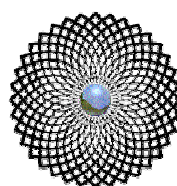

Neural Correlates of Consciousness:

Empirical and Conceptual Questions

Bremen 1998



ASSOCIATION FOR THE SCIENTIFIC
STUDY OF CONSCIOUSNESS

Neural Correlates of Consciousness: Empirical and Conceptual Questions

Main Organizer: Thomas Metzinger, *Hanse Institute for Advanced Study*

Organizing Committee: William Banks, David Chalmers, Christof Koch,
Thomas Metzinger, Antti Revonsuo, and Patrick Wilken

The second conference of the *Association for the Scientific Study of Consciousness* will be held from June 19-22, 1998, in Bremen, Germany, hosted and sponsored by the Hanse Institute for Advanced Study, Delmenhorst.

The search for neural correlates of consciousness (NCC) - specific systems in the brain that correlate directly with states of conscious experience - has become an active area of research in recent years. Methods such as single-cell recording in monkeys and brain imaging and electrophysiology in humans, applied to such phenomena as blindsight, implicit/explicit cognition, and binocular rivalry (among others), have generated a wealth of data. At the same time a number of theoretical proposals about NCC location have been put forward. In addition, important conceptual questions raised by this work are beginning to be addressed.

The ASSC conference will bring together neuroscientists, psychologists, and philosophers to focus on these issues. Empirical data from many different paradigms will be presented, along with proposals about what these results suggest concerning NCC location. Theorists will address conceptual and methodological issues concerning the search for NCCs. The conference will provide an opportunity for experimental and theoretical researchers to jointly compare and contrast NCC proposals, to consider key foundational questions, and to assess the current state and future of this area of research.

Confirmed speakers include: Ansgar Beckermann, Ned Block, David Chalmers, Patricia Churchland, Antonio Damasio, Stephen Engel, Dominic ffytche, Hans Flohr, Nick Franks, Vittorio Gallese, Melvyn Goodale, Valerie Gray Hardcastle, Beena Khurana, Christof Koch, Nikos Logothetis, Erik Lumer, Thomas Metzinger, Ernst Pöppel, Joëlle Proust, Vilayanur Ramachandran, Gerhard Roth, Arash Sahraie, Thomas Schmidt, Wolf Singer, and Petra Stoerig.

It is intended that the topic of the conference will be covered in an interdisciplinary manner and towards this end speakers are invited to discuss these issues from physiological, psychological, and philosophical perspectives.

Concurrent sessions will take place at HOLIDAY INN and ÜBERSEEHOTEL. Poster sessions, symposia and all plenary lectures will take place at DIE GLOCKE.

Program

FRIDAY, June 19

neural correlates of consciousness

9.00	WORKSHOPS: Sessions 1 – 4	
W 1	BERNARD J. BAARS <i>Using global workspace theory to clarify the brain basis of visual consciousness</i>	Holiday Inn Malmö
W 2	DAVID P. CAREY <i>Streams of processing in primate visual cortex</i>	Holiday Inn Karlstad
W 3	ANTTI REVONSUO <i>Consciousness and the binding problem</i>	Holiday Inn Göteborg
W 4	ULLIN T. PLACE <i>Consciousness and the identity theory</i>	Holiday Inn Marstrand
12.30	Lunch Break	
14.30	WORKSHOPS: Sessions 5 – 10	
W 5	TALIS BACHMANN <i>Visual masking as a tool in consciousness studies: Basic rationale, techniques, and common misunderstandings</i>	Überseehotel Bremen
W 6	C. RICHARD CHAPMAN / WOLFGANG H. R. MILTNER <i>How we hurt: An introduction to pain as a phenomenon of consciousness</i>	Holiday Inn Malmö
W 7	ROBERT F. DOUGHERTY <i>Functional magnetic resonance imaging of the human brain: Fundamentals and future directions</i>	Holiday Inn Karlstad
W 8	CHRISTOF KOCH <i>The mammalian visual system</i>	Holiday Inn Göteborg
W 9	PHIL MERIKLE / MEREDYTH DANEMAN <i>Distinguishing conscious from unconscious perception</i>	Holiday Inn Marstrand
W 10	MARTINE NIDA-RÜMELIN <i>Qualia and materialist theories of mind</i>	Überseehotel Europa
18.00	Opening Remarks and Informal Dinner	Die Glocke Foyer
20.00	PLENARY TALK CHRISTOF KOCH <i>The neural correlates of consciousness and the frontal lobes</i>	Die Glocke Kleiner Saal

SATURDAY, June 20

9.00 PLENARY SESSIONS

Die Glocke
Kleiner Saal

- 9.00 **PETRA STOERIG**
Observations pertaining to the neuronal basis of conscious vision
- 10.00 **THOMAS SCHMIDT**
Visual perception without awareness: Priming responses by colour
- 10.30 **BEENA KHURANA**
Face representation without conscious processing
- 11.00 Break
- 11.15 **VITTORIO GALLESE**
From neurons to meaning: Mirror neurons and social understanding
- 12.15 Lunch Break

14.00 CONCURRENT SESSIONS

CS 1 CS 1: The Explanatory Gap

Holiday Inn
Stockholm 1

- 14.00 **DIETER BIRNBACHER:** *Causal interpretations of correlations between neural and conscious events - the relevance of neuroscience to neurophilosophy*
- 14.30 **MICHAEL PAUEN:** *Puzzles, problems, and perspectives: Identity, property dualism, and the 'hard problem of consciousness'*
- 15.00 **MICHAEL SCHMITZ:** *Consciousness and identification*
- 15.30 **RÜDIGER VAAS:** *Toward a naturalistic theory of mind: Why neural correlates of consciousness are fine, but not enough*

CS 2 CS 2: Neural Correlates Of Thought

Holiday Inn
Malmö

- 14.00 **WOLFGANG PRINZ:** *Understanding intentionality: The NCC is not enough*
- 14.30 **WALTER J. FREEMAN:** *Intentionality is prerequisite for consciousness*
- 15.00 **DIETRICH LEHMANN:** *Brain functional microstates during spontaneous, conscious visual imagery and abstract thought - The atoms of thought*
- 15.30 **JEAN-LOUIS DESSALLES:** *Phenomenal consciousness as a phenotype*

CS 3	CS 3: Neuropathology	Holiday Inn Göteborg
14.00	GIANFRANCO DALLA BARBA: <i>Awareness of anosognosia</i>	
14.30	GEORG NORTHOFF: <i>What catatonia can tell us about the nature of consciousness: A neuropsychiatric approach</i>	
15.00	WALTER MASSING: <i>Mirror agnosia, filling-in and consciousness</i>	
15.30	KAI VOGLEY: <i>The prefrontal cortex and the self in schizophrenia research</i>	
CS 4	CS 4: Unconscious Perception	Holiday Inn Stockholm 2
14.00	ARMIN HEINECKE: <i>Unconscious perception: priming of multiple features?</i>	
14.30	ULLIN T. PLACE: <i>The neuroanatomy of consciousness and the zombie-within</i>	
15.00	LIONEL NACCACHE: <i>Imaging unconscious semantic priming: A chronometric, ERP and fMRI study</i>	
15.30	RAINER WOLF: <i>When the brain does not accept the eyes' message: Perceptual suppression of iconoclastic sensory data</i>	
Symposium	SYMPOSIUM 1 (Moderator: THOMAS METZINGER) <i>Foundational issues in the cognitive neuroscience of consciousness</i>	Die Glocke Kleiner Saal
16.00	ANSGAR BECKERMANN <i>What would it mean to explain consciousness?</i>	
16.20	DAVID CHALMERS <i>What is a neural correlate of consciousness?</i>	
16.40	JOËLLE PROUST <i>Awareness of being the actor of one's actions: Three levels of analysis</i>	
17.00	NED BLOCK <i>Why the explanatory gap is not as wide as it seems to be</i>	
17.20	Discussion	
18.00	<i>Guided Tour: Rathaus Dinner: Rathauskeller</i>	
20.00	PLENARY TALK GERHARD ROTH <i>Evolution and ontogeny of consciousness</i>	Die Glocke Kleiner Saal

SUNDAY, June 21

9.00	PLENARY SESSIONS	Die Glocke <i>Kleiner Saal</i>
9.00	WOLF SINGER <i>The putative structure of representations supporting phenomenal awareness</i>	
10.00	NIKOS LOGOTHETIS <i>Neural mechanisms underlying bistable perception</i>	
11.00	Break	
11.15	ERIK D. LUMER <i>Neural basis of perceptual rivalry in the human brain</i>	
11.45	MELVYN GOODALE <i>The role of the temporal lobe in the mediation of conscious vision</i>	
12.15	Lunch Break	
14.00	CONCURRENT SESSIONS	
CS 5	CS 5: Conceptual Foundations	Holiday Inn <i>Stockholm 1</i>
14.00	ALVA NOE: <i>Conceptions of content and consciousness</i>	
14.30	KLAUS OBERAUER: <i>Consciousness and simultaneous access in working memory</i>	
15.00	MAURICE K.D. SCHOUTEN: <i>Progress in consciousness research: Shifting references</i>	
15.30	PRADEEP MUTALIK: <i>The fallacy of the neural correlation of consciousness</i>	
CS 6	CS 6: Attention and Self	Holiday Inn <i>Malmö</i>
14.00	FRANCOIS ANCEAU: <i>The attention point, a possible location for the self</i>	
14.30	GREGOR RAINER: <i>Selective representation of relevant information in prefrontal cortex</i>	
15.00	C. ULLMANN: <i>Autobiographical memory and personal identity at the interface between neuropsychiatry and neurophilosophy</i>	
15.30	MARIA STONE: <i>Studying privileged access with functional MRI</i>	

CS 7	CS 7: Volition and Emotion	Holiday Inn Göteborg
14.00	RIMAS CUPLINSKAS: <i>Self-knowledge and self-control: Levels of reflexivity and constraints in their realization</i>	
14.30	GILBERTO GOMES: <i>Consciousness and time: A reinterpretation of Libet's results</i>	
15.00	DOUGLAS F. WATT: <i>Emotion, corticolimbic connectivities and neurodevelopment: Implications for current extended reticular thalamic activating system (ERTAS) theories of consciousness</i>	
15.30	HENRIK WALTER: <i>The neurophilosophy of free will: Theory and empirical results</i>	
CS 8	CS 8: Implicit Processes	Holiday Inn Stockholm 2
14.00	BILL BANKS: <i>Signal detection analysis of unconscious and inhibitory influences in memory and perception</i>	
14.30	ARNAUD DESTREBECQZ: <i>Using the Process Dissociation Procedure to measure implicit and explicit processes in a sequence learning task</i>	
15.00	JACKIE ANDRADE: <i>Using anaesthetics to assess the role of conscious processes in learning</i>	
15.30	BERND ANTKOWIAK: <i>Cellular mechanisms of gamma rhythms in the neocortex probed by general anaesthetics</i>	
Symposium	SYMPOSIUM 2 (Moderator: ANTTI REVONSUO) <i>The NMDA-receptor-complex and the NCC</i>	Die Glocke Kleiner Saal
16.00	<u>Target Paper:</u> HANS FLOHR <i>NMDA-receptor-complex-mediated computational processes as a candidate for the NCC</i>	
16.40	<u>Commentary 1:</u> VALERIE GRAY HARDCASTLE <i>How to understand the N in NCC</i>	
17.15	<u>Commentary 2:</u> NICK FRANKS <i>An assessment of the role of NMDA receptor function in consciousness: What can we learn from the mechanisms of general anaesthesia?</i>	
17.45	Discussion	
18.00	POSTER SESSION	Die Glocke Foyer
19.00	PLENARY TALK PATRICIA CHURCHLAND <i>Modules and muddles</i>	Die Glocke Kleiner Saal
20.30	Buffet Dinner with Music	Die Glocke Innenhof/Foyer

MONDAY, June 22

9.00	PLENARY SESSIONS	Die Glocke <i>Kleiner Saal</i>
9.00	THOMAS METZINGER <i>Being No One - Why the NCSC is important</i>	
10.00	ANTONIO DAMASIO <i>In good consciousness</i>	
11.00	Break	
11.15	VILAYANUR RAMACHANDRAN <i>What neurological syndromes can reveal about consciousness: Lessons from Capgras syndrome, phantom limbs, neglect and denial</i>	
12.15	Lunch Break	
14.00	CONCURRENT SESSIONS	
CS 9	CS 9: Consciousness and Representational Content	Holiday Inn <i>Göteborg</i>
14.00	FRANK HOFMANN: <i>Transparency and physicalist internalism</i>	
14.30	DAN RYDER: <i>The autonomic nervous system and representational theories of phenomenal consciousness</i>	
15.00	ALEXANDER STAUDACHER: <i>Can phenomenal content be explained as nonconceptual content?</i>	
15.30	MARIUS USHER: <i>Brain representations and phenomenological experience: A framework based on computational models of perception</i>	
CS 10	CS 10: NCC Methodology	Holiday Inn <i>Malmö</i>
14.00	BERNARD J. BAARS: <i>Criteria for consciousness in the brain: Methodological implications of recent developments in visual neuroscience</i>	
14.30	ERIK MYIN: <i>Criteria for the neural correlate for color experience</i>	
15.00	DONALD PERLIS: <i>The WHs of NCC</i>	
15.30	ANTTI REVONSUO: <i>A cognitive neuroscience of consciousness: Theoretical and empirical problems</i>	
CS 11	CS 11: Computational Models	Überseehotel <i>Bremen</i>
14.00	J.M. BISHOP: <i>Neural Stochastic Diffusion Search Network - A theoretical solution to the binding problem</i>	
14.30	KLAUS PAWELZIK: <i>How we know where we are: Self-Organization of Location Representations in Autonomous Agents</i>	

15.00	JUN TANI: <i>Puzzling in the middle of top-down and bottom-up pathways: A robot learning experiment</i>	
15.30	THOMAS TRAPPENBERG: <i>How does our mind wander around? A modeling point of view</i>	
CS 12	CS 12: Vision and Consciousness	Überseehotel Europa
14.00	ROLF D. HENKEL: <i>Binocular rivalry and the construction of the cyclopean view</i>	
14.30	J. D. PETTIGREW: <i>An inter-hemispheric switch in binocular rivalry?</i>	
15.00	ANTONY MORLAND: <i>To see or not to see in a human hemianope</i>	
15.30	ROMI NIJHAWAN: <i>Conscious registration of continuous and discrete visual events</i>	
CS 13	CS 13: Qualia	Holiday Inn Karlstad
14.00	ALEXANDER HEINZEL: <i>Phantom sensations and Qualia</i>	
14.30	WILLIAM ROBINSON: <i>Homogeneity and consciousness</i>	
Symposium	SYMPOSIUM 3 (Moderator: BILL BANKS) <i>Neuroimaging and the NCC</i>	Die Glocke Kleiner Saal
16.00	ARASH SAHRAIE <i>Neuronal correlates of visual processing with and without awareness</i>	
16.30	STEPHEN ENGEL <i>Comparing perceptual and cortical sensitivity to color</i>	
17.00	DOMINIC FFYTCHÉ <i>The anatomy of conscious vision</i>	
17.30	Discussion	
18.00	CONCLUDING LECTURE ERNST PÖPPEL <i>A syntopic view</i>	
19.00	End of Conference	

WORKSHOPS: Friday, June 19

Abstracts

W 1

Using Global Workspace Theory to clarify the Brain Basis of Visual Consciousness

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Global Workspace theory is a cognitive architecture designed to explain a large array of evidence about conscious and unconscious processes. It was initially developed on a large behavioral empirical base, but has more recently been applied to brain functions (Baars, 1993, Newman & Baars, 1993, Baars, 1997). Such a theory can help to organize the existing evidence, lead to functional interpretations, and suggest new, testable hypotheses. This workshop will apply the theory to four sources of evidence on visual consciousness: Binocular rivalry, blindsight, selective visual attention, and parietal neglect. Each of these research programs compares conscious and unconscious neural events that are otherwise quite similar, allowing us to "treat consciousness as a variable." Crick and Koch have further advanced a distinction between brain tissue that is necessary for visual consciousness, and regions that also "explicitly represent" the conscious event. A set of cumulative criteria is suggested, which together set a very high threshold for the identification of brain events underlying consciousness. Visual neuroscience may provide a textbook example of how to proceed in clarifying the brain mechanisms of personal experience.

Hour One: Criteria for consciousness in the brain.

Methodological implications of recent developments in visual neuroscience. Weiskrantz, Logothetis & Sheinberg, Crick & Koch, Stoerig & Cowey.

Hour Two: Consciousness has limited capacity, but creates global access in the brain.

The broad outlines of theory. A review of theoretical claims made by Crick, Damasio, Singer & Engel, Edelman, Schacter, Baars & Newman, and others. Dennett & Kinsbourne and the "Cartesian theater" critique.

Hour Three: Integrating evidence and theory.

Predictions for a functional architecture of the brain.

Readings: (Some will be provided to participants.)

Baars, B.J. (1998) Metaphors of consciousness and attention in the brain. Trends in Neurosciences. Vol. 21, No. 1.

W 2

Streams of Processing in Primate Visual Cortex

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- Cowey, A./Stoerig, P. (1992) Reflections on blindsight. In D. Milner/M.D. Rugg (Eds.) The Neuropsychology of Consciousness. London: Academic Press.
- Crick F.H.C. (1984) Function of the Thalamic Reticular Complex: The searchlight hypothesis, Proceedings of the National Academy of Sciences USA 81 4586-93 July
- Dennett, Daniel C./M. Kinsbourne (1992) Time and the observer: The where and when of consciousness in the brain. Brain and Behavioral Sciences, 15, 183-247.
- Sheinberg, D.L./Logothetis, N.K. (1997) The role of temporal cortical areas in perceptual organization. Proceedings of the National Academy of Sciences, USA, 94, 3408-3413

"Two visual systems" theory, as introduced by Ungerleider and Mishkin (1982), has represented the dominant heuristic in visual neurophysiology and neuroanatomy. The idea of two streams, specialised for spatial vision and object vision, is easy to remember and apparently fits with a host of findings in monkey and human vision. Recently, new proposals for describing the functions of these two streams have been put forward by Goodale and Milner (1992) and Jeannerod (1994). For some scientists, the distinctions between these three variants of two visual systems theory is minimal. In fact, a clear understanding of the distinctions leads to some rather different predictions about the spared and disordered visual capacities of brain damaged patients. Recent case studies in neuropsychology will be reviewed with these comparisons in mind. Similarly, the competing theories of the visual streams make rather different predictions regarding which brain regions should be most active during different visual tasks performed by neurologically-intact participants. The relevant neuroimaging literature will be summarised, contrasting the implications of the data for the rival theories.

The proposed workshop:

- A. Some excellent anatomy with a dash of neuropsychology: Ungerleider and Mishkin (1982) revisited.
- a.. Monkey lesions studies prior to 1980
- b.. Two pathways from primary visual cortex
- c.. The aftermath: A lot of covering neurophysiology in the 1980s
- B. Why so unchallenged? Thoughts on the phenomenology of visual experience
- a.. Metaphors of vision: The eye as camera (now digital, of course)
- b.. Neuropsychology: "visual disorientation" and visual agnosia
- C. Goodale and Milner (1992). The infamous DF and implications of her case for two visual systems
- a.. What is so special about visual form agnosia in DF?
- b.. Goodale and Milner's theory
- c.. Misunderstandings and criticisms (valid and not-so-valid)
- D. Jeannerod's (1994) Pragmatic and semantic streams
- a.. Jeannerod's theory
- b.. "Object-oriented" behaviours
- E. Neuroimaging studies of object recognition, space perception and visuomotor control
- a.. Earlier PET studies of object and space perception
- b.. The eye movement problem
- c.. fMRI and PET studies of perception and action
- F. Summary

W 3

Consciousness and the Binding Problem

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Binding refers to the ability of the brain to produce coherent representations of the world and harmonious, functional sequences of behavior, although information about the external world is received in multiple forms through numerous sensory channels, and initially processed in a multitude of separate pathways and areas that appear to reside in a fragmented fashion throughout the brain. Binding and integration takes place in various forms at many different levels of description and organization: (1) The phenomenal level (the contents of consciousness), (2) The level of neural and neurocognitive mechanisms, and (3) The level of organism-environment interaction. At the phenomenological level we need to ask: In what sense are the contents of consciousness normally integrated? In which ways can the contents of consciousness become disintegrated? At the neurocognitive level, we need empirically testable theories of the neural and cognitive mechanisms of binding. We need to ask: what kind of mechanisms integrate neural activity at spatially different locations into unified and functional wholes? What is the empirical evidence for 40-Hz synchronization as a mechanism of binding? At the behavioral level, we may ask: Why is integration useful anyway? Why should neural activity or conscious perception show such features in the first place?

In this workshop, the binding problem is analysed especially from the point of view of the contents of consciousness. We review the relevant conceptual foundations and empirical findings, and try to develop an understanding of the problem at the different levels of description. The core question is whether binding at the phenomenal level can be understood or explained by referring to neurocognitive mechanisms working at a different level of description.

W 4

Consciousness and the Identity Theory

ULLIN T. PLACE

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This workshop will examine whether the thesis that consciousness is a process in the brain differs from other cases of what I call "compositional type-identities" in science, such as 'Water is H₂O', 'The temperature of a body is its rate of molecular motion', 'Lightning is an electric discharge through the atmosphere', only to the extent that the brain process or processes in question have not yet been precisely specified by neuroscientific research. The rapid development of such research in recent years makes it likely that such exact specification will soon be possible. It is, therefore, imperative that we examine whether the analogy holds good, or whether the alleged disanalogies are such as to rule out such identification. We begin with a brief history of the identity theory, beginning with Boring (1933), Place (1954; 1956), Feigl (1958; 1967), Smart (1959), followed by a glance at subsequent developments, such as eliminative materialism (Feyerabend 1963; Rorty 1965; Churchland 1981), central state materialism (Armstrong 1968), token identity physicalism (Davidson 1970/1980), Kripke's (1972/1980) intuition, and the qualia problem (Nagel 1974). We shall then examine topics such as the nature of the identity relation, the 'is' of composition versus the 'is' of identity, Boring's claim that perfect correlation is identity, the process whereby compositional type identities become analytic, with a consequent change in the meaning of the common sense concept involved, once they become matters of established scientific fact, before considering some of the alleged disanalogies between the consciousness brain-process case and standard cases of compositional type-identity.

Armstrong, D.M. 1968. A materialist theory of the mind. London: Routledge and Kegan Paul.

Boring, E.G. 1933. The physical dimensions of consciousness. New York: Century.

Feigl, H. 1958. The "mental" and the "physical". In H. Feigl/M. Scriven/G. Maxwell (eds.) Minnesota studies in the philosophy of science, Volume II. Minneapolis: University of Minnesota Press, 370-497.

Feigl, H. 1967. The "mental" and the "physical": The essay and a postscript. Minneapolis: University of Minnesota Press.

Feyerabend, P.K. 1963. Materialism and the mind-body problem. The review of metaphysics, 17: 49-66.

Kripke, S. (1972/1980) Naming and necessity. In: Semantics of natural language, ed. G. Harman/D. Davidson. Dordrecht: Reidel. Reprinted with modifications as naming and necessity. Oxford: Blackwell.

Nagel, T. (1974) What is it like to be a bat? Philosophical review, 83: 435-450.

Place, U.T. 1954. The concept of heed. British journal of psychology, 45: 234-255.

Place, U.T. 1956. Is consciousness a brain process? British journal of psychology, 47: 44-50.

Smart, J.J.C. 1959. Sensations and brain processes. The philosophical review, 68: 141-156.

W 5

Visual Masking as a Tool in Consciousness Studies: Basic Rationale, Techniques, and Common Misunderstandings

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Visual masking has been one of the basic experimental methods to control the availability of visual stimulus information for the perceiver's consciousness. Regardless of the massive data gathered, the nature of the masking effect and the limits and constraints of masking as the technique have not been conclusively understood. The purpose of the workshop will be to review the essential features of the masking method, to discuss its applicability and constraints vis-a-vis the consciousness problem, and pinpoint the most often met, common, misunderstandings of its nature and potential. The neurophysiological levels of processing masked and masking visual signals will be analysed. At the end of the workshop basic conclusions as for what masking does and what it does not will be made.

W 6

How We Hurt: An Introduction to Pain as a Phenomenon of Consciousness

Pain represents tissue trauma in consciousness, but it is far more than a primitive sensation. Pain is a complex subjective experience with sensory, emotional, motivational and cognitive aspects. Research over the past quarter century has provided a rich knowledge base on the basic sensory mechanisms of pain, and new information is illuminating its emotional and cognitive dimensions. This workshop will provide an overview of current knowledge and theory concerning pain, and it will

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W 7

*Functional
Magnetic
Resonance
Imaging of the
Human Brain:
Fundamentals
and Future
Directions*

**ROBERT F.
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W 8

*The Mammalian
Visual System*

review psychophysiological research that brings consciousness issues into the pain research arena. Participants will gain: a) a basic understanding of pain mechanisms and the psychological aspects of pain) familiarity with the field of pain research including methods and current issues in the field, and c) an understanding of how pain research can contribute to knowledge and theory on consciousness.

C. Richard Chapman is Professor in the Department of Anesthesiology at the University of Washington and a Member of the Fred Hutchinson Cancer Research Center in Seattle, Washington, USA.

Wolfgang H.R. Miltner is Director and Professor at the Institute of Psychology and Chair of the Department of Biological and Clinical Psychology at Friedrich-Schiller-Universität, Jena, Germany. Both speakers are psychologists. Each has engaged in multidisciplinary laboratory and clinical research on pain for more than two decades.

Placing a human in a powerful and slightly varying magnetic field causes their tissue to emit radio-frequency energy. These RF emissions can be processed to produce a strikingly detailed image of their internal organs. This technology can also be used to measure blood oxygenation changes in the living human brain. These oxygenation changes are highly correlated with areas of heightened neural activity. Because it is non-invasive and has good spatial and temporal resolution, functional magnetic resonance imaging (fMRI) has become a popular method of exploring the workings of the human brain and mind. I will discuss how fMRI helps us to understand brain function, how it fits into the broad spectrum of neurophysiological methods, and review the basic physics and physiology behind fMRI. I will discuss general fMRI paradigms in the context of a review of recent fMRI research. There are, however, limits to what fMRI can tell us, so I will cover these as well. Fortunately, some of the limitations of present fMRI methods can be overcome. I will conclude with current and future trends in fMRI which attempt to overcome some of these limitations. These trends include: looking at the early metabolic response, rather than the more sluggish and spatially diffuse hemodynamic response that is currently imaged; innovative paradigms, such as those used to map out the human retinotopic visual areas; more powerful magnets, which produce higher signal to noise ratios; and the coregistration of fMRI with complementary techniques such as EEG and MEG.

"Vision" and "Visual Consciousness" represents - for now - the most promising model system for understanding the psychology, the neuronal basis and the function of consciousness in monkeys and humans. Any such understanding must be based on knowledge of the anatomy and physiology of the primate visual system. This three and a half hour long

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workshop will review the anatomy and the electrophysiology of the visual system of the macaque monkey, from the distal retina to the posterior parietal and inferior temporal cortices. This will be complemented by a description of the anatomy and physiology of the human visual system based on functional imaging methods (in particular fMRI). Course material will be handed out. Topics to be covered include: retina, lateral geniculate nucleus, striate/primary visual cortex (V1), extrastriate cortex (V2, V3, V3A, V4, MT), Van Essen & Felleman cortical hierarchies, pulvinar, magnocellular and parvocellular pathways, posterior parietal cortex and the dorsal pathway, inferior temporal cortex and the dorsal pathway, pathways for color, functional maps in humans using fMRI, face processing areas.

W 9

*Distinguishing
Conscious from
Unconscious
Perception*

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One issue that has motivated much of the research and thinking regarding conscious and unconscious perception concerns the most appropriate method for distinguishing conscious from unconscious perception. Even though it is generally agreed that conscious perception is perception that is accompanied by the subjective awareness of perceiving and that unconscious perception is perception that is unaccompanied by the subjective awareness of perceiving, there is no generally accepted method for capturing this distinction in experimental studies. In this workshop, we will consider the strengths and weaknesses of three major methods that have been used in attempts to capture the distinction between conscious and unconscious perception. The methods that will be considered are: 1) subjective measures of awareness, 2) objective measures of awareness, or 3) direct comparisons of qualitative differences in the influence of consciously and unconsciously perceived information on thoughts, actions, and feelings. For each method, examples will be presented to illustrate how it has been both used and misused in studies of perception without awareness, perception without attention, memory for events during anesthesia, and perception in brain-damaged patients.

W 10

*Qualia and
Materialist
Theories of
Mind*

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So-called Qualia of Experience (the specific qualitative aspect of your experience when e.g. you smell a rose or see the sky on a sunny day or listen to the sound of a violin) represent - according to widespread opinion - one of the most serious problems for materialist theories of mind. Qualia-based objections to physicalism often include the theses that (a) an epistemically satisfying description of a conscious being is necessarily formulated by using irreducibly mental terms, (b) that there are facts that cannot be expressed in physicalist vocabulary and (c) that there are facts about conscious beings that cannot be explained within empirical science at all. The workshop will present a systematic overview of the contemporary discussion about Qualia and the difficulty they represent for materialist theories of mind. Special focus will be put on the question how these issues are relevant to the interpretation of empirical theories of phenomenal experience and consciousness in general.

CONCURRENT SESSIONS: June 20-22

Abstracts in Alphabetical Order

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The Attention Point, a possible Location for the Self

In the spirit of the GW model introduced by B.J. Baars, we will make a distinction between conscious (voluntary) and non-conscious (automatic) psychological processes.

G.M. Edelman has shown that the "attentional functions" come under the control of conscious intentions. The availability of focusing one's attention could be the mechanism which could be used for triggering all the conscious mental functions, making conscious thinking an extension of the voluntary attention mechanism.

The properties of conscious thinking lead us to suggest that it is only a serial "supervising mechanism" which has no direct "functional capacity", but distributes the mental activity to non-conscious functions running in parallel.

We will call "Attention Point" the focusing point of the attention mechanism. The moving of this point makes conscious thinking serial. To perform a conscious process, this point triggers non-conscious functions by moving to their triggering areas. The moving of this point in the mental space could be controlled by global conditions (i.e. affects) that we can see as out-shaping a virtual surface on which the attention point would move like a ball.

We suggest that this point represent the Self.

The neural correlates of this theory lead us to represent this point as an activation point in a layer concerned by voluntary attentional mechanism where neurons are interconnected by long range inhibitory connections. Such kind of layer exists both in the NRT and in the layer 1 of the cortex. These two layers are bi-directionally interconnected between them. NRT is known to be implicated in the attention mechanism. Several brain nuclei are projecting on the NRT. They inhibit it during awakening states. Such inhibition could be the necessary condition for creating the attention point.

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Our research uses studies of volunteers receiving low doses of anaesthetic, and studies of patients receiving general anaesthesia for surgery, to explore the effects of loss of consciousness on implicit and explicit memory formation. We use electrophysiological measures of depth of anaesthesia to contrast the effects on learning of surgical

*Using
Anaesthetics
to assess the
Role of
Conscious
Processes in
Learning*

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*Cellular
Mechanisms of
Gamma
Rhythms in the
Neocortex
probed by
general
Anaesthetics*

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*Criteria for
Consciousness
in the Brain:
Methodological
Implications of
recent
Developments
in Visual
Neuroscience*

stimulation and arousal with those of dose of anaesthetic, and techniques such as Jacoby's process dissociation procedure to tease apart the contributions of explicit and implicit memory to performance on post-operative memory tests. Our data indicate that anaesthetics affect explicit and implicit memory equally and that some learning during surgery with general anaesthesia is explicit not implicit. Therefore, although research using divided attention and subliminal presentation methods has shown that phenomenal experience is not necessary for learning, we argue that some other aspect of consciousness is essential for implicit memory formation.

It has been proposed that cortical gamma rhythms are generated within networks of GABAergic interneurons (mutual inhibition; Whittington et al., Nature 373:612-615, 1995). To test this hypothesis, the actions of the volatile anaesthetic isoflurane on 40 Hz-oscillations in the human EEG were compared with those in neocortical brain slices. At 0.15-0.2 mM, isoflurane induced the loss of consciousness in man and simultaneously decreased the frequency of auditory evoked gamma-oscillations in the EEG by 50 per cent (Madler et al. 1991, Br.J.Anaesth.). The mutual inhibition model predicts that changes in the frequency of gamma oscillations should be inversely related to changes in the decay time constant of GABAA-receptor mediated synaptic currents (IPSCs). To test this prediction, we determined the effects of isoflurane on IPSCs recorded from voltage-clamped pyramidal cells and on gamma oscillations, detected in the local field potential of brain slices. The results were indeed in good accordance with the model: At 0.16 mM, isoflurane lengthened IPSC-decays by a factor of 1.7 and decreased the frequency of gamma oscillations by 41 per cent. NMDA-receptor antagonists like ketamine are also potent general anaesthetics but leave sensory evoked gamma-oscillations unaffected. In vivo studies have shown that, in the primary somatosensory and visual cortex, NMDA-receptor-antagonists do not alter stimulus evoked firing in cortical layers 4-6 but abolish the responses of layer 2 cells. This may indicate that, in contrast to recent suggestions (Gray/McCormick, Science 274: 109-113, 1996), pyramidal cells in the superficial layers are not an essential part of the oscillator mechanism.

When can scientists infer that some brain region or activity underlies conscious experience? That question has caused considerable controversy. Though recent empirical findings are widely accepted, debate continues about the evidence and its interpretation. Such debates are common at the leading edge of any scientific effort. Biochemists two decades ago found it useful to develop a set of explicit criteria for the identification of proteins, and a similar set of high criteria may help build a working consensus on what would constitute adequate evidence for the brain basis of conscious experience.

Recent developments in visual neuroscience suggest some possible criteria. We currently see several convergent lines of evidence, each involving comparisons between closely matched conscious and unconscious visual processes for cases like blindsight, binocular rivalry, parietal neglect, and visual selective attention. In all cases the conscious visual stream can be "reported" in detail, even by macaque monkeys, though animals obviously do not give verbal reports. Comparable unconscious processes are not reportable, but may look

very similar at the neural level. Operational distinctions can also be made between visual consciousness as such compared to closely related constructs like working memory and selective attention. Crick and Koch have further advanced a distinction between brain tissue that is necessary for visual consciousness, and regions that also “explicitly represent” the conscious event. A set of cumulative criteria is suggested, which together set a very high threshold for the identification of brain events underlying consciousness. Visual neuroscience may provide a textbook example of how to proceed in clarifying the brain mechanisms of personal experience.

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*Signal Detection
Analysis of
Unconscious
and Inhibitory
Influences in
Memory and
Perception*

We show how various sources of memory (or perceptual) information may be combined in a multivariate signal-detection model. Decisions are predicted by collapsing information onto a unidimensional decision axis and applying criteria on this axis to generate ROCs, beta, and d' or Az. We apply this analytic model to a number of experimental paradigms that have been used to study source memory, unconscious influences in recognition memory, and inhibitory process in memory and perception. Our analyses give a simpler representation than multinomial modeling, and they do not require the discrete or threshold assumptions of multinomial modeling, nor do they force an order of processing on the data. We find that a single multidimensional representation can capture the results of recognition memory, inhibitory interference, source memory, and Jacoby's exclusion measure. For each of these measures a different decision axis is generated within the same spatial model. Our results support some important conclusions of multinomial analyses of source memory. We find that conscious and unconscious influences in memory do not appear as separate dimensions but are integral aspects of recognition judgments. Applications of the methodology to neural correlates of conscious and unconscious processing will be discussed.

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*Causal
Interpretations
of Correlations
between Neural
and Conscious
Events - the
Relevance of
Neuroscience to
Neurophilosophy*

The contribution will seek to establish four theses: 1. Causal interpretations of empirical correlations between neural and conscious events are meaningful even if not fully verifiable. An account of causality can be given that makes interactionism, epiphenomenalism and Leibnizian parallelism semantically distinct conceptions of psychophysical (non-)causality. 2. Neuroscience cannot strictly prove or exclude any one out of the range of causal interpretations, but it can establish differential plausibilities, especially in combination with general methodological principles such as adequacy to established facts, simplicity, economy, and coherence. 3. Methodological principles favour a causal interpretation on epiphenomenalist lines, both for greater metaphysical parsimony and for greater coherence with established physical principles such as conservation of energy. The objections to an epiphenomenalist account of psychophysical causality put forward by K.R. Popper, H. Jonas and P. Bieri can be met. 4. An important contribution of neuroscience to the interpretative problem is the elucidation of the empirical and theoretical presuppositions of epiphenomenalism: that there are neural correlates for every conscious event, that they precede these events, that the principle of the conservation of energy holds true for the CNS, and that “causal gaps” due to an autonomous act of will are unforthcoming in the neural correlates of voluntary action.

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*Neural
Stochastic
Diffusion
Search Network
- A theoretical
Solution to the
Binding Problem*

We present a hypothetical solution to the binding problem - a subject of fundamental importance for studies of cognition and consciousness. The solution is based on the idea of tagging neuronal messages and on the mechanism of Stochastic Diffusion Search. Tags allow to organise information processing to bind separate features into coherent, stable mental representations. Binding itself is performed dynamically by Neural Stochastic Diffusion Search Network (NSDSN). The neural correlates of the percepts are, in our model, dynamic rather than static patterns of activity. These mental representations - a form of working memory - could be either further integrated into the conscious stream or unconsciously stored in the memory for further recall. In the paper we will present NSDSN and its properties in the context of visual information processing. We will also discuss neurobiological evidence that lead us to the formulation of our model. Alternative solutions to the binding problem, proposed in the literature, will be also briefly discussed.

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*Self-knowledge
and Self-
control: Levels
of Reflexivity
and Constraints
in their
Realization*

Any attempt to explain self-consciousness must, at least implicitly, deal with the phenomenon of self-knowledge. The acquisition of self-knowledge is itself a prerequisite for exercising self-control, which in turn (depending on the degree and level of reflexivity) substantiates a subject's status as a (moral) agent. In what is actually an investigation of the problem of free will (Elbow room, 1984), Daniel Dennett also analyzes the physical and practical constraints we face when designing a "perfect deliberator", i.e. a self-controlling system capable of acquiring sufficient reliable knowledge about itself and its environment to make optimal decisions (relative to its interests) under realistic time constraints. Dennett's reflections on self-knowledge go back to Ryle's observations concerning the "systematic elusiveness of 'I'" and Popper's work on the impossibility of complete self-knowledge. I wish to present and examine Dennett's work on this subject, paying special attention to the possible reflexive levels of self-control and, hence, self-knowledge, and their respective implementation in biological and technical systems. Specific to human behaviour is what I call metareflexive self-control: the level at which a system is capable of grasping, reviewing and, if need be, revising the beliefs and desires governing its own actions. Although metareflexive self-control is not itself a necessary element of self-consciousness, I claim that its prerequisite, metareflexive self-knowledge, is.

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The question of the epiphenomenality of consciousness can be addressed from an evolutionary perspective. If phenomenal consciousness is not an evolutionary epiphenomenon, but is it part of our phenotype, we should conclude that consciousness is not a functional or neuronal epiphenomenon.

Phenomenal consciousness, in each modality, is topologically structured (cf. Clark, 1993). Do phenomenal properties or the underlying neural structures have been selected through evolution? In other words, which one is the phenotype (Dawkins, 1982)?

Some bird songs have acoustic features that make them locally optimal for their (presumed) function. In such case, the song is the phenotype, whereas brain structures that make the song possible are only one element in the causal link between genes and phenotype. The

Phenomenal Consciousness as Phenotype

optimality of such brain structures is inherited from the optimality of the song. The latter can be directly assessed and even checked (e.g. with artificially produced songs). This is not true for the optimality of underlying neural structures.

A parallel argument holds for phenomenal consciousness. The topology of qualitative spaces is not fortuitous. In each sensory modality, physically most distant stimuli are experienced as most dissimilar. For signal processing theorists, this property would appear as optimally designed for a discriminative function. Since this optimal design must be the result of natural selection, phenomenal consciousness should be considered as a phenotypic character. In other words, it cannot be considered as an evolutionary epiphenomenon. This suggests a possible role of consciousness in discriminating information and, as its topological structure is specific to each modality, it can also play a role in identifying the source of information.

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Using the Process Dissociation Procedure to measure Implicit and Explicit Processes in a Sequence Learning Task

The process dissociation procedure (PDP) is proposed as a way to produce measures of implicit and explicit sequence learning in a choice reaction time task (CRTT). In such tasks, people have to react as fast and as accurately as possible to systematic sequences of events. Recent results suggest that such situations lead to the acquisition of both explicit and implicit knowledge (Jiménez & al., 1996). The PDP was first described by Jacoby (1991) in the context of implicit memory research in order to measure the consciously controlled and automatic influences of memory. We apply this framework to a CRTT in which measures of implicit (i) and explicit (e) learning are based on performance on a sequence completion task that followed the CRTT and that was performed both under inclusion and exclusion instructions. The validity of the procedure was examined by manipulating subjects' learning orientation (intentional vs. incidental conditions). Buchner & al. (1997) have shown that this manipulation leads, for the intentional subjects, to an increase in e while i stay unaffected. We failed to obtain this simple dissociation with our material, but i appears to be the main influence on performance - a result that is consistent with theories that assume that learning is essentially implicit in sequence learning situations. In additional experiments, we explore the effects of manipulating the RSI and the number of cues in the CRTT. Results will be presented at the meeting.

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We studied one patient (J.A.) who displayed anosognosia and found, surprisingly, that, while being unaware of his cognitive deficit, he was aware of his anosognosia. J.A.'s anosognosia was evaluated formally by asking him to judge his performance on four memory tests and four tests traditionally considered sensitive to frontal dysfunction. Following the execution of each test, J.A. was asked to judge his performance on a 0 (very bad)-4 (very good) point scale. His performance on all these tests was dramatically impaired. Nevertheless for each test he judged his performance to be very good, systematically assigning a score of 4

Awareness of Anosognosia

to his performance. In contrast with his anosognosia, JA was aware of his unawareness of deficit. In order to have a more formal account of the discrepancy between J.A.'s unawareness of deficit and his awareness of anosognosia, we asked to J.A. to complete a memory functions questionnaire, first according to his own feeling about his memory and then "as if he were his wife". J.A.'s wife was also asked to complete the same questionnaire. Results showed that J.A. had a very good opinion of his own memory, but when he was asked to answer as his wife would have answered, he judged his memory even worse than his wife did. We conclude that J.A.'s anosognosia is the result of his frontal damage that prevents him from performing two tasks simultaneously; he performs the task but cannot judge at the same time how the task is performed. In contrast, he derives his awareness of his anosognosia from how his family and friends react to his behaviour.

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The study of pathology has proved to be a major area of insights into the organization of human memory processes.

Approaches to human memory disorders have been largely devoted to the study of organic amnesia associated with brain damage. In contrast, psychogenic amnesia (corresponding to clinical category of dissociative amnesia) related to psychological trauma, has received sparse attention from theorists of memory at present.

In addition to its psychological origin, there are two other features that characterize dissociative amnesia: a) it usually entails restricted loss of autobiographical memory; and b) it is potentially a reversible disorder. So, although delayed recovery of childhood traumatic memories is currently under discussion, the empirical entity of this syndrom is supported by documented cases of both loss and recovery of traumatic memories in adulthood as well.

If we review organic amnesia hypotheses in relation with dissociative amnesia, the encoding/storage one must be rejected because of the intrinsic reversibility of dissociative amnesia. The retrieval (disconnective) hypothesis seems to be more plausible, but applying it to dissociative amnesia requires to postulate some kind of functional disconnection, that is, physiological (such as inhibitory disconnective mechanisms) instead anatomical (brain lesions).

There are grounds to propose a hypothesis of functional disconnection. Psychological phenomena of retrieval inhibition and neuropsychological evidence of interhemispheric inhibitory interactions could provide insights in order to develop such a hypothesis. Therefore, this report deals with the initial steps towards this direction.

Psychogenic Amnesia calls for new Enquiries into Human Memory. Mechanisms relevant to Consciousness

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Studies of the electrophysiological correlates of conditioned behavior in animals have led me to the concept of intentionality, as it was defined Aquinas, not in the Husserlian sense ("aboutness"), nor psychological senses of "purpose" and "motivation". Intentionality precedes consciousness; which cannot exist without it. Thomian intentionality has three properties.

Unity:

This is seen in the unified structure of brain activity that coordinates all parts. Learning new behaviors changes the way organisms as a whole respond to each situation, including recurrences of those already learned. It is manifested in the spatial coherence of neural activity patterns observed over sensory cortices and the limbic system.

Intentionality is Prerequisite for Consciousness

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Consciousness and Time: A Reinterpretation of Libet's Results

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Wholeness:

Organisms act to optimize performance in each action throughout life. Their genetic and environmental "thrownness" originates life trajectories that are shaped by self-organizing dynamics toward realization of maximal potential. Merleau-Ponty called this "getting a maximal grip" on the world. It is manifested in the cumulative changes in neural activity observed over long periods of training and recording.

Intent:

Each organism learns by acting into its environment and modifying itself on the basis of the consequences. All its knowledge of the world comes by adjusting its behavior as it minimizes the discrepancy between desired outcomes and what happens, Merleau-Ponty's 'intentional arc'. It is manifested in the emergent patterns created through cerebral nonlinear dynamics during learning.

An extended examination of Libet's works led to a comprehensive reinterpretation of his results (Gomes, G., forthcoming, *Consciousness and Cognition*, 1998). According to this reinterpretation, the Minimum Train Duration of electrical brain stimulation should not be used for inferring the latency for conscious sensation of peripheral origin. Backward masking with cortical stimuli suggests a 125-300 ms minimum value for the latency for conscious sensation of threshold skin stimuli. For determining temporal relations between stimuli that correspond to subjects' reports, the *end* of cerebral Minimum Train Duration should be used as reference, rather than its onset. Results of coupling peripheral and cortical stimuli are explained by a latency after the cortical Minimum Train Duration, having roughly the same duration as the latency for supraliminal skin stimuli. Results of coupling peripheral stimuli and stimuli to medial lemniscus (LM) are explained by a shorter LM latency and/or a longer peripheral latency. This interpretation suggests a 230 ms minimum value for the latency for conscious sensation of somatosensory near-threshold stimuli. The backward referral hypothesis, as formulated by Libet, should not be retained. Long readiness potentials preceding spontaneous conscious or nonconscious movements suggest that both kinds of movement are nonconsciously initiated. The validity of Libet's measures of W and M moments (Libet et al. 1983a) is questionable due to problems involving latencies, training and introspective distinction of W and M. Veto of intended actions may be initially nonconscious but dependent on conscious awareness.

Experimentally dissociating conscious and unconscious stimulus effects (Reingold/Merikle, 1988) has been a promising approach in the investigation of unconscious perception. Using this approach, Neumann/Klotz (1994) have used metacontrast-masking for studying the effects of an unconscious first stimulus (prime) on a later stimulus (target). They found that although subjects could not identify the primes, response speed on targets was nevertheless affected by the primes. We have studied the time course of priming effect, by varying the interstimulus-interval (ISI) between prime and mask (Vorberg, Mattler, Schmidt, Heinecke & Schwarzbach, 1997). Our experiments demonstrated priming effect that increase with ISI, irrespective of the subjective awareness of the primes.

The present study compares the effects of multiple features of prime stimuli, employing both colour and form as dimensions relevant for the

*Unconscious
Perception:
Priming of
Multiple
Features?*

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reactions to the target. The principle findings are: (1) Priming-effects arise from each single feature, with additive combined effects. (2) Under speed stress, primes were identified better than chance; however, this information was lost immediately, as revealed by secondary identification responses that asked for more feature details of primes. These findings will be discussed within the scope of a simple neural accumulator model.

*Phantomse-
nsations and
Qualia*

The philosophical efforts to construct a uniform physicalistic theory of consciousness are, despite many successful approaches, confronted with some obstacles which seem to be insurmountable. One of these problems consists in the phenomenal content of perception, which is described in the recent philosophical discussion by the term "qualia". In this examination a neurophilosophical method is used. The philosophical conception should directly be referred to the results of the empirical examinations (in this case clinical studies of patients). Because of their special properties the phantom sensations have been chosen. Following the philosophical conception the phantom sensations are divided in phantom sensation as a perception on the one hand and in the way it feels to have them (= qualia) on the other hand. The data of several clinical studies, which have been analysed with regard to the problem, are opposed to the philosophical theses. It results that the view of the proponents of qualia, that a pure phenomenal part of the perception should be distinguished from the whole perception, can empirically not be justified. The patients do not discriminate phantom sensation and the way it feels to have them. The philosophical conception that implies this difference is shown as empirical inadequate in this case.

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Disparate images falling onto the retinae of the two eyes can give raise to a variety of perceptual qualities: one of the most fascinating is binocular rivalry, where perception alternates between very disparate views. The images seen by the two eyes are nearly always slightly different, but more common than rivalry is fusion of these images into a single cyclopean view, accompanied by a vivid sensation of depth, or the perception of transparency.

*Binocular
Rivalry and the
Construction of
the Cyclopean
View*

All these perceptual qualities can be identified as special internal states of a neural network based on the extension of a newly proposed theory of stereo vision ["A Simple and Fast Neural Network Approach to Stereovision", R.D. Henkel, Proc. NIPS*97, MIT Press] to multiple orientation channels. The different image interpretations arise as the result of coherence-detection between competing neuronal clusters. The network is able to fuse left and right retinal images into the cyclopean view of the scene, which displays the world from a perspective located midway between the two eyes, and to handle simple cases of transparency. Image areas where rivalry occurs are marked by low coherence-counts within the fusion network.

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Neurons in the hippocampus become active when the animal is at a particular location. These responses are only weakly dependent on particular sensory inputs, e.g. they persist also in the dark.

We present a model in which such representations of spatial locations self-organize from the sequence of sensory inputs and actions.

What appears as a representation of the environment on inspection of the model arises as a consequence of a successful prediction of the inputs. Thus, representations of the actual location in our model are not

*How we know
where we are:
Self-
Organization of
Location
Representations
in Autonomous
Agents*

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*Transparency
and Physicalist
Internalism*

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functions of the input but instead the set of possible inputs is a function of the internal state.

In this sense the internal states predict the inputs, e.g. the internal states are constructive for the conceptualization of the sensations. On a longer time scale also the internal dynamics that reflects the interaction with the environment is modified such that future inputs become more likely. We demonstrate the success of our approach by computer simulations and a miniature robot which learns its location in a maze to a very high accuracy.

Although the presented scheme is exemplified here in a simple environment, it bears interesting implications for conscious and sub-conscious processing of sensory data: (1) inputs are irrelevant when accurately predicted, (2) representations are formed as a by-product of successful prediction rather than as a direct mapping of the inputs, and (3) concepts are generated by active evaluation of sensory inputs and may thus contain information that is not part of the present inputs.

I would like to challenge physicalist internalism. This is the position that qualitative character, the 'what it is like'-ness of phenomenal states, supervenes on intrinsic physical and (narrow) functional properties. There is some indication that Ned Block and Sidney Shoemaker, for example, favor such a theory of Qualia, and many neurobiologists like Roth seem to hold to that position too. Stephen White has argued against physical internalism by putting forth the 'property dualism argument'. However, this argument is not very promising since it relies on dubious semantic premisses. I would like to raise a different objection, the 'transparency objection'. This objection points at the intuition that conscious experience has a peculiar 'diaphanousness' or 'transparency' (Harman, Dretske, Tye) and challenges the physicalist internalist to come up with an explanation of this feature of conscious experience. 'Transparency' is the crucial notion here and so it has to be made more precise, which I would like to do by distinguishing different kinds of transparency theses. I distinguish ontological transparency and content transparency. Ontological transparency (introspection reveals the full and true nature of Qualia) is much too strong. Content transparency (introspection reveals only representational content) is still too strong to be backed up by the transparency intuition. Yet a more restricted kind of transparency which concerns only the spatial representational content is justified by the transparency intuition. Assuming that semantic externalism is right about representational content, it seems as though physicalist internalism cannot account for this kind of transparency. What results is a kind of weak representationalism.

Brain activity is discontinuous, as evident in brain electric recordings displaying map sequences of momentary potential distributions: for brief, subsecond time epochs, map landscapes remain quasi stable, and stable epochs are concatenated by rapid landscape changes; the stable epochs were termed "microstates", and last 75-200 msec in spontaneous activity, rarely > 1 sec (event-related microstates much shorter). "Microstate" refers to the brain's global functional state, a mosaic of local states reflecting multiple, parallel processing. Different maps of electric potential must have been generated by activity of different neural populations; accordingly, the brain executes different functions during microstates characterized by different maps. Studying

*Brain Functional
Microstates
during
Spontaneous,
Conscious
Visual Imagery
and Abstract
Thought - the
Atoms of
Thought*

conscious, spontaneous, free-floating mentation, prompted reports of recall of subjective experiences were collected in a no input, no task, no response paradigm in healthy volunteers. Reports were classified into visual imagery and abstract thought. 19 channel brain electric activity (EEG) was continuously recorded, viewed as series of momentary field maps, and segmented into microstates (data-driven strategy), i.e., into time segments of quasi-stable potential landscapes with varying durations. The two types of experiences were associated with significantly different microstates (mean duration 120 msec) immediately before prompts; for abstract thought versus visual imagery there was a left shift of the microstates' electric gravity center and a clockwise rotation of the field axis. The novel functional imaging procedure of Low Resolution Electromagnetic Tomography showed maximal activity left anterior for abstract microstates but right central-posterior maxima for visual imagery. Microstates 2 seconds before prompting did not differ between experiences. The results indicate that microstates of the brain field implement conscious, reportable mind states, i.e., different classes of mentations, and are candidates for putative "atoms of thought".

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Ramachandran et al. recently reported a neurological symptom which they named 'mirror agnosia'. Stroke patients with left visual field 'neglect' confused the mirror image of an object with a real object. Ramachandran et al. placed a mirror on the right of each patient so that they could clearly see the reflection of objects placed in their left visual field. When shown a piece of candy or a pen on their left, the patients repeatedly banged the mirror with their hand or groped behind it in an attempt to grab the reflected object.

*Mirror Agnosia,
Filling-In and
Consciousness*

In a similar manner a patient I recently examined tried to grasp objects seen in a mirror on her right when these objects had actually been placed within the area of her left visual field. When the procedure was then reversed i.e. the objects were placed in her right visual field, she grasped the objects without hesitation. Computertomography and magnetic resonance imaging showed her brain to be intact. Mirror agnosia seemed to be a completely isolated symptom in the 81 year old woman. No further neuropsychological or intellectual disorders were detected. Instead, a certain psychiatric symptom could be observed. She had a strange feeling that other persons unknown to her were living in her apartment. Further analysis of the situation revealed that she was not only unable to identify her own reflection, but thought that it was a real person unfamiliar to her. The relationship of mirror agnosia and consciousness will be discussed and particular attention will be paid to the paranoid disorder, which appears to be a kind of 'filling in' within the context of anosognosia.

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Unilateral lesion to the primary visual cortex (V1) renders a patient clinically blind in half of the visual field (hemianopia). However, within the blind hemifield some patients exhibit residual visual capacities. These visual discriminations can be made in the absence of any awareness of the stimulus (blindsight). Even when aware of the visual stimulus, the patients report that they do not actually see the stimulus. We present data that shed light on this intriguing dissociation between visual perception and visual performance. We assess the visual percepts derived from the blind and seeing hemifields of a human hemianope. The hemianope, GY, is capable of matching stimulus colour

*To See or not
to See in a
Human
Hemianope*

and speed between the two hemifields demonstrating that a conscious and explicit representation of those stimulus parameters remains accessible in the absence of V1. However, GY was incapable of matching stimulus brightness between the two hemifields, even though he could do so when stimuli were presented to his blind field alone. This finding indicates that V1 is crucial in determining a normal perceptual representation of brightness. In the absence of a normal percept of brightness, the most fundamental of all visual attributes, the hemianope is blind.

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The present work critically examines the very premise of this conference - the neural correlation of consciousness - and finds it to be an intellectual error that omits several levels of description essential to an intelligible theory.

This point is driven home by three considerations:

1) The Pentium bug analogy: It would be reasonable for an alien civilization to call 1 sq. mm. of silicon on the Pentium CPU a "silicon correlate of division." Yet for them to understand a spreadsheet error with the buggy chip would require knowledge of logic gates, microcode, CPU assembler instructions, ASCII coding, compiled language instructions etc.

2) The "Oil refinery" complexity of circuitry. Neural circuit diagrams are all so complex that to claim that any one area carries out a high level function is simplistic and wrong.

3) The "afferent stub." No one would claim that the isolated afferent stub from retina to V4, without the rest of the brain, would retain conscious visual experience. Neither would the rest of the brain. Only complex meaning-laden interactions between the two produce conscious experience.

The only realistic road to building a theory of consciousness is to try and decipher what low-level neural coding entails and how it gives rise to higher and higher levels of meaning, which is used to generate consciousness. The only kinds of theory that attempt to do this are foundational theories such as that of Natika Newton which considers motor action to be the basis of internal meaning.

*The Fallacy of
the Neural
Correlation of
Consciousness*

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There are three kinds of criterion for a neural correlate of color experience. Structural criteria are relied upon in various claims about structural similarities between neurophysiological color state space and phenomenological color state space as warrants for the reducibility of the latter to the former.

Content criteria allow to link neural activity to experience by showing the same content is carried by both. A content criterion is used in the claim that activity in V4 is the neural correlate of color experience because reactions of neurons in V4 to color stimuli are unaffected by lighting conditions.

Functionalist criteria are used when one points to functional and physical connections a candidate neural correlate has to have, as in Crick and Koch's claim about the necessity of anatomical connections with the frontal lobes.

The main problem with the first kind of criterion is that it implies a vehicle/content confusion. The third suffers from dispositionalism: it makes the status of a state as conscious dependent upon its effects on states that occur after it.

Only the second kind of criterion remains, but it should be treated with

*Criteria for the
Neural Correlate
for Color
Experience*

caution. If, as is argued to be the case, any color experience involves more than purely modular chromatic content, the computational output of a color system can only be the neural correlate of an aspect of the global phenomenal content.

A model is then sketched in which modified versions of all three kinds of criteria play a role.

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*Imaging
Unconscious
Semantic
Priming: A
Chronometric,
ERP and fMRI
Study*

We introduce a novel visual masked priming paradigm in which unconscious semantic processing can be demonstrated and visualized using functional brain imaging. In a number comparison task, visual masked numbers (primes) are briefly shown before the presentation of target numbers. Targets have to be categorized as smaller or larger than 5. Subjects do not report conscious detection of the primes. Nevertheless, reaction times are significantly shorter in congruent trials, where primes fall on the same side of 5 as targets, than in non-congruent ones. Hence, the masked primes are categorized at a semantic level. Replication of this experiment while recording event related potentials shows a highly significant priming effect on the lateralized-readiness-potential and P300. fMRI demonstrates that this effect originates from motor areas. Our results imply that an entire stream of visual, semantic and response processes, involving a cascade of brain areas, can occur outside the focus of awareness.

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*Conscious
Registration of
Continuous and
Discrete Visual
Events*

Due to significant time delays between the stimulus presentation and the corresponding cortical event(s), our perception of that stimulus is delayed. It would seem to directly follow that in the case of a continuously moving stimulus such delays should translate into perceived spatial misalignment between the object's instantaneous location and its perceived location, with the perceived location lagging. However, this expectation would be satisfied only if the visual system could not exploit the regularity of motion to correct for this spatial lag and restore alignment between the actual and the perceived locations of moving objects. Such an expectation seems to be unwarranted. The requirements of speed in visually guided action also imply a visual correction as motor plans may be too slow to perform such corrections. It is proposed that a visual process, akin to "extrapolation" (Nijhawan Nature 6487 1994), utilizes the existing cortical representation for the moving object (assuming the object has been in view for a sufficient duration) and assigns it a spatial tag that corresponds to its current (not past) location in visual space. This extrapolation process manifests itself in the "flash-lag" effect where a flashed object occupying the same location as a moving object appears to lag behind. Given that it is not possible to extrapolate a briefly flashed object, its visibility must be delayed which causes it to spatially lag the moving object. These experimental findings suggest a method for calculating the delay between a discrete physical event (flash) and its conscious registration.

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In a recent series of articles, Block has argued that theorists working on blindsight and the neural correlates of consciousness (NCC) have tended to conflate two distinct concepts of consciousness, namely, access-consciousness and phenomenal consciousness (Block 1995; 1996; forthcoming). Phenomenal consciousness is experience, whereas access-consciousness is the availability of a representation for direct control of reasoning, reporting and action. The purpose of this paper is

Conceptions of Content and Consciousness

to explore Block's arguments on behalf of this distinction (building on my 1997), and to challenge his conclusions concerning how not to search for the NCC. I shall argue, positively, for the importance of distinguishing representations at personal and subpersonal levels, and I shall argue that many discussions of the NCC, including Block's and Crick and Koch's (Crick and Koch 1995), suffer as a result of their failure to attend to this distinction. Finally, I shall explore discussions of the NCC in light of recent criticism of so-called "analytical isomorphism". (Pessoa, Thompson/Noe).

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What Catatonia can tell us about the Nature of Consciousness:

A Neuropsychiatric Approach

INTRODUCTION: Neuropsychiatric disturbances may reveal psychophysical mechanisms of psychological functions for example of consciousness. A particular interesting disease in this context is catatonia. Catatonia is a psychomotor syndrome where the patients do not realize their motor deficits though they neither speak nor move. Subsequently catatonia raises the question for a disturbance of consciousness in general or, in particular for motor consciousness as well as for the respective pathophysiological mechanisms.

METHOD: 20 akinetic catatonic patients were investigated for their subjective experience of movements, emotions and cognitions with a semistandardized self-questionnaire and compared with non-catatonic psychiatric and akinetic parkinsonian patients. In addition, regional cerebral blood flow (r-CBF) and movement-related cortical potentials (i.e. MRP; including the readiness potential) were investigated in these patients in order to correlate the three levels of investigations.

RESULTS: Catatonic patients were fully aware of strong and intense emotions and/or ambivalent cognitions but, unlike parkinsonian patients, did not realize their severe motor deficits. R-CBF studies revealed significantly ($p < 0,001$) lower perfusion in the right fronto-parietal cortex in catatonics than in the other control groups. MRP's in right-fronto-parietal electrodes showed significantly ($p < 0,05$) lower amplitudes in right fronto-parietal electrodes (F4, C4, P4). Significant correlations in r-CBF and MRP's ($p < 0,0001$) were shown only between right frontal and right parietal areas.

CONCLUSIONS: Catatonic patients seem to suffer from a selective deficit in the motor consciousness which can neither be equated with dysfunctions in attention or awareness (i.e. for example neglect) nor be generalized to consciousness in general. Deficits in motor consciousness may be related with dysfunctions in right fronto-parietal areas which are reciprocally connected with each other, the parietal area subserving representation of body and its movements in space, the frontal cortex rather monitoring and controlling the generation of representations of movements in space.

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*Consciousness
and
Simultaneous
Access in
Working
Memory*

Building on the distinction between “phenomenal consciousness” and “access consciousness” (Block, 1995), I will propose that the functional correlate of conscious experience is a particular achievement of working memory: Establishing simultaneous access to several independently varying information elements. Simultaneous access to elements that at the same time are kept distinct is a prerequisite for computing new relations. The working memory function associated with conscious experience is therefore crucial for establishing new relational knowledge. Recent data suggest that the simultaneous access function can be dissociated from the “storage and processing” function traditionally ascribed to working memory.

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*Puzzles,
Problems, and
Perspectives:
Identity,
Property
Dualism, and
the ‘Hard
Problem of
Consciousness’*

One of the most vigorous discussions in the philosophy of mind during the last years has evolved around serious doubts whether the emergence of mental properties from neural properties can be explained at all (Levine, McGinn) or within the current scientific framework (Chalmers, Nagel).

The present paper argues that these doubts can be removed if the central question is rephrased in terms of perspectives rather than in terms of properties. The question deserves interest because it sheds light on some of the fundamental problems concerning the interpretation of correlations between neural and mental states.

(1) The demand for an explanation is usually based on a distinction of neural and mental properties. It will be demonstrated that on this account, given some widely accepted premises, (a) mental properties cannot support counterfactuals, and (b) no empirical facts can provide sufficient evidence for the mere existence of these properties.

(2) These problems can be avoided if it is assumed that mental and neural properties are identical. However, this move seems to ignore the apparent difference of these properties. It is suggested that different *modes of access* can account for this discrepancy. These modes emerge from an asymmetry between first person ‘introspection’ and third person perception of the *same* state.

(3) It follows that empirical science *can* provide a non-reductionist account of conscious states. If mental and neural states are identical, then, what counts as an explanation of the former in terms of physical or chemical microproperties will count as an explanation of the latter as well.

(4) Finally, criteria, implications and problems of identity claims that are based on psycho-physical correlations are reviewed.

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We consider, in addition to the **where** of the neural correlates of consciousness, also the **what**, **why**, **how**, **which**, and even the **who** and the **when**. We suggest that these questions also have their proper and important places in the overall search for NCC, and that they may mutually reinforce one another.

Since the natural-language meanings of WH-questions are quite ambiguous (e.g., “what” can refer to a definition, a mechanism, a content, etc), we will use them simply as convenient springboards to a more careful delineation of some key questions about consciousness.

The WHs of NCC

The upshot is that we cannot expect to narrow in on the where of NCC without concurrently narrowing in on the other WHs of NCC: it is hard-to-impossible to locate something if we do not know enough to recognize it. Furthermore, we suggest that the search for an understanding of conscious experience more generally will be greatly aided by a separation of distinct sorts of questions concerning such experience.

We will outline a number of issues that are sometimes conflated and are better viewed apart. The content of consciousness, for example, is sometimes confused with consciousness itself. Thus qualia - as usually described - are aspects of the former, not the latter. This will be discussed in light of connections and contrasts with certain views of Goodman and Tye (on imagery), and of Humphrey, Nozick and Pandya (on self-reference). Finally, suggestions will be drawn from this, as to ways to look for NCC.

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Recent work by Logothetis¹ and colleagues has exploded a long-held assumption that binocular rivalry occurs early in the visual pathway. Instead, binocular rivalry appears to be a high level perceptual process akin to attention². A problem associated with this view is the way in which a high level, "top down" process such as this can organise and separate all the components contributing to each of the rivalling percepts. The symmetrical connections between the hemispheres could help with this problem. In addition, the contrasting cognitive styles of the hemispheres might require a switching process between them. We propose an alternating interhemispheric switching mechanism for rivalry. In the present investigation, we obtained evidence from caloric vestibular stimulation (a technique known to activate the contralateral hemisphere) that binocular rivalry takes place at the level of the cerebral hemispheres, with switching between hemispheres linked to the perceptual alternations.

Normal, right-handed, paid subjects were recruited from a university undergraduate class, with informed consent obtained according to a protocol approved by UQ Medical Research Ethics committee. Binocular rivalry was studied using a VisionWorks package and liquid crystal shutters to restrict presentation of a vertical moving grating to the left eye and a horizontal moving grating to the right eye. Individual biases for one or other stimulus were evident and these could be shifted predictably after caloric stimulation of the right ear. Left ear stimulation also changed biases, but in a less predictable way. The results are consistent with the hypothesis of hemispheric switching. Transcranial magnetic stimulation of one hemisphere during binocular rivalry was phase-specific, consistent with the switching hypothesis.

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An Inter-hemispheric Switch in Binocular Rivalry?

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In Chapter 3 of their book, Milner/Goodale (1995) concede that, since the ventral and dorsal streams as defined by Ungerleider/Mishkin (1982) bifurcate "downstream" of the striate cortex (V1), neither stream can account for the visual functions which survive lesions of V1 ("blindsight"). However, on their Figure 3.1 (p. 68) they show another pathway which I call the 'Sub-Cortical (S-C) to dorsal pathway' (SUPERIOR COLLICULUS, PULVINAR, POSTERIOR PARIETAL CORTEX) which bifurcates from the ventral pathway (LATERAL GENICULATE

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*The
Neuroanatomy
of
Consciousness
and the Zombie-
within*

NUCLEUS, V1-V5, INFERO-TEMPORAL CORTEX) at the retina. Not only does the S-C to dorsal pathway explain blindsight. It also coincides exactly with Michael Posner's (Posner/Petersen 1990; Posner and Dehaene 1994) "posterior attention system". This allows us to identify the superior colliculus and pulvinar with that part of the "zombie-within" (Place 1997) which involuntarily attracts the focus of conscious attention to any input which it identifies as problematic and the posterior parietal cortex as the structure which, in addition to its role in the feedback control of voluntary movement, maintains voluntary control over the focus of conscious attention (in the ventral stream in the case of vision) until a satisfactory categorization of the input is achieved. This, when combined with the known functions of the ventral pathway, allows us, in the case of vision, to identify actual anatomically defined structures corresponding to most of the functionally defined modules envisaged in 'Consciousness and the zombie-within' (Place 1997) up to the point where conscious experience gives way to categorization.

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*Understanding
Intentionality:
The NCC Is Not
Enough*

What counts as a satisfactory theory of intentionality, and how can we get at it? I will argue that grounding theory building on NCC which is commonplace today (and is also the core theme of this conference) comes up to putting the cart before the horse. Instead, before we start building a correlational theory, we need to come up with a foundational theory of intentionality. Unlike correlational theories which seek to specify the formal correlates of intentionality, foundational theories seek to specify their material foundations. Foundational theory tries to understand how the personal quality of mental experience arises - that is, on what kind of mental architecture it is based and under which psycho-historical conditions it may have emerged. I will sketch the outline of a foundational theory that accounts for both of these two components, (1) the functional conditions for the emergence of an architecture that may produce the experience of subjectivity and personal quality, and (2) the social and cultural conditions for maintaining and cultivating this architecture. In conclusion, I will argue that foundational theory comes first and correlational theory second. We first need to identify the functional basis of consciousness (FBC) before we can hope to detect its neural correlates (NCC).

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Title: Only a small fraction of the visual world reaches our awareness at any given time. Under normal conditions, we direct our gaze to the location that is currently of interest. It is possible, however, to decouple

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*Selective
Representation
of Relevant
Information in
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Cortex*

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*A Cognitive
Neuroscience of
Consciousness:
Theoretical and
Empirical
Problems*

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attention from eye position.

In this study we wanted to investigate the effect of attentional selection on prefrontal delay activity, the putative neural correlate of working memory. Monkeys were presented with visual scenes containing three objects. On blocks of trials, only one of these objects was relevant. The position and identity of the relevant object needed to be remembered over the course of a short delay. Monkeys also performed separate trials where only the relevant object was presented. In different sessions, monkeys were either allowed to gaze freely at the peripherally located objects, or were required to maintain central fixation during scene presentation.

During the presentation of the visual scenes under free gaze, monkeys spent over 70% of the time looking at the relevant object, as compared with about 10% for each of the other objects. This indicates that monkeys were selectively attending to the relevant information. The delay activity of many prefrontal neurons reflected this attention to the relevant object. Neurons fired differently to identical sample scenes depending on which object was relevant. In fact, for many of these neurons the delay activity following a given array was identical to trials in which only the relevant object was presented.

Thus prefrontal cortex communicates only currently relevant information, a property critical for normal cognition.

A reasonable starting point for the cognitive neuroscience of consciousness (CNC) would seem to be the following assumption: "Consciousness is in the brain". However, several theorists (e.g. Dretske, Tye, Hut & Shepard, Velmans), although realists and non-dualists about consciousness, deny that consciousness should be found in the brain. Do such views present a serious challenge for the possibility of CNC? I think not. The view that consciousness literally is in the brain nevertheless involves the following paradox: nothing in the brain is believed to *resemble* phenomenal experience, but if consciousness is in the brain, then there must be something in there that exactly resembles phenomenal experience, namely consciousness "itself". Is CNC possible if its basic assumption leads to such a paradox? I argue that a theory of consciousness is not only possible but necessary for cognitive neuroscience: a description of the brain cannot ever be complete if it doesn't include a description of consciousness. Consciousness itself, however, must be characterized at a level of description different from the cognitive and neural *mechanisms* of consciousness. Thus, CNC should *reconceptualize* consciousness as the phenomenal level of organization in the brain, define a useful metaphor and a model system to initially describe this level of organization, and figure out what such a view means from the empirical point of view. Crucial questions for CNC are: At which level(s) of neural organization could the phenomenal level be realized in the brain? Can such a level be measured or discovered with the current methods of functional brain imaging? What would even count as "observing", "measuring" or "imaging" the phenomenal level?

Sensory qualities are homogeneous in Sellars' (1963) sense, i.e., temporally and sometimes spatially spread out. Because homogeneity is a pervasive and distinctive feature of sensory consciousness, it ought to be taken as an important guide in the search for neural causes of consciousness. That is, we should expect those causes to share, as far

Homogeneity and Consciousness

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The Autonomic Nervous System and Representational Theories of Phenomenal Consciousness

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as possible, the properties of spatial and temporal continuity that are exhibited by homogeneous sensory consciousness. Patterns of activation that may be found in our neural processes seem to be the candidates for causes of consciousness that best fit this criterion. In this paper, the resulting Patterns As Causes of Consciousness (PACC) view is explained and contrasted with alternatives. A key argument is that computations do not exhibit the kind of continuity that we should expect of the causes of sensory consciousness, and thus, computational descriptions of neural processes are the wrong category to use when investigating the causes of consciousness. The same point is applied to information, and to higher order thought theories of consciousness. The view that monitoring is essential to sensory consciousness is considered. This view leads to some difficult questions - questions that are also difficult for a PACC view. It is argued, however, that these are empirical difficulties, not conceptual problems for the PACC view offered in this paper.

Ideally, a theory of consciousness ought to propose necessary and sufficient conditions for a state to be conscious. One obvious way to refute any such proposal is to prove that the conditions proposed by the theory are not sufficient, i.e. to provide an example of a state which meets the conditions but which is not conscious.

One instance of this strategy which has been entirely neglected is using the non conscious, autonomic nervous system (ANS) as the refuting example. In this paper, we use the ANS counterexample against representational theories of phenomenal consciousness (e.g. Dretske, Tye, Harman, and Lycan). These theories propose to transform the problem of discovering the neural correlates of phenomenal consciousness into the (more tractable) problem of discovering the neural correlates of mental representation. However, according to the conditions on consciousness that representational theories defend, the ANS ought to be conscious - but of course it is not.

We now know that the ANS, far from being a simple reflex loop, is capable of elaborate differentiated behaviours which rival in their complexity the capacities of conscious systems. The particular component of the ANS which we appeal to is the subsystem which controls blood pressure. There is good evidence that the physiology of the portion of the central autonomic network which controls haemodynamics (especially the hypothalamus, periaqueductal grey matter, rostral and caudal ventrolateral medulla, and nucleus tractus solitarius) meets the conditions of current representational theories of phenomenal consciousness.

In this paper I diagnose certain profound conceptual difficulties surrounding the notions of identification, identity statement and identity as a main source of dispute concerning explanatory gaps and ontological gulfs between consciousness and the physical world. Physicalist and neutral monism as well as dualism are shown to be unsatisfactory attempts at overcoming these difficulties. Once the confusions are dissolved, the need for any such metaphysical document disappears. The key to such a dissolution is to understand that an identity statement announces a conceptual change brought about

Consciousness and Identification

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Progress in Consciousness Research: Shifting References

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Can Phenomenal Content be explained as Nonconceptual Content?

through the integration of previously isolated conceptual material. In this way the symmetrical character of the identity relation is respected. By contrast a widely held interpretation of theoretical identification tacitly treats identity as an asymmetrical relation ("x is really only / nothing but y"). Using the apparatus developed it is finally argued that a certain kind of 'bruteness' in integrational identification is unavoidable, ubiquitous and a main source of the illusion of a gap between consciousness and the physical world that has to be filled by a strange new physics, a metaphysical doctrine of dualism or the like.

"Consciousness" is an umbrella term that covers a plurality of phenomena. The observation that this ordinary (folk) concept is vague and slippery suggests that it may not pick out a natural kind. If consciousness is not a natural kind, then the possibility of a reductive explanation is frustrated.

Reduction requires that consciousness can be identified with a presumably neural counterpart; such a transparent mapping onto neurophysiological mechanisms is not likely.

Another option with respect to the relation of consciousness to neurophysiology, *eliminative materialism*, suggests that "consciousness" is a radically false concept and that we might as well dispense with it. This view is also implausible, because "consciousness" seems to refer to at least some aspects of reality.

In this paper, a third option is suggested, viz. that "consciousness" involves a plurality of world links. Even if "consciousness" does not have natural-kind status, then, we might still say it refers to a disjoint array of aspects of reality: consciousness is associated with, what Kitcher (1993) has termed, a 'reference potential'. Theory changes may be more accurately described as *shifting reference potentials* under influence of interdisciplinary selection pressures.

Some examples of shifting references will be discussed. These show that scientific progress may lead to substantial revisions as the reference potential of "consciousness" is redirected. Some of its links will then be made more robust, whereas others are severed or added.

Philosophers like Dretske and Tye have recently argued, that the phenomenal character of perceptual states can be analyzed as a special kind of intentional or representational content. According to these authors qualia (which make up the distinctive phenomenal character of a mental state) can be identified with the properties a perceived object is represented as having. (E.g. the specific quale of a perception of the blue sky is nothing but the blue of the sky.) The kind of representational content in question is to be distinguished from other types of representational content in that it is *nonconceptual* content. Whereas the thought, that the sky is blue, is a conceptual representation of the fact, that the sky is blue, our perception of the blue sky is to be considered as a nonconceptual representation of this fact.

Is this distinction of any help for an adequate philosophical analysis of phenomenal consciousness? If it is, it should be able to close the so called "explanatory gap", i.e. why experiences have the phenomenal character they have, or why they have any phenomenal character at all. I will explore, whether the features by which the notion of nonconceptual content is generally explained (peculiar "richness" of content, inaccessibility to conceptual treatment, how the ability to

represent is acquired), will capture the essential characteristics of phenomenal consciousness and thereby close the notorious gap. I will argue, that nonconceptual content so understood can't do the required job. It neither explains why qualities like color seem the way they do, nor why perceptions have phenomenal character at all.

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Studying Privileged Access with Functional MRI

There is a long-standing philosophical debate regarding how people learn about their own states of mind. According to one view (Ryle, 1949), people acquire this knowledge in the same way they acquire knowledge about other people's beliefs, desires, preferences, etc, or about other phenomena - by accumulating evidence and making conclusions on the basis of this evidence. According to another view (Ayer, 1963), self-knowledge is qualitatively different from other kinds of knowledge in that people have "privileged access" to self-knowledge. One way of addressing this question is to compare brain mechanisms involved in making judgments about self versus judgments about others. Three experiments compared the cortical activations associated with judgments about self, judgments about others, and rational, non-psychological judgments using fMRI. Participants saw names of food items on the screen (e.g., "ice cream") and made a judgment about the food item. In the first experiment, participants' task alternated between pressing a key for items that they themselves liked ("self" judgment) and pressing a key for items that an average American liked ("other" judgment). In the next experiment, the task alternated between "self" judgment and pressing the key for the foods rich in calcium ("rational" judgment). In the last experiment, the task alternated between "other" and "rational" judgments. We compared activation in several critical areas implicated in decision making in psychological and non-psychological domains in past research, and found differences in the pattern of activation associated with "self" versus "other" judgments. Implications for the debate about privileged access will be discussed.

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Puzzling in the Middle of Top- down and Bottom-up Pathways: A Robot Learning Experiment

This study attempts to describe the notion of "self" using dynamical systems language based on results of our robot learning experiments. A mobile robot, during its travel around a given workspace, encounters landmark objects and perceives them using vision. This visual perception is performed with Hopfield type associative memory. The prefrontal module, implemented by a recurrent neural network, learns the sequences of landmark encountering as episodic memory. As the memory is consolidated incrementally, the prefrontal module begins to anticipate which landmark comes next and when it does. The landmark objects are actually recognized as the results of interactions between this top-down anticipation and the bottom-up perception. The strength of the top-down pathway is modulated dynamically depending on the predictability of the prefrontal module. Our experiments with a real robot showed that the on-line learning process of the robot goes through switching between stable and unstable phases intermittently. In the stable phase, the anticipation works well as the coherence is achieved between the internal and the environmental dynamics. In the unstable phase, conflicts arise between the bottom-up and the top-down processes; the coherence is lost and strange attractor of chaos is observed in the internal neural dynamics. We argue that the "self" does not exist in the stable phase since the cognition proceeds automatically. It, however, emerges in the unstable

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*How does our
Mind wander
around?: A
Modeling Point
of View*

phase when the internal process loses its structural coupling to the environment.

An increasing number of experiments show that consciousness has neural correlates in various cortical and sub-cortical areas, and the question has been raised how a unified conscious state can be reached without a central conscious locus. The proposed mechanism to solve such a binding problem can be divided into temporal (i.e. synchronization) or spatial (i.e. competition) mechanisms. Taylor and Alavi (1992, 1993) have demonstrated that the physiological features of the thalamus - nucleus reticularis - cortex complex can give rise to a competitive mechanisms. Taylor (1996) also showed how such competitive mechanisms could account for the experimental findings by Libet and colleagues of sensory experiences after direct stimulation of the sensory cortex of awake subjects. In this paper we will ask how the "focus of attention" can shift within the framework of such competitive mechanisms and start by exploring the behavior of such competitive networks when disconnected from the physical world which occurs during paradoxical sleep. To do this we have implemented a simple model of spiking neuron assemblies with effective short range excitatory and long range inhibitory interaction matrix. A simulation of such a model reveals an interesting dynamic of a drifting and jumping locus of attention. In addition we will review other network mechanism which could lead to a flow of attention.

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*Autobiographical
Memory and
Personal Identity
at the Interface
between
Neuropsychiatry
and
Neurophilosophy*

INTRODUCTION: In the current philosophical debate about personal identity memory is often regarded either as a necessary and/or sufficient criterion of personal identity. However, the notion of memory is often only partially specified in philosophy despite extensive neuropsychological and neuropsychiatric research in this field in the last years. The purpose of the present study was therefore to relate both fields to each other which might be enriching for both.

METHOD: First, philosophical notions of amnesia and "q-memories" are discussed concerning their importance for the problem of personal identity. Second, neuropsychological research about autobiographical memory is briefly discussed and related to the philosophical characteristics of "q-memory". Third, two examples of neuropsychiatric disturbances, ego-disturbances in schizophrenia and psychogenic amnesia, are presented and interpreted in the above discussed philosophical and neuropsychological terms.

RESULTS: First, terms like "memory" and "amnesia" cannot be regarded as "unitary terms" but should be further specified and differentiated in the current philosophical debate. Second, neuropsychological research reveals that a particular kind of consciousness may be a necessary condition for the constitution of personal identity by means of autobiographical memory. However, the exact nature of these processes remain unclear. Third, ego-disturbances in schizophrenia may represent one empirical example of "q-memories" whereas psychogenic amnesia, where patients do not only loose their memories but their feeling of personal identity as well, demonstrates the constitutive role of autobiographical memories for personal identity. CONCLUSIONS: The exchange between philosophy, neuropsychology and neuropsychiatry underlines the importance and the closes ties between autobiographical memories and personal identity which, presently, however are not well understood. Further combined

neurophilosophical and neuropsychiatric studies may reveal processes and mechanisms of the constitutive role of autobiographical memories for personal identity.

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*Brain
Representations
and
Phenomenological
Experience
A Framework
based on
Computational
Models of
Perception*

Two of the most difficult conceptual problems that need to be addressed by a biological account of consciousness are the problems of intentionality and of phenomenal experience (qualia). The first problem is illustrated by asking, "in virtue of what do brain states represent states of affairs or objects in the external world?" The second problem is to provide an account for the biological realisation of phenomenal experience. We outline here a tentative framework for a theory of brain representations and phenomenal experience, based on computational models in cognition and neuroscience. It is proposed that the essential mechanism characterising brain representations is the process of categorical perception, implemented by attractor dynamics in the neocortex. It is shown that such a stochastic, but causal, process can generate an active interpretation-like process, that maps objects in the external world to states of brain, typically associated with those objects (relative to the organism's past experience) and which can address the problem of mis-representation. It is proposed that while the referent of a mental representation is encoded by a cell population code, the phenomenological experience of mental states is encoded by spatio-temporal patterns of neural activity. Simple examples of such patterns are the firing rate and the temporal synchrony of a neural population, that could map into the vividness of a perceptual state or the confidence level of a cognitive hypothesis. More complex spatio-temporal patterns could provide an account for the rich space of phenomenal experience. Using computational models we also show how cortical structures with strong recurrent connections generate spatio-temporal patterns (similar to those observed experimentally), even in the absence of inputs, supporting an active view of the cognitive system.

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*Toward a
Naturalistic
Theory of Mind:
Why Neural
Correlates of
Consciousness
are fine, but not
enough*

Let's accept the existence of Neural Correlates of Consciousness (NCC) at least for the sake of the argument. They seem to be not strictly localized (and need not either). It is sufficient if they take the form of more or less robust spatial and/or temporal distributed relations which may perhaps be described only in abstract ways of representations, e.g. vector spaces or order parameters, and different levels of organisation (cf. Churchland 1996, Flohr 1995, Jirsa/Vaas 1995, Metzinger 1993, Roth 1994). Unfortunately, even this rather weak account is not enough for scientific and philosophical purposes. On the other hand, there's more to NCC than meets the sceptics' eye.

(I) First, I shall demonstrate how NCC can explain some important properties of our conscious experience contrary to critics of neurophilosophy. I shall discuss three topics: (1) NCC are able to explain phenomenological features of consciousness - e.g. dreaming (Braun et al. 1998, Hobson 1998, Vaas in press). (2) NCC can account for phenomenological opaque facts - e.g. the temporal structure of consciousness (Metzinger 1995, Vaas 1997a). (3) NCC reveal properties and functions of consciousness which cannot be elucidated either by introspective phenomenology or by psychological experiments alone - e.g. vision (Zeki 1997).

(II) Second, I shall review and elaborate some problems and shortcomings of NCC: (1) Correlation is not causation. (2) Limitations

of empirical access due to the problem of other minds and the problem of self-deception. (3) Inter- and even intraindividual variations. (4) NCC cannot be caught by neuroscience alone because of the externalistic content of representations (body, physical and social environment, ontogeny and phylogeny). Therefore NCC are not sufficient for a Naturalistic Theory of Mind (NTM), (5) nor are they necessary (because of the possibility of conscious Artificial and Extraterrestrial Intelligences).

(III) Third, I shall illustrate the relevance and importance of NCC to the still rather notorious mind-body or mind-brain problem (MB) (cf. Bieri 1981): (1) NCC reveal features that are necessary at least for behavioral manifestations of human consciousness and self-awareness (cf. Vaas 1996). (2) NCC are compatible with very different proposals for a solution of MB. This seems to be both advantageous and detrimental. (3) NCC restrict nomological and type-identity accounts for MB (because of II,3+4). (4) The investigation of NCC can refute empirical arguments (e.g. in the manner of Eccles 1994) for Dualism (Vaas 1997b). (5) The discovery of NCC cannot establish an NTM alone due to conceptual and empirical (II,4+5) as well as ontological reasons (Vaas 1995). Therefore philosophical arguments are required. I shall show that we need both a form of identity theory and of supervenience for an NTM; one of them alone is not sufficient. But together they may even take the sting out of the "explanatory gap" or "hard problem" (Levine 1983, Chalmers 1996), treating them only as an epistemic or semantic, but not as an ontological issue.

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The Prefrontal Cortex and the Self in Schizophrenia Research

Among the basic principles in neocortical organization are functional segregation in unimodal association cortex areas and re-integration in heteromodal association cortex areas. The prefrontal cortex is the part of the heteromodal association cortex, to which all different unimodal association cortex areas in the parietal, temporal and occipital lobes converge, anatomically and functionally. By this re-integration mechanism the internal representation of a supramodal world model in our brain appears to be constituted. Additionally, the prefrontal cortex is the strongest candidate for the neuronal implementation site of the self model. This is suggested by close anatomical connections to the limbic system and by functional imaging and neuropsychological studies, which reveal that self-monitoring capacities are implemented in the prefrontal cortex. Such self-monitoring capacities are massively disturbed in schizophrenics as in such typical phenomena like hallucinations or delusions (Frith 1993). This is the rationale for macro- and microscopic post mortem research on the prefrontal cortex of schizophrenic brains with special interest in neuronal network changes therein. Therefore, we performed a combined macro- and microanatomic study on the frontal lobe of 25 schizophrenic brains compared to age- and sex-matched control subjects. The volume of the frontal lobe was studied by planimetric analysis. Volumetric data revealed a statistically significant bilateral volume loss of the frontal lobe in male schizophrenics compared to controls (right: -35%, $p = 0,026$, left: -41%, $p = 0,007$). Volume loss in male schizophrenics was due to a decrease in length of the frontal lobe. There was no significant volume change in female schizophrenics (right: +6%, left: +16%). Additionally, the gyrification index as ratio of inner and outer contour (Zilles et al. 1988) was measured bilaterally in six different slices in all brains by automatized image analysis. Data were

statistically worked up using MANOVA. The gyrification index revealed a significant change in the right frontal lobe in male schizophrenics in the area of right frontal pole as compared to control brains ($p = 0,024$). Gyrification measurements did not reveal any significant change elsewhere. Additionally, a microscopic study on cytoarchitectonic features of Brodmann area 10 belonging to the dorsolateral prefrontal cortex was performed and revealed a statistically significant decrease in cell density on the right side of the frontal lobe of schizophrenics compared to controls. As the gross macroscopic development of the frontal lobe including gyrification and neuronal migration to the cortex is completed during fetal life, its examination provide considerable information on early brain development. Changes in the development of the brains predisposing to schizophrenia strongly support the thesis of a neurodevelopmental origin of schizophrenia. Thus, the hypothesis of self model implementation in the prefrontal cortex is supported by psychiatric brain research in the pathological condition of schizophrenia.

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*The
Neurophilosophy
of Free Will –
Theory and
Empirical
Results*

There are three main questions concerning free will and autonomy: Are we able to do otherwise? What is intelligible volition? What is agency? Philosophical positions differ in what those concepts mean and argue about their correct interpretation. How could neurobiology help here? Whatever mental states they are realized by the brain. Therefore we may ask: What is the empirical evidence that certain interpretations refer to real mental properties? For example (c.f. Walter 1998): What is the empirical evidence for a crucial role of quantum events for brain physiology? Which brain mechanisms enable us to act otherwise in similar circumstances? What are the neural correlates of choosing? Which parts of the brain play a role for our sense of agency? We may exclude some answers to the above mentioned questions as empirically unsound and find support for others. Applying this strategy an empirically based version of autonomy can be formulated. In this talk I will concentrate on volition and agency. I will discuss some recent results of neuropsychology (lesion studies) as well as some functional neuroimaging results concerning volition and agency in normals, schizophrenics and patients with obsessive-compulsive disorder. Intelligible volition depends on a circuit involving critically the prefrontal cortex, the anterior cingulate and motor systems. A sense of agency results when these mechanisms are integrated with second-and-third-order central representations of the body in the right hemisphere. Secondary emotions do play an important role for what philosophers call practical reason. Implications for philosophy and future empirical studies are discussed.

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In the burgeoning literature about the neural basis of consciousness, affect (as one of the "easy problems?") is largely relegated to the back of the bus as an interesting "coloration" to the "hard problem" of consciousness, a position that this article attempts to redress. Most current theories of consciousness neglect many lines of evidence that emotion is a central organizing process for consciousness. We review four areas that converge on the relationship between consciousness, as a global workspace, and emotion, as a composite of processes reflecting the global representation of value: 1) intrinsic relations between three neuropsychological global state functions; 2) putative neural network underpinnings of emotion and their intersections with

*Emotion,
Corticolimbic
Connectivities
and
Neurodevelop-
ment -
Implications for
Current
Extended
Reticular
Thalamic
Activating
System
(ERTAS)
Theories of
Consciousness*

ERTAS systems; 3) current hypotheses about neural correlates of clinical syndromes that are diseases of consciousness; and 4) current research into neurodevelopmental issues.

From the first vantage point of neuropsychological function, we examine the deep and intrinsic interpenetration of three global state functions: affect, attentional functions and executive functions. Although the distinction between “hard” and easy problems has already been critiqued by Baars and many others, the intrinsic interpenetration of these three global state functions further underlines the specious nature of such distinctions. Conceptual-functional analysis suggests that these global state functions (attentional function, executive function, and affect) are closely tied to the “hard” problems of self, qualia, and the seamless integration of the more “modular” functions that consciousness demonstrates as a fundamental property. All three global state functions can be conceptualized as different dimensions of the principal manifestation of global integrative processes in the brain - consciousness itself. Clinical evidence strongly supports this neuropsychological-conceptual analysis, as lesions that generate attentional and executive problems almost universally affect emotional functions also.

From the second vantage point of neural network underpinnings, affective functions are “supra-modular” functions, involving globally distributed networks running from the base of the brain to the neocortical axis - the “limbic system” at this point is so widely distributed that it has very unclear limits. Affect reflects large scale interpenetrations of the “state space” of “re-entrant” modules in many subcortical and cortical systems. This generates affect's multi-dimensionality and its patterned autonomic, endocrine, motor, subjective pain/pleasure, social/signaling, and cognitive (other/self appraisal) integrations. This composite multidimensional nature of emotion has often generated perspectives on affect analogous to the three blind men inspecting different portions of the elephant. Critical neural network correlates suggesting a close relationship between affect and putative foundations for a global workspace are: 1) the “limbic” nature of much of the reticular core, particularly its monoaminergic portions; 2) the degree of limbic connectivity to NRT/ILN thalamic systems, particularly the modulation of NRT “gatelets” by nucleus accumbens, paralimbic cortices, BG, and DM thalamus-prefrontal regions; 3) the reciprocal connections of ILN to reticular core, limbic, BG, and multiple cortical systems. These limbic connectivities of the non-specific thalamic systems thought to subserve gating and binding functions crucial to consciousness suggest that affect is much more than simple “coloration”, and that gating and binding probably depend at least in part on affect's global “valence tagging” of all other encodings.

From the third vantage point, that of clinical syndromes or “diseases of consciousness”, we examine four “diseases of consciousness” - delirium, autism, MPD (DID), and schizophrenia, with three of these syndromes strongly neurodevelopmental in origin. Schizophrenia, autism, and MPD (DID) demonstrate that early pathology of corticolimbic connectivities or severe affect trauma do not simply generate the expected personality - affective problems, but produce basic pathology of self/consciousness/qualia. Delirium is also included in this review, as it reflects the collapse of working memory, which has important implications for any theory of consciousness. In delirium “the

lights are on, but no one is home." Disruption of NRT function may be a final common pathway of its multiple etiologies. Confusional states can be generated by focal insults confined to the cingulate, underlining the critical importance of embedded representations of value for attention and the ongoing generation of working memory frames. Without working memory, intact attentional function, or coherent agency, patients with deliriums or confusional states are lacking an organized or lucid consciousness, yet are without stupor/coma. Working memory itself demonstrates a critical embedding of value within implicit goals, suggesting a central and largely neglected principle about consciousness: without representation of value embedded in every working memory frame, there can be no focus, prioritizing, or motivation. This subtle embedding of value in virtually all higher cortical encodings suggests that affect must play a crucial role in any real solution to the "binding problem" - that affective activations tell the brain what is real and what matters. This is also underlined by research into the primary psychoses, where most evidence points heavily to limbic/paralimbic involvement, suggesting that the sense of what is real is much more dependent upon limbic/paralimbic vs. neocortical activations. This is counter-intuitive to reigning assumptions that qualia are largely generated by idiosyncratic and unimodal thalamocortical activations.

From the fourth vantage point, neurodevelopmental research literature and the prototype integrative work by Schore serves as an antidote to current assumptions in theories of consciousness that we sprang like Athena from the head of Zeus, and that development of the neural architecture for consciousness is independent from the activation of primary affective states in primary attachments. We know much less about the neurodevelopment of affect - the prototypes of attachment behavior, smiling, and separation anxiety in the infant - than we do about language and vision in the adult. This may be analogous to studying calculus before being able to count on one's fingers. Research suggests that orbitalfrontal and cingulate connectivities are crucial to attachment phenomena and the early matrix of emotional experience with mother, and that the early development of the key corticolimbic connectivities that modulate NRT/ILN systems is "experience-dependent." Current (very modest) information on early neurodevelopmental processes contributing to development of self suggests a heuristic focus on progressive myelination and synaptogenesis in paralimbic, limbic and basal ganglia regions sitting over the MRF-hypothalamic-brainstem core. The largely unmyelinated status of the NRT-ILN thalamocortical complex during the first two years suggests that in early childhood it cannot serve anything like its central function in the adult, with this ILN-NRT thalamocortical system probably "bootstrapped" via initialization of matrices of representations of value deriving initially from primary attachments. From an evolutionary standpoint, all other systems of higher cortical encoding would need to be "cross-referenced" or "indexed" to a complex matrix of representations of value, as this is the only means for globally integrating multi-modal information processing done by many relatively separate dedicated modular processing systems. Without central representation of value, available "on-line", and "in real time", there may be no basis for executive or attentional function at all, consciousness thus being impossible.

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*When the Brain
does not accept
the Eyes`
Message:
Perceptual
Suppression of
Iconoclastic
Sensory Data*

Sensory illusions are perceptual artifacts. They mostly originate from an inadequate use of the brain`s ingenious data processing. Challenging one`s mind to experience binocular depth reversal provides a unique chance to introspectively watch one`s own visual system in action. Highly unfamiliar perceptions are generally suppressed. Whether or not a percept is allowed to pass into consciousness depends on former experiences, and on mental health. In subjects suffering from acute schizophrenia, and in persons under the influence of cannabis or LSD, this kind of "censorship process" is impaired. In Psychiatry, depth reversal tests thus may be applied both for diagnosis of schizophrenia, and for minimizing its medication.

Depth reversal is generally suppressed in highly familiar, "canonical" objects like cars, houses, furniture, or human faces. But even depth-reversed faces can be easily perceived as hollow when they are alienated by providing them with an artificial high-contrast surface texture, or by turning them upside down.

Suppression of "iconoclastic" data might be performed in a separate censorship process ("top-down"). Alternatively, it might occur as an integral part of the recognition process itself ("bottom-up"): Nerve excitation patterns of the input signals induced by "canonical" objects might give rise to a well-imprinted excitation pattern of such intensity that minor inconsistencies, such as the hollow shape of a face, are completely masked. This model would work without requiring a separate "censorship department". It is intriguing, however, that this process should be separately blocked by drugs, or in schizophrenics.

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Abstracts in Alphabetical Order

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Brain Systems linked to Consciousness and Reality

Gamma band EEG oscillations in a patient with bizarre somatic hallucinations T. Baldeweg, S. Spence, C. Haenschel, S.R. Hirsch, J. Gruzelier Division of Neuroscience, Imperial College School of Medicine, London and MRC Cyclotron Unit, Hammersmith Hospital, London, United Kingdom. High-frequency electrocortical oscillations play a fundamental role in neuronal mechanisms of perception. Much attention has recently centered on the search for analogous phenomena in the human EEG. The human gamma band EEG (frequency > 30 Hz) activity is, however, of very low voltage and difficult to discriminate from noise or muscle artifacts. Here we report high-amplitude gamma band EEG oscillations in a unique patient with somatic hallucinations. During EEG recording the unmedicated 36 year old man reported bizarre somatic perceptions which he had experienced with increasing duration and frequency since adolescence. He repeatedly reported popping perceptions in his left cervical, temporal and pharyngeal regions, which then moved down to other body parts, including limbs and epigastrium. When reviewing the EEG reading, we noted high-frequency transients (frequency: 20-70 Hz, amplitude: 40-200 μ V) which appeared most frequently at times when he reported the most intense symptoms. These transients were accentuated over fronto-central and parietal derivations, with clear right-sided dominance. The same EEG features were also present during a second EEG recording, and their increased incidence coincided with some worsening of his symptoms. The scalp distribution of most individual EEG transients showed a focal pattern, which enabled the estimation of equivalent dipole source locations fitted to the patient's MRI. Dipole locations in the region of the lateral primary or secondary somatosensory cortex correspond well to the left-sided dominance of his symptoms. Synchronous high-frequency thalamo-cortical oscillations have been suggested to subserve a mechanism that binds activity in disparate cortical areas into one conscious percept (Llinas et al 1993). To our knowledge, this is the first description of an association between abnormal perception and human gamma band activity.

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*Knowing that
one is thinking*

This contribution addresses a recent attempt to use introspection plus externalism about mental content to construct an a priori refutation of external-world skepticism and ontological solipsism. The suggestion is that since thought content is partly determined by affairs in the environment and since we can have non-empirical knowledge of our current thought contents, we can, just by reflection, know about the world around us; we can know that our environment is populated with content-determining entities. After examining this type of transcendental argument in detail and discussing various objections found in the literature, I argue that the notion of privileged self-knowledge underlying this argument presupposes that we can learn, via introspection, that our so-called thoughts are propositional attitudes rather than contentless states. However, if externalism is correct and thought content consists in the systematic dependency of internal states on relational properties, we cannot know non-empirically whether or not we have propositional attitudes. Self-knowledge (a propositional attitude) is consistent with us lacking the ability to rule out, via introspection, the possibility that we lack propositional attitudes. Introspection provides us with knowledge what is 'in' our minds, but not that we have minds. The combination of externalism with the doctrine of privileged self-knowledge is unproblematic for it does not allow for an a priori refutation of external-world skepticism and solipsism.

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*The
Intentionality of
Emotions*

Current theories of intentionality are mostly concerned with the intentionality of beliefs and desires, whereas emotions receive astonishingly little attention.

Within the framework of cognitive theories of emotion - while being almost entirely decoupled from current debates about intentionality - emotions are viewed as propositional attitudes. Accordingly, emotions are caused by beliefs, judgments or desires, and they have intentionality. Despite numerous refinements and hybrid theories, cognitive theories of emotion remain reductionist in two ways: (1) emotions can only be explained through their causation (i.e. beliefs, judgments, or desires); (2) the intentionality of emotions is limited to propositional attitudes (and thereby to linguistic conceptualization).

In my presentation, I want to show why cognitive theories of emotions are unable to adequately accommodate emotional states. They cannot take into account that (1) not all emotions need to have propositional content (e.g. sadness, fear); (2) emotions are neither necessarily caused by underlying judgments or beliefs, nor do they necessarily follow from beliefs or judgments (e.g. our conscious beliefs can differ greatly from our occurrent emotions); (3) our evaluations need not even be emotionally structured; (4) emotional responses to imaginary objects like artworks are real (and not imagined); and (5) emotions are closely related to physiological changes.

I endeavour to revise the conceptualization of emotions as propositional attitudes (and thereby as conscious states) in light of neurophysiological research as well as recent theories of intentionality. Finally, I attempt to outline how the shortcomings of cognitive theories of emotion can be overcome with the help of a multiple layered, developmental concept of intentionality.

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*Implicit sequence
learning:
Learning without
Knowing, or
Knowing without
Learning?*

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*The Problem of
Qualia:
Contemporary
Approaches*

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*The Essential
Role of the
Functional
Architecture in
Understanding
Consciousness*

Constant interaction with a dynamic environment - from riding a bicycle to segmenting speech - makes sensitivity to the sequential structure of the world a crucial dimension of the cognitive system. Accounts of sequence learning vary widely, with some authors arguing that parsing and segmentation processes are central, and others defending the notion that sequence learning involves mere memorization. In this paper, we argue that sequence knowledge is essentially statistical in nature and that sequence learning involves simple associative prediction mechanisms. We focus on a choice reaction situation introduced by Lee (1997), in which participants were exposed to material that follows an extremely simple rule, namely that stimuli are selected randomly but never appear more than once in a legal sequence. Perhaps surprisingly, people can learn this rule very well, seemingly without concomitant awareness of the relevant regularities. Or do they? We offer a conceptual replication of the original finding, but a very different interpretation of the results, as well as simulation work that makes it clear how highly abstract dimensions of the stimulus material can in fact be learned based on elementary associative mechanisms.

Many researchers employ models of neural networks to approach the problem of the origin of qualia (phenomenal experiences: e.g., seeing red). These models usually assume, first, that the neural circuitry conjoined with a given type of qualia (representing it, in some sense) is also engaged in realizing or creating those qualia. Second, that a sufficiently detailed model (or description) of the circuitry is identical to explaining why and how that circuitry realizes or generates qualia. I will show that this approach is both logically and experimentally incomplete, and will recommend logical criteria for evaluating solutions to this problem. Given these criteria, certain implications of modeling neural networks suggest themselves. In particular, I will first investigate some general structural aspects of feedback circuits, and indicate what particular structural types seem most likely to be requisite for the generation of qualia. I will then suggest that the internal interpretation of neural dynamics implies a "dual aspect" circuitry in the CNS, and will indicate how, in general, this circuitry is realized and some of the implications for models of consciousness.

Any system using large numbers of devices to perform complex functionality is forced to adopt a functional architecture by the needs to construct the system, recover from damage, and modify functionality. Functionality is partitioned into components which are themselves partitioned into subcomponents and so on down to device level. At every level, the information which needs to be exchanged in the course of performing component functionality must be limited. Only two types of functional architecture are possible. In the instruction architecture components exchange information translated by its source component to be unambiguous to the receiving component, and functional outputs are system instructions. In the pattern extraction architecture, components receive ambiguous internal information from other components, and outputs are system action recommendations which compete for control. Commercial electronic systems ubiquitously use the instruction architecture: major physical structures are associated

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*EEG responses
to consciously
unnoticed
harmonic music
modulations*

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with major separations of that architecture (memory, processing) and system activations can be understood as implementations of instructions on various levels. Biological brains have been constrained to adopt the pattern extraction architecture: major physiological structures are associated with major separations of that architecture (categorization, competition) and system activations can be understood as implementations of categorization/recommendation functionality on various levels of detail. The experience of constant successions of sensory independent mental images, including self images, can be understood as a function performing extensive search through individual specific memory for behavioral recommendations, and related by a functional architecture through major physiological structures including cortex, thalamus, and hippocampus to the functioning of neurons.

PURPOSE: To differentiate brain activities at a millisecond timescale for conscious vs. non-conscious steps during acoustic stimulus categorisation.

METHODS: During 11-channel EEG recordings 20 musicians heard sequences of triads drawn randomly from culturally overlearned 'diatronic' categories (84% major chords; 16% minor chords: 'deviants'). Control 'atonal' triads (tritonus-quart) incorporated the same halftone difference. Subjects either just listened or tried to detect rare deviants (2AFC: 2-Alternative Forced Choice). Chord keys changed randomly necessitating chord categorisation before deviance detection. **RESULTS:** Harmonically deviant chords evoked a "mismatch negativity" (MMN) generated at auditory cortices for conventional major/minor chords and atonal triads. Late parietal positivities (600 ms) were observed only if harmonically deviant triads were consciously detected. In contrast, MMNs (200 msec) were evoked also by missed deviant chords.

CONCLUSIONS: Cortical responses up to 200 ms were independent of cultural long-term stimulus familiarity. MMNs evoked by categorically deviant but not detected chords indicate that "*when listening to music your brain knows more than you can say*". Such information about changes in chord category might be effective in subconscious musical influences on mood modulation. The mechanism for gating to conscious perception might be studied when operating at the output pathways of the auditory cortex MMN generator.

Environmental changes represent a cause for self-organized adaptive perception and cognition: learning and memory in living organisms. It is clear that cognitive structures and functions are based on the existence in the brain of the separate channels to process the information concerning different properties of visual objects. Task dependent and visual attribute dependent representation of sensory data in higher level visual processes is one of the important psychological and neurophysiological principles of visual information processing. The peculiarities of the processes of visual discrimination learning in rhesus monkeys caused by different types of visual information concerning the shape, color, spatial information were revealed. Cluster analysis of learning characteristics obtained divided visual stimuli into separate compact classes of similar objects, each of them differing from others by the degree of its biological significance. A scheme of the process of learning is proposed, the scheme including estimation of significance of

Neurophysiological mechanisms of learning and memory in monkeys: Visual attribute dependent representation of sensory data

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A Model of Object Selection Through Temporally Correlated Neural Activity

the sensory information. Specifics of spatial information induced a shorter storage as compared with other visual attributes of the stimulus in rhesus monkeys. The findings suggest that the short-term memory mechanisms involve visual information processing in the visual system as well as spatial discriminative features maintained by the parietal cortical mechanisms. Short-term storage of visual information seems to be determined by a set of cholinergic mechanisms, each of them dealing with a certain type of visual information. These mechanisms are involved into the visual information processing and forming spatial discriminative features. The results propose that biological significance of visual attributes represents an important factor of learning and memory systems.

To recognize an object in our visual field, the visual features of that object have to be kept separate from other features in the visual field. Otherwise, recognizing that object would be led astray by irrelevant visual features. Several authors (e.g. Von der Malsburg, 1995, Singer, 1993) suggest that the human brain groups visual features by means of a temporal code. If all the features that belong to a particular object in the visual field are bound together and then selected, keeping these features separate becomes possible. The present paper presents a way how this can be achieved.

Neurophysiological evidence for the idea of a temporal code has been provided by many empirical studies (e.g. Engel, König and Singer, 1991). There is a number of neural network models that describe the neural behavior in way plausible from a neurophysiological point of view (e.g. Eckhorn, Reitboeck, Arndt, and Dicke, 1990). However, they do not provide a full account of psychophysical data. Ziebell (1995) confronts several of these models with asynchronously presented objects, i.e. for a given object, one portion of features is presented earlier than the rest of the features. The time between the presentation of both portions is called Inter-Stimulus-Interval (ISI). In all models tested this way, the time necessary to achieve a correct binding heavily depends upon the ISI. In contrast, no ISI-effect has been found in Ziebell's experiments with human participants. Thus, ISI is a critical point for the models.

In the present paper, a model of grouping and selection is proposed that accounts for the results of the psychophysical experiments mentioned above. This will be documented by simulations with different ISIs. Several other interesting properties of the model will be discussed as well.

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*Inhibition of EAA
Neurotransmission
enhances
Methohexital
Anesthesia*

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*What is the
neural correlate
of a perceptual
reversal?*

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There is a growing body of evidence that general anesthetics modify excitatory neurotransmission mediated by excitatory amino acids (Flohr, 1995; Hudspith, 1997).

In the present study the anesthetic potency of the selective non-competitive AMPA antagonist GYKI 52466 (1-(4-aminophenyl)-4-methyl-7,8-methylenedioxy-5H-2,3-benzodiazepine) was investigated. The anesthetic potency of GYKI 52466 was determined by measuring the effect on the sleeping time of a standard methohexital anesthesia (80 mg/kg i.p.) in mice. GYKI 52466 was injected i.p. in four doses 30 min before methohexital. After barbiturate injection the mice were observed for loss of righting reflex (LORR). Sleeping time was defined as the time between LORR onset and LORR offset.

Fig.1: Prolongation of methohexital induced sleeping time by four doses of GYKI 52466 ((SE). * $p < 0.05$, ** $p < 0.05$ ANOVA with Fisher PLSD.

GYKI 52466 markedly prolongs the sleeping time of methohexital anesthesia in a dose-dependent manner (Fig. 1). It has recently been shown that GYKI 52466 exerts antinociceptive effects (Székely et al., 1997). The enhancing effects on the methohexital induced sleeping time observed here suggests that the response is not only an analgesic effect but involves higher integrative functions.

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Some visual patterns, such as Necker's cube, can appear to reverse in perspective such that the stimulus remains constant but the viewers perceptual interpretation alternates. One possibility is that the rate of alternation can be increased by conscious volition or 'will power'.

A methodological problem is that reports of reversal are observer dependent and consequently subjective. It might be that observers in different experimental conditions subtly change their personal threshold for what constitutes a reversal. Without arriving at an objective measure of a reversal the role of volition can not readily be addressed.

Although evoked potentials to reversals have been recorded using EEG and MEG, they could not be used directly to measure the rate of alternation. However, we are interested to find out if a temporally-modulated Necker cube could be used to entrain the perceptual reversals at an alternation rate equal to the period of the modulation. Then the possibility exists to search for the neural correlates of reversals in free EEG recordings.

The aim of this talk is to consider the viability of neural correlates as an objective measure of perceptual reversals which would then allow us to resolve the issue of volition.

Is "unconscious perception" something different than "perception in an altered state of consciousness"? Do we need to distinguish phenomenologically between sub- and supra (= normal) liminal

**INTRA-
ANAESTHETIC
COGNITION OF
SUBLIMINALLY
PERCEIVED
INFORMATION**

perception in an Altered State of Consciousness (ASC), like anaesthesia?

These questions served as a starting-point of this investigation, which accordingly deals with the phenomenon of implicit knowledge, in particular with "intra-anaesthetic cognition" and "subliminal perception".

For the first time, there has been investigated the effect of subliminally presented information during an ASC, namely during general anaesthesia. The term "subliminally" here refers to perception of stimuli, applied close to subjective threshold of awareness.

The results of this study are as follows:

1. There have been observed significant effects of implicit memory under anaesthesia compared to the control group, i.e. there is an effect of intra-anaesthetic perception.

2. There is a tendency that the subliminally presented information during general anaesthesia has more impact on implicit memory compared to supraliminally presented one.

3. For the first time there has been applied a non-verbal, behavioural test method for assessing implicit knowledge, generated during anaesthesia - additionally to the verbal one. The results show that the non-verbal method is significantly more likely to get access to implicit knowledge than is the verbal one.

It is concluded that if one tries to investigate information processing in an ASC and/or under unconscious modalities one cannot apply the mechanisms, concepts and approaches, that are used in the normal waking state or under supraliminal conditions of perception.

Further on, the combination of (two) concepts that activate unconscious processing (ASC and unconscious modality) may act as amplifier, with regard to the evoked implicit knowledge.

Thus, the findings constitute a strong evidence that the first introductory question has to be answered in the affirmative: indeed - not only because of epistemological reasons - there is a difference between "unconscious perception" and "perception in an altered state of consciousness".

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*Hierarchic
Model of
Consciousness
and Audio-vidio
Signals Skin-
transmitter*

Hierarchic Model of Consciousness (HMC) proposed is based on original Hierarchic Concept of Matter and Field (Kaivarainen 1995; 1997). In accordance to HMC, each specific kind of neuron ensembles excitation corresponds to hierarchical system of three-dimensional (3D) standing waves of following types:

- thermal de Broglie waves produced by translations and librations of molecules;
- electromagnetic (IR) waves;
- acoustic waves;
- vibro-gravitational waves.

Corresponding hierarchic system of 24 collective excitations could be generated by quantum transitions of the coherent water clusters, localized in the microtubules of neuron bodies. These primary quantum excitations, representing coherent clusters (effectons) are resulted from high temperature molecular Bose-condensation of water. The correctness of this important statement is confirmed quantitatively by means of our theory based computer program: "Comprehensive Analyzer of Matter Properties, CAMP" (copyright 1997, A. Kaivarainen).

It is assumed in our model that collective bending or deassembly of big

number of microtubules, induced by excitation and neuron's body depolarization is interrelated with its volume and shape 'pulsation'. The twisting of centrioles in cells to parallel orientation, corresponding to maximum energy of the MTs distant interaction is an important stage of excited neurons dynamic adaptation.

As a result of cell's volume/shape pulsation, the distribution of synaptic contacts on the surface of cells and/or ionic channels activity change. These redistributions provide the long-term and short-term memory correspondingly. The processing of huge number of such 'informational acts' in the head brain is responsible for consciousness and braining (Kaivarainen, 1996).

The mechanism proposed needs the existence of feedback reaction between following stages of HMC:

- a) simultaneous depolarization of big enough number of neurons, forming ensemble;
- b) increasing the fraction of collective excitations in microtubule system of this ensemble, stimulating cavitational fluctuations in MTs due to piezoelectric perturbations of MTs structure;
- c) collective deassembly of MTs of big group of depolarized neurons due to their destabilization by Ca^{+2} and resonant energy exchange between parallel MTs by means of IR photons and vibro-gravitational waves;
- d) simultaneous generation of nerve impulses (potentials of action) in axons of these cells - collective firing;
- e) volume/shape pulsation of neuron's body and dendrites, inducing reorganization of ionic channels activity and that of synaptic contacts in the firing neuron ensembles.

Our model predicts that if the neurons or other cells, containing MTs, will be treated by acoustic or electromagnetic field with resonance frequency of internal MTs water cavitational fluctuation excitation of about 40 kHz, it can reduce the energetic threshold of simultaneous deassembly of big number of MTs, responsible for maintaining the specific cell volume and geometry. As a result, it activates the neuron's body volume/shape pulsation. Such external stimulation of supercatastrophes has two important consequences:

- the first one is generation of strong high-frequency nerve impulse, propagating via axons and exciting huge number of other nerve cells, i.e. stimulation of nerve signals transmission in living organism;
- the second one is stimulation the leaning process as far long-term memory in accordance to HMC, is related to synaptic contacts reorganization, accompanied the neuron volume/shape pulsation. The first of these two consequences of HMC is in accordance with phenomena of 'ultrasound hearing', used in 'Neurophone' (Flanagan, 1996). It consists of a (30-50)kHz ultrasonic oscillator, amplitude modulated by ordinary acoustic waves that generated 3.000 volts peak across two insulated electrodes that were placed in contact with certain skin points. The skin under the electrodes was caused to vibrate by the energy field with ultrasonic frequency. Even totally nerve-deaf people can hear with Neurophone. It was shown that the signal transmission occur via axons, not via bones.

The second of mentioned above consequence of HMC is confirmed also by means of digital Neurophone version: Thinkman Model 50. It was demonstrated that if the educational tapes were played throw device, the information is very rapidly incorporated into long-term memory (Flanagan, 1996). These data can be considered as an experimental

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*Changes in
Frontal Lobe
Functions
associated with
Hypnosis*

proof of our Hierarchic Model of Consciousness.

In accordance to our model, the elementary and primary act of the information processing is a consequence of supercatastrophe: simultaneous shrinkage of a huge number of MT with parallel orientation in distant cells.

The catastrophe of each MT is induced by the intra-tubule water superdeformation excitation. The linear dimension of superdeformation is determined by the length of librational IR standing photon, equal to 10 micron. It is important that this dimension corresponds to the average MT length in cells, confirming in such a way our idea. Another evidence in proof is that the resonance wave number of excitation of superdeformons, leading from our model is equal to 1200 (1/cm). The experiments of G. Albrecht-Buehler (1991) revealed that just around this frequency the response of surface extensions of 3T3 cells to weak IR irradiation is maximum. Our model predicts that IR irradiation of MT system "in vitro" with this frequency will dramatically increase the probability of MT catastrophes, especially when their length in the process of assembly grows up to 10 micron.

We put forward here the idea of new device: Audio/Video Skin Transmitter. It leads from our model that modulation of weak IR laser beam with wave number around: 1200 (1/cm), directed to acupuncture points of skin by audio and/or video signals should induce corresponding modulation of MTs supercatastrophe in these points. We believe that propagation of nerve signals via axons to brain centers, responsible for next stage of information can induce the perception of video and audio signals even of blind and deaf people. Using the system of flexible wave-guides linking the IR laser beam and set of sensitive skin-points the effectiveness of Audio/Video signals skin transmitter could be enhanced.

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Hypnosis has initially been conceptualized as an altered state of consciousness, while more recently non- state approaches have been popular. The development of functional brain imaging methods has produced results which suggest also dynamic changes which differentiate high from low susceptibles in response to hypnotic induction. Some results also indicate differences in the baseline, non-hypnotic situation.

In the present study, we tested the hypothesis that hypnosis involves changes in cognitive functions connected with the frontal lobes. Such "frontal" or "anterior" functions are typically associated with e.g. reflective consciousness, monitoring, and self-awareness. Individuals (N=20) with high and low susceptibility were compared on neuropsychological tests of frontal lobe function in a baseline condition and after an induction of hypnosis. The test battery included two verbal tests with a word fluency to letter designated categories and a word fluency to semantic categories, the Stroop-test and the Wisconsin Card

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*The Double
Loop, a Path
from perceived
Signals to
Concepts in
Neural
Networks*

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*The Neural
Correlate of
attentional
Dysfunction in
Asthen-
emotional
Disorder*

Sorting Test (WCST). The battery involved also three computer aided tests (reaction time, choice reaction time and a vigilance task). The results show that in the baseline state the high susceptibles show superior anterior functions to low susceptibles and hypnosis reduces the performance of high susceptible individuals more than in low susceptible individuals. The results contribute to the evidence of neurophysiological changes with hypnosis in highly susceptible individuals.

This contribution describes an unsupervised and automated learning model. The model core is a double loop structure composed of cells forming a signal propagation loop. The model originality resides in the double use of the double loop: it is used both as a memory storage structure in a neural network, and as a path for signals from the low level structures (receptors, spine and thalamic centres) to the higher levels of perception (images).

Loop structures tend to associate easily to form double loops, and thus become more stable. In our model, the associative areas of the brain are the core of local flows organised in double loops.

This model shows that such an exchange organization creates the coupling between the external loop (which goes through spine from receptors) and the internal loop (which is strictly located in the associative areas). The double loops are the storage structure of any representation in the network. The signal flows going through the double loops induce the construction of nested mental models, as well as positive (reinforcement) and negative (confusion) interference phenomena between images.

In many cases of mild to moderate dysfunction of the brain, resulting from various external circumstances, the clinical picture is dominated by concentration difficulties, mental fatiguability, emotional lability and problems of learning and remembering. This syndrome, or close equivalents to it, have been known under many different labels such as "emotional-hyperaesthetic weakness state" (Bonhoeffer), "organic pseudo-neurasthenia" (Bumke) and, in DSM-IV, "mild neurocognitive disorder" (although the latter term does not cover the emotional component). Recently, the term "asthen-emotional disorder" (AED) has been suggested (Lindqvist & Malmgren 1990, 1993). AED is a very common cause of memory problems, which must be distinguished from those which occur in the more well-known Amnesic Syndrome (DSM-IV). The concentration difficulties and mental fatiguability in AED have phenomenological peculiarities which distinguish them from attentional disturbances of other kinds, for example, those occurring in somnolence-sopor-coma disorder, SSCD (cf the companion paper by the second author). For the purpose of differential diagnosis it is therefore important to pay attention to the patient's introspective reports as well as to the nature of her functional deficits. The pathogenetic mechanisms behind AED are of great interest to the issue of cerebral localization since the disorder can be caused by injuries almost anywhere in the brain. We hypothesize that the mental disturbances in mild cases of AED are functional in the sense that they represent an overload of pathological information (from the injured area) on higher cognitive mechanisms, which may themselves be anatomically and physiologically intact.

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*The Scientific
Study of
Consciousness
from a Strict
Quantum
Philosophical
Point of View*

Descartes has confronted science with a hard problem: the mind-body or, in modern terms, the consciousness-matter problem. According to the current state of modern theoretical physics - which is, basically, quantum physics - the question arises if we really should expect to solve the problems of mind independently of the problems of matter. Strangely enough, modern philosophy of mind deals extensively with concepts like physicalism, naturalism, or materialism, although the meaning of these concepts is by no means clear! There is a huge conceptual gap between classical mechanism and modern quantum physicalism. Nevertheless, even today physicists are not able to completely solve the question regarding the nature of matter.

Strictly speaking, matter does not belong to the fundamental concepts of quantum theory, but information or knowledge does! Thus, we should not say: consciousness must be reduced to physics since brains behave as (quantum) physical systems, but conversely: since quantum physics is primarily dealing with information, the information belonging to self-consciousness is involved in the same manner as the information "invested" into material objects. It is the purpose of this paper to take some steps in this direction of thinking which is mainly influenced by the philosophy of C.F. von Weizsaecker.

Plato did not require a mind-matter dichotomy in the sense of Descartes' mechanism - perhaps 21. century science will not either.

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*Two
Correlates of
Consciousness
and A Solution
to the Hard
Problem*

Chalmers distinguishes the hard problem of conscious experience from the easy problem of understanding neural correlates underlying cognition. Physical concepts seem to suffice for the easy problem, but they are inadequate in explaining conscious experience. Hard problem then appears to require some new fundamental concept for its explanation.

Conscious experience due to stimulus from a sensory modality is neither reducible, nor expressible in terms of experience from other modalities. There are certain properties in matter which are apparently responsible for conscious experience. Therefore it seems reasonable to postulate fundamental properties of matter related to experience in each sensory modality, called phenomenal properties. There are five senses - ears, eyes, nose, tongue and skin, and correspondingly five phenomenal properties, one in relation to each of these modalities namely, sound, vision, smell, taste, and touch.

The phenomenal properties are present in all objects in various proportions, and that a subject's attention to any of these properties results in two correlates of consciousness: neural and phenomenal. Neural correlates can explain how the external stimulus is processed in the brain and are related to the easy problem. The phenomenal correlates, on the other hand, give rise to conscious experience.

The paper will discuss phenomenal properties in detail, and show their candidature for addressing the hard problem. Phenomenal properties can throw new vital light on some current scientific and philosophical debates in the study of consciousness, namely, the binding problem, ambient vision and the mind-body problem and the paper will examine them individually in detail.

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In philosophy, terms like "conscious" and "consciousness" are usually used in one of three main senses:

- (i) consciousness as the phenomenal, subjective sphere (experience)
- (ii) consciousness as directedness of thought and perception

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*Can
"Disturbance of
Consciousness"
be used as an
Explanatory
Notion in
Psychiatry?*

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*Consciousness
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(intentionality)

(iii) consciousness as epistemic contact with the external world (knowledge)

Psychiatric so-called "disturbances of consciousness" do affect consciousness in all these senses. For example, depersonalisation and hallucinatory states involve profound changes in subjective experience, the usual directedness of thought is broken up in confusional disorder (Delirium; "clouding of consciousness"), and epistemic contact is gradually lost both in confusional states and in somnolence-sopor-coma disorder (pathological impairment of wakefulness; "lowering of consciousness").

Quite another question is whether the symptoms in question are in any way explained by referring to the mentioned disorders as "disturbances of consciousness". "Consciousness" must then refer to some underlying mental mechanism, or a set of such mechanisms, which are responsible for upholding consciousness and conscious phenomena in the first three, "descriptive" senses. Although such explanatory uses of the term "consciousness" can be found in the French psychiatric tradition, most Anglo-American and German authors are less clear on this point.

Great care is recommended in using the term "disturbance of consciousness" in psychiatry, since it invites confusions on the explanation/description issue. At the same time it is important that psychiatrists do not rest content with characterising the "disturbances of consciousness" at the descriptive level, but that psychiatric theorising in this field is also directed to the problem of finding appropriate explanatory concepts.

The idea is developed that consciousness in its present form has developed from two primitive functions: a) The focussing of attention, during which, e.g., sensory organs are directed towards an impression for closer inspection, and b) the function of keeping an impression "alive" in the brain, so that the time available for inspection becomes longer. Both functions make it easier to find out which ones of the many perceptible impressions from the environment are worth reacting to. During evolution, the various types of memory developed from function (b), and ways of handling stored information from function (a), from combination and interaction of both functions the construction of a "world model" in the brain, which is the basis for territoriality and various of its derivatives, and of mental activities such as "thinking". The effects of programs which organize, e.g., adequate motor reactions to the relevant impressions ("instincts" for feeding, fleeing etc.), or some types of learning (e.g. imprinting), or the very working-conditions of consciousness (waking, types of sleep), are discussed.

Implicit in neuroscientific studies of alert humans and animals is the assumption that observed patterns of neural activity correlate with particular subjective states. That such states continue to gain empirical foundation suggests that rather than deleting the mental realm from biological explanation, theoretical biology might consider the phenomenal characteristics of organisms, their subjective states, to be worthy of explanation. Modern textbooks of biology and medicine usually define the phenotype as the physical, biochemical and physiological features of an organism, the result of genes interacting with the environment. The Greek root, "*phainein*" to appear, refers to organismic

*Biology and
Consciousness:
Further
Extending the
Phenotype*

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*Neuronal nitric
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features as they appear to an observer. It has been suggested that the concept of the phenotype be extended to include the behavioural characteristics of an organism (also apparent to an observer) since such characteristics confer selection advantage or disadvantage. I propose that the phenotype concept be further extended to include a phenomenal category, defined in terms of appearances *to* rather than *of* organisms. The appearance of the world to an organism, contingent on its neurophysiological organization, is therefore part of that organism's phenotype. Biological explanation can thus acknowledge the existence of the subjective characteristics of organisms as it does any other organismic characteristic - in terms of the phenotype.

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The disruption of the nitric oxide (NO) signalling pathway has recently been proposed to play a crucial role in the mechanism of action of anesthetic agents [1,2]. In the present study the anesthetic properties of 7-nitro indazole (7-NI), a brain specific NO-synthase inhibitor, was investigated. In vivo, 7-nitro indazole selectively inhibits the neuronal NO-synthase with a potency similar to or greater than that of L-NAME. The anesthetic potency of 7-nitro indazole was determined by measuring the effect on the sleeping time of a standard methohexital anesthesia. Immediately after barbiturate injection the rats were observed for loss of righting reflex (LORR). Sleeping time was defined as time between LORR onset and LORR offset.

7-Nitro indazole dose-dependently prolongs the sleeping time of methohexital (Fig. 1). This effect can be antagonized by L-arginine, but not by D-arginine (Fig. 2). 7-Nitro indazole alone in doses up to 120 mg kg⁻¹ caused a marked reduction in locomotor activity but no loss of righting reflex over a period of 5 h.

The present data support the assumption that the augmentation of the anesthetic state by nitric oxide synthase inhibitors is due to a specific effect on the neuronal NO-synthase and a disruption of synaptic NO-signalling pathways. In the central nervous system the NO pathway seems to be an important link in activity-dependent plastic processes controlled by the NMDA synapse. Modification of the NMDA receptor function has recently been proposed as the final common pathway of anesthetic action [3]. The present findings are in accordance with predictions that follow from this theory of narcosis.

In every-day life it is beneficial to forget information that turned out to be wrong or that is no longer relevant. To further characterize the neurocognitive nature of memory-related inhibitory processes we used a modified version of the item method directed forgetting (DF) paradigm (Basden et al., 1993; Zacks et al., 1996). Six lists with 30 german nouns (5 per category) were presented sequentially with a 2.5 sec delay between each item and the "remember" or "forget" cue.

We observed significant directed forgetting effects, i.e. less errors and faster reaction times for to-be-remembered (TBR) as compared to to-be-forgotten items (TBF) in a forced choice (old/new) recognition tasks. To further differentiate for episodic and semantic memory we used the remember/know technique that requires a second classification for

Directed forgetting and Episodic Memory

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Multiple Drafts or Global Workspace? Maybe both - Possible Unifying Framework

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“old” items of either conscious recollection (“remember”) or (unconscious) familiarity (“know”) (Tulving 1985). Conscious recollection was significantly higher for TBR items. In the immediate recall (after each list) there was also a category specific effect, namely increasing recall rates with decreasing numbers of interfering TBF items within a given category.

In a second behavioral experiment the effect of rehearsal time, i.e. the time from cue onset until presentation of the next item, on directed forgetting was investigated. Recognition and recollection of forget items were influenced differentially by increasing (1, 2, or 4 sec) rehearsal time. These findings can be interpreted in the light of levels of processing and neuropsychological theories of memory consolidation (Rugg et al., 1997).

Baars’ Global Workspace Metaphor postulates theatre model of consciousness with conscious content lit up by a spotlight of attention. One of the conclusions of the metaphor is that conscious processes are serial.

Dennett and Kinsbourne’s Multiple Drafts model stresses parallel co-existence of dynamic ‘drafts’ of conscious content.

This article proposes a metaphor that could resolve this apparent incompatibility. The metaphor is based on the Neural Stochastic Diffusion Search Network (NSDSN) and allows for incorporating both Baars’ and Dennett and Kinsbourne’s views. The NSDSN is based on bivariate units and the Stochastic Diffusion Search, mechanisms solving the binding problem. The percepts are bound together dynamically by a tagging mechanism reflecting spatio-temporal properties of the incoming stimulus. The stable mental representation is supported by a dynamic cluster of units. The hierarchy of SDNSN’s, differing in time scales of stabilisation on the corresponding representations, could create complex hierarchical meta-representations of increasing generality. This could be achieved by networks higher in the hierarchy operating on the ‘meta-units’ corresponding to representations lower in the hierarchy of the NSDSN’s.

The cluster on the top of the hierarchy would support content of subjectively immediate consciousness if the number of ‘meta-units’ exceeded certain threshold. This hypothesis encompasses the Global Workspace metaphor because the content of consciousness would be subjectively perceived as moving smoothly and serially in time. This would also be consistent with the Multiple Drafts metaphor because physically the meta-cluster is spatially distributed and the actual subjective experience is dynamically updated. The metaphor allows for distinguishing temporal properties of representations and representations of temporal properties discussed by Dennett and Kinsbourne.

In *Explaining Attitudes*, Lynne Rudder Baker criticizes the claim of the so-called Standard View that beliefs are identical with or constituted by neural states. Starting with a critique of Baker’s arguments, I develop an alternative view called “Contextual Realism” according to which beliefs are constituted by neural states but only relative to a given context.

The main argument relies on a distinction of relational properties, on the one hand, and context-dependent properties, on the other. It is shown that beliefs are context-dependent but nonrelational. The arguments

*Brain States
and Beliefs:
Beliefs are
constituted by
Neural States in
a given Context*

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*Strategies for
experimental
testing of the
qualia-in-
attractor
hypothesis*

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*Who is
conscious?*

against the type-identity theory and the arguments that motivate functionalism illustrate that there is no identity relation at the level of dispositions between the property of having certain types of neural states and the property of having a certain belief. A main reason for this is the context-dependency of beliefs. Therefore, at best, we can defend a weak form of reduction which would account for context-dependency.

The general reasons for taking weak reductionism to be true are the following: Both Baker's Practical Realism and the Standard View attempt to characterize the nature of belief within a naturalistic framework. According to Baker, neural states or processes are necessary for having beliefs, because of the neural organization of human beings, but more cannot be said about the relation between neural states (or processes) and beliefs. This is implausible because not any neural state (or process) can implement any belief in a given internal and external context. If we presuppose an internal and an external context (i.e. the biography of a specific person and his standard physical, social, and linguistic environment) then there are only certain types of neural states that can implement a certain belief. This relation can be plausibly described by weak reductionism while at the same time accepting the strong arguments for the context-dependency of beliefs that Baker worked out.

It has been proposed that qualia of phenomenal experiences are coded in the shape of the attractors produced by neural dynamical activity. However, this hypothesis is difficult to test. Although mathematical modeling can provide some support, firm support for the hypothesis can come only from experimental data. By employing mathematical concepts from dynamical systems theory (i.e., fractal dimension, decrease in dimensionality due to coupling) in combination with known facts about underlying neural structure, it is possible to formulate experimentally verifiable predictions. Experimental tests would involve objective psychological measures on tasks that require judgments about phenomenological experiences (i.e., response times, response probabilities and absolute judgments), as well as indirect measurement of the properties of the underlying attractor (i.e., dimensionality of EEG and MEG), in response to stimuli that would be expected to induce certain changes in these properties.

The limits of our thought may forever obscure an objective understanding of what is most manifest in our subjective perspective - phenomenal experience. But if such an understanding is to be possible we must have a theory which entails a criterion for distinguishing conscious from non-conscious creatures. The formulation of the "hard problem" by Chalmers (1996) initially appears to be on the right track, but his property dualism contains no seed of such a criterion. The suggested Wittgensteinian alternative to dualist or materialist starting points is that consciousness is not a private object but a lived bodily experience. The present paper argues that this position leads back to physicalism if the requested distinction shall be applicable.

The only reasonable explanation of what constitutes phenomenal experience on a basic level appears to be that the lived body is

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constitutive of consciousness. The lived body then has to be defined, which must be carried out in connection with a study of its instantiations. Every theory of consciousness that takes the question of an applicable distinction between conscious and not conscious as primary, has to be able to tell which intersubjectively observable properties make the difference. What could these be if not physical properties, relations and abstractions? So the instantiations of the lived body must be intersubjectively observable if we shall be able to work out a distinguishing criterion from them. Although an applicable theory of consciousness cannot start from physicalism it has to end in physicalism.

My contribution for this year's ASSC Conference includes two diagrams showing a suggested arrangement of modules within two interacting input-output transformation systems in the brain which I call respectively "consciousness" and "the zombie-within". These diagrams are lineally descended from the "information-flow diagram for the organism" which Donald Broadbent published as Figure 7 (p. 299) in his 1958 book PERCEPTION AND COMMUNICATION. In DECISION AND STRESS (1971, pp. 11-16) Broadbent introduced no less than SEVEN modifications to the model as proposed in the 1958 book and set out in the original diagram. He made no attempt, however, to produce a new information-flow diagram incorporating these changes.

For an unpublished series of lectures given in the University of Amsterdam in 1973-4, I prepared a revised version of the 1958 diagram incorporating these changes, but including some additions and omissions of my own. Further revisions of this diagram were prepared for papers, also unpublished, presented:

in 1988 at the Annual Conference of the History and Philosophy of Psychology Section of the British Psychological Society in Leeds,
in 1991 at the Neurosciences Institute, then in New York, NY,
in 1995 at the Annual Meeting of the European Society for Philosophy and Psychology in Oxford, and
in 1997 at last year's Inaugural ASSC Conference at Claremont, CA.

In so far as copies still survive, all these versions together with some related documentary material will be displayed as an historical record of the evolution of the current model.

References:

Broadbent, D.E. (1958) Perception and Communication. Oxford: Pergamon.

Broadbent, D.E. (1971) Decision and Stress. London: Academic Press.

Conscious experience is characterised by a unique flavour and immediateness which can be felt only by the individual having that experience. Nevertheless, essential features of conscious experience, as the spectrum of colours perceived or the way how space and time are represented, are shared by the members of a species and can be understood as adaptations with an evolutionary history. However, by promoting inclusive fitness the brain systems linked to consciousness are designed in a way as to provide the individual with fairly realistic constructs of the world in some contexts and strongly biased (illusory) constructs in other contexts.

An important step in understanding the action of central neural systems which generate a view on the world (as opposed to brain systems involved with sensory perception), is to identify states of mind and

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*Adaptation of
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the History of
Brain Activities:
A Formal
Proposal*

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*The Mind-
Machine: An
Engineering
Solution to an
Information
Problem*

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corresponding neural activity dealing with real world information. Recent studies on brain activity suggest that processing of real world information is special. A second step is to separate proximate and ultimate factors leading to rather realistic from those leading to illusory constructs. A model formally equivalent to signal detection theory allows for independently describing and evaluating factors determining the reality of representations and factors influencing the brain's 'decision' on the reality of mental representations.

While being interested in constructing artifacts with brain-like functionalities, there is a strong need for formal models representing the organization of brain processes and admitting the discussion of their consequences with respect to the emergence of observable phenomena. Despite of regarding brain activity as an observable representation of a single event, we regard a brain as a self-referential dynamical system according to which an event becomes represented as an attractive fixed point (see e.g. Grossberg, Freeman) having a symmetry group which reflects the symmetry of the event with respect to the set of past events. Its construction is assumed to be directed by a process tending to maintain certain internally defined conditions necessary for the persistence of the system. Accordingly, the actually established dynamical system reflects the present input according to the past history of the system with respect to its stability. Consequently, remembering an earlier event is not a process of re-reading of some previously stored information, but is based on a process of re-constructing a certain attractive fixed point from the present (see Bartlett, Edelman).

Once we conclude that consciousness is causally dependent on brain activity, there are still two ways of thinking of it, 1) that it is a terminal causal by-product of brain activity and 2) that while it is a causal product of brain activity, it has itself a further causal function related back to brain activity. In effect, I treat consciousness as a natural technical solution to an information engineering problem, and it would not be figurative to consider it the next level of technology above the bio-mechanical. In the history of the scientific treatment of the human organism, the first stage was that of the matter-machine, the second that of the bio-machine, and I propose that we should expect the third to be that of the mind-machine. But if the mind is as much machine as the skeleto-muscular system and the brain, then the mind must also have identifiable adaptive functions. In this paper, I attempt to clarify in terms of information coding and management, the special unifying function of mind with respect to perceptual data, arguing that this function could not in principle be served by either material or bio-technology, requiring instead a technology as different from these as bio-tech is different from matter-tech. In addition, if consciousness can be shown to have an identifiable function or functions, this increases the likelihood that the brain has a discrete and identifiable physical structure or organization that is directly correlated with its presence in an organism.

In the past various psychoactive substances (e.g. LSD, psilocybin, mescaline, amphetamines and ketamine) have been used as adjuncts in

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*Consciousness
Research Using
Hallucinogenic
Drugs.
Psychotropic
Effects of the
Phenethylamine
DMMPEA*

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*Correlates of
Language and
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psychotherapy as well as an useful tool in model psychosis research. Looking for more tolerable short-acting compounds some new orally active phenethylamines have been synthesized. In a non-comparative human study the psychoactive properties of DMMPEA (2,5-Dimethoxy-4-Methyl-Phenethylamine) were evaluated in 18 subjects.

In this paper the experimental design of the study and the results are presented and discussed in view of the implications for consciousness research.

The specific Altered State of Consciousness (ASC) produced by hallucinogenic drugs like DMMPEA is characterized by an increase of body awareness and receptiveness of inner stimuli, activation of individual affective patterns, eyes-closed imagery and dream-like subconscious material. The consciousness remains clear and enables the subject to observe, to control and to communicate the intrapsychic changes. Embedded in an anxiety reducing psychotherapeutic setting no true hallucinations, delusions nor psychotic reactions are observed.

All subjects recovered completely within few hours and showed no adverse reactions or unwanted after effects. Psychometric tests and clinical evidence revealed an improvement in emotional insight, self-esteem and ego-strength.

The results of this pilot study suggest that DMMPEA and similar drugs provide an easily controllable ASC of short duration and good tolerability. It may therefore serve as an useful adjunct to psychodynamically oriented self-experience and psychotherapy as well as an interesting research model for the study of affective, cognitive and perceptual processes in Altered States of Consciousness.

Edelman is correct in distinguishing two main levels of conscious organization: primary consciousness and higher-order consciousness. Each of the main levels comprises in turn several sub-levels. Higher-order consciousness, which I shall discuss exclusively, is determined by the ways in which the neuro-biologically realized faculties of language are involved.

Two essential levels of higher-order consciousness must be distinguished:

- situation-determined consciousness, in which language competence merely provides a categorization of the implicit memory of the perception and action cycle (cf. Fuster), and
- cultural consciousness, in which language competence provides an organization of sophisticated structures in explicit memory.

In my contribution, I shall be more concerned with the latter, in which two basic functions of language competence determine two sublevels of cultural consciousness:

- communicative consciousness and
- knowledge consciousness.

The former is instantiated in the perisylvian area of the left brain hemisphere and provides an organization of efficient communication by structured speech, the latter structures thought processes by an interplay of the perisylvian organization of language form with the interactive organizations of explicit memory processors based in prefrontal areas, supplementary motor areas, gyrus supramarginalis, angular gyrus, and parahippocampal and hippocampal areas.

Higher order consciousness achieves a still higher level of organization in acquiring the competence of reading and writing. As a consequence higher order consciousness is only partially determined by neural

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*Functionalism -
It Just Ain't
Natural!*

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*Neural
correlates of
altered states of
consciousness*

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correlates in individuals but partially by the externally stored written or printed information.

This has led some theoreticians of higher order consciousness to postulate a memetic analysis of cultural consciousness (Dawkins, see esp. Dennett) and to claim that cultural consciousness is not a property of individuals but of populations of individuals and their environment. This analysis is, however, highly misleading since it underestimates the importance of the interpretative and generative faculty which still resides in the individuals' brains.

Causal role functionalism owes more to the computer metaphor than its proponents within the philosophy of mind care to admit. Its applicability as an *explanatory* concept in the brain sciences hinges on an adequately fine-grained description of the neurophysiological processes involved. My contention, backed up by arguments both philosophical and empirical, is that any proposed candidate for the 'right' functional level can be pushed further back into our wetware. Introduced originally as a strategy to naturalize mental states, Functionalism turns out to be *not naturalistic enough*: replicating the causal roles of a system as sensitive to incremental material changes as the brain means replicating its material base. Which should come as no surprise: Practically everywhere we *expect* the material base to be responsible for essential features of objects or processes. This is particularly plausible for phenomenal consciousness, but generalizes to other debates. The claim that identity of abstract causal role descriptions implies identity of the processes described is empirically empty and philosophically questionable, since it relies on doubtful neobehaviorist assumptions. Functionalism is useful as a *heuristic* strategy to impose a first approximation of order and identify structures that have to be explained further in the neurosciences, but it does not of itself *explain* what conscious states are and what it is like to experience them.

Correlation of spontaneously arising altered states of consciousness, related to physiological stress, and different physiological parameters was studied. It was demonstrated that there exists correlation between indices of alteration of consciousness and bioelectric signals recorded from scalp in EEG and infraslow ranges. The patterns of correlations were independent for these two ranges, which suggests the existence of different hierarchical levels, providing maintenance for these states. Stimuli, specific as well non-specific, as electrical and photostimulation of definite frequencies can also alter state of consciousness. Anxiety level measured by Spielberg scale, related to alteration of consciousness as well, correlated to activation of definite brain structures, measured by PET.

Wilhelm von Humboldt (1836) asserted the "Untrennbarkeit des menschlichen Bewusstseins und der menschlichen Sprache" (nonseparability of human consciousness and human language). But even to the present day the nature of this "nonseparability" remains to

*Is
consciousness a
transitive
construction?*

be discussed in more detail. If the specificity of human consciousness is impossible to consider without taking into account language capacity, it still remains unclear what levels of language structure can and indeed implement structures of consciousness on-line. On the other hand, in consciousness studies it is quite usual to speak about the "object" or "subject" of consciousness without being aware that these concepts have their correlates in both the syntax and semantics of every known natural language.

In this paper I will discuss the specificity of the transitive construction which is considered to be the core or prototype sentence construction from the point of view of both syntactic and semantic specification. According to this standard definition, the prototypical transitive construction expresses a conceptual relationship in which the entity specified as "affected" by the action denoted by the verb ends up as an object, while the entity specified as "affecting" ends up in the position of the subject.

On the other hand, since the time of Descartes there has been a tendency to accept that the subject of consciousness is constituted by the cognitive activity of object-oriented consciousness. The "subject" of consciousness which is capable of explication is just one among the many possible "objects" of consciousness. This view is summarized in the famous adage of Descartes "Cogito, ergo sum" (where the subject of "cogito" is absent from the surface syntactic structure of the sentence as Latin is a pro-drop language).

I will compare the basic characteristics of the "subject" and "object" of consciousness with those of subject and direct object of the transitive construction in grammatical theory. The outcome of the comparison will reveal that the "subject" and "object" of consciousness appear, in some respects, quite unlike their grammatical correlates. The consequences of this conclusion will be considered for developing a viable theory about the nature and way of implementation of consciousness in language-specific structure. Emphasis will be placed on the necessity to develop such a theory in order to conceptualize appropriately the relationships between language, cognition, and consciousness.

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*Conscious
Events as
Functional
Events?*

The paper focuses on the conceptual grounding of consciousness from an analytical point of view: Answering empirical questions about the relation between conscious mental events and their neural correlates presupposes minimal conceptual clarity about the nature of the phenomenon under consideration. Furthermore it requires clarity about the kind of explanation that will be accepted to yield a satisfying account of consciousness. As van Gulick (1995) has pointed out for conscious mental events there are several possibilities to combine the areas of explanandum, explanans and their interconnections, depending on which aspect of the phenomenon will be regarded as the explanandum (i.e. the aspect of subjectivity), which scope will be accepted for the explanans (i.e. the realm of the physical) and which kind of connecting relation will be taken to be adequate (i.e. nomological sufficiency). Functionalism has been one major attempt in the Philosophy of Mind to describe those interrelations defending the option that functional explanations are generally appropriate for mental events. Various critical points have already been made on this enterprise but I will concentrate on a key-problem of Teleofunctionalism, the version of Functionalism that explicitly

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*Inhibition of
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decreases
Threshold of
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Anaesthesia*

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and Evolution*

considers conscious mental states. For this kind of Functionalism I will argue that as long as there is no precise and differentiated use of the term >function<, it will not be possible to remedy the deficiencies of "classical" Functionalism by introducing an evolutionary perspective, as proposed by contemporary teleofunctionalists. And consequently there will be no satisfying explanation of mental events, let alone conscious ones.

Introduction: Inhibition of nitric oxide synthase (NOS) has been demonstrated to reduce the anaesthetic requirements of volatile anaesthetics¹. The effect of NOS inhibition by Nitro^G-L-arginine-methyl-ester (L-NAME) on the anaesthetic action of the intravenous anaesthetics thiopental, propofol, ketamine and the α_2 -adrenoceptor agonist dexmedetomidine was examined in this study.

Methods: With approval of the local animal care committee, the anaesthetic potencies of thiopental, propofol, ketamine and dexmedetomidine or combinations of the compounds with L-NAME (1 mM) were determined in *Xenopus laevis* tadpoles. At least ten animals per concentration were exposed to the anaesthetic. Anesthesia was defined as loss of righting reflex (LRR)². Concentration-response curves were generated according to the method of Waud for quantal biological data and half-maximal concentrations (EC₅₀) as well as slopes of the curves were calculated³. All values are reported as mean \pm sem. Statistical significance was determined by Student's t-test ($p < 0.05$).

Results: The EC₅₀ of the anaesthetics thiopental, propofol, ketamine, and dexmedetomidine were determined to be $25.5 \pm 2.0 \mu\text{M}$, $1.9 \pm 0.1 \mu\text{M}$, $59.7 \pm 0.7 \mu\text{M}$, and $7.8 \pm 0.6 \mu\text{M}$ respectively. Addition of L-NAME shifted the concentration-response curves to the left in a concentration dependent manner. In presence of 1 mM L-NAME the EC₅₀ of thiopental was reduced by 43%, the EC₅₀ of propofol by 26%, the EC₅₀ of ketamine by 63%, and the EC₅₀ of dexmedetomidine by 51%. L-NAME administered by itself in a concentration range from 0.1 μM to 1 mM did not alter the behaviour of the tadpoles.

Conclusions: The results of the present study demonstrate that acute inhibition of NOS by L-NAME results in reduced requirements of the intravenous anaesthetics thiopental, propofol and ketamine as well as the α_2 -adrenoceptor agonist dexmedetomidine for induction of the anaesthetic state. This interaction of L-NAME and intravenous anaesthetic agents may indicate a site of their anaesthetic action.

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1. Anesthesiology 77: 779 - 784, 1992.
2. Anesthesiology 77: 926 - 931, 1992.
3. J Pharmacol Exp Ther 183: 577 - 607, 1972.

When defining consciousness we must be aware of the vast timescale of evolution. Worms appearing 600 - 700 million years ago exhibit a clearly functioning neuronal system. During the same period the first vertebrates developed. The leap from these time periods to primates appearing about 5 - 8 million years ago is enormous. We know now the rest of the story: Brains have developed very fast during the last million years but the biochemical background of the neuronal tissue is most probably the same leading to a stepwise development from the same building blocks which are the foundation of all biology.

Then when would consciousness or experience have jumped into the

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*Visual
awareness of
coherent
objects is
associated with
increased 40-Hz
power in human
EEG*

biological system? Although consciousness is still evading proper explanation in spite of many elegant theories we must assume that it has been present all the way during evolution if we accept the reductive view. Our task would be to find biological compounds, molecules, which are able to store information also in very primitive organisms. In fact such molecules have been found like bacteriorhodopsin a protein from a prokaryocyte Halobacterium halobium with an estimated age of 3.5 billion years. It can interact with light in a way that most proteins cannot.

Corresponding data sorting molecules in the brain system including vision would enhance our understanding of consciousness as an archaic element in the biological system.

The visual information that enters the nervous system as two distinct two-dimensional retinal images is processed at multiple cortical and subcortical areas. How these distributed sensory features and fragments are put together into unified, meaningful, consciously perceived wholes is still unclear. In the present experiment we tested the hypothesis that visual binding of coherent objects is reflected as increased synchronization of the high-frequency (36-44 Hz) electrical rhythms in human EEG.

Here we report preliminary results from a group of right-handed healthy adults. Two types of stimuli were used: line drawings of meaningful objects and meaningless nonobjects. The pictures of objects were selected from the standardized stimulus set of 260 pictures by Snodgrass and Vanderwart (1980). The nonobjects were generated by randomly rotating circular areas within the object drawings until the object became completely disorganized and unrecognizable (Vanni et al.

1996, 1997). The masked stimuli were presented for the observer below (27 msec) and above (108 msec) the recognition threshold in consecutive sessions. After each stimulus the observer responded by pushing one key if he had seen a coherent object, another key if he had failed to see whether the stimulus was an object or a nonobject, and a third key if he had seen a disorganized nonobject. While the observer was performing the task, EEG was recorded using 20 scalp electrodes (Ag/AgCl) arranged according to the 10/20 system.

The EEG data was filtered at 36-44 Hz and analyzed in ways analogous to those described in Revonsuo et al. (1997). The responses in 40-Hz power to objects and nonobjects were compared when the difference between the two stimulus types (1) was not consciously perceived at the short stimulus duration and (2) was consciously perceived at the longer stimulus duration. The results suggest that when the stimuli are not consciously perceived, there is little or no difference between 40-Hz responses to objects and nonobjects, but when the stimuli briefly enter visual awareness (i.e. are consciously perceived), coherent objects seem to be associated with stronger 40-Hz responses than incoherent nonobjects.

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Revonsuo A., Wilenius-Emet, M., Kuusela, J./Lehto, M. (1997). The neural generation of a unified illusion in human vision. *NeuroReport*, 8: 3867-3870.

Snodgrass, J.G./Vanderwart, M. (1980). A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity. *Journal of Experimental Psychology: Human Learning and Memory*, 6(2): 174-215.

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*Subconscious
Processing
affects
Measures of
Response Bias
rather than
Measures of
Discriminative
Sensitivity*

Vanni, S., Revonsuo, A., Saarinen, J./Hari, R. (1996) Visual awareness of objects correlates with activity of right occipital cortex. *NeuroReport* 8: 183-186.

Vanni, S., Revonsuo, A./Hari, R. (1997). Modulation of the Parieto-Occipital Alpha Rhythm during Object Detection. *The Journal of Neuroscience*, 17(18): 7141-7147.

Measuring subconscious perception and unconscious memory has always been a controversial issue in cognitive and applied psychology. Recent approaches including process dissociation paradigms suggest that unconscious (preattentive) influences on behavior is less discriminative than conscious processing unless the behavior is being overlearned.

We tested the hypothesis that unconscious perception of threat and unconscious memory affect false-alarm rates (in terms of signal detection theory) rather than measures of discriminative sensitivity. We presented an implicit memory task involving discrimination of tachistoscopically presented words and nonwords and a subsequent recognition task to 30 healthy subjects and 30 patients with panic disorder. We found that stimulus valence (threat vs. neutral) affected the tendency to respond with false alarms (=response bias) significantly in both tasks while discrimination performance was unaffected. Furthermore, panic patients (who are presumed to suffer from a hyperactive preattentive alarm system) showed more false-alarm responding than controls whereas the two groups did not differ with respect to discrimination performance. In addition, implicit memory had increased the response-bias in both groups. Results indicate that stimulus valence and repeated presentation can affect subject's behavior irrespective of whether subjects are actually able to identify or remember the stimuli consciously. A subsequent study investigates whether these effects are mediated by the holistic, emotional, receptive processing mode of the right hemisphere rather than by the discriminative, serial processing mode of the left hemisphere which is probably more important for controlling motor actions.

Travel – Hotels

Travel

The second conference of the *Association for the Scientific Study of Consciousness* will be held in Bremen, Germany, about an hour's drive from Hamburg, from the 19th to 22nd of June 1998.

The closest airport to the conference is **Airport Bremen (BRE)**. Bremen airport is in fact an international airport, but some travel agents don't seem to know this. You should ask your travel agent to check if you can get a direct flight, but quite likely you will have to go via **Hamburg, Frankfurt, Amsterdam, London** or **Paris**. If you want to fly by Lufthansa you can book directly over the Web. If you fly into Hamburg, it's about a half hour by bus to the train station, and an hour by train to Bremen. There are several trains per hour.

Hotels

Special room rates for conference attendees will be available at the *Holiday Inn* and at the *Überseehotel* Bremen. Please book your rooms directly at the addresses given below, indicating that you are attending the ASSC conference. Special Rates are DM 200,- for a single room and DM 275,- for a double room at the *Holiday Inn*, DM 150,- for a single and DM 200,- for a double at the *Überseehotel*. Both include a buffet breakfast.

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