative or only quantitative differences between the underlying mechanisms. Vorberg, Mattler, Heinecke, Schmidt and Schwarzbach (2003) used metacontrast masking and reported that varying the time interval between the stimulus and mask (or SOA) affected conscious and unconscious processing, measured in different blocks of trials, in qualitatively different ways. The authors concluded that conscious perception, indexed by forced-choice discrimination performance (i.e., an objective measure of conscious perception) and unconscious perception, indexed by action priming (i.e., an indirect measure of perception), reflect qualitatively different processes. Here, we applied the SOA manipulation to a subjective measure of conscious perception (using a visibility scale ranging from 0 to 3), as well as to an objective and an indirect measure of perception, under the same task demands. Our results suggest that (1) direct (subjective and objective) measures of perception tap the same mechanism but with different sensitivities, (2) SOA effects on action priming are strongly influenced by attention and should therefore be assessed under similar conditions as their effects on conscious processing and (3) action priming remains significant when visibility is null but disappears when objective performance fails. Thus, whether the mechanisms underlying unconscious processing, indexed by indirect measures, and conscious perception, are qualitatively different, remains an open question.

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6. Measuring the level of consciousness in flies with integrated information

Naotsugu Tsuchiya [1,6], Dror Cohen [1], Agelique Paulk [2], Masafumi Oizumi [3,4], Paul Shaw [5], Bruno van Swinderen [2]

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Recently, it has become possible to detect consciousness in non-communicable patients using non-invasive fMRI (Owen et al 2006). If neuronal recording are reliable enough, the same strategy might be applicable to detect consciousness in non-communicable animals. Such deductive strategy for the conscious level might work up to primates, possibly mammals. However, due to gross difference in anatomy, neuronal activation patterns, and evolutionary history, this approach is not possible for invertebrate species, such as insects. An entirely different approach towards building a general “consciousness meter” is a recent theoretical framework, called Integrated Information Theory (IIT), proposed by Tononi (2004). IIT proposes that the level of consciousness directly relates to the amount of information that is integrated within a system. Building upon recent theoretical development (Balduzzi & Tononi 2008, Barrett & Seth, 2011, Oizumi et al, under review), we applied our improved estimate of integrated information to local field potential data from the fly, *Drosophila melanogaster*. The neuronal data was recorded with 16-channel silicon linear electrodes, which spanned across most major brain areas in the flies (Pauk et al, submitted). Sleep-like state was induced in flies by expressing heat-sensitive cation channels in neurons, including those that project to dorsal fan-shaped body (Donlea et al 2011). Our preliminary results show that during the “sleep” period neuronal activity became highly synchronized across recording sites, while integrated information dropped. The results are consistent with an idea in IIT that too much synchrony reduces information, and thus, degrades the level of consciousness.

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Posters

(*Nautilus 4 & 5*)

Evidence and methodology for investigating the hypothesis of the out-of-body experience as an objective event

Nelson Abreu [1, 2]

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(P1-072 July 14th, 1330-1530)

The ability of consciousness to acquire information and experience about places and events beyond the usual physical senses has been reported since the beginning of recorded history and described in many cultural traditions. In recent times, these phenomena have been referred to as “Out-of-Body Experiences (OBEs),” “Near Death Experiences,” “Remote Perception,” among other labels. While still regarded with skepticism by most scientists, a number of scholarly studies and subjective reports invite us to consider that what are thought to be physiological causes of such phenomena, may be merely correlates and the OBE may be both a subjective phenomenon and an objective or veridical event. This presentation summarizes evidence to date related to “projections of the consciousness” and the arguments that challenge the idea that consciousness emerges from the brain and that OBE's are oneiric in nature. It briefly introduces falsifiable hypotheses and methodology (both first and third-person perspective) for further research.

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Psyche as an informational strategy

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(P2-001 July 15th, 1430-1630)

This paper presents a reductive “functionalist information theory” remedy to historic problems in modeling the human Psyche (consciousness). It argues that all information, at a minimum, possesses an inviolate dual aspect of “form + content.” This dual informational aspect is shown (herein) to resolve the duality typical to many historic views of Psyche (e.g., the Hard Problem). With this minimal dual aspect in mind, the paper then compares three recent information theory approaches to modeling Psyche: Tononi’s Integrated Information Theory (IIT), Terrence Deacon’s common dynamical logic (CDL), and General Information Theory (GIT), for a brief survey of information theory treatments of Psyche.

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On the physiological generation of antinomies and paradoxes

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(P2-002 July 15th, 1430-1630)

It is proposed that subconscious retro-predictions in conjunction with brain state update cycles are instrumental in the physiological generation of conscious sensations and perceptions, and in all abstract thought. In this paper the hypothesis is supported by conducting a detailed a re-evaluation of the self-referential statements in set theory and formal logic known as antinomies. This study concludes that the recursive behavior exhibited by abstract enigmas such as “Russell’s Paradox” is generated by a similar process, and is analogous to the oscillations typical of bistable perceptual phenomena.

Intrinsic causation and consciousness

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(P1-026 July 14th, 1330-1530)

Building upon integrated information theory (IIT) (e.g. Tononi, 2012), we investigate parallels between phenomenological axioms of consciousness (existence, compositionality, information, integration, and exclusion) and the intrinsic causal structure of physical systems. Central to our approach is the claim that causation has an informational aspect: a mechanism can only have a causal role within the system, if its present state constrains the potential past and future of the system, referenced to all possible counterfactuals (system states). Sets of mechanisms can have a compositional causal role, provided they are integrated, meaning they are irreducible to the causal roles of their parts. By assessing the amount of integrated information specified by sets of mechanisms, one can assess both the quality, or 'causal role', and the quantity, or 'causal power' they exert within a system. Finally, sets of mechanisms that generate local maxima of irreducible causal information form causal complexes. These exclude other, overlapping causal entities, and thereby avoid overdetermination. These causal principles are illustrated in simple networks of neuron-like linear threshold units. Our approach has consequences not only for the fundamental relationship between information and causation, but also for our understanding of emergence, adaptation, and meaning. Finally, this approach identifies consciousness with a local maximum of causation (a causal complex). Tononi G (2012) Integrated Information Theory of Consciousness: An Updated Account. Arch Ital Biol 150: 56–90.

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The reflexive imagery task: Unintentional imagery despite extensive training and voluntary set selection

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Christina Merrick [1]

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(P2-044 July 15th, 1430-1630)

Some models of consciousness propose that, under certain conditions, contents can enter consciousness in a unintentional manner resembling reflexes (Helmholtz, 1856). Study 1 ($n = 32$) used the Reflexive Imagery Task (RIT), a paradigm based in part on Wegner's (1989) 'ironic processes' and Gollwitzer's (1999) 'implementation intentions,' to demonstrate systematically that, when presented with a visual object and instructed to not subvocalize the name of the object, unintentional subvocalization is almost inevitable: Only 4 participants experienced unintended imagery on less than 90% of trials. The unintentional condition yielded significantly longer latencies, $F(1,29) = 29.87$, $p < .0001$. In Study 2, prior to performing the RIT, participants ($n = 17$) were trained extensively on one action set (e.g., to 'color name') and then, when presented with stimuli, were given the choice to perform the trained action set or a novel action set (e.g., to 'count the objects'). After each trial, participants reported about set-related and set-unrelated mental imagery (e.g., about numbers). Consistent with theories proposing that the conscious contents represent several potential action plans, participants were equally likely to have set-related imagery (60%) or set-unrelated imagery (51%). Preliminary data suggest that training, nor choice of set, influenced the type of imagery participants

experienced across trials, $F(1, 15) = 0.211$, $p = .652$, ($hp2 = .014$), $F(1, 15) = 0.848$, $p = .372$, ($hp2 = .053$), respectively. We discuss the theoretical implications of these findings and delineate other variants of the RIT that could be used to elucidate the nature of consciousness.

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Visual Awareness Negativity correlates with small changes in conscious experience

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(P2-034 July 15th, 1430-1630)

Visual Awareness Negativity correlates with small changes in conscious experience Lau M. Andersen, Michael N. Pedersen, Kristian Sandberg & Morten Overgaard The Visual Awareness Negativity (VAN), an event related difference wave, has been proposed as a neural correlate of consciousness (NCC) (Koivisto & Revonsuo, 2010). The Perceptual Awareness Scale (PAS) was created by subjects who were instructed to develop a scale to rate visual experiences where each point reflected an experience qualitatively different from any other point on the scale (Ramsøy & Overgaard, 2004). It contains four points: NE = no experience, WG = weak glimpse, ACE = almost clear experience, CE = clear experience. PAS has since been used in several experiments (Melloni et al. 2011; Overgaard et al. 2006; Ruzzoli et al. 2010). Some of these experiments suggest that PAS is a more sensitive measure of consciousness than other current methods (Sandberg et al. 2010) We tested the hypothesis that VANs would be found between PAS-ratings, which would corroborate that VAN is a candidate for an NCC. To investigate this hypothesis, we ran an experiment using magnetoencephalography (MEG) to obtain event-related fields (ERFs) for each of the PAS-ratings. Based on the sensor space data, we successfully trained a classifier to discern between the four PAS-ratings. VANs were found for the planned contrasts, and we found suggestive evidence for differences between ratings in source activity and source localization. In conclusion, we found evidence for VANs between the different ratings, and thus evidence for VAN being an NCC that does not only correlate with whether the subject is aware or unaware, but also with experienced differences in conscious content. References: Koivisto, M., & Revonsuo, A. (2010). Event-related brain potential correlates of visual awareness. *Neuroscience and biobehavioral reviews*, 34(6), 922–34. doi:10.1016/j.neubiorev.2009.12.002 Melloni, L., Schwiedrzik, C. M., Müller, N., Rodriguez, E., & Singer, W. (2011). Expectations change the signatures and timing of electrophysiological correlates of perceptual awareness. *The Journal of neuroscience : the official journal of the Society for Neuroscience*, 31(4), 1386–96. doi:10.1523/JNEUROSCI.4570-10.2011 Overgaard, M., Rote, J., Mouridsen, K., & Ramsøy, T. Z. (2006). Is conscious perception gradual or dichotomous? A comparison of report methodologies during a visual task. *Consciousness and cognition*, 15(4), 700–8. doi:10.1016/j.concog.2006.04.002 Ramsøy, T. Z., & Overgaard, M. (2004). Introspection and subliminal perception. *Phenomenology and the Cognitive Sciences*, 3(1), 1–23. doi:10.1023/B:PHEN.0000041900.30172.e8 Ruzzoli, M., Marzi, C. a, & Miniussi, C. (2010). The neural mechanisms of the effects of transcranial magnetic stimulation on perception. *Journal of neurophysiology*, 103(6), 2982–9. doi:10.1152/jn.01096.2009 Sandberg, K., Timmermans, B., Overgaard, M., & Cleeremans, A. (2010). Measuring consciousness: is one measure better than the other? *Consciousness and cognition*, 19(4), 1069–78. doi:10.1016/j.concog.2009.12.013

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Hypnotic synaesthesia; is it behaviourally similar to natural synaesthesia?

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Hypnosis can be used to create hallucinations reported to be phenomenologically similar to synaesthetes experiences however whether 'hypnotic' and natural synaesthesia are functionally similar is undetermined. We researched two types of synaesthesia; grapheme-colour, when graphemes trigger a colour experience; and hearing-motion, when viewing movement or flashing lights causes a concurrent auditory experience. Grapheme-colour synaesthetes outperform controls for embedded shapes tasks made of digits as the colours aid in the detection of the shape. In experiment 1, participants highly responsive to hypnosis completed an embedded shapes task with and without a hypnotic grapheme-colour suggestion. Participants did not perform better in the hypnosis compared to control condition, but did report seeing a greater percentage of graphemes as coloured for correct compared to incorrect trials. The colours therefore seem to be added post-trial using mental imagery rather than actually aid detection of the shape. Behavioural advantages have been found for hearing-motion synaesthetes when making same/different judgements for pairs of flashing light sequences. People are better at making judgements for auditory sequences (beeps) in comparison to visual sequences (flashing circles). Synaesthetes benefit from the concurrent sound. In experiment 2, participants completed two blocks; baseline and with a post-hypnotic or mental imagery suggestion to hear beeps when viewing flashing circles. Post-hypnotic suggestion created the phenomenological experience of synaesthesia but not behavioural advantages like those of natural synaesthetes. The phenomenological experience of synaesthesia is therefore not enough to behave like a synaesthete suggesting that neurological and functional processes interact to create synaesthesia.

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Fingerprints of subjective experience in the animal brain

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(P1-027 July 14th, 1330-1530)

Fingerprints of subjective experience in the animal brain: an immediate early gene mapping approach Consciousness and memory are tightly linked in neural mechanisms of subjective experience. We have previously shown that memory consolidation involves neuronal expression of immediate-early genes (IEGs) (Maleeva et al., 1989) and that it can be used to map memory assemblies in the brain (Anokhin, 1989). Behavioral induction of IEGs is triggered by subjective novelty (Anokhin & Sudakov, 1993) and occurs in single-trial episodic-like memory events (Anokhin et al., 1991; Ryabinin & Anokhin, 1993). In extension of this line of research I propose that imaging of behaviorally induced expression of IEGs can be used to image the episodes of conscious experience that are consolidated in long-term memory in experimental animals. With this purpose we developed techniques to visualize activation of IEGs during behavior in GFP transgenic mice (Anokhin et al., 2012), optical clearing of a whole mouse brain after behavioral episodes of induction of IEGs (Efimova & Anokhin, 2009) and whole brain cell-resolution optical tomography to image experience-driven distributed cell assemblies tagged by IEGs expression (Morozov et al., 2010). I further suggest that linking IEGs promoters to optogenetic tools will allow moving from correlative to causal analysis of neural bases of subjective conscious experience. Supported by RMSE Grant 11.G34.31.0071 and RAS "Fundamental Science to Medicine" Grant

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Does level of processing influence the transition from unconscious to conscious processing of stimuli?

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(P1-047 July 14th, 1330-1530)

The Neural Global Workspace and the Recurrent Processing theories put forward contradictory views on the transition from unconscious to conscious perception, suggesting, respectively, an all-or-none and a gradual pattern of this process. Recently, Windey, Gevers, & Cleeremans (2012) proposed that the two views may be integrated if levels of processing (LoP) will be taken into account. Accordingly, low and high LoP should produce, respectively, gradual and binary patterns. To test this hypothesis, we used classic Posner's paradigm, in which participants have to classify pairs of letters as the same or different, based either on their physical identity (e.g. 'AA'), which involves low LoP, or on a rule (letters are consonants or vowels), which involves higher LoP. To differentiate levels of awareness, the stimuli were presented for eight time intervals (within 17 - 144 ms range) and then masked. For subjective ratings Perceptual Awareness Scale (PAS) was used after each trial. The results of objective measure of performance, i.e., response times, showed large differences between low and high LoP, closely replicating the classic results. The subjective measure of awareness showed that when stimuli exposure time was 48 or 64 ms (i.e., those, in which accuracy was moderate), the middle PAS ratings were used more often in the low than in the high LoP condition. The results therefore confirm that processing information at the lower level might produce more gradual pattern of ratings, thereby suggesting that LoP might influence the transition from unconscious to conscious processing of stimuli.

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Are resonances in Integrated Information signatures of conscious states?

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(P2-024 July 15th, 1430-1630)

The Integrated Information Theory of Consciousness proposed by Tononi et al (and its subsequent stochastic version by Barrett and Seth) seeks to quantify the level of consciousness attainable by any dynamical network by estimating the causal information generated by the network as a whole over and above that of parts, in the course of a dynamical transition from one state to another. According to this proposal, conscious systems are those which process high quantities of integrated information (denoted as ϕ). However, we find that ϕ can in fact be unbounded for a variety of simple networks. More precisely, we report the existence of resonance poles in integrated information (ϕ), which reside in the parameter space of network coupling strengths and are stable under perturbations of the solution. These are undamped resonances of ϕ , which arise when the coupling strength approaches any of the inverse eigenvalues of the network. Computing ϕ for several prototypical network topologies, we establish the widespread existence of a network topology-specific spectrum of ϕ resonance peaks. Furthermore, upon adding dynamics to the "synapses" or link coupling strengths, we find that the resonances translate to temporal spikes in ϕ . The ϕ spike-train thus obtained is characteristic of both network structure and dynamics. These findings raise two important questions. Firstly, in the light of these resonances, is it still meaningful to compare information integration capabilities of two networks based on an absolute value of ϕ at a single instantiation? We argue that such dynamic network comparisons require systematic information spike analysis in much the same way as we perform neural spike analysis. The second question concerns the interpretation of the poles themselves. In the vicinity of these resonances, the value of ϕ becomes very large, implying very high network complexity. From the physics of emergent phenomena, poles in observables are associated to critical points of the system, which upon regularization, mark the transition to new phases of matter. We are currently investigating whether regularizing poles in ϕ yields phase transitions to new states of complexity. Is it reasonable to identify these resonances with conscious states?

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Illusory body-ownership for the proxy hand causes automatic compensative movement toward it.

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(P1-048 July 14th, 1330-1530)

The sense of body ownership involves the integration of vision and somatosensation. This is evinced in the rubber hand illusion (RHI), a phenomenon in watching a rubber hand being stroked synchronously to one's own unseen hand, temporarily causes observers to perceive the rubber hand as belonging to their own bodies. The rubber hand illusion may elicit proprioceptive drift, whereby the observer's sense of his or her own hand's location drifts toward the external proxy hand. The current experiments examined not the proprioceptive but the actual drift "movement" toward the proxy. The participants' hands, which were located on a horizontally movable board, tended to move toward the rubber hand only while they observed synchronous visuo-tactile stimulation. Furthermore, even when participants' hands were located on a fixed, unmovable board (i.e., conventional RHI paradigm), participants were automatically administering a pushing force toward the rubber hand. These findings suggest that since awareness of our own body (sense of body ownership) and action (sense of agency) are fundamental to self-consciousness, these components of the "minimal self" are closely related and are integrated into "one agent" with a unified awareness of the body and action.

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On the linearity of threshold for visual awareness in the lateralized two-stream RSVP task.

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(P2-045 July 15th, 1430-1630)

Studies on threshold for visual awareness have shown either an all-or-none or a gradual pattern of transition between unconscious and conscious processing of stimuli. The cause of this ambiguity is unclear. The aim of the present study was to investigate the role of attentional lateralization in thresholding of visual awareness. Attention is assumed to be a gatekeeper selecting targets from noise, and the right hemisphere has been shown to be superior in attentional selection. Therefore, it is plausible that the transition between unconscious and conscious processing might be more gradual for right visual field (RVF), in which attentional selection is less efficiently controlled, than for left visual field (LVF), in which more efficient selection should produce more all-or-none-like pattern. To meet the objective, the two-stream rapid serial visual presentation (RSVP) task was used, in which participants were asked to identify and then rate awareness of two consecutive targets, T1 and T2, embedded in either of two streams of successive distractors. For the subjective ratings Perceptual Awareness Scale (PAS) was used. The results showed, first, the expected large LVF advantage in accuracy of the targets identification, and second, a more linear pattern of subjective rates, combined with a larger variance of these rates, for the RVF stimuli. Taken together, the results seem to suggest that the right hemisphere specialization for spatial attention can cause VF asymmetry in variability and quality of subjective perceptual experience, and thereby also modulate linearity of subjective rates of perceptual awareness.

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How does unconscious inhibition accumulate over time? The specific role of response latency and its relation with prime-target delay

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(P1-049 July 14th, 1330-1530)

Is awareness necessary for inhibition of action? What is the time course of such processes? Previous studies on masked priming have revealed that inhibition can occur even without conscious perception and without any voluntary effort. Although it is now clear that automatic inhibitory mechanisms need time to unfold, little is known about how temporal factors influence such inhibition. Here, we hypothesized that both prime-target delay (SOA) and target-response delay (response latency) play a role in automatic inhibition. We also expected that these temporal factors are not purely additive but instead interact strongly. As expected, we found that although inhibition increased across

response latency for each SOA, the impact of response latency was significantly stronger for intermediate SOAs (70-80 ms) than for short (0 ms) or long SOAs (150 ms). Thus, when the SOA clearly determines the direction of prime influence, as was the case for short and long SOAs (strong facilitation or inhibition), response latency had but a weak impact on priming. Conversely, when the SOA was intermediate and could not unequivocally determine the direction of the influence of the prime, response latency strongly influenced priming. For those SOAs, although priming was globally absent, fast responses resulted in facilitatory priming and slow responses in inhibition. Our study thus suggests that although variability in response time is generally taken to be noise, it might instead represent a meaningful temporal factor for investigating inhibition mechanisms in nonconscious priming.

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Spectral Theory of Consciousness

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(P2-025 July 15th, 1430-1630)

Spectral theory is a well-established mathematical tool to study stable states of dynamic systems. These stable states correspond to localized vibrations or confined waves with definite energies and describe a variety of physical phenomenon ranging from the spectrum of light emitted by atoms and molecules, sound created by acoustic waves to the solutions of the wave equation in quantum mechanics. Based on the tools of the spectral theory, we introduce a new theoretical model to study (the neural correlates of) consciousness, i.e. the spectral theory of consciousness. Assuming that neural representations (certain firing patterns) exist which correspond to different conscious experiences, e.g. different qualia, we define a dynamic system based on the time evolution of neural activity. Conscious experience is associated with the stable states of this complex dynamic system. The model integrates the changes caused by external stimuli as well as by the internal dynamics of the (neural) system. Thus, three cases are distinguished within the model: 1) stable (conscious) states in presence of external stimulus corresponding to different qualia, 2) stable (conscious) states in absence of external stimulus and 3) changes in the internal dynamics of the system leading to a change in the state of consciousness, e.g. sleep state. We hope that like in optics, acoustics and quantum mechanics, the simple mathematical model of spectral theory will provide a new perspective towards understanding the nature of our conscious experience.

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Radical skepticism, the Sleeping Beauty paradox and ‘in house’ betting.

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(P2-080 July 15th, 1430-1630)

I will begin with a spatial version of the ‘sleeping beauty paradox’ (similar to Nick Bostrom’s) with two identical rooms and two pairs of identical participants Mike, a ‘thirder’ and Bob, a ‘halfer’. The two, who love betting, immediately place a wager on their credence to the coin toss. Bob argues that the only way he could lose is if he were made to concede that it is possible that he is really in the other room ‘right now’ and that he sees no reason for doing that. Mike replies that this is not enough and that the onus is on Bob to prove that radical skepticism of identity is false. Bob replies that accepting radical skepticism about identity makes their bet impossible because if Bob is really in the other room betting with the other Mike than Bob cannot owe money to ‘this’ Mike, adding that assumptions that undermine the legitimacy of the bet should be avoided. I will conclude that this kind of wager is not easy settle. Its not clear who wins (if only we could do the experiment) but it seems like the halfers’ position is tenable. There is also the question of whether this version of the SBP makes radical skepticism of identity less palatable. I will end with comments on AI and synthetic indexical categories suggesting that in certain circumstances the SBP can be used as an

alternative to the celebrated Turing Test.

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Attention during spontaneous conscious thought: Diffuse or decoupled?

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(P1-050 July 14th, 1330-1530)

The mind flows in a “stream of consciousness” which often neglects immediate sensory input in favor of focusing on intrinsic, self-generated thoughts or images. There is now convergent support for the proposal that perceptual processing is dampened during periods of spontaneous conscious thought, which is consistent with the hypothesis that attention becomes decoupled from the external environment during such internally directed states. However, a prominent alternative account of these findings is that spontaneous thought instead results in a diffuse or broadened attentional focus, which could plausibly aid in monitoring the environment for unexpected events while the mind is focused elsewhere. In the current study, we evaluated these competing hypotheses using a frequency-tagged steady-state visual evoked potential (SSVEP) paradigm. The amplitude of the SSVEP is modulated by visual spatial attention and thus provides a continuous electrophysiological measure of attentional allocation (e.g., Hillyard et al., 1996). Participants (n=16) completed a go/no-go sustained attention to response task (SART) while 15Hz and 20Hz uniform visual flicker (flicker rate counterbalanced across blocks) was presented continuously at a central task-relevant and a peripheral task-irrelevant location. During the task, individuals were intermittently interrupted by experience-sampling prompts and asked to report their current attentional state. The results reveal an attenuation of the SSVEP response to the peripheral flicker over the central occipital scalp region during periods preceding reports of spontaneous conscious thought. These results support the hypothesis that self-generated conscious thought is associated with a state of decoupled rather than diffuse attention to the external environment.

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Losing the left side of the world during sleep onset: Neglect-like effects on a visual prior-entry task in drowsy normal participants.

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(P2-026 July 15th, 1430-1630)

Unilateral neglect, a common consequence of stroke, refers to a lack of awareness for information on one side of space. It has been suggested that states of low alertness may exacerbate neglect for left space in particular. In a recent study using an auditory localisation task, we found that drowsy sleep-transitions in healthy volunteers were also accompanied by marked shifts in spatial awareness towards the right – suggesting that normal mechanisms may be implicated in the disorder. Spatial neglect can occur across modalities. Here, 26 healthy participants performed a lateralised visual temporal order judgment (TOJ) task with their eyes closed whilst transitioning in and out of sleep. In spatial TOJ tasks, stimuli at attended locations have an earlier subjective onset. Left and right LEDs mounted on goggles were flashed with left-right SOAs of 0, 20, 40, 80 and 160ms. Reaction times averaged over 10 trials were used to define relatively drowsy and alert performance epochs. There was a significant alertness x side-of-error $F(6, 20) = 4.878$, $P = .003$ interaction with participants increasing errors on left-first trials with drowsiness. The finding is

consistent with the mechanisms underpinning alertness-dependent shifts in spatial awareness operating across modalities.

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Mind and self: Navigating streams of consciousness through an ocean of other

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(P1-001 July 14th, 1330-1530)

Much of cognitive science still works under the assumption that individuals (or individual brains) are the fundamental units of cognition. However, as is becoming increasingly clear in the fields of psychology, economics, sociology and anthropology, the social, environmental, and epistemological systems of which organisms are but parts are intimately and inextricably involved in so-called individual mental processes. Drawing from multiple organismal models of collective cognition, I discuss how a wide array of cognitive percepts, from self-consciousness to scientific theories, are not only dependent upon but emergent from interpersonal and interorganismal interaction. Both bottom-up computational models and top-down theoretical approaches have illuminated and informed this "ecological" approach towards cognition, suggesting that the phenomena of consciousness are extraordinarily malleable, emergent not only from neuronal activity but ultimately from a planetary network of minds.

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Neuroimaging of olfaction in obsessive-compulsive disorder

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(P2-070 July 15th, 1430-1630)

Background: Obsessive-compulsive disorder (OCD) is a common psychiatric illness. Neuroimaging studies show that OCD patients have greater activation of their right insula to disgusting images compared to healthy controls (HCs). OCD patients may in fact be more sensitive to unpleasant stimuli regardless of the sensory modality, which may trigger their obsessions and compulsions. Methods: We investigated the function of the olfactory system in response to pleasant (banana, vanilla, chocolate) and unpleasant (garbage, feces, urine) odors in OCD patients (N=7) compared to HCs (N=8) using fMRI and our specially developed olfactometer. Unscented air was the control stimulus. Subjects rated stimuli on intensity and valence and completed questionnaires measuring odor identification, OCD symptoms, disgust sensitivity, and emotion. Results: Compared to HCs, in response to unpleasant (vs. pleasant) odors OCD patients had increased activation of their right anterior insular, left posterior insular, and anterior cingulate cortex/superior cingulate; and decreased activation of their left lateral orbitofrontal cortex, left dorsolateral prefrontal cortex, and putamen (bilateral). Conclusions: Similar to results in the visual domain, people with OCD appear to be more "neurally sensitive" to unpleasant odors. Their decreased activation in prefrontal regions in response to unpleasant odors implies that they have less cognitive/top-down control over their increased unpleasant feelings (indicated by increased insula and cingulate activation). This is the first study to examine olfaction in OCD using fMRI and further elucidates the neural underpinnings of OCD, which may contribute to the development of better treatments.

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Visual experience depends on level of processing

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(P2-046 July 15th, 1430-1630)

The nature of our visual experience of the world has been examined thoroughly in both philosophy and cognitive psychology, but a number of issues remain the object of hot debates. One such pending issue is whether our visual experience is graded or dichotomous. Considerable evidence has been collected for both views. In a series of experiments, we tested whether the level of processing of the presented stimuli can account for seemingly contradictory results. Participants expressed either low-level judgments (color naming) or high-level judgments (number or word categorization) on the very same stimuli. We analysed both mean performance and mean subjective visibility ratings for stimulus durations ranging from 10 to 80 ms. Earlier work has shown that psychophysical curves exhibit a significantly more dichotomous transition in the high-level task than in the low-level task. The present research expands upon this work. Using different subjective measures, we examined whether participants use more intermediate scale points in the low-level condition than in the high-level condition, which would suggest a more graded perception for low-level stimuli and tasks. Results using confidence ratings were found to confirm this prediction. Altogether we propose that whether visual experience is graded or dichotomous depends on the level of processing of the stimuli during task execution. This has important implications for theories of consciousness that make claims about the graded vs. dichotomous nature of visual experience, such as global workspace theory.

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Impaired metacognitive capacities in individuals with problem gambling

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(P1-051 July 14th, 1330-1530)

Impaired insight into behavior may be one of the clinical characteristics of pathological gambling. In the present study, we tested whether the capacity to evaluate accurately the quality of one's own decisions during a non-gambling task was impaired in problem gamblers. Twenty-five problem gamblers and 25 matched healthy participants performed an artificial grammar-learning paradigm, in which the quality of choice remains uncertain throughout the task. After each trial of this task, participants had to indicate how confident they were in the grammaticality judgements using a scale ranging from 1 (low confidence) to 7 (high confidence). Results showed that (i), problem gamblers' performance on the grammaticality test was lower than controls'; (ii) there was a significant correlation between grammaticality judgments and confidence for control participants, which indicates metacognitive insight and the presence of conscious knowledge; (iii) this correlation was not significant in problem gamblers, which suggests a disconnection between performance and confidence in this group. These findings suggest that problem gamblers are impaired in their metacognitive abilities on a non-gambling task, which suggests that compulsive gambling is associated with poor insight as a general factor. Clinical interventions tailored to improve metacognition in gambling could be a fruitful avenue of research in order to prevent pathological gambling.

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Transforming the mirror: Hierarchical "verticality" fundamentally changes spontaneous facial mimicry

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(P2-047 July 15th, 1430-1630)

Hierarchical “verticality” involves the ability to control the actions of others—either from an internal perspective for the perceiver (i.e., the feeling of power) or externally via cues from the target (i.e., status within the social ladder)—and affects a variety of interpersonal behaviors, including empathy, emotion recognition, and self-regulation. Yet, research into how both perceiver and target verticality impact spontaneous facial mimicry (an important driver of affiliation and rapport) has not been explored. To bridge this gap, we used facial electromyography (fEMG) to measure activity from two muscles in the face: zygomaticus major (“smiling muscle”) and corrugator supercilii (“frowning muscle”). To gauge spontaneous facial mimicry, subjects watched dynamic videos after completing a writing prime to manipulate them into different levels of verticality (i.e., make them feel powerful or powerless). We then manipulated target verticality by having these perceivers watch videos of happy and angry expressions for 4 different FACS-coded targets that were randomly assigned to high- and low-verticality professions. While low-verticality perceivers smiled to all targets and expressions, high-verticality perceivers only returned smiles to low-verticality targets. Moreover, for smiling, high-verticality perceivers exhibited a distinct counter-mimicry pattern to similarly high-verticality targets. With frowning, all participants showed a more intense mimicry pattern to the frowns of high-verticality targets. Overall, we are the first to demonstrate that the verticality of both the target and perceiver interact to significantly affect spontaneous facial mimicry, revealing that social hierarchy can dictate who and what emotions we mimic, even at the lowest level of muscle activation.

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Bodily awareness and the schema/image distinction

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(P1-004 July 14th, 1330-1530)

Bodily awareness is amongst the most discussed subjects of study concerning consciousness. The Body Schema/Body Image distinction (henceforth BS and BI) is one of the main developments in the study of bodily awareness. In this work, we will take into account two different approaches of such distinction: Shaun Gallagher’s and Frédérique de Vignemont’s. We argue that despite the fact that Gallagher’s approach has a phenomenological inspiration, it fails to be sensitive to the distinction between pre-reflective and reflective consciousness -holding instead a distinction between consciousness and ‘pre-noesis’. We believe this later term, as involuted as it is, ends up being ambiguous between the mere subpersonal and the pre-reflective. On the other hand, de Vignemont’s version of the BI/BS distinction presupposes another quite controversial division: that between perception and action. However, if –as claimed by sensorimotor approaches– perceptual experiences and body movements are co-constitutive, the perception–action distinction would turn out to be unsustainable. We suggest an alternative reading according to which BS and BI are not well understood in terms of separate neuropsychological mechanisms but of different roles, and that is still capable of giving an account of the empirical cases cited by Gallagher and de Vignemont. Such empirical data comes from neuropsychological cases such as deafferetation, numbsense, phantom limb syndrome, neonate imitation, rubber hand illusion, etc. In contrast to Gallagher’s, our view of the matter is sensitive to the distinction between pre-reflective and reflective consciousness and, in contrast to de Vignemont’s, it does not separate perception from action.

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Who have better working memory, chimpanzees or humans?

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(P2-003 July 15th, 1430-1630)

Do chimpanzees have better working memory than humans? In this paper, I argue that the different performances in the "limited-hold memory task" between chimpanzees and humans are not related to their capacity of working memory but caused by their preferences to pictorial representations or symbolic representations. I will use Victor A.F. Lamme's theory to distinguish the different representations. In the "limited-hold memory task", chimpanzees outperformed humans with higher accuracy and speed, Sana Inoue and Tetsuro Matsuzawa (2007) therefore inference that chimpanzees have better capacity of working memory than humans. However, Peter Cook and Margaret Wilson disprove this argument by showing humans beat chimpanzees after adequate practices. I argue that chimpanzees' and humans' different performances of the "limited-hold memory task" are not because of the capacity of their working memory but rather different stages of recurrent processing. Lamme (2010) proposes that visual stimulus can reach four different stages of neural processing according to different depths and routes of processing in brain. According to his theory, I assert that the digits were processed as pictorial representations in the localized recurrent processing (Stage 3) for chimpanzees while they were processed as symbolic representations in the widespread recurrent processing (Stage 4) for humans. Chimpanzees prefer to use pictorial representations which can deal with more digits at once within shorter time, while humans get used to symbolic representations which needs more time to complete the widespread recurrent processing. Nevertheless, I argue that human can use pictorial representations as well as chimpanzees do through training.

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The effect of electro-acupuncture on visual attention

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(P2-048 July 15th, 1430-1630)

Chinese acupuncture has been used to treat a wide range of disease for approximately 3000 years. Some clinical studies have shown that the acupuncture therapy could elevate the therapeutic effect for the patient with ADHD (Li, Yu, & Lin 2010; Li, 2004). A study employed the visual attention task and showed that electro-acupuncture stimulation resulted in significantly better sustained attention performance (Chen, Thompson, Kropotov, & Gruzelier, 2011). Although these works revealed that the acupuncture can influence the attention, but how it works is still unknown. Posner and Petersen (1990) proposed three networks, alerting, orienting, and executive control, as the underlying mechanisms of visual attention. The aim of the present study is to evaluate the impact of electro-acupuncture on the efficiency of three attention networks. Fifteen participants will perform the Attention Network Test (ANT), proposed by Fan, McCandliss, Sommer, Raz, & Posner (2002), in the three study phases, before, during, and post electro-acupuncture stimulation. The selected two acupoints of both hands, LI-4 (HeGu point) and P-6 (NeiGuan point), were stimulated. The results will reveal the effects of electro-acupuncture on improving which attention network by comparing the reaction time of the before-stimulation and the during-stimulation study phases. We will also explore the sustained effect by comparing the reaction time of the during-stimulation and the post-stimulation phases. Our preliminary results demonstrated that alerting networks were affected by electro-acupuncture stimulation.

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Mental representation: Symbolic or pictorial?

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(P2-004 July 15th, 1430-1630)

Autism spectrum disorder (ASD) has been characterized as a heterogeneous neurodevelopmental condition. Different theories try to explain ASD in terms of different cognitive atypicalities, such as deficits in theory of mind, central coherence and executive function. However, they end up just showing different aspects of ASD and thus are inadequate explanations. If we really want to understand ASD, we need a new framework. I propose that we have to distinguish between two kinds of mental representation: symbolic representation and pictorial representation. As for people with ASD, they have deficits in their symbolic representation and their minds operate with pictorial representation. Pictorial representation is formed in visual cortex when outside stimuli are received. When the information is delivered to prefrontal cortex, the amount of the information is decreased. It is the way of abstraction and then symbolic representation is formed in prefrontal cortex. In Lamme's theory, the localized recurrent processing and widespread recurrent processing (Lamme, 2010) can be the neural basis of symbolic representation and pictorial representation. This framework fits in well with empirical findings that people with ASD are impaired in abstraction, symbolic thinking and language while having powerful visuospatial abilities. Furthermore, because of the impairment in symbolic representation, people with ASD lack the ability for understanding other's symbolic mind, fail to grasp the global whole but focus on detailed elements, and have inflexible behaviors.

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Interaction theory, individualism and autism

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Interaction theory is proposed to include what the individualistic approach, the dominant view in psychology, fails to include in the explanations of human minds (Gallagher, 2004; Gipps, 2004). What individualism fails to consider, suggested by interaction theorists, is the interpersonal elements, such as interactions between individuals, in accounting human psychology. By including the interpersonal elements in psychology, interaction theory shows a better accommodation of evidences from both developmental psychology and phenomenology. In addition, including the interpersonal elements in psychology also helps to provide a more comprehensive account of autism. Interaction theory can account for both the social and non-social traits of autism while the individualist view of autism, theory of mind, explains only the social traits of autism. These advantages suggest that interaction theory might be a better theory in psychology than the individualist approach. However, I think there are two main problems that the interaction theorists should worry about. First, the evidences used to support interaction theory are from psychologists who belong to the camp of the individualist approach. Second, the way interaction theorists understand autism is still individualistic. I suggest that these two problems of interaction theory must be solved or interaction theory is just another individualist theory in disguise. In this paper, I will discuss these two problems of interaction theory and propose possible remedies to rescue interaction theory.

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Three levels of self-consciousness

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(P2-005 July 15th, 1430-1630)

There are still hot debates about whether animals or autistic patients have self-consciousness. The main reason of objection is that animals and autistic patients are believed to have no, or very limited, ability to deploy linguistic concepts, which are usually presumed to be the prerequisite of self-consciousness. Even I also admit that the ability to use language and concepts is important for forming self-consciousness, I claim that there are at least three levels of self-consciousness. They are, from the most basic to the highest, implicit self-consciousness, non-linguistic self-consciousness, and quasi-linguistic self-consciousness. The confusion of these levels of self-consciousness generates most of the disagreements among theories and the interpretations of experiments. I suggest that implicit self-consciousness is just the ability to distinct the subject from the environment, and this ability does not require the concept of self. Nevertheless, the higher two levels of self-consciousness require the capacity that an organism can self-recognize, and it is difficult to imagine that an organism can recognize itself without having the concept of self. Against the mainstream thought that concepts are all linguistic, I will argue for the idea of non-linguistic concepts (of self) that some animals (e.g. apes) and autistic patients are able to use even they lack linguistic ability, and the non-linguistic self-consciousness is sophisticated enough to meet many criteria that we usually use for self-consciousness, for example, the mirror test.

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Stimulation in the ventrolateral prefrontal cortex increases guessing responses in a feature binding task

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Nelson and Narens (1990; 1994) proposed a metacognition model that dissociated the objective processing of information (object-level) and the subjective evaluation of the performance (i.e., the metalevel). Neurophysiological evidence also indicated the prefrontal cortices (PFC) would be the brain areas to perform the metalevel function (Fernandez-Duque, Baird, & Posner, 2000; Pannu & Kaszniak, 2005; Stuss, Gallup, & Alexander, 2001). A corresponding neural mechanism of Nelson and Narens's model, called dynamic filtering theory (Shimamura, 1996; 2000), indicated the object-level processing were distributed in the posterior cortices and regulated by the prefrontal cortices with a filtering or gating mechanism to select appropriate signals and to suppress inappropriate signals and noises. Based on the model, a hypothesis can be developed that, under uncertain circumstances of the object-level processing, the activities of the prefrontal cortices will be more active to modulate signals and noises. The inference can be supported by a recent fMRI study (Chiang et al., 2013) that the ventrolateral PFC was in activation when subjects were not confident about their percepts of a feature binding task. Here, we reported the guessing responses increased significantly when applying rTMS on the ventrolateral PFC (vIPFC), compared to the other three control conditions (i.e., No-TMS, sham TMS on vIPFC, and rTMS on Cz). The results were compatible with the filter dynamic theory and suggested that unnecessarily excess activities in the vIPFC would interfere with the original modulation of signals and noises, and result in the poor quality of percepts and then the increase of guessing responses.

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Pain in women: Early perceptual processing of emotional prosody in primary dysmenorrhea

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(P2-071 July 15th, 1430-1630)

Primary dysmenorrhea (PDM), menstrual pain without pelvic abnormality. We previously reported functional and structural alternations of pain-laden brain regions in PDM. However, it is unknown how menstrual pain affect perceptual process of emotion. In this magnetoencephalographic (MEG) work, we studied the central processing of emotional prosody during menstrual (state) and peri-ovulatory (trait) phases, respectively, to elucidate the functional reorganization of emotional circuitry in PDMs. All 25 PDMs and 25 age-matched controls both with regular menstrual cycle were enrolled. We implemented a paradigm of emotional prosody to probe the automatic brain responses in face of different emotional voices. The brain responses were recorded with a whole-head 306-channel MEG in both menstrual (MC) and peri-ovulatory (OV) phases as confirmed by blood test of gonadal hormones. We used the beamformer method for source localization (co-registered on T1 MRI images) to estimate emotion-evoked brain activity. During menstrual phase, the most prominent attenuation of responses to angry emotion was found in prior regions, especially bilateral STG, anterior insula, IFG, and IPL. Similar pattern was revealed in happy emotion. In the between phase-within group comparisons, we observed only mild differences in the PDM group but more differences in the control group. Since our paradigm is an implicit design of passive and inattentive listening to emotional prosody, the processing is essentially automatic and involuntary. Based on the absence of significant difference between phases in the PDM group, the findings should be ascribed to trait changes of functional plasticity under long-term cyclic pain. On the contrary, the control group manifests phase differences of emotional processing across menstrual cycle, which implies a state-related reaction. Our data disclosed that menstrual pain could interfere with early unconsciousness processing of emotional-laden auditory network.

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Tales of creativity and consciousness

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There was once a lonely girl who wanted a friend, so she built a robot. It was built to be like her; fully functioning and creative. However, the girl noticed that the robot seemed to mimic everything she did, from drawing pictures to storytelling. This made the girl question whether her relationship with the robot was as real as other friendships she saw between humans. The girl wondered: "is the robot really conscious if it's just copying me?" Curious, the girl asked the robot what it was like to be a robot. It responded: "Why are you asking me this? What's it like to be human? By the way, I'm not a robot; I'm an autonomous agent!" Here we examine the relationship between consciousness and creativity. Do we need to be creative to be conscious? Do we need to be conscious to be creative? We survey some history on the topic then provide examples showing that the relationship is complex and that simply pursuing necessary and sufficient conditions may be inadequate. Non-conscious cognitive processes abound and underlie some

of the most complex activities from artistic expression to problem-solving. We consider the intertwining role of creativity and consciousness in heuristic tasks, especially in embodied and social contexts. We also consider whether quantification and rigid definition are necessary for understanding these factors. We further suggest that attempts to investigate, reduce, and validate using standard neuroscience methods may undermine the very essence of the phenomena. We explore the possibility of new narrative approaches.

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Neural signatures of perceptual transitions for a novel bistable auditory stimulus

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(P2-081 July 15th, 1430-1630)

Multistable figures allow the investigation of neural processes associated with conscious perception while holding physical characteristics of a stimulus constant. Using an intermittent stimulus presentation paradigm, previous event-related potential (ERP) experiments have consistently reported two components associated with perceptual transitions of bistable visual stimuli (e.g. Necker cube, face-vase), the "reversal negativity" (RN) and the "late positive complex" (LPC). The RN, which appears over the occipital-parietal scalp at ~250msec post-stimulus is thought to reflect changes in perceptual representations in the ventral stream, while the LPC (~400msec) is likely to index working memory updating. Because prior research has focused exclusively on visual stimuli, it was unclear whether analogous neural signatures might exist in other sensory modalities. The present experiment utilized a novel bistable auditory stimulus based on Shepherd Tones. Pairs of complex tones with ambiguous pitch relationships were presented while subjects reported whether they perceived the tone-pairs as ascending or descending in pitch. ERPs elicited by the tones were compared between trials in which perceived pitch-motion changed direction relative to the previous trial versus trials in which perceived pitch-motion remained the same across trials. An auditory RN component was evident at similar latencies as the visual RN (~210msec) over fronto-central scalp locations, suggesting sources in auditory brain regions. An auditory LPC component was also evident at subsequent latencies (~330msec). These results suggest an auditory analog of the RN which bolsters the claim that this ERP component may reflect transitions between neural representations that form the moment-to-moment contents of conscious perception.

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Current science of consciousness is inconsistent or incomplete (or worse)

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Controversy has often followed those who have advocated that Godels 1931 proof regarding limits of formal number theory is a basis for rejecting materialism and accepting some kind of dualism (e.g., Penrose). There is a much less belabored derivation of how current scientific epistemology leads to either incompleteness or inconsistency. A rigorous informal argument makes it clear that scientific method as usually characterized cannot help but exclude the primary phenomena of consciousness. Worse yet it totally depends upon them. The result is a kind of unacknowledged schizoid dissociation endemic to the way we approach the development of a science of consciousness. We make observations and interpret them to produce a physical world view which then is challenged to find a place for non-mysterian veridical observation in the physical theory. This strange-loopiness leads to views of emergence (I'm OK, but simple systems are not so hot), reductionism (denial), eliminative materialism (don't talk about it), dualism or dual aspect theories (have your cake and eat it too), or the ever so frightful position of panpsychism (recursive sentience). The cause of the ongoing conundrum is the hidden 'axiom' of physicalism, the assumption that there is no sensation nor cognition nor memory in simple physical processes. Only by boldly challenging this assumption will we avoid another 17 years of Abbot and Costello "Who's on First?" type endless debate over the hard problem, and the ongoing embarrassment of lacking a satisfying definition of what consciousness actually is beyond the trivial "What is it like?"

Increased gamma brainwaves amplitude in different meditation traditions

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(P1-028 July 14th, 1330-1530)

Despite decades of electro-encephalography (EEG) research on meditators, the basic effects of meditation on EEG are still being defined. In this study, we address the hypothesis that different types of meditation can lead to similar neural correlates. We compare 3 types of meditation practices and a group of control participants. Meditation practices included open awareness meditation (Vipassana), focused meditation (Himalayan Yoga), and "passive meditation" (Isha Yoga). Each group had 16 gender-matched participants of similar age ranges. Participants were asked to practice 20 minutes of meditation followed or preceded by 20 minutes of instructed mind wandering (IMW). We did not find difference between the meditation and the IMW tasks. However, meditators of all traditions tended to show significantly higher 60-110 Hz gamma activity than control subjects during the meditation period. This gamma activity was independent of muscle activity and eye-movement activity as isolated using the independent component analysis algorithm. In addition, we observed higher 7-11Hz alpha activity for the Vipassana group during meditation compared to all other groups. We have shown that regular meditation practice evokes changes in the EEG that can be common to all meditation practices. Our results emphasize the need to include control participants and groups of different meditation traditions following the same experimental protocol for studies aiming at characterizing the neural correlates of meditative states.

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The Process Dissociation Procedure is not an exhaustive measure of consciousness

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(P2-064 July 15th, 1430-1630)

Consciousness research crucially depends upon the validity of the methods used for measuring it. For this reason, several awareness rating scales have been compared over the last years in order to examine which scale shows the best correlation with task accuracy. The Process Dissociation Procedure (PDP) has been proposed as an objective measure of unconscious perception as it does not rely on the subjective ratings of participants. An essential component of PDP is the exclusion task. Here, single words are presented briefly as primes to participants, and the participants are subsequently asked to complete word stems without using the prime. Use of the prime is taken as evidence for subliminal perception. However, other researchers argue that participants may have vague, but nonetheless conscious representations of the word. We tested this claim in an experiment where 16 participants performed an exclusion task with prime durations of 0-200 ms. After word completion, participants rated their experience of the prime using the Perceptual Awareness Scale (PAS). Results showed that participants used the primed word significantly more when prime duration was around 50 ms compared to other prime durations, and that the prime was not only used when participants claimed to have 'no experience' of the prime, but more importantly equally often when they claimed to have perceived a 'weak glimpse'. This finding indicates that PDP is not an exhaustive measure of conscious perception and that it potentially shares some of the flaws with other methods that

it was created to replace.

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Proposal of a pattern recognition model to cognitive science and philosophy of mind

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(P2-075 July 15th, 1430-1630)

This work proposes the concept of pattern recognition as a central principle to solve the problem of mind representation in cognitive science and philosophy of mind. To address some problems on the definition of the pattern recognition concept, one definition is proposed as physical quantities variations. It is then proposed a model to build definitions of any cognitive function from simple physical systems to complex neurological, or computational systems. It is given a clear explanation of how gradual increasing of combinatorial cognitive pattern complexity can be described from basic physical mechanisms, to biological process, up to cognitive and neurological functions. It is argued that cognitive functions definitions with mathematical and physical pattern recognition structure are universal and unambiguous. The model proposed here allows to build comprehensive pattern mechanisms explanations from basic cognitive functions like instincts and learning to complex functions like consciousness. A key result obtained from this model is one unambiguous and comprehensive definition of the concept of consciousness. It is showed that this definition can be applied to explain both human and nonhuman (animal or computational) consciousness as a simple pattern recognition functional mechanism. The explanation of the consciousness and others cognitive concepts as used in various cognitive science related fields (neuroscience, psychology, and philosophy of mind) are also discussed. The fast technological development and scientific importance of the pattern recognition field implies that this theoretical proposal may be scientific and technologically promising.

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The power of real-life stimuli in unconsciously triggered response inhibition

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In recent years, a series of experiments has provided evidence for the possibility of unconscious response inhibition. For example, in the Go/No-Go task, even heavily masked No-Go signals proved to be efficient in slowing down responding. Chiu and Aron (2012) recently confirmed this intriguing observation of unconscious cognitive control, but claimed that it was heavily dependent upon an executive setting. The authors reasoned that the brain network responsible for response inhibition can only be triggered by unconscious No-Go signals when it is primed by conscious No-Go signals first. Confirming this prediction, when all Go and No-Go signals were presented heavily masked, so that subjects did not had the executive setting for outright stopping, unconscious No-Go signals were completely inefficient in triggering response inhibition. In the current study, we examined whether the power of real-life stimuli might moderate this effect of executive setting. We hypothesized that real-life stimuli which have an intimate link with stopping behavior (i.e., a stop signal), are so overlearned that they do not need an executive setting, and can directly trigger response inhibition without conscious access. To examine this possibility, we conducted a Go/No-Go task, once with arbitrary stimuli and once with real-life stimuli. Results showed that the real-life No-Go stimuli were very efficient in slowing down responding when presented in an executive context, however, this effect vanished completely when all No-Go stimuli were presented unconsciously. Thus, our results seem to confirm that unconscious No-Go signals require an executive context, in order to effectively trigger response inhibition.

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Vegetative State: The missing piece of the puzzle

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Vegetative state (VS), ethically one of the most challenging conditions of modern medical care, shows an apparent dissociation between the two cardinal elements of consciousness: awareness and wakefulness. Recent neuroimaging studies showed awareness to depend on a critical minimum level of brain cortical activity, driven by subcortical activating circuits whose failure would determine VS. Nonetheless, the efforts to cure VS (e.g. Deep Brain Stimulation) by restoring cortical activity have given inconstant results, suggesting that hypoactivity is only one aspect of a multifaceted dysfunction. Through neuroimaging functional resting-state techniques combining non-inferential (independent component analysis) and inferential (seed-based general linear model) methods in a group of 18 patients, here we show that hypoconnectivity is not necessarily a global hallmark of impaired awareness in VS, and specifically that patient's neural hypoconnectivity is associated with emergent hyperconnectivity to neural structures of the limbic system, highly implicated in gratification processing. Our findings reveal surprising information, demonstrating that VS brains host hyperactive connectivistic processes in delicate yet powerful neural pathways, which process gratification and reward. Their hyperactive neural connectivity may reflect the persistent engagement of patients' residual neural activity in self-reinforcing, gratification processing loops. It could be that this hyperconnectivity permanently engages patients' residual neural activity and prevents them from regaining consciousness. This evidence is partially convergent with previous knowledge on VS, but implies a profound reanalysis of VS neurobiology, and has the potential to produce totally new therapeutic perspectives, targeting the specific neural sites of dysfunctional hyperconnectivity.

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Measuring motor consciousness: Developing a scale for sense of control

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Consciousness is an intrinsic internal state, and it is difficult to know how it is best measured. Nevertheless, in visual perception research, recent studies indicate that the best correlations between accuracy and awareness are obtained using a scale that resembles how participants spontaneously describe their experiences. In motor research, however, little or no work has focused on examining whether some scales are better than others, nor how participants prefer to report their subjective experiences of motor control. The present study aimed to develop a participant-generated scale that combines the subjective component (internal state regarding how the control was experienced by the reporting individual) and the objective components (measurable noise level and task performance). 35 Participants completed a task where they attended a target before its disappearance and subsequently moved the cursor on the screen to the remembered target location as fast and accurately as possible. To manipulate the objective level of control over the motion, noise was added to the cursor movement. After each trial, participants recorded their subjective experience of motor control. The results showed that the number of scale steps preferred by participants followed a log-normal distribution with a 6-point scale as the mode. Further experiments will examine if a 6-point scale predicts task performance better than do those used in current motor research (dichotomous or visual analogue scale). It will also be investigated whether one's natural scale preference affects one's performance using a 6-point scale.

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First and third person theory, third person data, and methodology of competitive support

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(P1-052 July 14th, 1330-1530)

If the scientific study of consciousness is to have a focus on what consciousness explains in mental activity—for example, in learning or reasoning or volition-- it should proceed with the phenomenological rationale that is most defensible theoretically and methodologically. We all—whether experimenters or experimental subjects—have first person access to conscious states. As experimenters, we have our own (1) first person theories, and so we may hypothesize comparable, or analogous, or even disordered, relations among the conscious states of experimental subjects. This is then our (2) third person theory of interrelations among our subjects' conscious states. Some conscious states are belief or evaluation modes carrying propositional contents within deliberative mental episodes, and others are perceptual or feeling modes carrying sub-propositional contents in associative mental episodes (Dulany, 1997, 2012). Aspects of these conscious states may vary quantitatively over subjects and/or occasions. Antecedents then have their loci of effect, and mental episodes can have their action consequences. Any phenomenal report of a conscious state by the subject provides (3) third person data for the investigator. As with any assessment of what is unobservable by the investigator, this is a mapping of the theoretical construct to a data variable—and such mappings have validity conditions: in this case, immediate memory conditions for representation of the state in higher order awareness, explicit memory conditions for any delayed reporting, the appropriate level of verbal facility, and the acceptably standard level of subject motivation (Dulany, 2004). Since first order theories of a phenomenon are common among investigators,—along with metatheoretical or ideological commitments—challenges to another theory and report validity can be common. We therefore need (3) a methodology of competitive support, with three parts we can draw on (Dulany, 2012). On (a) the Duhem-Quine thesis, theoretical assertions, T, Mappings, M, and Auxiliary conditions, A, and jointly imply data: (T&M&A) à D . Combining this with (b) Bayesian analysis, we have a way to judge the relative credibility of competing aggregates including validity of reports And on the (c) logic of theoretical networks, the richer the mapped theory and its implied data, the less credible are saving assumptions for its competitors—and thus the greater the validation of the reports (Dulany, 2012). As with any imperfect assessments, too, very strong relations among awareness measures may have acceptable error variance, but that questions claims for “null awareness.” Current brain imaging is also unable to register the particular neural interactions that would

permit the identification of form and content of specific conscious states (Dulany, 2011). This strategy will be briefly illustrated with experimental analyses: examining a theory of volitional control with a linear regression model (Wilson & Dulany, 1983), a theory of causal reasoning with a linear difference model (Carlson & Dulany, 1988), and theory of implicit and explicit learning (Dulany & Pritchard, in preparation). Although first person data for conscious states has been proposed from Titchener (1912) to Chalmers (1996), it is inconsistent with a fundamental data language requirement—replicability over observers for common experimental conditions (Dulany, 2009). Ericsson & Simon's (1980) "thinking aloud" can be theoretically suggestive in a "pilot experiment," but it does not provide the orderly abstraction required for theory or lawfulness. Furthermore, higher-order awareness has for decades been recognized as a memory consequence of first-order awareness, not its precondition (Dulany, 2004). Both this approach and Dennett's heterophenomenology (2003) emphasize the importance of a third person data language, but we also need a specific focus on theory of the interrelations of reportable conscious states and a methodology that can provide confidence in report validity. Carlson, R., & Dulany, D.E. (1988). Diagnostic reasoning with circumstantial evidence. *Cognitive Psychology*, 20, 463-492. Chalmers, D. (1996). The conscious mind: In search of a fundamental theory. Oxford: Oxford University Press. Dennett, D. (2003). Who's on First? Heterophenomenology explained. *Journal of consciousness studies*, (10), 19-30. Dulany, D.E. & Pritchard, E. (in preparation) Awareness and novelty in implicit and explicit learning and transfer. Dulany, D.E. (2012) How should we understand implicit and explicit processes in scientific thinking? In R.W. Proctor & E.J. Capaldi (Eds.) *Psychology of Science: Implicit and Explicit Processes* (pp. 197-227). New York, NY: Oxford University Press. Dulany, D.E. (2011). What should be the roles of conscious states and brain states in theories of mental activity? *Mens Sana Monographs*, 9(1), 93-112. (Keynote Address for International Symposium, Brain, Mind, and Consciousness). Dulany, D.E. (2009). Psychology and the study of consciousness. In T. Bayne, A. Cleeremans, & P. Wilkens (Eds.) *Oxford Companion to Consciousness*. (pp. 540-544) Oxford, England: Oxford University Press. Dulany, D.E. (2004). Higher order representation in a mentalistic metatheory. In R.J. Gennaro (Ed.), *Higher order thought theories of consciousness* (pp. 315-338). Amsterdam & Philadelphia: John Benjamins. Dulany, D.E. (1997). Consciousness in the explicit (deliberative) and implicit (evocative). In J. Cohen & J. Schooler (Eds.) *Scientific approaches to consciousness* (pp.179-212). Mahwah, NJ: Lawrence Erlbaum Associates. Ericsson, K.A. & Simon, H.A. (1993). *Protocol analysis: Verbal reports as data*. Cambridge, MA: MIT Press. Wilson, M.N. & Dulany, D.E. (1983). An analysis of cognitive control of self-disclosure in a clinical analogue. *Cognitive Therapy & Research*, 7(4), 297-314.

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Oneiros states of subjectivity and their philosophical implications

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(P2-007 July 15th, 1430-1630)

The study of consciousness can be broken down into two approaches: subjective states of consciousness i.e., direct experience and the objective study of those subjective states. The second method involves the correlation of direct experience with brain, sensory and nervous system activity. The objective approach has been able to explain the physical expression of consciousness but not consciousness itself, or the many elusive aspects of consciousness e.g., imagination, inspiration, creativity, knowingness, understanding, decision-making and meaning, to name but a few. These aspects of consciousness have lead to what is known in philosophy as the hard problem of consciousness. In this paper I will show that subjective states of consciousness extend far beyond the hard problem into what I call the metaphysical problem of consciousness. The metaphysical problem is best illustrated in oneiros states of subjectivity. To better illustrate the difficulty that these states present I have developed an 11 category working model for extended subjectivity. These extended states are: vague awareness with no imagery; vague awareness with sensory input; semi-conscious awareness of self; awareness of self and sensory input; detached consciousness awareness of sensory input; integrated conscious awareness of sensory input and self i.e., a vivid oneiros state; semi-integrate conscious awareness of self, environment and location i.e., a detached lucid oneiros state; fully-integrated conscious awareness of self, environment, location and physical body i.e., an integrated lucid oneiros state; and lastly an oneiros state that results into autoscopia i.e., full conscious awareness of self as a distinct entity from the physical self. These oneiros states form the basis of the metaphysical problem of consciousness.

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Multisensory integration without awareness: A factorial study

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(P2-053 July 15th, 1430-1630)

Multisensory integration is crucial for understanding our multi-modal environment and interacting with it. Here, we addressed in a full-factorial design the role of perceptual awareness during the integration of audio-visual semantic information. We asked participants to indicate whether a pair of visual and audio letters presented simultaneously were the same or different. The letters were preceded by a pair of audio and visual prime digits, which could either be both supraliminal, one supraliminal and the other subliminal, or both subliminally presented using masking. This last experimental condition is crucial to experimentally measure the integration of two unconscious events of different modalities into one higher-order integrated representation. We hypothesized that in the presence of audio-visual integration, responses on same-target letter pairs would be faster when preceded by same-prime digit pairs. We discuss the implication of our results in reference to the global workspace and information integration theories of consciousness.

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Dynamical systems, representations, and consciousness

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(P1-005 July 14th, 1330-1530)

The cognitive revolution can be considered to have been a revolt against behaviorism's commitment to the inability of the mental—including consciousness—to generate testable predictions. Within the cognitive science immediately following the cognitive revolution and, in general, continuing to this day, 'cognition' is defined in terms of computations acting over representations of the world. In this way, representations are intended to play a major role in testable theories of the cognitive and mental. In this talk, I will attempt to motivate the claim that representations have become an explanandum. That is to say, representations do not explain cognition or the mental but require explanations themselves. In place of explanations that rely on representations, I present examples of dynamical systems accounts of cognition. These dynamical systems accounts can do the work to explain cognitive phenomena traditionally considered to be representation-hungry, namely, phenomena believed to be inexplicable without incorporating representations as part of the explanation. A potential consequence of providing non-representational accounts of cognition is whether or not terms such as 'mental'—including 'consciousness'—refer to any testable phenomena.

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Body swap illusion and the first-person pronoun

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(P1-006 July 14th, 1330-1530)

In Shoemaker's IEM theory, he distinguishes two different uses of the first-person pronouns: "I" as subject and "I" as object (Shoemaker, 1968). However, in Timothy Lane and Caleb Liang's article, they criticize Shoemaker's IEM theory

that “I” as subject isn’t immune to error (Lane & Liang, 2011). In this article, I would like to argue against this view raised by Lane and Liang. “I” as subject, one of the first-person pronouns Shoemaker distinguished, is said to be “immune to error through misidentification relative to the first-person pronouns,” and for the other one, “I” as object, isn’t. But in Lane and Liang’s stance, “I” as subject may be wrong. Take the experiment of Body Swap Illusion for an example, subjects in the experiment report that while shaking hands with mannequins in front of them, face-to-face, they experience the feeling of shaking hands with themselves. Supported by this experiment, Lane and Liang claim that people may ascribe the first-person pronoun, “I” as subject, to wrong persons. And so, “I” as subject may error in identification. It is necessary to point out that Lane and Liang make mistake on the distinction Shoemaker advocated. The error in the experiment is actually happened in “I” as object, but not in “I” as subject. No matter those subjects experience from their own perspective or from the mannequin’s perspective, it is the same point of view subjects experience feelings. There is no way for ascription of “I” to the wrong person in the “I” as subject.

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The case for using brain-based devices to study consciousness

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(P2-029 July 15th, 1430-1630)

Artificial models allow us to investigate consciousness in ways that are currently not feasible using human subjects or other animals. Yet a model of consciousness must take into account current theories of its biological bases. Great -- and perhaps undue -- emphasis has been placed on purely phenomenological models. We advocate for an approach to modeling consciousness that is based on realistic neural mechanisms and rich interactions. The cornerstone of this approach, the Theory of Neuronal Group Selection (TNGS), guides the creation of synthetic neural models that have many of the same properties as real nervous systems (Edelman, 1987). Because the brain is embodied and the body is embedded in the world, it is essential that a biologically based model of consciousness be embodied in a robotic device capable of rich autonomous interactions with a non-trivial environment. We have created a series of so-called Brain-Based Devices (BBDs) over the last two decades to address how neural mechanisms may give rise to elements of perception, cognition, and motor control (Edelman, 2007). Here we set forth a proposal to use BBDs as a tool to study consciousness. We argue that embodied spiking neural models with reentrant connectivity consistent with TNGS will aid in understanding the neural bases of consciousness. We outline how mental imagery provides a benchmark task for examining consciousness in a BBD, and discuss some of the physical and neural requirements. Edelman, G.M. (1987) Neural Darwinism: The Theory of Neuronal Group Selection. Edelman, G.M. (2007) Science 318, 1103–1105.

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Neural correlates of conscious and unconscious processing in implicit sequence learning

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(P1-029 July 14th, 1330-1530)

It is well documented that both conscious and unconscious processes can contribute to implicit sequence learning. However, it remains unclear what the neural correlates of the different processes are. The present study aimed to address this question by distinguishing conscious and unconscious knowledge in probabilistic sequence learning. Three types of stimuli were adopted in the training phase. Standard stimuli followed a second order conditional (SOC) sequence with a probability of .833. Transfer stimuli followed a different SOC sequence with a probability of .083,

while deviant stimuli followed neither SOC sequences with a probability of .083. After the training, participants were asked to complete one inclusion test and one exclusion test. ERPs were recorded during both training and testing phases. The behavioral results showed that participants unconsciously acquired knowledge of the differences between standard and transfer stimuli (i.e. knowledge of n-grams), but consciously acquired knowledge of the differences between transfer and deviant stimuli (i.e. knowledge of abstract structures). The ERP results revealed that transfer stimuli elicited greater N2 and N400 effects than standard stimuli throughout the training while deviant stimuli led to greater N2 and P3 effects than transfer stimuli in the second half of the training, indicating different neural correlates for unconscious and conscious processing. The results confirmed that the emergence of P3 as an indicator of conscious processing consistent with some previous claims in subliminal perception and implicit sequence learning and first demonstrated that the N400 as a correlate of unconscious processing in implicit sequence learning.

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Development of multisensory integration and prediction: Fetus simulation with a cortex model

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(P1-073 July 14th, 1330-1530)

Neonates and infants learn relations between intermodal information associated with their own movements, which engenders the development of self. Recent developmental studies have suggested that such intermodal integrations and predictions start from the fetal period. For example, fetuses open their mouths before their hands can reach it. Despite accumulating knowledge about early multisensory development, the neural basis of such development remains largely unknown. To deepen our understanding of underlying mechanisms, we ran computer simulations with a human fetus model and investigated whether the model can integrate and predict intermodal sensory information. Our fetus simulation comprises a body model and a cortex model. For the body model, the fetus model has the following three features: i) whole-body movements generated by 198 muscles for the whole body, ii) Physical parameters corresponding those of fetuses with 30-week gestational age, iii) three sensory modalities of vision, proprioception, and touch. The cortex model is a module network representing cortical areas such as visual cortex, somatosensory-motor cortex and associative areas by dense intra-connections and sparse inter-connections. Through experiments, we confirmed that bimodal neurons emerged in associative areas of the cortex model and responded for multiple modalities information. Furthermore, we showed that the cortex model can predict intermodal sensory input after integrating contingent multisensory information. Proprioceptive information changed cortical activities in the associative area before a hand entered the visual field. We suggest that multisensory integration and prediction can emerge without prior knowledge by exploiting relationships between sensory modalities.

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Simulating bistable perception with periodically interrupted ambiguous stimulus using stochastic self-oscillator dynamics with percept choice bifurcation

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(P2-072 July 15th, 1430-1630)

Formal modeling of cognitive bistability (e.g.[1][2]) is an interesting problem because a constant stimulus (e.g. the Necker cube) excites quasi periodic alternations between only two well defined perception states. Periodic stimulus-off switching (toff < 1 s, ton = 300 ms) was introduced by Orbach et al. [3] as experimental paradigm to get more insight into the underlying perceptual dynamics. Their Necker cube experiments showed a maximum of the percept

reversal rate R at $R_{\max} = 36$ 1/min and toff ca. 200 ms which was confirmed by recent experiments [4]. Noest et al. [5] demonstrated with a low level neural activation model [6] that a bifurcation of the percept choice dynamics during the ambiguous-stimulus on-off switching dominates the statistics of the reversal time series. Our simulations based on a macroscopic (behavioral) dynamics model [7] (similar to [1]) support this finding and show that the measured R vs. toff-time characteristics can be fitted with basically three parameters: attention fatigue (= adaptive feedback gain) time constant of 1 – 2 s, feedback delay T ca. 40 ms, gain-noise power J . Synchronisation of attention fatigue induced self-oscillations (yielding inter-stimulus transition time ca. 4 – 5 T) with stimulus-onset induced percept bifurcation appears to determine the reversal rates and the toff-value at R_{\max} . A linear approximation allows for an estimate of the cognitive damping time constant (ca. 1 s) which by use of the Fluctuation-Dissipation theorem via noise power J defines an index of cognitive inertia (suggested in [8]) as crucial parameter of the simulated dynamics. [1] Ditzinger, T., Haken, H. (1989). Oscillations in the Perception of Ambiguous Patterns. *Biol. Cybern.* (61) 279-287 [2] Huys, R., Jirsa, V.K. (2010): *Nonlinear Dynamics in Human Behavior*. Springer Verlag, Berlin Heidelberg. [3] Orbach, J., Zucker, E., Olson, R. (1966). Reversibility of the Necker Cube: VII. Reversal rate as a function of figure-on and figure-off durations. *Percept. Motor Skills* (22), 615-618 [4] Kornmeier, J., Ehm, W. Bigalke, H., Bach, M. (2007): Discontinuous presentation of ambiguous figures: How interstimulus-interval durations affect reversal dynamics and ERP's. *Psychophysiology*, 44, 552-560 [5] Noest, A.J., van Ee, R., Nijs, M.M., van Wezel, R.J.A. (2007) Percept-choice sequences driven by interrupted ambiguous stimuli: A low-level neural model. *J of Vision* 7, 1-14 [6] Amari, S. (1977): Dynamics of pattern formation in lateral-inhibition type neural fields. *Biological Cybernetics* vol. 27, 77-87 [7] Fürstenau, Norbert (2010). A nonlinear dynamics model for simulating long range correlations of cognitive multistability. *Biol. Cybern.*, vol. 103. (3) 175-198 [8] Gao, J.B., Merk, I., Tung W. W., Billok V., White, K.D., Harris J G, Roychowdhury V P. (2006). Inertia and memory in visual perception. *Cogn. Processing* vol. 7 105-112

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Historical consciousness, perceptual binding, and the formation of social memory

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(P1-007 July 14th, 1330-1530)

This paper proposes to investigate the binding force within social consciousness responsible for the formation of social memories. The paper will attempt to apply William James's analysis of the unity of consciousness to the process by which communities create and shape social memories. This attempt will take place within the context of Collingwood's understanding of historical consciousness as a form of social consciousness. The paper will also draw parallels between the formation of social memories and the integrative processes involved in perceptual binding. Disconnected images of scenes long past, seemingly drawn from widely differing periods of an individual's life, are nevertheless united within the experiencing subject of consciousness. Memories, the shattered fragments of lived-through episodes, are understood as belonging to the same experiencing subject. R. G. Collingwood understands memories as unmediated representations of past experiences. These raw images must ultimately be thought through, or interpreted by, historical consciousness to determine the degree to which individuals understand the life-processes (both personal and social) through which they have passed. As applied to social experience, memories are built upon the interaction between shared interpretations of the past and individual recollections. Eventually, from competing models of the historically established past and the fragments culled from individual experiences, a standard social memory is formed. The paper will end by establishing that perceptual binding and the mechanisms responsible for the creation of social memories illuminate each other.

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A quantum physical argument for panpsychism

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(P1-008 July 14th, 1330-1530)

It has been widely thought that consciousness has no causal efficacy in the physical world. However, this may be not the case. In this talk, I will show that a conscious being can distinguish definite perceptions and their quantum superpositions, while a physical measuring system without consciousness cannot distinguish such nonorthogonal quantum states. The possible existence of this distinct quantum physical effect of consciousness may have interesting implications for the science of consciousness. In particular, it suggests that consciousness is not emergent but a fundamental feature of the universe. This may provide a possible quantum basis for panpsychism.

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Visual experiences have graph-like contents

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(P2-009 July 15th, 1430-1630)

When we experience the properties 'red' and 'square', we may experience them as belonging to the same object. But we may also experience those properties without that relation. By contrast, when I experience one thing as crimson and another as light pink, I automatically experience the first as redder than the second. I can't experience those properties without experiencing that relation. And this holds for experiences of comparative relations between all kinds of visual property, not just colors. How are we to account for this phenomenon at the level of representational content? In this paper, I argue that the automaticity of comparative experience indicates that the contents of perception are graph-like. Graphs represent quantitative information in visual, particularly spatial, form. By virtue of this spatial syntax, the representation of any number of objects in a single graph space makes explicit the relations between all of them. I suggest that we should think of each visual dimension as functionally equivalent to a graph space, and perceived properties as objects represented in that space. This suggestion fits well with other features of perceptual content, such as its analog nature. Not only do graph-like contents provide an answer to the question 'why do we experience comparative relations automatically?', they also promise to cast light on other troublesome questions about perceptual representation, such as 'what is it to perceive something as a color?'

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Human single-neuron correlates of binocular rivalry

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(P1-030 July 14th, 1330-1530)

Single neurons in the human medial temporal lobe (MTL) were shown to reflect the phenomenal visual experience rather than the actual visual input using both flash suppression (Kreiman et al 2002) and backward masking (Quiroga et al 2008). However their possible role in generating conscious perception is still unclear, as in these paradigms perception is externally manipulated rather than internally driven. Here we used a binocular rivalry paradigm, where the perceptual switches are internally driven, in epilepsy patients implanted with depth electrodes (for clinical purposes). For each patient we used pairs of images found to elicit responses in his MTL neurons. Patients were asked to report the initiation and the completion of their perceptual switches by pressing and releasing two buttons. We found that the MTL neuronal response starts up to 1000ms before patients reported the initiation of the perceptual switch to the cells' preferred image. This was true both for increased and decreased firing rate responses. It appears that neurons in different areas responded with different latencies relative to the report of the perceptual switch, with

the amygdala generating some of the earliest responses. Even after accounting for motor response time, these neuronal responses are still quite early, especially given the typical latency of MTL neurons, which is 300-400ms after stimulus presentation. Our results suggest that MTL neurons are not merely reflecting conscious perception but likely take part in the process leading to a conscious percept or to a switch in perception.

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A practical exploration of information theories of consciousness

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(P1-074 July 14th, 1330-1530)

Information theories of consciousness including Tononi's Integrated Information Theory and Friston's Free Energy Theory seek to explain phenomenal states via their relationship to statistical measures of information density. These theories rely upon defining boundaries in thinking systems (primarily internal and external) and positing information bearing structures and complexes. However, they are often criticised for taking an idealised form for information itself and being divorced from familiar neuronal structures. The author will contrast how these theories differ in their interpretation of familiar neuroscientific tests. The example experiments are chosen to show how information metrics differ. For instance, Sperling's (1967) short term memory experiments are used as an example of percepts becoming stored informational structures, while decision making experiments modelled on those of Morrone et al. 2005 reveal how the brain contrasts information to make directed actions. The presentation will explain the mathematical principles using practical examples rather than complex formulae. The author will then consider what sort of physical processes may match with the boundaries and informational structures proposed by the models. In particular the reciprocal interchange of information between the world and the brain will be discussed from a dual-aspect framework of consciousness. It is hoped the audience will gain from a more practical appraisal of these theories instead of considering them as disembodied mathematical artefacts.

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Unconscious movement processing and prediction

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(P2-054 July 15th, 1430-1630)

In our everyday life we implement our abilities to recognize trajectories of moving objects and predict their future positions. However, it hasn't been shown yet that these tasks can be performed unconsciously as well. In our research, we examined whether it is possible to unconsciously recognize and process movement, extract the trajectory and make a prediction regarding the location of a future target on the trajectory. We conducted several experiments in which participants were presented with unconscious moving probes using Continuous Flash Suppression. The response times to conscious targets that were presented a short time after the unconscious movement were measured. In 50% of the trials the targets appeared in the predicted location according to the trajectory of the probes. In the other 50% the targets appeared in a location orthogonal to the trajectory. We made sure the participants were not aware to the moving probes using objective and subjective measures. Our results show that when moving probes are presented unconsciously, response times to conscious targets in the continuum of the trajectory are faster than to control stimuli. These results indicate that it is possible to unconsciously process movement, extract its trajectory and make a prediction regarding the location of a future target. This allows us to add an important ability to the unconscious capabilities arsenal.

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Building a roadmap of human emotion: The big five emotion clusters

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(P2-052 July 15th, 1430-1630)

We intuitively know that some pairs of emotions are more similar than others. “Joyful” and “happy” share more qualities than “joyful” and “sad.” We formalize these similarities and try to explain their origin by analyzing a large and comprehensive dataset of emotion descriptions. The dataset consisting of 'mood updates' by users of the social networking site the Experience Project. When users sign in to the site they can describe how they feel by selecting an emotion from a list of 175, an intensity level ranging from 1 to 5 and a brief description of their experience. The dataset contains 1.3 million mood updates from 290,000 users. We compute a transition probability metric for each ordered pair of emotions by using a decay factor to encode the relative temporal proximity between entries. The resulting transition probability matrix summarizes the overall flow from one emotion to the next. Based on this matrix we build a 'roadmap of human emotion' represented by a weighted graph with directed edges corresponding to transition probabilities. We cluster the nodes in the graph using community detection algorithms, and identify emotion clusters. We show that five clusters are distinctly present, and they correspond to semantically meaningful descriptions: positive emotions, sexual feelings, negative emotions of low and high arousal (one cluster each) and bodily feelings. We hypothesize that these behavioral clusters are semantically meaningful because they are the phenomenological manifestations of distinct underlying states of mind, each of which generates emotions of a distinct kind. More here: <http://www.kanjoya.com/blog/kanjoya-eng/building-a-roadmap-of-human-emotion-part-1/>

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The end of working memory

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(P2-010 July 15th, 1430-1630)

Recent meta-analyses of dozens of neuroimaging studies of working memory (i.e., a short-term store of information used to guide behavior; “WM”) leads one to suspect that our functionalist concept of WM is ill-suited to characterize what may be a diverse group of interdependent neural systems engaged in very basic and ubiquitous neuro-computational processes (Rottschy et al., 2012). I address this from a philosophical perspective, arguing that the traditional, functionalist, concept of WM obfuscates and homogenizes relevant finer-grained distinctions in the kinds of neuro-computational processes active in even the simplest WM paradigm (e.g., the interaction of spatial attention and pre-motor intentions in a matching task) (Ikkai & Curtis, 2011). Instead, philosophers and psychologists must develop concepts that reflect these finer-grained distinctions amongst what are likely more basal, executive processes, generalized in WM experiments. Drawing from work on pre-motor intentions and spatial attention, I offer candidates for these narrower concepts. I also defend these narrower concepts from anti-reductionist objections by appealing to the explanatory power of multi-level mechanisms in neuroscientific research (Craver, 2007). Lastly, I argue that these narrower concepts (e.g., spatial attention), give us better purchase on philosophical issues than the broad concept of WM. By virtue of their fine-grain, they help illuminate the nature of the information or the representations used in basic executive processes, including those attentional processes that may underwrite conscious experience (Curtis, 2006; Duncan, 2001; Prinz, 2012).

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BOLD activation in colour-selective areas is modulated by subjective experience in grapheme-colour synaesthesia

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(P1-032 July 14th, 1330-1530)

In grapheme-colour synaesthesia (GCS) the presentation of letters or numbers induces a concurrent experience of colour. Early fMRI investigations of GCS reported activation in colour-selective area v4 during the concurrent experience. However, others have failed to replicate this key finding. Here, we address this issue by examining fMRI BOLD responses in a large population of grapheme-colour synaesthetes (n=20) and matched controls (n=20) and correlating activations with individual differences in phenomenology. We used an independent localiser to identify colour-selective areas in both groups. Activation in these areas was assessed during veridically coloured, achromatic synaesthesia inducing and achromatic non-inducing conditions. At a group level, synaesthetes showed significantly increased response to veridical colour compared to controls, in both left and right hemisphere colour-selective areas. However within synaesthetes we found no increased activation in colour-selective areas in response to achromatic inducing letters compared to achromatic non-inducing symbols. We next used regression analysis to assess whether individual differences in synaesthesia phenomenology could predict the degree of activation in colour-selective areas. Here we found that the “automaticity” of concurrents significantly predicted the BOLD response in left hemisphere colour areas, while the spatial localisation of the concurrent (on a projector-associator scale) predicted the response in right hemisphere colour areas. This relationship was true for both veridical and synaesthetic colour experiences. Our results establish that activation in colour-selective areas is modulated by individual differences in GCS phenomenology. These findings help reconcile the diversity of previous results regarding colour-selective BOLD responses during synaesthesia, and they establish an important bridge between neural responses and individual synaesthetic phenomenology.

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An improved measure of information integration based on synergy

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In Balduzzi, Tononi (2008) they propose a measure of state-dependent information integration called the *effective information over a partition P^* , denoted $ei(X_0 \rightarrow x_1/P)$, which calculates the integration among the parts of an arbitrary partition P . Although conceptually novel, effective information has several counter-intuitive properties including: (1) can exceed the entropy of the entire system, (2) decreases with intra-part memory, and (3) does not correlate with "causal cooperation among diverse parts". We introduce a novel measure of state-dependent information integration based on *synergistic mutual information* from Griffith, Koch (2012) that resolves these difficulties and compute upper and lower bounds on this measure.

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Issues in neuromorphic engineering as an empirical approach to the science of consciousness

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Neuromorphic engineering creates inorganic substrates capturing the desired features of a biological original. The neuromorphic chip (NC)-based empirical science of consciousness contains under-examined ambiguity with important ramifications. Fundamentally, at issue is the level of physics-equivalence that the NC has with the natural original. Weak physics-equivalence is emulation. The chip implements a model of the physics in the original. Strong physics-equivalence is replication. The chip includes, literally, the physics of the original, inorganically implemented. Consider two brain tissue chips, NC_A (emulation) and NC_B (replication). Which of the claims “NC_A is conscious” or “NC_B is conscious” is better justified? Unlike emulation, replication requires no extra presuppositions to support consciousness claims. NC_B wins, even if the principles of consciousness are not understood. Consider a simple analogy: the NC study of fire. NC_A runs a model of combustion. NC_B has the physics of combustion in it. NC_B literally burns. Brain tissue is a subtle kind of ‘fire’, but the logical position is identical. The latest brain tissue findings tell us there are two kinds of signalling: action potential (AP) and electromagnetic (EM) coupling. NC studies of brain tissue can therefore emulate (NC_A) or it can contain the actual signalling physics inorganically replicated (NC_B). Both can be constructed now, and NC_B can be claimed to be conscious. This claim has superiority, even when we don’t know what causes consciousness. NC_B wins the argument, and teaches us about consciousness, in the same way that flying planes taught us about the physics of flight.

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DOT is HOT: The 'Deeper Order Thought' theory of consciousness

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The brain can be viewed as an anatomical hierarchy, with lower processes (brainstem, thalamus, primary cortex) ascending to higher executive regions (e.g. pre-frontal cortex, PFC), which then project downward. Higher-order thought (HOT) theories suggest mental states become conscious when a suitable HOT (e.g. from PFC) is directed downward at that state. HOT theories offer advantages but: 1) PFC is not always active in consciousness, e.g. when humans view a movie, or in young children and presumably conscious animals. 2) How HOTs and their conscious states differ biologically (not just anatomically) from not-HOT or non-conscious states is unspecified, 3) The 'hard problem' of why selected content would have phenomenal conscious experience persists. Here we consider the relevant brain hierarchy distinguishing conscious from non-conscious cognition to be not anatomical, but scalar, with consciousness originating in smaller, faster scales - a 'deeper order' within neurons - which projects upward in scale to larger, slower functions. In recent years brain information and representation have been shown scale-invariant (1/f, fractal-like) with multiple scales of self-similar representation in EEG, neuronal dynamics, eye movements, memory, and structurally in 'small world' and 'grid cell' neuronal networks in entorhinal cortex. Here we 1) extend scale-invariance intra-neuronally to faster, smaller classical and quantum information processing in dendritic-somatic microtubules, and 2) suggest such activities constitute 'deeper order thought' (DOT) projecting consciousness upward to membrane and network-based cognition. DOT can apply to HOT, access/phenomenal, information integration, self-representation and other approaches. DOT is testable, falsifiable and biologically plausible.

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Consciousness from reflexion - A hypothesis regarding the emergence of qualia

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The notion of qualia is widely considered a key aspect of how human consciousness manifests. However, the question of how qualia might emerge from the material world remains unanswered. I hypothesize that qualia arise whenever a physical system recursively reflects upon its own state, allowing it to “feel what it is like” to be in that state. Thus, the most fundamental qualia is that of a simple feedback loop, as found in many physical systems including all living beings. Consequently, whether a system experiences qualia is a question of scale, since small systems such as molecules may reflect upon themselves and thus have qualia, while also being part of a larger system that performs no reflexions and therefore is not conscious. The inverse also occurs, whenever a non-conscious system is part of a bigger, self-reflecting system. It is apparent that the recursive reflexions taking place in living beings, from bacteria to humans, differ from simple physical feedback loops in that they are complex and regulated and often include some sort of memory. If and how these differences lead to the emergence of qualitatively different qualia is an open question, as is the emergence of population-level qualia through recursive interactions between individuals and institutions in a society. The goal of this work was to describe the idea of consciousness from reflexion and to explore possible answers to these manifold questions with the intent of making the hypothesis eligible for further philosophical or scientific study and discourse.

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The case for interspecies discourse ethics

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The possibility for an interspecies discourse ethic has been shut-down by many analytic philosophers, who base intelligent communication on rationality. Davidson and Dennett, for instance, are skeptical of nonhuman animals having consciousness, as they connect thinking, speech, and consciousness to each other. Steven Vogel and Robert Brulle also interpret Habermasian discourse ethics to be non-applicable to nonhumans due to the problems of verifiable validity claims and responsibility. The common line taken by most environmental discourse ethicists is that nonhuman species cannot participate in the human dialogue, but instead nonhumans can only be talked about, with other humans. This concession is the genesis of the moral patient versus agent category Tom Regan ascribes to nonhuman animals for his case that animals can have rights without being accessible as intelligent creatures deserving of subjecthood. Nonetheless, science studies, posthumanism, and postnormal science all contribute to the idea that interspecies communication is indeed possible, at least with certain species and to certain degrees. Widening discourse ethics according to the hermeneutic tradition’s method of listening and understanding-based communication rather than the speech-based propositional logic some strands of discourse ethics require, interspecies interaction as meaningful discourse gains a more acceptable foundation. Surprisingly perhaps, the best evidence for consciousness and indeed interspecies communication comes not from armchair philosophers but from natural scientists engaged in studying animals in their habitats. The actual field experiences of primatologists such as Barbara Smuts, Sue Savage-Rambaugh and Frans de Waal tell of interspecies communication not based on human standards, but based on the communicative capacities and conventions of the species they interact with. Their field experience of meeting nonhumans on their own grounds, so to speak, reveals that perhaps discourse ethics and lab experiments attempting to train animals to perform human language capacities has gone about interspecies communication in the wrong direction. Building on the insights of these new academic disciplines and approaches, I offer a preliminary sketch of interspecies discourse ethics based on deep listening, meeting nonhumans on their own terms, and unpacked definitions of responsiveness and play.

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Music and consciousness: The hard problem of musical value

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Consciousness-studies might benefit from interdisciplinary intercourse between musicologists and philosophers. In this paper I set out, in a preliminary fashion, a case for intrinsically mental properties by taking musical experience as

an exemplar of consciousness. Borrowing Chalmers' explanatory argument, I argue for an identification of music and phenomenal consciousness, claiming that work in musicology, music-psychology and aesthetics could invigorate and enrich the debate over qualia by illuminating an experientially salient phenomenon for which explanation seems conspicuously lacking in certain significant respects. Music is valued. Even if we resist the association with aesthetician's terms like beauty, or even pleasure, we can say that, at bottom, musical experience is sought; it motivates listening. My aim here is to set out a number of desiderata a theory would want to fulfil in order to explain the value of musical experience, and further claim that fulfilment of such desiderata appears very unrealistic. I suggest that analytical disciplines like music-psychology and musicology would need to reconcile on an overarching explanative model by which musical value is engendered (typically proffered by aestheticians and philosophers who do not favour close formal analysis) that explains in terms of structure and function, i.e. spatiotemporal structures and causal roles in the production of a systems behavior (Chalmers 2003: 4). Without such an account of what would appear the most basic characterization of music, something to which I choose to listen, musical experience starts to look like a mental phenomenon that cannot be physically or functionally reduced.

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Mental causation in the parallel distributed processing neural network

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Philosophers and Scientists are arguing for the genuine existence of mental causation for decades, but just as Jaegwon Kim's famous "causal exclusion argument" says, it is difficult for us to accept that a physical cause and another distinct mental cause could simultaneously overdetermine a single event. On the other hand, we also find it problematic to find a strict law at the psychological/conceptual level and it makes mental causation extremely puzzling. I want to re-emphasize Kim's distinction between level and order, while causation can only be discussed among levels organized in part-whole relations. Mental properties, being realized second-order properties, are too flexible to be described in terms of physical causal laws. My view can be supported by the theory of parallel distributed processing (PDP) theory of neural network. In the PDP model, causations occur on the sub-conceptual level are the interactions between nodes and units, and these interactions are composed of physicochemical reactions. The syntaxes of neural networks on the sub-conceptual level realize and secure the semantics on the conceptual level through the process of evolution. But the concepts, although being useful in our daily life, cannot support counterfactual causal laws. We can describe many correlations among mental concepts and physical actions, but causation only occurs on the sub-conceptual level. In conclusion, I suggest that by combining my causal theory based on the level-order distinction and the PDP model, we can delineate a very satisfiable physicalist theory for mental causation.

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Changes to the phenomenal world: Acquiring a concept or a qualia?

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Phenomenal consciousness seems to provide primitive data for high-level cognition. If so, acquiring new concepts means that our high-level cognition have more sophisticated access to the phenomenal world without changing our phenomenal world. In this paper, I argue that many discussions in consciousness studies are based on this framework, but connectionism indicates that cognition and the phenomenal are not separated. In theories of perception, we discuss whether people have new qualia when he/she acquire a new concept, and in theories of emotion, we discuss

whether a complex emotion exists or is an illusion caused by the acquisition of a new concept about emotion. These claims are based on a “clear” separation between concepts and phenomenal world. However, from the connectionist perspective, the claims are unjustified, and acquiring a new concept is equal to a structural change of the phenomenal world. Based on a connectionist framework, higher-level processes are not separated after phenomenal-related processes, but a structural modification of the phenomenal world. Cases of synesthesia, I argue, provide a partial evidence for the modification of the phenomenal world. The acquisition of a high-level concept, such as the concept of numbers, can induce a structural change of the phenomenal world. Structural changes to the phenomenal world do not add new qualia, but form new dimensions of phenomenal world as suggested by the mathematical analyses of connectionism. Thus, this analysis indicates a philosophical framework of mathematical models for more sophisticated explanations of the structure of consciousness.

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When our memory is spontaneously retrieved: A diary study on prospective memory.

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(P2-055 July 15th, 1430-1630)

We often have spontaneous retrieval of memory in everyday life. In many cases, this spontaneity is triggered by external cues, but in some cases there are no external cues. Spontaneous retrieval has been dealt with mainly in prospective memory research. Most of them, however, have focused on the spontaneous retrieval entirely with external cues in their necessity of the research paradigm and limitations. Therefore, features of spontaneous retrieval without external cues have been still unclear. How often does the spontaneous retrieval occur when there are no external cues? To answer this question, we conducted a memory diary study on prospective memory. Fourteen undergraduates carried both notebooks and IC recorders for 22 days, and recorded their spontaneous retrieval on prospective memory with either of the tools. They also recorded what they were doing and whether there were retrieval cues at that moment. As a result, a total of 77 episodes were collected. Twenty-eight episodes (36.4%) were without external cues, and remaining 49 episodes (63.6%) were triggered by external cues. Further analysis of the former 28 episodes revealed that 20 episodes (71.4%) were accompanied by internal cues, and eight episodes (28.6%) were not. Spontaneous retrieval on prospective memory without external cues might occur about once for three times, and most of them might be also accompanied by internal cues. Features of spontaneous retrieval on prospective memory without external cues will be discussed in terms of cognitive subjectivity and some kind of product led by implicit and/or explicit memory processing.

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Sex differences in the clinical expression and resting state brain connectivity of bipolar disorder

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The course and expression of bipolar disorder (BD) clearly differs between women and men. Women more often have a seasonal pattern of mood disturbance, and are more likely to experience rapid cycling than men. Men are more likely to have a comorbid substance use disorder, while women more frequently have comorbid anxiety disorders. Previous studies have observed sex effects in connectivity of the default mode network (DMN) of healthy individuals, but more research is needed to see whether a similar effects holds among BD patients. This study investigates 1) how sex differences in DMN activity among BD I patients compared to individuals without BD, and 2) how sex differences

may relate to clinical or cognitive differences in BD. We compared 21 euthymic patients with bipolar I disorder to 29 age and gender comparable healthy participants using functional magnetic resonance image during a period of eyes open rest. Averaged functional activity between the nodes of the DMN (medial prefrontal cortex, posterior cingulate, and bilateral angular gyrus) revealed that BD females tend to have greater connectivity within the default mode network than male BDs, which contrasted with the pattern of greater connectivity among male healthy participants compared to females ($p=.08$). This interaction was significant for the connections between the right angular gyrus and other nodes in the network ($p=.02$). Negative psychotic symptoms were more pronounced in male than female bipolar participants ($p=.03$). There was a trend for a negative relationship between right angular gyrus connectivity and negative symptoms ($r(19)= -.35$, $p=.11$), and a significant negative correlation of average DMN connectivity with negative symptoms ($r(19)= -.44$, $p=.05$). These results suggest subtle sex differences in the inter-relationship of resting brain activity within the DMN that may relate to clinical differences between men and women with bipolar disorder, including severity of negative psychotic symptoms.

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A new technology for studying visual qualia

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(P1-035 July 14th, 1330-1530)

Breakthroughs in understanding complex systems are often associated with new technologies. Our unique combination of adaptive optics with ultra stabilization provides a new capability for revealing what patterns are accessible to conscious awareness and what invisible cortical activity can influence behavior. This newly available technology enables one to repeatedly stimulate the same individual cones day after day, year after year. Three of these instruments have been built, one for use with primates to study lateral geniculate and cortex, one for studying clinical retinal abnormalities and one for studying normal and abnormal human perception. Several surprises concerning color naming will be discussed. It has become clear that stimulation of a single cone type, say long wavelength cones, can produce different color qualia: red, green, blue, white, based on observers' reports of their subjective experiences. Multiple hypotheses regarding the mechanisms that produce the surprisingly diverse color percepts are now being tested and will be discussed. In addition our future experiments will focus on two additional areas: 1) How do invisible stimulus features affect perception? The new technology stabilizes foveal patterns so accurately that they rapidly disappear from consciousness. We expect to find conditions where the invisible stimuli have perceptual consequences. 2) By using information from the parallel research on primates we anticipate being able to examine the impact of attentional and contextual manipulations on the perception associated with single lateral geniculate cell activation. We look forward to discussing with conference attendees other possible experiments for revealing the microstructure of qualia.

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A detection theoretic explanation of blindsight suggests a link between conscious perception and metacognition

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Blindsight refers to the rare ability of V1-damaged patients to perform visual tasks such as forced-choice discrimination, even though these patients claim not to consciously see the relevant stimuli. This striking phenomenon can be described in the formal terms of signal detection theory: (i) blindsight patients use an unusually conservative criterion to detect targets; (ii) in discrimination tasks, their confidence ratings are low and (iii) such confidence ratings

poorly predict task accuracy on a trial-by-trial basis; (iv) their detection capacity (d') is lower than expected based on their performance in forced-choice tasks. We propose a unifying explanation that accounts for these features: that blindsight is due to a failure to represent and update the statistical information regarding the internal visual neural response, i.e. a failure in metacognition. We provide computational simulation data to demonstrate that this model can qualitatively account for the detection theoretic features of blindsight. Because such metacognitive mechanisms are likely to depend on the prefrontal cortex, this suggests that although blindsight is typically due to damage to the primary visual cortex, distal influence to the prefrontal cortex by such damage may be critical. Recent brain imaging evidence supports this view.

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Spatial attraction with causality perception based on semi-intentional action through synchronized tapping exchange between two persons

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(P1-036 July 14th, 1330-1530)

An intentional action naturally involves an event with a variety of sensory consequences in the physical world. Temporal attraction (Haggard 2002), a striking distortional effect verified by many researchers, shows our brains are prone to interpret that an event happens in close sync with an action to strengthen the perception of causality. Turning to the spatial aspect, some studies have shown that a combination of mutually causal visual events (Buehner et al. 2010) or a touch action guided by an experimenter and the synchronized event of the subject being touched (Ehrsson et al. 2005) can lead to a spatial attraction. However, whether an intentional action involves spatial attraction is still unclear. This research shows that a causality perception together with an intentional action can also induce a strong spatial attraction. In our experiment, a blindfolded subject tapped on a left hand (LH) of an experimenter with his/her own right hand (RH) rhythmically in time to successive tunes played on a speaker. After the subject learned to touch in a nearly intentional way, the experimenter RH tapped on the subject's LH, placed on a stand 13 cm below from the desk simultaneously. Almost all of the participants felt as if they had touched their own hand and estimated the height of own LH to be at a significantly higher position than under the normal condition, which is evidence of a vertical spatial attraction between the action plane and the sensory event plane. Furthermore, we discuss a characteristic RH movement observed during tapping that may be attributed to an actual body attraction to the imaginary hand.

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Perceptual changes and emotional impact of sensory augmentation

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Enacted theories of consciousness conjecture that perception and cognition arise from an active experience of the regular relations that are tying together sensory stimulation and associated motor actions. Previous experiments explored this hypothesis employing the technique of sensory augmentation with the feelSpace belt. This belt maps directional information measured by a compass to a set of vibrators by activating the element pointing north. Here we systematically investigate perceptual changes in a larger cohort. A total of 14 subjects and controls trained over a period of 7 weeks with/without a newly designed fMRI compatible feelSpace belt. We combined daily diaries, weekly evaluations, and psychometric tests to assess changes in sensory experiences. We find that a high appeal and usability of the feelSpace belt throughout the training period. Over time the tactile perception diminished and was less consciously perceived. Phantom vibrations occurred less frequently and the signal was more perceived as location or

directional information. All but one subject reported qualitative changes in perception of space. Perceived space was described as getting wider and including areas that were not directly visible or tangible. Subjects reported an increase in several aspects of spatial orientation, and improved their orientation and navigational performance in their own estimation. For the subjects the most important effect of the belt was an enhanced feeling of security in known and unknown surrounding. The presented results are compatible with enacted theories of conscious perception and demonstrate the pragmatic utility of the feelSpace belt.

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Exaggerated self in schizophrenia evaluated by the sense of agency task (Neo-Keio method)

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The sense of agency (SoA) is the attribution of oneself as the cause of one's own actions and their effects. We have reported that patients with schizophrenia demonstrated excessive SoA using our original task where participants were asked whether they attributed the self as a cause of change in a visual stimulus, which exhibited a variable degree of temporal discrepancy with their own actions (Maeda et al., 2012). This task could evaluate both feeling and judgment components of SoA, and we previously discussed that judgment components would play a key role in over-attribution of agency. In order to intensively evaluate the contribution of judgment components, we revised our former SoA task. This study applied an "adaptation method" on a trial-by-trial basis. When a participant attributed self-agency to a certain temporal delay, the delay in the next trial was extended so that the individual was less likely to make a self-attribution. Conversely, the delay was shortened when the subject attributed to a "non-self" cause. This style makes their judgment difficult. Moreover participants were instructed to make a same styled color judgment as control task. Thirty patients with schizophrenia and 30 controls were enrolled in this study. We found that patients demonstrated extremely excessive SoA even in longer temporal delay. Uncertain task situation would induce pathological contributions of judgment component of SoA in schizophrenia, resulting in the exaggerated self. On the other hand, both groups showed normal color judgment, which means that their aberrant results are specific problem in sense of agency.

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Inducing task-relevant responses in the sleeping brain

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Sleep is characterized by a lack of behavioural responses to the environment, but the extent to which the brain continues to process external stimuli remains largely unknown. Here, by combining a task induction strategy with

electroencephalographic (EEG) measures of response preparation, we studied whether sleeping subjects can perform decisions on the meaning of spoken words. Awake subjects categorised words as either animals or objects while transitioning towards sleep and then continued being tested for covert response preparation towards the appropriate category during early non-REM sleep. Two brain markers of intention-to-act, lateralized readiness potentials and effector-specific desynchronisation in mu and beta bands, revealed that the participants continue to trigger category-specific responses even after falling asleep. These findings show that despite the absence of awareness and behavioural responses, individuals can still extract task-relevant information from external stimuli and prepare to respond during sleep.

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Subliminal priming of spontaneously experienced memories

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Research reveals that conscious contents can be influenced by unconscious processes (Morsella & Bargh, 2011). Limited research, however, has investigated whether unconscious processes influence spontaneously experienced memories. To examine this phenomenon, we primed participants with subliminal words using backward masking and then asked participants to reflect on their autobiographical memories. In Study 1, participants ($n = 38$) completed three blocks that primed different life settings (e.g., Familial: e.g., 'HOME'; Artistic: 'PAINT'; Recreational: 'CAMPING'). Afterwards, participants were asked to reflect briefly (3 min) on autobiographical memories. Following the reflection period, participants rated on a scale of 1 to 8 how representative pictures (from six distinct life settings) were of the memories they experienced. Category content related to the subliminal primes was rated as more representative of the experienced autobiographical memories ($M = 4.29$, $SEM = .29$) than unrelated content ($M = 3.41$, $SEM = .21$), $F(1, 37) = 11.83$, $p = .0015$ ($\eta^2 = .24$). In Study 2, participants ($n = 10$) completed two blocks in which they were primed with words from different life settings (i.e., Familial and Career). Following each subliminal word presentation, participants were asked to reflect (15 sec) on autobiographical memories and then paraphrase what they happened to reminisce about. To ensure that stimuli were rendered subliminal, we included a forced-choice word selection task, revealing that stimulus detection was at chance levels (33.89%). Participants' memories revealed an effect from the familial primes, $t(10) = -2.56$, $p = 0.03$. We discuss the theoretical implications of these findings.

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Shielding consciousness from ambiguity: We know nothing about what we did not see in an ambiguous display

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In a series of six experiments with ten observers each of whom participated in twelve hours of data collection, I show that no information is available about the unseen versions of an ambiguous stimulus. The experiments use dot lattices (Kubovy, 1994), a class of stimuli that has proven to be a powerful tool for the quantification of perceptual organization. These stimuli are quadristable, and when they are briefly displayed, nothing can be inferred from what was seen about what might have been seen. Because they have four alternatives, we can use the second-choice technique first used to refute the high-threshold theory of signal detection sixty years ago. The logic of the second-choice experiment runs thus: present a stimulus that offers four mutually exclusive responses, one of which is correct. On trials during which observers chose incorrectly, give them a second opportunity to identify the correct alternative out of the remaining three. If they have no information beyond what they thought they saw, the probability of a

second-choice correct response is 1/3. Using two variants of this technique which do not require the existence of a correct response, I show that observers know nothing beyond what they saw. I conclude that in this situation, consciousness is shielded from ambiguity. I conjecture that all consciousness is shielded from ambiguity.

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Is free will a state or a process?

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Free will seems to be eliminated by neural-psychological evidence, such as Benjamin Libet's classic experiment (2005). However, these theories presuppose what I call a "state-view" of free will. In this paper, I argue for the distinction between a state-view versus a process-view framework of neural-psychological theories. Traditionally, we regard a free voluntary action as a moment of endogenous mental choice at a specific time slice. Thus, researchers started to answer whether we have free will by analyzing the relationship between those endogenous mental states and other states. For instance, Libet wanted to know the order of free choice and readiness potential (RP). Daniel Wegner (2002, 2004) aimed at finding whether there is a real causal relation between conscious will and behavior. I will propose a process-view framework, which regards free will as a process of making decisions, to reinterpret the results of previous studies without presupposing the state view. This process includes three phases: reacting to stimulus, simulation, and prediction and comparison. This view is consistent with a recent trend towards process-oriented theories. According to recent scientific studies, related to free will, we realize that our voluntary actions involve several cortical motor circuits. Patrick Haggard (2008) raises a naturalized model of human volition which contains five stages. Volition happens not just at any single stage but in a whole process. When we adopt the process view, it is natural to ask what is going on when or before RP happened, which can give us more fine-grained theories of free will.

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Taking a jab at the 'hard problem'

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(P2-015 July 15th, 1430-1630)

Philosophers and cognitive neuroscientists have been grappling with trying to come up with neurophenomenological proposals that would crack what is known as the 'hard problem' of consciousness (Chalmers, 1996). According to Chalmers, the many attempts figuring in literature provide answers to the 'easy' problems: figuring out the mechanisms of attention, memory, self-reflection and information processing of a cognitive system; however, the 'hard' problem is about showing why these mechanisms, in principle, are coupled with feelings or sensations – phenomenal consciousness. My proposal is threefold: firstly, I suggest that the solutions must be located in neural mechanisms; secondly, I content that the best candidate for showing how sensations and perceptions are coupled together in psychological time is found in the re-entrant neuronal looping between the thalamus and widely distributed cortical areas; and thirdly, that the bedrock of this mechanism is found in what is called 'central pattern generators'.

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Switching attention to the rubber hand

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When the rubber hand illusion (RHI) is induced, participants experience an imitation hand as belonging to self. Typically it is induced by having participants look at the imitation while it is stroked in synchrony with the occluded, real hand. Models purporting to explain the illusion emphasize multisensory integration and passive response (Ehrsson, 2012; Moseley et al., 2012; Tsakiris, 2010), while excluding executive functions. But these models fail to explain diversity of reaction to RHI induction attempts. Seeking to explain diversity we discovered that mind wandering negatively correlates with the RHI, while task switch and shift attention positively correlate with it. Mind wandering was assessed by a version of the Sustained Attention to Response Task; task switch, by having participants render judgments when performing distinct tasks, with ability to switch determined by comparing switch and repetition trials; and, shift attention, by an Attentional Control Scale. In light of these data, we propose that sufficient explanation will require inclusion of executive functions that enable switching from internal thoughts and feelings of mind wandering back to task-related, external stimuli. Our findings imply that the illusion might need to be re-characterized, such that experiencing the illusion involves task performance—choosing between two hands when sensory experiences conflict. Inclusion of executive functions helps explain success and failure to experience the illusion, as well as apparent anomalies, e.g. the feeling that a block of wood belongs to self (Armell and Ramachandran, 2003). It also situates the RHI within a comprehensive framework for understanding consciousness.

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Frequency of precognitive dreams and lucid dreams: Differential patterns of association with consciousness in impactful dreams

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(P1-054 July 14th, 1330-1530)

There is evidence that altered states of consciousness (ASCs) were found to be more conducive to psi function (including precognition) (Tart, 1978). There is also some evidence that a certain amount of reflective awareness (the expansion of consciousness; Rossi, 1985) may occur during dreaming (Gackenbach, 1991; Green & McCreery, 1994; LaBerge, 1985). The growing body of research on lucid dreaming and conscious awareness pointed in the direction that, as Ullman, Krippner, and Vaughan (1973) suggested, “dreams” should remain a major focus in the quest to understand precognitive phenomena. Perhaps, clarifying the similarities and differences between precognitive dreaming and lucid dreaming is critical in the early stage of research in this mysterious realm. The present research was intended to explore the relationships between frequencies of precognitive dreaming experiences, lucid dreaming experiences, and features of consciousness (especially reflective awareness; Lee, 2010; Lee, Kuiken, & Czupryn, 2007) within reported impactful dreams. The findings suggested that dream recall rate was associated with both frequencies of precognitive dreaming experiences and lucid dreaming experiences in the past one year. However, higher frequency of precognitive dreams was associated with increased depersonalization in a recent (within the past three months), most impactful dream; in contrast, higher frequency of lucid dreams was associated with increased lucid mindfulness in a recent, most impactful dream. The implications of this study will be further discussed.

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Autism, complex emotions, and the symbolic representations

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(P1-015 July 14th, 1330-1530)

People with autistic spectrum disorders (ASDs) usually have problems with emotion expressions and emotion recognition. In this paper, I develop a new hypothesis of complex emotions to argue that autistic patients have such kind of problems due to the deficit in the ability of symbolic representations. Some studies assume that autistic patients have problems with social-related emotions because they lack some abilities to use language or the ability of theory of mind. However, there is no theory which can fully explain why autistic patients have problems with expressions and recognition of social-related emotions. I argue that the deficit in emotion expressions and recognition of autistic patients is caused by the deficit in their complex emotions. Complex emotions presuppose the ability of symbolic representation, the ability to use abstract symbols to represent objects in the environment, which is more fundamental than the ability of theory of mind and ability to use language. Autistic patients have deficit in their abilities of symbolic representations, and thus cannot develop enough complex emotions to express and to understand others' emotion expressions. Furthermore, my hypothesis can explain why the Asperger's patients, who have better ability of symbolic representations than high-functioning and low-functioning autistic patients, can have better social-related emotion expressions and emotion recognition than the others.

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Working memory modulates conscious and unconscious cognitive control in a metacontrast masking task

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(P2-061 July 15th, 1430-1630)

Recent studies found that cognitive control can occur both consciously and unconsciously in a metacontrast masking task. However, it remains unclear what the roles of working memory are in unconscious and conscious cognitive control. The present study aimed to address this question by adopting n-back tasks in a metacontrast masking task. During the metacontrast masking task, participants were asked to respond to the direction of targets and ignore the primes. During the n-back task, participants had to report whether the currently presented letter was identical to the letter two or one trial before in 2- or 1-back condition, and whether the current letter was X in 0-back condition. Participants in the single-task condition completed only the metacontrast masking task, but participants in the dual-task condition needed to complete an n-back task preceding the metacontrast task on each trial. Whenever the prime was 14 or 126 ms, participants in both conditions responded slower to incongruent (directions of primes and targets were opposite) than congruent trials (directions of primes and targets were identical). However, the conflict effect in the single-task condition was smaller for trials preceded by an incongruent trial than trials preceded by a congruent trial, but the conflict effects in the dual-task condition with all n-back tasks were not. The results first demonstrated that unconscious and conscious control within trials was not influenced by working memory load although the conflict effects between trials were. The findings help to understand the relationship between working memory and conscious and unconscious cognitive control.

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What is the most fundamental unity of consciousness?

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(P2-013 July 15th, 1430-1630)

According to the classifications made by Tim Bayne (2010), there are four different kinds of unity of consciousness: subject unity, representational unity, access unity, and phenomenal unity. Among these unities of consciousness,

Bayne asserts that the subject unity is trivial and takes the phenomenal unity to be the most fundamental one. However, I will use Allen Y. Houn's Unifying Process Model (UPM) of the self (2013) to argue that since the phenomenal unity presupposes the subject unity, the subject unity is the most fundamental unity which can never be disrupted. According to the UPM theory, self is a dynamical unifying process for unifying the interoceptive and the exteroceptive stimuli. Through unifying the interoceptive information, the self then constructs a point of view which can experience the world. All the information experienced by the point of view is thus unified to the same subject and give rise to the subject unity which makes all the conscious states are had by the same subject of experience at the same time. The formations of other unites, including the phenomenal unity, are based on the subject unity. By unifying more stimuli, the self then constructs a phenomenal field based on the formed point of view. All the experiences are subsumed by the phenomenal field and thus result in the phenomenal unity that makes the subject has an experience of "something it is like to be in all the conscious states at once". The UPM theory analyzes the cause of the unity of consciousness and shows that the subject unity is the most fundamental unity.

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How do calendrical savants answer date questions?

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(P1-055 July 14th, 1330-1530)

Calendrical savants have the astonishing ability to answer the day of the week of a given date without the help from external devices. For example, they can tell you that July 14 in 2020 is Tuesday within seconds. It has been proposed that they may be memorizing the calendars they have seen before through extensive practice and studying, or they could be calculating the answers by using some calendar regulations or rules. The exact method of how they achieve it is still under debate. In a series of studies, we investigated this issue in several Taiwanese calendrical savants. Experiment 1 showed that all of our calendrical savants could answer date questions with high speed and accuracy in different range of dates. Experiment 2 showed that they could memorize a year calendar with only short exposure to it. In Experiment 3 and 4 we also found that they could use some calendar rules and anchor date knowledge to calculate the answers. In sum, the results suggested that each of our calendrical savants might use both memory and calculation to different levels to answer date questions. Other savants in the world may also have different memory abilities and calendar knowledge, which may affect how they answer the date questions. Findings from this field may have important contribution to the understanding of how human memory and cognition work.

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Paying attention to yourself: The relationships among episodic memory, attention and self-consciousness.

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(P2-014 July 15th, 1430-1630)

Going back as far as Locke is the idea that selfhood depends exclusively on memory. In the history of psychology and cognitive science, some have suggested that selfhood depends in particular on episodic memory. This proposal has recently been challenged by a number of studies showing that patients who lack the ability to form new episodic memories are able to maintain some sense of "self" limited to the present. While episodic memories may be important for maintaining a sense of self extended in time, I argue that a sense of self plays a key role in the formation of such memories, turning the dependency claim on its head. Relatedly, I maintain that attentional resources are required to maintain a sense of self, such that when said resources are directed away from self, episodic memory formation is reduced. I present insights gleaned from an ongoing study about the relationship between self-consciousness and episodic memory in neurotypical participants. I hypothesize, first, that self-consciousness requires self-directed attentional resources, and secondly, that the encoding of episodic memory is significantly reduced in the absence of specifically self-related thoughts. I discuss the latest results of this study and what they suggest about the

link between an extended sense of self and episodic memory. I will also explore the implications of these results on the debate about whether or not consciousness entails or implies self-consciousness.

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The relationship between depth of interocular suppression and neural processing of visual object stimuli

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A widely accepted theory in vision science concerns the functional specialization of the primate visual system into a dorsal “vision-for-action” and a ventral “vision-for-perception” stream. As opposed to processing in the dorsal stream, ventral stream processes are thought to be closely associated with visual awareness. Recent neuroimaging work that investigated this differential link to consciousness has yielded controversial results. One study reported reduced ventral activation for invisible stimuli (rendered invisible by continuous flash suppression, CFS) compared to visible stimuli while dorsal activation appeared unaffected by stimulus visibility (Fang & He, 2005). Others found equally reduced activity in response to invisible stimuli in both streams (Hesselmann & Malach, 2011). To resolve these conflicting results, we investigated category-selective blood oxygen level dependent (BOLD) activity in both visual streams as a function of stimulus visibility and depth of interocular suppression. As in previous studies, we used images of faces and tools to target ventral and dorsal stream processing, respectively. Target stimuli were shown to one eye while the other eye was either presented with CFS masks (invisible condition) or with a blank screen (visible condition). In the invisible condition, suppression strength was manipulated by varying the contrast of the CFS masks. Additionally, we asked whether dorsal stream responses to tool stimuli were related to their connection to visually guided action or rather to their specific (elongated) shape. To this aim, we compared BOLD responses to tools that were clearly manipulable but not elongated to activation to tools with an elongated shape.

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Introspection reveals covert intentions during serial search

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Humans have the ability to monitor their own cognitive operations but this introspection is typically thought to be inaccurate. Here, we challenged this view by comparing objective and subjective reports within trials. Subjects were asked to perform a visual search task and to subjectively report the trajectory of their eye movements. The comparison of introspected eye movements to ‘real’ eye movements revealed that subjects were able to report part of the sequence of eye fixations. Some eye fixations remained unnoticed but intriguingly, some introspected fixations were not related to any eye movement. These ‘illusory’ fixations followed the observer’s strategy, predicted part of the variance of the reaction time and were preceded by longer eye fixations. We suggest that these illusory fixations reflect covert movements of attention during serial search. These data allows an estimation of the quality of observers’ introspection, and reveals experimental effects of visual search that would be inaccessible otherwise.

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Reflections of visual uncertainty and subjective confidence on memory load and pupil dilation

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(P1-042 July 14th, 1330-1530)

Pupil size increases proportionally to the cognitive load required by mental tasks and decreases subsequently as soon as the required cognitive load is reduced. Moreover, pupil size also increases slightly when subjects are warned they will be asked to perform a difficult task. Thus, pupil size can be used as an index of the momentary memory load on a subject. Because consciousness is by definition a subjective entity, no objective measure exist that can provide information on it. However, it is possible to tap into its mechanism indirectly by means of subjective measures such as confidence and visibility ratings. Given that the pupil dilates with sympathetic activity and constricts with parasympathetic activity and it is a measure of the resources invested in a task, its objective accuracy and unobtrusiveness in combination with subjective measures have the potential to shed new light on the mechanisms underlying subjective reports. Here, low-level features of several stimuli were modified creating several versions of otherwise identical stimuli. These stimuli were presented under different task conditions requiring different levels of processing depth. Furthermore, visibility and confidence ratings were also obtained in separate sessions. Data were analyzed using signal detection theory and psychometric function fitting methods. Between the two current major models for second-order judgments, namely the dual-route and the hierarchical model, the results seem to support the former. Indeed, as preliminary results suggest, even a priori irrelevant for judgment low-level features turn out to impinge on subjective measure reports.

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Synesthesia: Continuous or discrete? A study on the prevalence of number personification in Japan

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(P2-062 July 15th, 1430-1630)

Synesthesia is thought to be found in just a small percentage of people. For instance, number-color synesthesia is observed in only around 1% of the population (Simner et al., 2006). However, as additional types of cross-modal association are recognized as synesthesia, e.g. ordinal linguistic personification, a question arises regarding the evaluation of the overall degree of synesthesia. We hypothesized that some types of synesthesia could be continuous, and that weak forms could be found in general. In this research, we focused on number personification, which is regarded as a type of synesthesia because of its automaticity and consistency (Simner and Holenstein, 2007). We conducted an online questionnaire to study its prevalence in a population of Japanese students. We asked our 53 participants to choose personalities (gender, goodness, age and sociability) from given 3 choices (e.g. 'male', 'female', and 'none') for a randomized set of numbers. The test is repeated again after more than one month to calculate consistency. We expected that the population is divided into two distinct groups; synesthetes and non-synesthetes; where synesthetes would consistently choose personality attributes, while non-synesthetes would tend to answer inconsistently or choose 'none'. However, the results show that a large number of non-synesthetes also chose personal attributes, with a modest consistency level. This suggests that the population cannot be neatly divided into two distinct groups. We argue that synesthesia in general is not only found in a special subset of people, but weak

forms of it are more prevalent than previously expected.

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False belief attribution: An investigation of the neural pattern account

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In developmental psychology, the false belief task is used to measure children's ability to attribute beliefs, intentionality etc., to others. Because children typically pass this test around four years of age, most researchers agree that by 4 years old children possess a theory of mind (ToM). The debate in ToM research lies in the discrepancies of implicit vs. explicit task passing. Researchers have reported that infants are passing the false belief task implicitly, via eye gaze measurement, as early as 13 months, though they cannot explicitly, or verbally, pass it until 3 ½ or 4 years of age. Multiple, and often contradictory, theories exist in an attempt to explain why there is this gap, or the illusion of a gap, between implicit and explicit passing, as demonstrated by the false belief task. Most of these accounts are psychological ones that use mental states, representation, belief and desire as explanatory forces. However, some psychologists like Ruffman and Perner (2005), Clemens and Perner (1994), and Sirios and Jackson (2007) have claimed that, in addition to these accounts, there is a rival theory that supposedly could incorporate brain regions, active/latent memory systems, and/or inhibitory mechanisms, etc. in explaining ToM. These psychologists seem to believe that psychological accounts of ToM are separate from, and incompatible with, neuroscientific ones. Following Marr's (1982) original idea that there can be levels of explanation in psychology, we looked into the neuroscientific accounts explaining the gap in ToM acquisition. This paper focuses on the implications, and ultimate invalidity, of a neural pattern account proposed to explain the implicit passing/explicit failing gap.

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Admitting the pragmatic reality of multiply realized mental states

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(P1-018 July 14th, 1330-1530)

I argue that radical reductionists beg the question in the debate over multiple realizability (MR) by ambiguously arguing with the premise that distinct functional properties necessarily entail distinct physical states, which is identical to their conclusion. I focus on John Bickle's rebuttal to Kenneth Aizawa, in which MR is implied as a possibility by the use of non-reductive identifiers like "memory consolidation", but is subsequently rendered impossible with the argumentative claim that physical states are identical to their supervening functional properties. Specifically, Bickle observes memory consolidation in multiple species, but argues under the pretense that this is only verifiable when the function is rooted in identical biochemical processes. This paradigmatic incommensurability endorses the pragmatic value of a pluralistic stance which affirms MR where anti-reductionist theories apply and denies MR where reductionist theories apply.

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Dissociative disorders develop their symptoms in a particular order

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Seven patients are considered as dissociative disorder and shown as examples here. When these patients are stressed, they had a tendency to develop their symptoms in a particular order. The symptoms appeared as follows: (1) Anxiety (depression, hyperventilation) (2) Cognitive dysfunction (memory disturbance, visual perception dysfunction) (3) Unconscious behavior (parasomnia, etc.) (4) Hallucination (auditory hallucination, optical illusion) At level (4), many patients are diagnosed as dissociative disorder or schizophrenia. Patients at level (1) and (2) are diagnosed acute stress disorder or depression, and often visit doctors from home. In our cases, the patients had a symptom of hyperventilation or sleeping problems at the beginning, when they were stressed. However, their symptoms gradually moved on to (2), (3) and (4) levels. Dissociative disorder is very hard to diagnose by psychiatrists. The developmental phase of the disorder is unconsidered as much, which may causes the diagnose issue. The seven cases that show the series of symptoms in the order should give an idea and help very much psychiatrists to diagnose their patients.

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Difference between the nature of involuntary and voluntary memories for future events

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(P1-060 July 14th, 1330-1530)

The aim of this study was to explore difference between the nature of voluntary and involuntary memories for future events. In three experiments undergraduate participants performed free association tasks. In voluntary condition, participants were instructed to remember memories for future events during the performance of the free association tasks. In involuntary condition, they received no instruction regarding remembering. Immediately after performing each free association task, they were asked to report whether they remembered memories for future events during the performance of the task. Furthermore, the participants who reported to have remembered memories for future events were asked to rate the specificity of the remembered memories and the extent to which they had intended to remember the memories. Results from the experiments showed that the number of memories reported in the voluntary condition was significantly greater than that in the involuntary condition. However, it also shown that there was no difference in the specificity of remembered memories and the extent of intentionality between the voluntary condition and the involuntary condition. These results are discussed in terms of awareness of intention and the differences in cognitive processes underlying voluntary and involuntary memory retrieval.

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Emergence of conscious percepts in degraded images: Phenomenology and stochastic model based on feature-combination coding of visual objects

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It is well known that recognition of severely degraded images such as two-tone 'Mooney' images is facilitated by top-down processing, in which priorly given information about the objects hidden in the images play a critical role in performing segmentation and interpolation of the defective object image. Even in the absence of any such prior information, however, we can still recognize the hidden objects during continued observation in an emergent manner that is frequently accompanied by a feeling similar to the 'Aha!' experience. Neural mechanisms of this kind of emergent recognition without the top-down facilitation are poorly understood. Since this phenomenon is characterized by a long latency ranging from seconds to minutes, we measured time for subjects to recognize objects hidden in degraded images. We found that the time follows a particular exponential function of parameters indicating the severity of image degradation and the subject's capability, which could be determined independently each other. This kinetic function was well accounted for by a theoretical model based on feature-combination coding of visual objects, in which the coincidence of stochastic activation of neurons representing the object's features removed by the image degradation complements the representation of the object to be recognized. These results suggest that the stochastic process working on feature combination coding of objects underlies the emergent recognition.

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Affective priming by biological motion

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(P1-061 July 14th, 1330-1530)

Emotion is a pervasive and important aspect of human experience and consciousness. Relatively little is known about the mechanisms underlying the perception of emotional body movements, despite its inherent presence and influence in our daily lives. Here, we employed an affective priming paradigm, where subjects were primed with point-light biological motion stimuli (arm movements) conveying anger, happiness or neutral affect. They subsequently were asked to make judgments on target words that were either positive or negative in valence. Responses in affectively congruent trials were significantly faster than those in incongruent and neutral trials, indicative of a positive priming effect. In a second experiment, point-light displays were spatially scrambled to disrupt the global form of the primes while retaining the local motion cues. No significant difference was found between any of the prime-target conditions, indicating a role for global form cues in driving the affective priming effect. In a third experiment, we prevented the primes from reaching awareness by using a stereoscope. We found a main effect of prime type; responses for the happy primes were significantly faster than those for angry or neutral primes. Taken together, these data show that emotion cues conveyed by biological motion modulate the processing of incoming affective stimuli, adding to the literature on both biological motion and affective priming research. Biological motion appears to influence affective processing even when rendered unconscious, indicating future work is needed to delineate similarities and differences between conscious and unconscious processing of affective biological motion.

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Neural mechanisms of normal and disrupted confidence in sensory awareness

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(P1-040 July 14th, 1330-1530)

Sensory awareness has been often suggested to emerge from the thalamo-cortical complex. However, less is known about how the thalamus functions in sensory awareness, compared to the cortical functions. The aim of the current study was to elucidate the thalamic roles in visual awareness. The primate visual thalamus has two regions: the lateral geniculate nucleus (LGN; the relay from the retina to the primary visual cortex) and the pulvinar, the largest thalamic area, which has markedly expanded during primate evolution and connects with multiple visual cortices. Previous studies indicated that visual experience consists of content and confidence in that content. We hypothesized that these two thalamic nuclei play different roles in a subject's visual experience. Therefore, we first recorded the neural activities in the visual thalamus while monkeys performed a perceptual categorization task evaluating experienced content, and an opt-out task evaluating the subjects' confidence levels. We further carried out pharmacological inactivation of the visual thalamus to test whether the LGN and pulvinar are functionally linked to perceptual content and confidence. As a result, we found that pulvinar inactivation affected opt-out choices, but not visual categorization. In contrast, LGN inactivation affected both categorization and opt-out choices. These findings show that the LGN acts upstream of perceptual categorization while the pulvinar acts downstream of it and contributes to perceptual confidence.

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Uncovered discrepancies between part and whole in social inferences.

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We report that preschoolers and adults differently response social stimuli in term of social inferences. Sense-making involves both of individual traits and global evaluations in social contexts. The relationship between such part and whole is, however, still unclear. To understand social cognition, following two steps would be required. First step is to provide an experimental framework in which a discrepancy between part and whole is uncovered. Next one is to find intermediates between them for covering the discrepancy. Current study approached the first step. We prepared six types of scenarios in which one puppet with goal-dispositions was helped or hindered by another one. The six types of scenarios further classified into three groups according to the clearness of global evaluations. Twenty preschoolers and eighteen adults participated in our experiments. In preliminary sessions, they viewed scenarios and learned two symbols paired with goodness or badness scenarios belonging to one group respectively. In a following test phase, all of them assigned one of learned symbols to each scenario similar to learned one or different from it. Preschoolers showed asymmetrical assignments between learned and answered symbols only after they learned assignments to scenarios with unclear evaluations. This suggests that present experimental settings uncover the discrepancy between part and whole in a context of social inference.

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Full body peripersonal space as the self's sphere.

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(P1-056 July 14th, 1330-1530)

Peripersonal space (PPS) - i.e., the space immediately surrounding the body - has been traditionally conceived as the space reachable through limb movements, and therefore, it remained centered on a specific peripheral extremity (most prominently, the hand and the face). However, we do experience our body in its space as a whole and not only as a discrete addition of body parts, thus begetting the question: Is there a full body representation of PPS? And if so, what are its characteristics and boundaries? In addition, we do perceive our Self within the PPS, hence suggesting the question: What is the relationship between self-consciousness and PPS representation? In a first set of experiments, through the use of a new audio-tactile paradigm, we (i) established the presence of a full body PPS, (ii) determined its boundary both in the front and backspace, and (iii) compared its spatial extent to the one of the peri-hand space. Then, we used the so-called Full Body Illusion (FBI) to manipulate bodily self-consciousness, and test whether it affected PPS representation, as measured by the mentioned audio-tactile paradigm: we hypothesized that an evoked drift in self-location and self-identification through the FBI will be reflected in an enlargement of the full body PPS. Our results claim for the existence of a full body PPS and directly link it to bodily-self consciousness, suggesting the full body PPS might be the space of the Self.

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Innovative prognostic testing of comatose patients using fMRI

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(P2-074 July 15th, 1430-1630)

Background: Coma, a state of profound unconsciousness, is not permanent and so questions arise about how to predict the chances of functional recovery. Current clinical tools for prognosis are limited and focus only on poor outcome measures which make predictions about the extent of recovery particularly challenging. Functional magnetic resonance imaging (fMRI), which is widely used to assess cerebral function, might be valuable in this regard. Methods: Nine comatose patients and eighteen healthy control participants were recruited and underwent fMRI imaging. A passive auditory language task was used to independently assess sound perception, speech perception and speech comprehension in an individual basis. Two volitional mental imagery tasks were also employed to determine the level of awareness in patients. Results: The two comatose patients who showed the most robust activation for both auditory and speech processing, similar to healthy control participants, had the greatest functional recovery. All nine comatose patients showed no activation to either mental imagery task suggesting the inability to command follow which is in keeping with the behavioural characteristics of all patients. Conclusion: Robust neural activation during sound and speech perception tasks may be an early predictor or cue for the recovery of consciousness.

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How magicians influence choice without awareness

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(P1-062 July 14th, 1330-1530)

Forcing occurs when a magician influences an audience's decisions without their awareness. We investigated forcing in terms of five stimulus characteristics: visibility, memorability, likability, and visual and verbal accessibility (Olson,

Amlani, & Rensink, 2012). We also examined personality measures such as locus of control (Duttweiler, 1984) and transliminality (the extent to which stimuli enter conscious awareness; Lange, Thalbourne, Houran, & Storm, 2000). We showed 105 people a magic trick in which they selected a playing card while the magician flipped through a deck. One card, the target card, was shown longer than the rest. Almost all (98%) participants chose that card, and most (91%) reported feeling that they had a free choice. Next, we showed 43 participants a sequence of 26 cards (on average 44 ms/card) on a computer with the target card shown for longer (150 ms). Participants chose any card they wanted then reported what it was. Each participant saw 28 trials. Afterwards, participants were asked whether they noticed that one card was shown longest. Results show that personality measures predict forcing better than the physical characteristics of the cards do. Many observers (41%) did not notice that one card was shown longest. This group had a higher internal locus of control and a lower transliminality score, and spent less time using computers each day. These findings confirm magicians' intuitions that some types of people are more affected by unnoticed events and therefore may be more susceptible to magic tricks.

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Two kinds of concept related to the phenomenal content of consciousness

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(P2-016 July 15th, 1430-1630)

Whether the phenomenal content of conscious experience can be influenced by our cognitive system is the issue of cognitive penetrability of perception and has been a long debate in philosophy and psychology. Recent researches of synesthesia seem to side with the view that visual experience is cognitively penetrable. For example, for the color-grapheme synesthesia, a letter within different context will induce different colors, like the letter 'c' in 'Pct' and 'Jack'. There is also evidence which shows that synesthete could shift the associations to novel inducers after learning new symbol system. Both cases reveal that the concepts might play a role in the content of visual experience. However, I think those cases could not be objections. Based on a framework of connectionism, I argue that we can distinct two different kinds of concepts. One is the 'access concept', which is the top-down mechanism relating to the access of experience, and the other is 'phenomenal concept', which is the information stored within synaptic connections participating the constitution of phenomenal content. Furthermore, this distinction of two kinds of concept is supported by the distinction of two different neural mechanisms. The mechanism of prefrontal cortex is related to the access concept. The function of phenomenal concept should be realized by the neural connections within the sensory cortex. I propose the issue of cognitive penetrability is about the access concept. The case of synesthesia is only relevant to the phenomenal concept and cannot be against the view that experience is cognitively impenetrable.

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Heart-brain interactions shape visual consciousness

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(P1-041 July 14th, 1330-1530)

Reporting, "I saw the stimulus," is the hallmark of conscious vision, but where does the "I" come from? First-person perspective requires a minimal sense of the self that could be based on the neural representations of internal bodily signals. To test whether conscious perception could be predicted from bodily responses, we measured magnetoencephalographic brain responses to heartbeats in participants detecting a visual stimulus at threshold. Trials were classified as hits or misses based on participants' responses, and heartbeat evoked MEG responses were compared between the two types of trials. The amplitude of neural responses to heartbeats before stimulus onset predicted stimulus detection, in the viscerosensory insula, and in areas belonging to both the self-related and default-

mode networks: right inferior parietal lobule and ventro-medial anterior cingulate and prefrontal cortices. EKG activity itself was not different between hit and miss trials and correction of cardiac artefact using ICA did not affect the results of heartbeat evoked MEG responses. Other measures of autonomic arousal and visual cortex excitability such as pupil diameter and parieto-occipital alpha power during prestimulus interval did not vary between hits and misses. Stimulus detection subsequently slowed down the heart, and this effect was predicted by prestimulus differential heartbeat evoked responses in ventro-medial cingulate and prefrontal cortices. Conscious vision therefore appears associated with bodily signal monitoring in the cortical self-related network.

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Biasing moral choice by interrupting gaze: A dynamical systems approach

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(P1-064 July 14th, 1330-1530)

An embodied and dynamical systems view of cognition entails that sensorimotor processes are part of, and, reciprocally reinforce, cognitive processes such as perception, categorisation and language (Spivey, 2007). In the current study we adopted this approach to study the moral mind. In particular, we were interested in a potential coupling between eye movements and moral decisions. Based on earlier work on factual judgements (Richardson et al. 2009) we ran a series of experiments to gauge the role of gaze in the moral domain. Participants were asked to respond to a number of statements spanning the breadth of morality with one of two alternatives. Stimuli were based on Moral Foundations Theory (Graham, Haidt & Nosek, 2009). First, we established a descriptive and causal link between gaze and moral judgement using standard forced exposure paradigms (Shimojo et al. 2003). In our main experiment, we measured participants' eye movements to track the time course of their moral decisions. We demonstrated that by interrupting participants' decision process based on their gaze position; we were able to influence what they decided. We interpret our findings as establishing the existence of a novel link between gaze and moral choice. This coupling is strong enough to allow us to bias participants' judgements. The results further raise questions concerning the stability of, and, potential limits to the introspective accuracy of our everyday moral judgements.

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Consciousness dynamicity and the duarchical model

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(P1-063 July 14th, 1330-1530)

It is now commonly assumed that, although no task is ever purely implicit or explicit, unconscious knowledge can be captured separately from conscious knowledge when one is able to detect, discriminate or decide, and yet remains unable to identify, know or judge. Evidence of such dissociative patterns has been revealed in numerous studies under the assumption that objective and subjective measures are tapping right into their respective types of knowledge, without any interaction. Nonetheless it has recently been discussed whether some objective measures, such as Post-Decision Wagering (PDW), could have the power to capture contents of subjective knowledge as well, and therefore, whether the measures used in our experiments really best capture awareness, exclusively and exhaustively. In this study we suggest that this methodology could have indeed been misleading, for not only we still do not know if

unconscious and conscious processes form a serial hierarchy (as the Higher-Order Thought theory states) rather than two parallel channels, but most crucially we still fail to see that consciousness is inherently dynamical. We hence present an alternate view, based on a hybrid model – so-called duarchical for it integrates two independent channels in a hierarchical manner – able to account for experimental data based on PDW. We then test the three architectures (hierarchical, parallel and duarchical) in an unconscious perception paradigm, in which the order and the modality of the objective and subjective measures are manipulated in order to assess dynamical relationships between conscious and unconscious processes.

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Measures of conscious and unconscious perception with perceptual and attentional manipulation of consciousness

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(P1-071 July 14th, 1330-1530)

Are conscious and unconscious perception processes qualitatively or only quantitatively different? Previous studies have examined this question by investigating how different measures of visual processing are affected by the time interval between the target and a mask during meta-contrast masking. In particular, Peremen and Lamy (under review) have shown that direct measures (subjective reports and forced-choice discrimination performance) and indirect measures (action priming) of perceptual processing follow similar time courses. In addition, they showed that while objective performance is at chance when subjective visibility is null, action priming remains significant. However, it is important to realize that the different ways in which conscious perception is prevented may profoundly affect unconscious processing. In particular, it has been suggested that perceptual and attentional blindness should be distinguished. Here, we examine whether the associations and dissociations between subjective reports, objective forced-choice discrimination performance and indirect measures of perceptual processing demonstrated in earlier research can be generalized to other forms of attentional blindness (using masking by substitution) and to perceptual blindness (using backward pattern masking). Our results provide additional support for the need to distinguish between attentional and perceptual manipulations of conscious perception in the study of conscious perception.

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The brain at war: Epistemic and ethical implications of β -blocker therapy for combat-induced PTSD.

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(P2-077 July 15th, 1430-1630)

Combat-induced post-traumatic stress disorder (PTSD) in U.S. military personnel is a growing health concern for the U.S. Department of Defense (DoD). Conservative estimates suggest that 29% of U.S. soldiers deployed to Iraq and Afghanistan have been diagnosed with PTSD alone (Bagalman, 2011). Consequently, suicide rates among recent war veterans are markedly increased. The U.S. Army suicide rate (20-30 per 100,000), for example, is the highest recorded in 3 decades (Bush et al., 2013). Given that military operations in Afghanistan will end in 2013, it is anticipated that the prevalence of psychiatric injury will increase as young soldiers return home and begin to contemplate their battlefield experience. In response to this problem, recent advances in psychopharmacology have yielded drugs that may be an effective means of attenuating anxiety-inducing flashbacks quintessential of psychiatric injury (Giles, 2005). The use of the β -blocker propranolol, for example, has allowed some military personnel to effectively numb their anxiety response to traumatic memories. Despite this success, two emerging lines of inquiry in PTSD research, namely the Dissociative Subtype of PTSD (Lanius et al., 2010) and Moral Injury (Litz et al., 2009), raise doubts about the effectiveness of emotional numbing in the veteran population. In cases of dissociation or moral anguish, it is suggested that β -blockers may instead lead to an exacerbation of psychiatric injury, rather than psychiatric healing.

This presentation reviews the relevant neuropsychiatric literature on PTSD in order to identify the salient epistemic and ethical problems that emerge from β -blocker use in the veteran population. It is argued that in special cases of complex trauma and moral injury, pharmacological intervention may not be an appropriate treatment for repairing the psychiatric wounds of war.

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The Emperor is still naked: There is no empirical case for consciousness in virtue of targetless HOTs

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(P2-017 July 15th, 1430-1630)

Some higher-order theorists have recently argued that there are empirical data demonstrating subjects who undergo phenomenally conscious experiences in virtue of targetless HOTs (e.g., Richard Brown, Hakwan Lau, and David Rosenthal). I argue that the data can be challenged. They do not support the case for consciousness in virtue of targetless HOTs, also known as the intentional inexistents version of HOT theory. However, they do lend some support for what Lau calls a "joint determination view." Joint determination, though, is ambiguous and can be developed in different ways. I briefly develop the notion of joint determination in terms of a self-representational theory, or what I call "intrinsic higher-order theory" and argue that this interpretation is superior to competing interpretations.



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Mind wandering as a possible mechanism of self-deception

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(P2-018 July 15th, 1430-1630)

Self-deception is defined in this poster as a motivated kind of hypothesis-testing that leads to a certain level of reality decoupling and results in an evidence-incompatible representation that has a functional role of belief. The given poster will explore the possibility that mind wandering, which is characterized by perceptual decoupling and can be defined as engaging in cognitive processes decoupled from current environment (Schooler, Smallwood et al. 2011), is a mechanism of self-deception. In virtue of this aim, delusion, mind wandering and meditation will be compared to self-deception at the conceptual level, as well as at the level of neuronal structures. It will be argued that both delusion (Langdon & Coltheart 2000, Davies 2009) and mind wandering bear a conceptual similarity to self-deception, as well as lead to the activation of the default mode network (delusion: Gerrans 2013, mind wandering: Schooler, Smallwood et al. 2011). Meditation, on the other hand, is conceptually dissimilar to self-deception and mind wandering and leads to reduced activation of the default mode network (Brewer et al. 2011). Thus, at least certain kinds of self-deception may occur as a result of the activity of default mode network (Yamada et al. 2013). As default mode network (DMN) involves motivational processing (Gerrans 2013), if both self-deception and mind wandering occur as a result of the DMN activation, then, given the conceptual definitions of self-deception and mind wandering, the possibility for mind wandering to be a mechanism of self-deception needs empirical testing. References: Davies, M. (2009). Delusion and motivationally biased belief. Self-deception in the two-factor framework. In T. Bayne & J. Fernández (Eds.): *Macquarie monographs in cognitive science, Delusion and self-deception. Affective and motivational influences on belief formation*, pp. 71–86. New York, NY: Psychology Press. Gerrans, P. (2013). Delusional Attitudes and Default Thinking. *Mind & Language*, 28(1), 83–102. Langdon, R., & Coltheart, M. (2000). The Cognitive Neuropsychology of Delusions. *Mind & Language*, 15(1), 184–218. Schooler, J. W., Smallwood, J., Christoff, K., Handy, T. C., Reichle, E. D., & Sayette, M. A. (2011). Meta-awareness, perceptual decoupling and the wandering mind. *Trends in Cognitive Sciences*. doi:10.1016/j.tics.2011.05.006  Yamada, M., Uddin, L. Q., Takahashi, H., Kimura, Y., Takahata, K., Kousa, R. et al. (2013). Superiority illusion arises from resting-state brain networks modulated by dopamine. *Proceedings of the National Academy of Sciences*. doi:10.1073/pnas.1221681110 

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Towards a working definition of social cognition

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(P2-019 July 15th, 1430-1630)

This paper provides a preliminary working definition of social cognition which serves as a basis for a meta-theoretical perspective on current research. This perspective is necessary in order to gain a conceptually coherent overview of the field of study and to reveal strengths and weaknesses of current theories. There is a growing interest in the role of social cognition for consciousness research in both philosophy and neuroscience (Thompson 2001, Adolphs 2007), but yet a clear description of the target phenomenon is missing. I will first argue that such a description is necessary in order to determine the common goal and thereby to make interdisciplinary research more fruitful. Secondly, I name three criteria which a working definition should fulfill: (1) encompassment, (2) multi-directionality and (3) theory-neutrality. It will be shown that none of the existing definitions given in the literature fulfills these criteria. This is especially for the fact that these definitions already inhabit strong background assumptions about the nature of cognition and can be assigned to either the view of Classic Cognitivism or Enactive Cognitivism (de Bruin & Kästner 2012), thus precluding directions of research. Lacking a characterization meeting these criteria, researchers often end up talking past each other and thereby hindering interdisciplinary work. Finally, I will propose a preliminary working definition which does not presuppose any specific theory. It is broad enough to allow for a meta-theoretical perspective and suggests ways in which the target phenomenon can be narrowed down.

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Know your feelings: Neural basis of individual differences in emotion regulation

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(P1-065 July 14th, 1330-1530)

This work addresses specialized recruitment of brain regions in response to negative emotional provocation. Specifically, we focus on affect-labeling (describing emotions) as an emotion regulation strategy. Previous studies, notably by Lieberman, have localized affect-labeling to the right ventrolateral prefrontal cortex (RVLPFC), after finding increased RVLPFC activity during an affect-labeling task. Lieberman further reported concurrent amygdala suppression, which he suggested was the result of inhibition by the RVLPFC and the likely cause of reduced impact of negative emotion. Our study investigated congruence of these findings with individual differences regarding affect-labeling. Instead of cueing subjects to affect-label, we observed uninstructed emotion regulation, and explored individual differences (using well-established self-report measures). We recorded neural activity in timecourses over the stimulus presentation window, involving primary-disgust—inducing images with voice-over descriptions (rotting food, person vomiting, etc.). Although we confirmed lowered amygdala activity in adept affect-labelers, we found that these individuals displayed _less_ overall RVLPFC activation in response to negative affective stimuli than those who relied on other mechanisms. We speculate that, while the RVLPFC indeed suppresses the amygdala, the RVLPFC is implicated in a _range_ of emotion regulation strategies, rather than exclusively in affect-labeling. Concurrently, adept affect-labelers have stronger inhibitory pathways that suppress the amygdala, therefore requiring less RVLPFC activation to achieve a given degree of amygdala suppression. Finally, as an antecedent emotion-regulation strategy, affect-labeling targets negative emotion before it is fully formed, thereby preventing amygdala activation from reaching as high a level as it would in later mechanisms. Thus, adept affect-labelers may need less inhibition to reach appropriately low amygdala activation.

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Cognitive machinery and phenomenal flow of consciousness

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(P1-019 July 14th, 1330-1530)

Abstract: It appears that consciousness science is progressing deeply, especially in its search for the neural correlates of consciousness (NCC). Can contemporary research on NCC give us a new understanding of the difference between cognitive machinery and the phenomenal flow of consciousness? There are two main approaches to solving this problem, one is functional-based (focusing on the assumption of eliminative materialism: that consciousness can be reduced to our cognitive functions), the other is state-based (focusing on the assumption that in a certain sense phenomenal consciousness overflows cognitive accessibility). I argue that from a conceptual point of view both approaches are problematic: the functional-based approach seems to set aside such crucial aspects of consciousness as its phenomenology; and the state-based approach seems to overestimate first-person conscious experience in trying to demonstrate that the core neural bases for phenomenal consciousness and for access consciousness are located in anatomically separate regions of our brain. I will discuss in detail the line of argumentation of both approaches in order to see whether the experimental paradigms in a search for the NCC bring new light to the fundamental difference between cognitive machinery and the phenomenal flow of consciousness. **Keywords:** neural correlates of consciousness, the overflow argument, awareness, access consciousness, phenomenal consciousness, Block, Dennett.

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Comparing the effects of subliminal primes and phrases on working memory performance: Are they mediated by motivation?

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(P1-066 July 14th, 1330-1530)

Subliminal stimulation has been shown to enhance mood (Weinberger et al., 1997) and cognitive behaviour (Lowery et al., 2007), using both subliminal primes (single words) and subliminal phrases (short multi-word sentences), yet there has been no comparison between these two formats to ascertain which may elicit the more robust effect. Specifically, memory research has utilised only subliminal primes to influence memory performance in both young (Mitchell et al., 2002; Chartrand & Bargh, 1996) and elderly (Levy, 1996) participants. Hence experiment 1 compared the two formats to examine which would elicit the most robust behavioural change on a working memory task. Sixty participants completed a Conceptual Span Task (CST) and were randomly assigned to one of six conditions, 3-prime and 3-phrase, during which they were exposed to subliminal stimuli for 10msec. thirty times using a Lexical Decision Task (LDT). On completion of the LDT participants again completed the CST. Results showed no clear change in working memory performance. There are two plausible reasons for this null effect, a lack of motivation and a lack of statistical power. According to Strahan et al. (2002) subliminal stimulation will only be effective in altering behaviour if the participant has a goal, or motivation to change the behaviour. In addition, power analysis conducted on experiment 1 indicated low power as a result of the small sample size. Thus, experiment 2 aimed to subtly manipulate participants' motivation to encourage them to improve their working memory performance and increased the power of the study by completing the test on a larger sample. Results of this experiment are pending.

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The neurological process responsible for mental continuity: Reciprocating transformations between a working memory updating function and an imagery generation system

Jared Edward Reser

(P2-035 July 15th, 1430-1630)

A neurological process, suggested to be involved in consciousness and the maintenance of mental continuity, is delineated here. This process involves reciprocal interactions between nodes in higher-order association cortex capable of sustained firing, and nodes in lower-order sensory cortex capable of generating mental imagery in the form of topographic maps. Nodes in higher-order association areas are multimodal, module independent, and have a capacity for sustained firing allowing the maintenance of salient, novel or goal-relevant features through elapsing time. Nodes in lower-order sensory areas receive top-down inputs from association areas and combine multiple individual features into composite, topographic maps. The higher-order nodes select new features from each mapping to add to a limited-capacity store of temporarily maintained features. Gradual changes in this store of simultaneously coactivated nodes occur as association nodes that continue to receive sufficient activation energy are maintained, nodes that receive reduced energy are released from activation, and new nodes that are tuned so as to receive sufficient energy from the current constellation of coactivates are converged upon, and incorporated into the remaining pool of active nodes from the previous cycle. This updated set of features is again fed back into lower-order sensory nodes where the features are continually used to guide the construction of successive topographic maps. The sustained and dynamically overlapping activity of higher-order nodes allows consecutive topographic maps: to have different but related content; to implement learned algorithms; to exhibit progressive qualities; and to carry thematic continuity over sequential processing states.

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Implicit evaluation of competences as a function of goal-pursuit

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(P1-057 July 14th, 1330-1530)

Objects related to current goal pursuit are rated as more positive which allows including them into attention. Our previous studies showed that the above relevance is assigned differently depending on regulatory foci: both preventive and promotive participants rated objects that fulfilled task criteria as more positive, but since prevention is associated with vigilance, preventive participants expressed positive attitude also towards impediments to the goal. These studies dealt with objects relevant to goal pursuit, but external to the doer. In current study we aimed to observe whether facing a task brings to attention one's own competences by temporal changes in their value. Participants rated neutral hexagrams preceded by words describing competences (presented for 75ms) twice – before and after introducing a manual task (constructing a shape from domino tiles). The list of words comprised helpful (e.g. precise), disruptive (e.g. impatient), positive and negative unrelated features (e.g. communicative, lazy) and neutral words (e.g. bill). We observed faster reaction times in judgment after task introduction. While both promotion- and prevention-oriented participants rated helpful competences as positive, and disruptive as negative, only for promotive participants the judgment differed significantly after task introduction. Moreover, the results showed that promotive participants rated competences that can help perform this task (e.g. fast) more positively after task introduction, while they slightly devalued other positive competences that do not relate to task performance (e.g. friendly). The results indicate that implicit judgments of self can change temporarily along with current goal pursuit.

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Balancing visual consciousness: Natural vestibular stimulation modulates access to visual consciousness in a continuous flash suppression task

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(P1-043 July 14th, 1330-1530)

Information from bodily senses has been shown to be of paramount importance to self-consciousness. However, the role of bodily signals in shaping our visual consciousness has seldom been investigated. Here, we demonstrate that natural vestibular stimulation influences visual consciousness. We induced perceptual suppression by using continuous flash suppression (CFS) while stimulating the vestibular system by rotating participants on a rotating chair. Participants had to judge the color of the dots in an optic flow display which could be congruent or incongruent to their self-rotation. When the optic flow was congruent to the participants' rotation perceptual suppression was broken more rapidly than during incongruent trials. Our findings provide evidence of a vestibular influence in visual consciousness, suggesting that vestibular information not only influences own body perception and consciousness, but also visual consciousness.

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Introspection of thoughts

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(P1-020 July 14th, 1330-1530)

In the philosophical debate about the nature of introspection, it is common to examine the nature of our access to beliefs. But it is much less common to propose an account of introspective access to thoughts, the mere entertaining of some content, rather than a commitment to it, as in the case of belief. Alex Byrne has proposed such an account that explains our introspective access to thoughts, which links introspection not only to reasoning, but also to auditory imagination. Though it is a fascinating account, I argue that it has two substantial problems. First, it crucially relies on a claim about the nature of auditory imagination and its connection with belief, which I show to be unmotivated. And second, Byrne needs all thoughts to be represented through an introspectively recognizable medium, or be "symbolized", in order for his account to explain our access to those thoughts. But some data from Russell Hurlburt show that not all thoughts are symbolized, which undermines the generality of Byrne's account. In light of these problems, Byrne's account of introspecting thoughts is untenable; but perhaps a different reasoning-based account of introspection could work.

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Anxious animals? A novel method for assessing the awareness of emotions in nonhuman animals

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(P1-078 July 14th, 1330-1530)

Consciously experienced emotions are feelings or sensations with 'valence' (being positive/preferred or negative/aversive). Trained rats and pigs can use emotions (e.g. anxiety; pain) as 'discriminative stimuli' (DSs): stimuli that in operant paradigms indicate which action (e.g. pressing a certain lever) will yield reward. They can also

'generalize' from drug DSs with emotional components to certain non drug-induced states (e.g., from states induced by anxiogenic drugs to states induced by electric shock or by an aggressive defeat by an intruder male in rats). Some authors using drug discrimination procedures in humans hypothesise that participants' conscious awareness of drug effects is necessary for the drug to function as a DS. If correct, this suggests that when animals use drug- or experience-induced emotions as DSs, they may also be aware of them. To test this hypothesis, we mined data from 22 experiments on humans who were subjected to drug discrimination tasks and asked to self-report their sensations. We compared the lowest dose of each drug that could act as a DS, with the lowest dose causing reportable sensations. Across all 22 studies, we found a tight correlation between the two types of threshold dose. Furthermore, the slope did not significantly differ from 1, and the two thresholds did not significantly differ. This suggests that in humans, the ability to use internal states as DSs is a "Type-C" process: one dependent on conscious awareness. Correspondingly, animals' abilities to use emotions as DSs may therefore indicate awareness of those emotions.

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Cognitive penetration: What's under the hood?

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(P1-021 July 14th, 1330-1530)

What is cognitive penetration? In the literature, 'cognitive penetration' has no established usage: for Pylyshyn (1999) it is a kind of rational influence of cognitive states on experience; for Siegel (2012) it is a species of causal influence of the cognitive on visual experience that meets a counterfactual constraint; for Macpherson (2012) it is a rationally explicable causal influence of cognitive contents on visual contents, for which she proposes a specific mechanism; for Deroy (2012) it is the influence of conceptual content on perceptual processing rules; for Stokes (2012) it is the causal influence of a cognitive state on perceptual experience where the causal route is appropriately internal. Thus opinions diverge on the nature of cognitive penetration: the range of permissible penetrators, what it is that gets cognitively penetrated, and the necessary and sufficient conditions that must hold between them. I identify and critically assess two foundational theses, not thematised in the philosophical literature, on which these proposals differ: a thesis about the interaction between levels of explanation in cognitive psychology and a thesis about the nature of rational relations. I further identify *prima facie* reasons for rejecting both of these theses, thereby allowing a more expansive conception of cognitive penetration than has been defended till date.

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Effects of vibrotactile biofeedback device on postural stability without visual information in healthy young adults

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(P1-079 July 14th, 1330-1530)

Sensory substitution and augmentation has increasingly gained importance in clinical settings and neuroscience research, because of its significance in rehabilitation and understanding the concepts of consciousness. The purpose of this research was to examine the effects of a newly-developed vibrotactile biofeedback device on postural stability without visual information. Twelve healthy young adults participated in this study. Participants were divided randomly into two groups (experimental and control) and asked to maintain balance in the upright position with their eyes closed. The biofeedback device mapped changes in the centers of pressure (CoP) on their backs, using a 2 × 2 vibrator array. During the baseline phase, postural stability (sway area of CoP) was measured in both groups. During the test phase, postural stability was measured with biofeedback in the experimental group and without biofeedback in the

control group. To determine the extent of changes in postural stability, the value of the sway area during the baseline phase was subtracted from the test value. A lower value indicated that the participant's posture became stable during the test phase. The effects of the device were evaluated by comparing the extent of change between groups. The extent of change was significantly lower in the experimental group than in the control group. This result suggests that the vibrotactile biofeedback device may compensate for a loss of visual information in controlling postural equilibrium, by providing additional sensory information on CoP. This device may thus be used in the rehabilitation of patients with visual or neurological disorders.

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Unconscious perception of biological motion

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(P2-065 July 15th, 1430-1630)

Biological motion processing is critical for survival and social interaction, but whether processing of these stimuli can take place outside awareness is unknown. Point-light walkers (PLWs) consisting of about a dozen markers attached to the limbs of an actor have been used for decades to study the perception of biological motion. Here, we investigated whether biological motion PLW stimuli masked and rendered invisible by interocular suppression could induce adaptation for subsequent unmasked target PLWs. First, we established that discrimination of the direction of heading of consciously-perceived PLWs was faster if they were preceded by an invisible adapter PLW heading in the opposite direction, indicating unconscious biological motion stimuli can induce adaptation. In a separate experiment, we showed that this effect depended on adapter duration. Single frame (12ms) or 300ms-long PLWs did not induce adaptation, but 600ms and 2350ms long invisible adapters did. In all experiments, we ran controls to ascertain the adapter PLWs direction were not consciously perceived by the observers. Further studies are exploring whether adaptation is driven by the (global) form information or the (local) motion information of the invisible adapter PLW. Overall, we showed that perceptual processing of biological motion does not require awareness, and more specifically, that adaptation to biological motion can occur outside of awareness.

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Spectral EEG at rest predicts behavioral appearance in Disorders of Consciousness

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(P2-036 July 15th, 1430-1630)

Objective: Patients suffering from a Disorder of Consciousness still present a diagnostic challenge due to the fact that their assessment is mainly based on behavioural scales with their motor responses often being strongly impaired. We,

therefore, focused on resting EEG in order to reveal potential alternative measures of the patient's current state independent of rather complex abilities (e.g. language comprehension). Methods: Resting EEG was recorded on four occasions in 7 Minimally Conscious State and 10 Vegetative State patients. Behavioural assessments were conducted using the Coma-Recovery Scale-Revised. The signal was analyzed in the frequency domain and association between CRS-R Score and EEG amplitude were calculated using Pearson correlation and repeated measures ANOVAs. Results: Analyses revealed remarkably robust positive correlations ($r > .70$) between CRS-R scores and band amplitude above 12 Hz as well as negative correlations between with frequencies below 8 Hz. Furthermore, the absolute alpha/theta ratio as well as the spectral peak were highly indicative of the patient's behavioral state. Conclusions: The strong relationship between various resting EEG parameters and CRS-R score provide significant clinical relevance. Not only is resting activity easily acquired at bedside, but furthermore, it does not depend on explicit cooperation of the patient. Especially in cases where behavioural assessment is difficult or ambiguous, spectral analysis of resting EEG could complement clinical diagnosis and indicate residual cognition and conscious awareness.

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Conscious and unconscious error processing in ADHD children: An event-related potentials study of the stop-signal task

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(P1-067 July 14th, 1330-1530)

The aim of the study was to determine whether conscious and unconscious error processing distinguishes children with a diagnosis of attention deficit hyperactivity disorder combined type from normally developing children. 40 right-handed children aged between 6.9 and 12.3 years participated in the study, with 16 boys and 4 girls in each of the control and ADHD groups. Children were individually age- and gender-matched. Participants performed a standard stop-signal task with an auditory stop-signal stimulus while the EEG was recorded. Relative to controls, the go stimulus reaction time and the stop-signal reaction time were prolonged in children with ADHD. Motor reaction event-related potentials were calculated separately for correct and incorrect (unsuccessfully inhibited) responses. Both components associated with error processing were markedly reduced in ADHD children relative to healthy children – the ERN, reflecting error detection, which has been shown to be independent of conscious awareness and the Pe, more evaluative in nature, associated with conscious awareness or affective processing related to an erroneous response. The ERN group effect had a frontocentral distribution, being more pronounced in the right hemisphere, while the Pe group effect had a centroparietal scalp distribution. These results support the hypothesis of a complex deficit of error recognition mechanisms in ADHD. This may suggest that the ADHD children attach less significance to errors, and in consequence are less likely to alter their task-related behavior.

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The neurophysiology of feedback: A mechanism for binding

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(P2-037 July 15th, 1430-1630)

Recurrent cortico-cortical connections have been implicated in conscious perception in a variety of psychophysics studies and theories of consciousness. What are the neural effects of such feedback connections? What functional roles at the level of single cells, networks, and global computation, might these connections play? In this biophysical work, we begin to consider the possible role feedback plays in affecting the dendritic tufts of layer 5 pyramidal neurons in the neocortex and the implications of such a mechanism for perceptual binding. We explore single cell properties of pyramidal neurons in the mouse primary visual cortex and show how feedback input controls burst firing in a model, and discuss how concurrent bottom-up, feedforward and top-down cortico-cortical feedback drive into a cortical column can act as a mechanism for perceptual binding. Alongside our own experiments in mouse exploring the specific physiological effects of TMS on the neocortex, recent psychophysics work using TMS to disrupt conscious perception is explained in light of our hypothesis.

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Top-down emotional brain modulation in disorders of consciousness

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(P2-082 July 15th, 1430-1630)

Background Emotion is a key feature of inner mental states. Whether patients with disorders of consciousness (DOC) experience such states remains unknown. Thus far, active functional neuroimaging paradigms in DOC patients have focused on demonstrating voluntary modulation of brain activity to a cognitive task, implying covert awareness. However, no such study has examined modulation of emotional brain processing, which may allude to emotional awareness and the existence of subjective experiences. Methods In a hierarchical cognitive-emotional fMRI paradigm four vegetative and two minimally conscious patients and twelve healthy controls were asked to imagine one of their parents' faces. Analyses focused on activations in the fusiform face area (FFA) and the amygdala. Results Two vegetative patients displayed amygdala activations during familiar face imagery. One of these patients further displayed FFA activation during the imagery condition, resulting in activation maps indistinguishable from those of healthy volunteers. Both minimally conscious patients displayed amygdala and FFA activations during familiar face imagery. Furthermore, of the four vegetative patients, only the two that exhibited activations during this task later improved neurologically to a minimally conscious state. Conclusions These results suggest that some patients with DOC retain a brain ability to selectively perform volitional top-down emotional brain modulation, supporting emotional awareness. Accordingly, subjective emotional mental states in these patients may also be driven by internal processes. The existence of such emotional reactivity may carry prognostic significance, though it remains to be determined. The possible existence of inner mental states in DOC, and especially in vegetative patients, carries immense significance to their care and to the study of consciousness in general.

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Sustained electrophysiological activity reflects perceptual awareness for different object categories

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(P2-083 July 15th, 1430-1630)

Recently, we have demonstrated how a percept fading in and out of consciousness can be tracked with an electrophysiological correlate of visual working memory (VWM). This particular component - the contralateral delay activity (CDA) – typically tracks the number of items maintained in (VWM), irrespective of the identity of these items. Here, we manipulate the type of object which participants see in a bilateral shape-from-motion display to test whether the CDA as a measure of object awareness is content-specific or content-invariant. The display involves a line drawing of an object moving in counter-phase to randomly oriented background lines. When in motion, the object can be easily segregated from the background. When the motion stops, the percept persists for a little while in the observer's conscious experience before it fades from awareness. The recruitment of the contralateral delay activity during the perceptual persistence phase suggests that visual working memory may play an important role in subjective awareness. By manipulating the type of object which participants view, we demonstrate that the recruitment of this ERP component is invariant with respect to object, animal and human face stimuli. This suggests that the CDA reflects whether a visual item moves in or out of conscious awareness, irrespective of object category.

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Is there a "distinctive common quality" in the experience of pleasure?

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(P1-022 July 14th, 1330-1530)

Prominent ethicists have claimed it is clear from introspection there is no experiential quality shared by all pleasures. For example, Parfit has claimed that the pleasures of, "satisfying an intense thirst or lust, listening to music, solving an intellectual problem, reading a tragedy, and knowing that one's child is happy...do not contain any distinctive common quality," (1984, p. 493). Similarly, Griffin has claimed that there is no "homogenous mental state" in common between the positive states of "eating, reading, working, creating [and] helping," (1986, p. 8). In contrast to these views, Crisp has argued that all pleasures share the "same felt property" of enjoyableness (2006, p. 629). Empirical research has shown that common pleasure-related brain areas are activated across a number of different experiences, including sexual pleasure, pharmacologically induced pleasure, and the pleasure of listening to music (i.e. sex, drugs, and rock 'n' roll), as well as the pleasures of social rewards, humor, and winning money (Smith et al. 2010). I will argue the following: the existence of shared activation patterns across different types of pleasures does not settle the question of whether there is a common phenomenological feature of pleasurable experiences, since it is possible these brain areas are not directly contributing to the phenomenology of pleasure (cf. the dopamine system). However, this empirical evidence does undermine the strength of Parfit and Griffin's introspective arguments, and the right empirical evidence combined with arguments like Crisp's could establish that there is a shared phenomenological feature of pleasurable experiences.

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Lexical relations, mental re-presentations and the opposites of experience

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(P2-079 July 15th, 1430-1630)

Lexical relations are the relations between word and word-like expressions in the mental lexicon. The basic ones are

those of synonymy, antonymy, homonymy, hypo- and hyperonymy, etc. From semantic point of view, they could be envisaged as specific types of relations that are established between the meanings of two or more different words. The binary principle of juxtaposition between them is best exemplified by antonyms as juxtaposition of two opposites of meaning. Mental re-presentation is conceptualized here as a way to develop concepts that categorize experience. In this way mental presentations of different types of feelings, emotions, perceptions and movements become re-presented in terms of concepts that may become integral part of the linguistic convention. The potential for contrastive study of feelings, etc. and their conceptual re-presentations becomes most challenging when we come to antonyms in language like happy and sad. While on the one hand they are part of the linguistic convention (in a certain language- and culture-specific way), on the other hand they have to refer to 'givens of experience'. When the conventionality aspect is taken into account, the way becomes open for considering words for experiences in general and for opposites in experience in particular as 'natural kinds' (unlike the stance to 'folk concepts' in contemporary psychology of emotions). One such advanced case will be discussed in detail – the nature of the relationship in German of the antonyms heimlich-unheimlich and the psychological reality they refer to.

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Color and luminance influence, but can not explain, binocular rivalry onset bias

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(P1-067 July 14th, 1330-1530)

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. Recent research has suggested that the first conscious experience, or the initial 'onset' period of rivalry, is not random and may be different in its neural mechanism than subsequent dominance periods. It is known that differences in luminance and contrast have a significant influence on the average dominance during sustained rivalry and that perception of luminance can vary between individuals and across the visual field. We therefore investigated whether perception of luminance contrast plays a role in onset rivalry. Rival targets were matched for brightness in each of eight locations of the near periphery for each observer. Observers then viewed the rival targets for brief presentations in each of the eight locations and reported the color that was first dominant. Results show that minimizing differences in brightness and contrast yields a stronger pattern of onset dominance bias and reveals evidence of monocular dominance. Specifically a significant advantage was observed for the temporal hemifield. These results suggest that both contrast and monocular dominance play a role in onset dominance, though neither can fully explain the effect. Drawing from additional current research, a brief overview of additional factors contributing to dominance at the onset of rivalry will also be presented. Together, these results further clarify the distinction between perceptual dominance at onset and the dominance periods during subsequent alternations.

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The semantic priming effect: How to explain individual differences?

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(P2-067 July 15th, 1430-1630)

Several studies have shown that semantic priming (SP) is directly associated to the association strength between the prime and the target words (e.g., Chwilla & Kolk, 2002). However, Yap et al. (2010) showed that this phenomenon was only observed in people with little vocabulary knowledge. They argued that participants with more vocabulary knowledge made equally strong representations for weak and strong related stimuli. However, this explanation is not sufficient because individual differences in SP have been shown even when vocabulary is controlled. We hypothesize that the SP effect should be larger for participants who are more able to identify similarities between words, independently of their vocabulary knowledge, and that this ability would depend on implicit learning processes (see Kaufman et al., 2010). In Experiment 1, participants performed two tasks. In the first one, they were presented a pair of words for which they were asked to identify as many words as possible which could associate both these words. In the second one, they performed an SP task (i.e., a lexical decision task in which some prime and target pairs were semantically related). In Experiment 2, they performed an implicit learning task (i.e, serial reaction time task) and an SP task. Results show that, when vocabulary is controlled, the SP effect is determined by the ability to identify similarities between concepts and by implicit learning abilities. These results are discussed in the context of Ullman's (2001) declarative/procedural model and of dual process theory.

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Using choice blindness to shift political attitudes and voter intentions

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(P2-068 July 15th, 1430-1630)

Political candidates often believe they must focus their campaign efforts on a small number of swing voters open for ideological change. Based on the wisdom of opinion polls, this might seem like a good idea. But do most voters really hold their political attitudes so firmly that they are unreceptive to persuasion? We tested this premise during the most recent general election in Sweden, in which a left- and a right-wing coalition were locked in a close race. Our participants stated their voter intention, and answered a political survey of wedge issues between the two coalitions. Using a sleight-of-hand we then altered their replies to place them in the opposite political camp, and invited them to reason about their attitudes on the manipulated issues. Finally, we summarized their survey score, and asked for their voter intention again. The results showed that no more than 22% of the manipulated replies were detected, and that a full 92% of the participants accepted and endorsed our altered political survey score. Furthermore, the final voter intention question indicated that as many as 48% were willing to consider a left-right coalition shift. This can be contrasted with the established polls tracking the Swedish election, which registered maximally 10% voters open for a swing. Our results indicate that political attitudes can be far more flexible than what is assumed by the polls, and that people can reason about the factual issues of the campaign with considerable openness to change.

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Multisensory integration across interoceptive and exteroceptive domains modulates the experience of body ownership

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(P2-038 July 15th, 1430-1630)

The experience of owning and identifying with a particular body is a central aspect of conscious selfhood. This

experience is thought to depend on multisensory integration of body-related signals across exteroceptive and interoceptive domains. Previous work exemplified by the classical “rubber hand illusion” has demonstrated that body-ownership can be modulated by manipulating exteroceptive (visual and tactile) feedback. The strength of these effects is associated with individual interoceptive sensitivity, suggesting a link between exteroceptive and interoceptive processing. However, a direct connection between interoceptive feedback and the experience of body ownership has not previously been shown. Here, we demonstrate such a connection by implementing a version of the rubber hand illusion incorporating visual feedback of interoceptive (cardiac) signals, using augmented reality and physiological monitoring. This allows us to superimpose a “virtual rubber hand” within a participant’s visual field, the visual appearance of which can be modulated by cardiac signals such that the modulation is either synchronous, or asynchronous, with a participant’s actual heartbeat. We find that synchronous “cardio-visual feedback” leads to enhanced ownership of the virtual hand, when assessed by both objective and subjective measures. We also replicate the standard visuo-tactile rubber-hand results within our virtual environment. Finally, our data suggest positive correlations between individual interoceptive sensitivity and the strength of both the cardio-visual and tactile-visual illusions. Altogether, our results establish that interoceptive signals can directly influence the experience of body ownership via multisensory integration within individual subjects, and they lend support to models of conscious selfhood based on interoceptive predictive coding.

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Affective modulation of agency and its role in self-serving and self-blaming bias

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(P1-080 July 14th, 1330-1530)

The belief that actions and external events are under control of conscious will is pervasive, and it is rarely doubted. This belief is built on a feeling that one’s intentional actions caused specific events in the outside world (sense of agency). However, people often make misjudgment on causality depending on rewarding or punishing outcomes of action. One well-known phenomenon is self-serving bias; when one’s voluntary action caused negative outcome, subject tend to build a post-hoc account that negative outcome was caused by external factors. In contrast, patients with depression show opposite causality bias: they tend to attribute cause of negative event more to themselves than external factors. Although these self-serving and self-blaming biases imply that rewarding and punishing outcome of action exercise different effects on agency depending on subject’s internal affective states, empirical evidence to this issue is lacking. In the present study, using a variant of action-effect binding (intentional binding) paradigm combined with classical conditioning procedures, we investigated postdictive influence of affective valence of action on agency in healthy young subjects and depressive patients. We found that non-depressive and depressive subjects showed different pattern of modulation of action-effect binding by action outcomes. In healthy subjects, consistent with self-serving bias, action-effect binding was attenuated when their action produced negative events. In contrast, depressive patients showed same degree of action-effect binding irrespective of valence of action outcome, possibly reflecting depressive realism. Our study provides a new insight for cognitive mechanism underlying human causality bias and psychopathology of depression.

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Multimodal relation between perceptual simultaneity and neural simultaneity

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(P2-040 July 15th, 1430-1630)

There are several types for the binding problem. Multimodal perceptual binding (MPB) itself is a puzzling problem in terms of cognitive binding how the several concepts and the several kinds of percept are bound together. The problem of neural binding (NB) is the more puzzling, which is often argued how the specially and also temporally separate neural activities are bound with each other. Unified binding problem, in which we would like to understand the relation between MPB and NB, has been difficult problem to solve. Relation between neural simultaneity and subjective simultaneity for several stimuli in the different modalities from each other is considered to be a key issue for understanding the unified binding problem. Audiovisual simultaneities (subjectively simultaneous time period) are measured using tone sound and flush light stimuli. The neural activities both in the primary visual cortex and the primary auditory cortex are measured by MEG (Magneto-Encephalo-Graphy) during the audiovisual experiments. Estimated Current Dipole (ECD) latency analysis within the subjectively simultaneous lag shows an extension of visual latency as if the visual response is waiting for the auditory response. Since the visual response and the auditory response can affect each other only through the neural interaction, there should exist a transmission lag between the cortices in principle. Therefore, the simultaneity among those multimodal neural responses by the extension of the visual latency has got not to be necessary. Such relation between subjective simultaneity and neural simultaneity suggests that the neural interaction requires bidirectional relation.

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Visual sampling and integration of information in object recognition

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(P2-069 July 15th, 1430-1630)

Eye movement control is relatively well understood in reading, but less so in object recognition, where research has been focused mainly on perception of scenes containing multiple objects. The current study aims to investigate eye movements during visual recognition of individual objects. The main obstacle in achieving this goal is the fact that object identification tends to be extremely fast (usually within the time-span of a single fixation). To prolong this quasi-instantaneous process and force participants to sample and integrate visual information across multiple fixations, we applied the "Dots" method developed in our laboratory (Moca et al., 2011). Starting from a source image, this method identifies regions containing contour information and then deforms a lattice of dots to represent these regions in a controlled fashion. The resulting stimulus can contain an arbitrarily small amount of information about the original image, thus being more difficult to recognize. Here we used photographic source images representing either coherent or scrambled objects. Ten healthy young adults were asked to discriminate between these two categories, and to correctly name the coherent objects. Results indicate that our method was successful in inducing participants to generate a relatively high number of fixations before reaching a decision. Additionally, exploration patterns were different for the two categories of stimuli: when viewing coherent objects, participants generated a lower number of (longer) fixations, and had a tendency to sample and integrate less of the lattice deformation, but more of the underlying contour information.

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Between memory theories and specious present theories

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(P1-023 July 14th, 1330-1530)

Theories attempting to explain the experience of the passage of time through the human experience of motion or an auditory stream have been classified by Dainton (2008) and others into three broad categories: memory, retentionalist and extensionalist theories. I argue first that the current conception of auditory working memory as involving phonological loops, and not a separate memory module, casts doubt into distinguishing the first two groups of theories. Then I propose a description of the human cognitive architecture that retains the insights of all three theories without putting them into direct competition. Three separate paths from sense to consciousness are distinguished, each roughly corresponding to one of the three theory categories, all of which are involved in normal-working human processing of change. Moreover, all three can be viewed as parts of objective perceiving, and all three are needed to explain abnormal cases such as akinetopsia. I conclude that there is an argument for including all three theory categories in a philosophical explanation of our experience of the passage of time.

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When are we determined?

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(P2-020 July 15th, 1430-1630)

The issue of free will and determinism keep focusing on the moment of decision making through years. In this paper, I argue the issue could be discussed without debating on the nature and the moment of decision making. Benjamin Libet (1999) shows that free will may not initiate a voluntary act but can veto it, but the framework is based on a controversial assumption which presupposes that free will happens at some specific moments. Daniel Dennett thus argues the framework has the problem of Cartesian Theaters that presuppose some mysterious moments of the occurrence of free will. Furthermore, Patrick Haggard recently raises a naturalized model of human volition, arguing that the volition happens in a whole process, and that the moment when free will occurs cannot be specified. The issue of free will seems to become a debate about the nature and the moment of decision making. However, by the neural evidence proposed recently, I argue that determinism could be supported without resolving such debate. A research performed by Po-Jang Hsieh (orally presented) demonstrates that aesthetic evaluations of abstract fractal art can be predicted with up to 75% accuracy by the BOLD fMRI image of brain states before the stimuli were presented. The implication of this research improves the problem of Libet's experiment. In conclusion, I argue that Hsieh's experiment shows that neural signals exist much earlier than we expected, and it show more support to the hard determinism.

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Perceptual suppression mechanisms in the fly brain: insights into loss of consciousness.

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(P2-039 July 15th, 1430-1630)

A reversible loss of consciousness (LOC) can occur under three different conditions in most animals: sleep, general anesthesia, and selective attention. While LOC in sleep and anesthesia seems obvious, the fact that humans and most other animals also become unconscious while awake, namely of unattended stimuli, suggests active mechanisms that block perception. We propose that understanding perceptual suppression mechanisms in a simple animal model, the fly *Drosophila melanogaster*, can provide insight into the mechanistic origins of consciousness. Flies have a selective attention, display different levels of sleep intensity, and are rendered unresponsive at the same general anesthetic concentrations required to produce LOC in humans. We describe these three, complementary approaches to understanding LOC in the *Drosophila* model. To study patterns of neuronal activity and coherence across the fly brain during sleep, anesthesia, or attention experiments, we have developed a multichannel recording preparation for *Drosophila*. We exploit *Drosophila* genetic tools to transiently control different circuits in the fly brain, highlighting key neuromodulators, neurotransmitters, and brain structures involved in regulating neuronal activity and coherence

across the fly brain.

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The many minds of meditation: A survey of the varied techniques of modern meditation research

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(P2-021 July 15th, 1430-1630)

The neuroscientific study of meditation has had an increasing focus since the early 2000's due to studies indicating it's clinical efficacy in treatments ranging from social anxiety to pain regulation. Meditation has been shown produce alterations in consciousness characterized by changes in electrical activity, functional connectivity, and the structures of brain regions. Despite the progress that has been made in this field, a uniform definition of meditation is yet to be developed. Furthermore, the methods used to investigate the meditative state are varied across and within these meditative practices. We have reviewed and evaluated the strengths and limitations of recent meditation and mindfulness studies to establish what common changes in consciousness consistently occur and to define some best practices for future research.

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Conscious perception of apparent motion enhances predictability

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(P1-068 July 14th, 1330-1530)

Viewing two stimuli flashing in rapid succession creates the visual illusion of apparent motion. What is, however, the functional property of perceiving motion? Recently we proposed that perceived motion helps the visual system to predict upcoming visual stimuli (Alink et al., 2010) which are then processed more efficiently. Here we investigate whether visual predictability effects are dependent or independent of conscious perception. We employed a paradigm in which subjects detected targets on the apparent motion trace, either occurring in-time (predicted) or out-of-time (unpredicted) with the illusory motion token. Consistent with earlier results (Schwiedrzik et al., 2007), we found that whenever subjects reported to have perceived motion, in-time targets were detected better than out-of-time targets. However, in trials where subjects did not perceive motion, the detection advantage of in-time targets occurred only at high apparent motion frequencies, but not at low frequencies. These results suggest that 1) targets predicted by fast continuous motion are processed more efficiently even if no motion is perceived. Thus, the internal model of predicting motion may work independently from conscious perception if the model is supported by sufficient external motion cues. 2) Predictable targets embedded in slower motion are only processed more efficiently if the illusion of apparent motion is perceived. In this case, the function of conscious perception may lie in the increase of predictability.

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What do we mean when we ask "Do we have free will"?

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(P2-022 July 15th, 1430-1630)

There are many, sometimes conflicting, definitions of free will. For a scientific approach to succeed it should not begin by selecting one such definition, but start with the definitions, incongruent or not, and specify possible empirical ways to address these, and the epistemological and methodological obstacles. Will is taken as conscious experience related to action generation. This gives rise to the same problems and questions as investigating the mind-brain problem: How will relate to neural states? The first step is to investigate phenomenological experiences related to action generation, using first-person perspective methodologies; then relate these to the physiological mechanisms in action generation. To answer whether will is free demands a different approach. Freedom can be defined in several ways, and each definition has its own metaphysical assumptions. Freedom defined as either 'genuine freedom' in the metaphysical sense, or as autonomy is considered, including how the level of analysis (psychological, fundamental, etc.) affects the scientific answers we can ask. Together this leads to the problem of mental causation. Including the previous questions, this goes beyond asking whether mental states have causal properties or are determined. Instead we should view action generation as function of a complex system, involving many conscious and unconscious processes. Empirical focus should be on describing causal pathways in neural networks and relate different experiences of will to these. For specific actions we can build model of how will contribute to action, and, depending on the definition of freedom we choose, state whether it was a "free will-action".

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Unconscious processing improves sensory decision-making

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(P2-041 July 15th, 1430-1630)

Scientists and philosophers have long been captivated by the quest to discover the possible functions of conscious awareness. Recently, the role of consciousness in the decision-making process has garnered much attention, as debate has centered around the controversial claim that information can be processed and evaluated unconsciously to improve decision accuracy. Here, we address this contentious issue through a novel paradigm that allowed us to manipulate conscious awareness while controlling decision variables. Noisy visual stimuli, which involve information being gradually accumulated until a decision has been reached, were suppressed from conscious awareness through the simultaneous presentation of a dichoptic suppression stimulus. We found that information suppressed from awareness, when presented both before and following consciously perceptible information, could be used to improve decision accuracy. We show that this improvement in accuracy increases with longer suppressed stimulus presentations, indicating that information was being accumulated over time. However, when conscious information was removed, the suppressed information could not be used for decisions. Our results provide compelling evidence that information can be accumulated in the absence of conscious awareness and used to improve decision accuracy. This unconscious boost to accuracy was not accompanied by a similar boost to confidence, suggesting that we are not aware of unconscious influences on our decisions. These findings advance our understanding of unconscious information processing and reveal the limited conscious control and metacognitive awareness we possess when making decisions.

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Meditation improves precision expectations

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(P1-024 July 14th, 1330-1530)

Empirical findings show that meditation can improve performance in the attentional blink (AB) task (Slagter et al. 2007). Based on the claim that attention can be analyzed as precision optimization (Feldman & Friston 2010, Hohwy 2012), this paper explores the hypothesis that meditation improves precision expectations. Specifically, it is argued that meditation leads (in the context of the AB task) to (a) higher temporal precision expectations or (b) lower non-temporal precision expectations. Justification for this claim is provided by arguing that subjects with lower temporal precision expectations perform worse in the AB task, while greater temporal precision expectations lead to improved performance (and vice versa for non-temporal precisions). The argument is backed up by reference to empirical studies. The paper concludes by suggesting (i) how to investigate the mechanisms through which meditation can improve precision expectations and (ii) how to connect the presented results on precision expectations to philosophical discussions about the subjective experience of time.

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A behavioral paradigm for investigating the mechanisms of conscious report

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(P1-044 July 14th, 1330-1530)

Valid and reliable behavioral tasks are needed to investigate the neural mechanisms of consciousness. Prior studies on conscious report of stimulus perception have demonstrated that attention can enhance conscious perception. However, few studies have investigated conscious report across multiple sensory modalities, with or without attentional modulation. We have developed a paradigm that implements stimulus-driven and goal-oriented behavior to reliably study conscious report, validated across different sensory modalities. We obtained behavioral data from 11 subjects cued to attend either to visual or auditory stimuli calibrated to threshold perception levels. They were then forced to identify left versus right location of either stimulus while also reporting their subjective perception of its presence. We find that when subjects report perceiving stimuli, location accuracy is very high (96% for visual, 83% auditory). This is significantly higher than for stimuli that they report not perceiving, which have accuracy near chance levels (54%, 51%; $p < 0.0001$). We also observe that attention modulates conscious perception of visual stimuli. Thus, conscious visual perception is more likely reported with visual cuing (68%) versus without visual cuing (58%; $p < 0.0001$), but this effect is not observed with auditory stimuli (53% versus 52%, respectively). These findings suggest that the current paradigm is a valid method for testing conscious report of simultaneous visual and auditory stimuli. With the addition of simultaneous high-density or intracranial electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) recording in future studies, this paradigm may allow us to isolate neural mechanisms occurring during tasks that enable subsequent conscious report.

Does embodiment contribute to the development of consciousness? Fetus simulation with a thalamocortical model

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(P1-081 July 14th, 1330-1530)

The question of how we come to be conscious through developmental processes presents a daunting challenge across disciplines. Results of recent developmental studies have suggested that a fetus or a neonate integrates multiple sensory information into an organized phenomenal experience, which is the fundamental function of consciousness. However, the underlying mechanism and the factors which contribute to the development of consciousness remain unknown. Here, we argue that embodiment structures sensory information through interaction with the environment, which then contributes to the development of consciousness. To this end, we simulated a human fetus with the following features: (i) A musculoskeletal body of which the physical parameters were adjusted to match those of a fetus; (ii) multisensory organs providing functions including vision, touch, and proprioception; (iii) a fetal environment; (iv) a large-scale nervous system consisting of spinobulbar and thalamocortical neural networks. The spinobulbar model generates whole body movements and reproduces the hallmark of spontaneous movements observed in fetuses, which are complex and highly variable. The thalamocortical model is a spiking neural network with spike-timing-dependent synaptic plasticity, which enables the network to integrate sensory information. We showed that the fetus model learned uni-sensory and multi-sensory representations of its own body and the environment, such as posture and peripersonal space. Furthermore, results showed that learned network activities exhibited widespread global synchrony and thalamocortical interactions, which match observations in existing neural correlates of consciousness. We also demonstrated the impacts of embodiment in shaping representations and characteristic network activities by changing their embodiment.

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Estimation of the number of internal states in the brain as an indicator for the conscious level and content: An ECoG study in monkeys

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(P1-045 July 14th, 1330-1530)

One key characteristic of consciousness is segregation and integration of psychological processes, which is believed to correlate with the network complexity of underlying brain dynamics. Here, our goal was to use the total number of internal states in the brain as an indicator for the network complexity, and verify its link to the level and/or the content of consciousness. We recorded electrocorticographic (ECoG) signals from most of the lateral cortex in five macaques during awake (eye-open, eye-closed), sleeping (slow-wave), and anesthetic conditions. Ketamine-medetomidine and propofol were used for the anesthetic agents. ECoG signals were binned by 200ms non-overlapped windows, and the power spectrum was calculated for each window and each channel from 5 to 100Hz. For each frequency band, the number of internal states was defined as the number of spatial patterns in the powers, which was automatically determined by a cluster analysis. We found the number of internal states in gamma frequency band was significantly greater in the awake condition than in the anesthetic and sleeping conditions. The findings suggest that non-conscious state (under anesthesia or slow-wave sleep), compared to the conscious state (awake), could be

characterized by the decrease of complexity in neural dynamics. Furthermore, the number of internal states was calculated for each cortical region. We found a significant difference between the numbers of internal states in the primary visual cortex between eye-open and eye-closed states in the awake condition, which suggests that the number of internal states could also reveal the content of consciousness (visual awareness).

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A study on the independence of theories of mental state individuation and theories of mental content individuation

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(P1-025 July 14th, 1330-1530)

The paper is about to prove that a conscious mental state seems to include multiple contents in multiple modalities and to include multiple attitudes all at once. Through a review of Rosenthal's argument of reporting and expressing, we find that for Rosenthal, it is the assertive force, i.e. the mental attitude of the higher-order thought that makes mental states conscious. Rosenthal's objection to one state with multiple attitudes, however, is not agreeable with both Gennaro's "wide intrinsicity view" and Kriegel's "cross-order information integration model"(COI). Hence, if a plausible case can be made that conscious states have complex structure with parts, then the notion of multiple attitudes become far more plausible. But if the view that multiple attitudes are incorporated into a conscious state with a multiple content structure in multiple modalities can be established, then theories of mental state (or act) individuation are orthogonal to theories of content individuation as the nature of a theory of mental state individuation is independent of that of a theory of content individuation. The position held here will be reinforced by an analogy of Frege's idea of functions in mathematics. But Frege's analogy of functions, I maintain, is inherent in the common idea that there is a large multivariate space of conscious mental states. I argue that the multivariate space, a term from physics, is like a possible world, wherein a conscious state may carry several possible variables-one for a mental content, another for the attitude towards that content, etc.

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A computational model of the rubber hand illusion

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(P1-069 July 14th, 1330-1530)

The Synchronization of Visual and Tactile Signals Model (SVT) enables us to produce a computational representation of "harmony" between different sensory modules, as seems to occur in the rubber hand illusion (RHI). The basic principles are straightforward: first, a sensory module receives input from the outside and transfers that to a synchronization mechanism. This synchronization mechanism, or inner sense, can be represented as an activation matrix, a matrix that contains the activation pattern of the nodes. Each layer of nodes can be regarded as a mental representation for positions on the finger that are brushed during the RHI. Next, the activation pattern from the visual module is compared to that of the tactile module by multiplying the non-diagonal elements of these two activation matrices. These elements represent the energy or "inner harmony" of the mechanism. When the RHI is induced, during the synchronous condition, tactile input generates an activation pattern identical to that of the visual input (or vice versa), thereby yielding a small amount of energy in the synchronization mechanism. Nearness of the energy representations for the two patterns is indicated by an algorithm. The less the energy, the more stable the mental state. Degree of synchronization is computed by $E = -\epsilon \sum_i \sum_j Z_t Z_v$ or $E = -\epsilon \sum_i \sum_j Z_v Z_t$ for $i \neq j$, with ϵ as the energy constant. The SVT model not only predicts that ownership will be experienced for the rubber hand, it also predicts that disownership will be experienced for the biological hand. Moreover, it helps explain how the unity of conscious experience is achieved, in this instance how the visual and the tactile are integrated.

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Attention modulates auditory stream segregation context effects

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(P1-070 July 14th, 1330-1530)

Auditory perceptual awareness can be studied using tone sequences of alternating low-(A) and high-(B) frequency tones. Such tone sequences can be perceptually integrated into one auditory stream or segregated into two auditory streams, with larger frequency separation (Δf) between tones increasing segregation. The perception of two streams increases over time, a context effect known as build-up. Another context effect occurs when previously hearing a tone sequence with a larger Δf leads to the perception of one stream for subsequent tone sequences. We studied how attending to context sequences influenced the percept of integration vs. segregation in a subsequent test sequence that always had an intermediate Δf . During the context sequence, the Δf varied from small to large and participants performed one of three tasks; making streaming judgments, detecting amplitude-modulated tones and performing a judgment on a visual stimulus. Results from Experiments 1 and 2 showed that although the prior Δf modulated perception of the test sequences for all context-task conditions, the effect was reduced when streaming judgments were not made during the context. Experiment 1 failed to show build-up, likely because of a silent gap that was inserted after the context. Experiment 2 omitted this silent gap, which allowed us to observe build-up. Preliminary analyses from Experiment 2 show less build-up when attention is diverted away from the context stimulus. These experiments suggest that ignoring context patterns and switching tasks modulates perception of subsequent patterns.

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Cognitive complexity and disorders of consciousness

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(P2-042 July 15th, 1430-1630)

Previous experiments report significant ERP findings in patients with DOC. Larger P3b responses have been found, if the stimuli are connected to an emotional trigger ei. the sound of a family member or the patient's own name, when compared to non-emotional stimuli. (Perrin et al., 1999, Lew et al., 1999) Brain imaging studies also show increased activity in auditory cortex, when hearing a familiar voice compared to a non-familiar voice. (Perrin et al., 2006) Experiments with N400 sentence paradigm show significant N400 responses in vegetative and near vegetative patients. (Vanhaudenhuyse et al., 2008) The aim of this study is to investigate the relationship between significant evoked response potentials (ERP), mainly focusing on mismatch negativity and N400, and consciousness level in patients with DOC. Is there a correlation between the cognitive ability to evoke a response and consciousness level? We have constructed 4 auditory paradigms with different levels of sound and semantic comprehension, reflecting a hierarchy of different cognitive complexity. These paradigms were presented to 3 different types of patients: coma-patients, vegetative and minimally conscious patients. All participants in the vegetative and minimally conscious stage were behaviourally tested with the Coma Recovery Scale- Revised. Coma patients were scores by the Glasgow Coma

scale with a value equal to or below 9 to be included. Results will be analysed with the intention to find significant ERP and in what way (if that's the case) do they correlate to the patients consciousness level.

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Percolation model for electrophysiological effects and loss of consciousness during general anesthesia

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(P2-043 July 15th, 1430-1630)

Little is understood about the systems-level mechanism of general anesthesia or the manner with which it achieves its main clinical effect - phenomenological loss of consciousness. Here, we employ a model based on percolation theory, a statistical mechanical process used to model flow through porous media, to generate the electrophysiological effects seen during anesthetic induction. Our model reproduces four features of electroencephalographic activity during general anesthesia - frequency shift, alpha synchronization, anteriorization, and burst suppression - at critical levels of inhibition in the network. Furthermore, we tie such critical phenomena to the disintegration of information transmission through a neural network. Our model also reproduces the clinical dose response curve of general anesthesia. These findings suggest network mechanisms for loss of consciousness during general anesthesia.

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ASSC 17 and the 5D Institute Present: Perception and Action in Immersive Worlds

Chairs:

Sergei Gepshtein, PhD, *Center for Neurobiology of Vision, The Salk Institute*

Alex McDowell, RDI, *School of Cinematic Arts, University of Southern California*

This one-day symposium will celebrate and promote the rapidly growing interaction between two communities: researchers engaged in the scientific study of human perception and action and the practitioners of interactive and immersive narrative media technologies. Leading researchers and artists will discuss human behavior and conscious experience vis-à-vis physical, social, and imagined realities represented in purely virtual worlds, as well as in the 'mixed' worlds that interlace physical and virtual realities.

The symposium will comprise a series of sessions, each featuring two speakers: a scientist and an artist or immersive-reality practitioner. The speakers will first present their approaches and then review both existing and prospective links between their domains of expertise. Following each session, generous time will be devoted to questions from the audience.

Speakers:

Thomas Albright - Director, Vision Center Laboratory and Conrad T. Prebys Chair in Vision Research, Salk Institute for Biological Studies

Nonny de la Peña - Fellow, Interactive Media Arts Department, University of Southern California; Documentary Filmmaker and Journalist

Sergei Gepshtein - Center for the Neurobiology of Vision, Salk Institute for Biological Studies

Perry Hoberman - Center for Stereoscopic 3D, School for Cinematic Arts, USC

Donald Hoffman – Cognitive Sciences, University of California, Irvine

Michael Kubovy - Dep't of Psychology, University of Virginia

Greg Lynn - Architecture and Urban Design, University of California, Los Angeles; Principal, Greg Lynn Form

Alex McDowell - Director, World Building Media Lab and Creative Director, 5D Institute, School of Cinematic Arts, USC

Howard Poizner - Institute for Neural Computation, University of California, San Diego

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Addendum: Errata

1. In the brief list of posters on pp. 8-13, the title of the abstract submitted by Ming-Ni Lee (p.9) should read, "Frequency of precognitive dreams and lucid dreams: Differential patterns of association with consciousness in impactful dreams." The 's' in 'dreams' was dropped from the title. We regret the error.

2. The following poster was not included in the brief list of posters on pp. 8-13, though both the abstract and detailed author and affiliation information can be found on p. 64. We sincerely apologize for the omission.

Neural signatures of perceptual transitions for a novel bistable auditory stimulus

Gray Davidson, Michael Pitts (Dep't of Psychology, Reed College Portland)

P2-081 July 15th, 14:30-16:30

3. The following poster abstracts were erroneously omitted from the program book. We sincerely apologize for these omissions.

A new perspective on the debate on synesthesia

Yi-Jen Lin [1], Allen Y. Hough [2]

[1] National Taiwan University

[2] National Yang-Ming University

P1-016, July 14th, 13:30 – 15:30

There exists a hot debate on whether synesthesia is a perceptual or cognitive phenomenon. In this paper, I will propose a new perspective on grapheme-color synesthesia, one of the most common variants of the phenomenon, to make these two theories compatible. In fact, the two groups are discussing about different issues about synesthesia. The "perceptual group" (Ramachandran and Hubbard, 2001) focuses on "how the synesthetic experience be induced" whereas the "cognitive group", who asserts that learning and cognition have a profound effect on synesthesia (Mroczko et al., 2009; Witthoft and Winawer, 2013), focuses on "the linkage between visual stimuli and the synesthetic experience". To set up or adjust the linkage between the visual stimuli and synesthetic experience is cognition-involved, however, once the linkage is connected, such synesthetic experience can be induced by perception only. According to Victor Lamme's theory (2010), the stimuli evoke a localized recurrent processing in visual cortex will become phenomenal conscious while some evoke the widespread recurrent processing, involving the frontoparietal network, will become access conscious. In the experiment performed by Mroczko et al. (2009), the learning of Glagolitic graphemes is cognition-participated, involving the activation of frontoparietal. The linkage between Glagolitic grapheme and synesthetic experience is set up after training. Therefore, when Glagolitic graphemes were presented again, the stimuli are unnecessary to be sent to frontoparietal area but being processed in the localized recurrent loop, which is perception-involved only, to induce the synesthetic experience. With this new perspective on synesthesia, the two views can be compatible, solving the problem that exist for several decades.

Fronto-parietal cortex mediates perceptual transitions in bistable perception

Weilhammer, V. A. [1], Ludwig, K. [1,2], Hesselmann, G. [1], Sterzer, P. [1]

[1] Visual Perception Laboratory, Department of Psychiatry and Psychotherapy – Charité Universitätsmedizin Berlin, Germany

[2] Klinische Psychologie, Institut für Psychologie, Mathematisch-Naturwissenschaftliche Fakultät II, Humboldt-Universität zu Berlin, Germany

P1-038, July 14th, 13.30-15.30 (*Nautilus 4 & 5*)

During bistable vision, perception oscillates between two mutually exclusive percepts while the incoming sensory information remains constant. Greater blood oxygen level dependent (BOLD) responses in fronto-parietal cortex have been shown to be associated with perceptual transitions as compared to "replay" events designed to closely match bistability in both perceptual quality and timing. It has remained controversial, however, whether this enhanced activity reflects causal influences of these regions on processing at the sensory level or, alternatively, an effect of stimulus differences that result, e.g., in longer durations of perceptual transitions in bistable perception compared to replay conditions. Using a rotating Lissajous figure in a functional magnetic resonance imaging (fMRI) experiment, we controlled for potential confounds of differences in transition duration and confirmed previous findings of greater activity in frontal and parietal

brain areas for transitions during bistable perception. In addition, we applied Dynamic Causal Modeling (DCM) to identify the neural model that best explains the observed BOLD signals in terms of effective connectivity. We found that enhanced activity for ambiguous events is most likely mediated by a modulation of top-down connectivity from frontal to visual cortex, thus arguing for a causal role of fronto-parietal cortex in perceptual transitions during bistable perception.