2nd International Workshop
Neuro-Cognitive Mechanisms of Conscious and Unconscious Visual Perception

Delmenhorst, June 30 – July 2, 2014

Organizers:
Prof. Dr. Markus Kiefer
University of Ulm, Germany
Prof. Dr. Michael Niedeggen
Free University Berlin, Germany
Prof. Dr. Bruno G. Breitmeyer
University of Houston, USA

Venue:
Hanse-Wissenschaftskolleg
Institute for Advanced Study
Lehmkuhlenbusch 4
27753 Delmenhorst
Germany
www.h-w-k.de
**Monday, June 30**

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<td><em>Action Without Perception: What blindsight can tell us about the neural substrates of visuomotor control</em></td>
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<td><em>Consciousness and cognitive control: A closer look at unconscious conflict adaptation</em></td>
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<td><em>Attentional sensitization of unconscious cognition: functional and neural mechanisms</em></td>
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Tuesday, July 1

08:30 – 10:15  Session 2: Mechanisms of Conscious Vision
Chair: Rolf Verleger
08:30 – 09:05  Axel Cleeremans
Is Consciousness Graded or All-or-None?
09:05 – 09:40  John-Dylan Haynes
The Role of Awareness in Perceptual Decision Making
09:40 – 10:15  Michael Niedeggen, Lars Michael & Gesche Winther
From Distractor-Induced Blindness to Attentional Blink

10:15 – 10:45  Coffee Break

10:45 – 12:30  Session 2: Mechanisms of Conscious Vision (continued)
Chair: Niko Busch
10:45 – 11:20  Andreas K. Engel
Intrinsic Coupling Modes and Consciousness
11:20 – 11:55  Fred Hamker
Neuro-Computational Mechanisms of the Transition from Unconscious to Conscious Processing
11:55 – 12:30  Rolf Verleger, Kamila Śmigasiewicz, Agnieszka Karaś & Christian Kaernbach
Consciousness Wanted, Attention Found, Emotions Still Waiting: Reasons for the Advantage of the Left Visual Field in Identifying T2 Among Rapidly Presented Series

12:30 – 13:30  Lunch

13:30 – 15:00  Poster Session 1

15:00 – 16:10  Session 2: Mechanisms of Conscious Vision (continued)
Chair: Fred Hamker
15:00 – 15:35  Niko Busch
On the Temporal Dynamics and the Trial-by-Trial Variability of Conscious Visual Perception
15:35 – 16:10  Uwe Mattler & Martina Wernicke
Metacontrast Masking and Pattern Masking Enable Different Effects of Prime Stimuli

16:10 – 16:40  Coffee Break
16:40 – 18:10  
**Poster Session 2**

19:00  
Dinner

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**Wednesday, July 2**

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| 08:30 – 10:15 | **Session 3: Attention and Consciousness**  
*Chair: Hans-Otto Karnath*  
Bianca De Haan, Maria Bither, Anne Brauer & Hans-Otto Karnath  
*Neural Correlates of Spatial Attention and Target Detection in a Multi-Target Environment* |
| 08:30 – 09:05 | Ralph Weidner, Sabine Bertleff & Gereon R. Fink  
*Functional Mechanisms of Top-Down and Bottom-Up Control in Selective Visual Attention* |
| 09:05 – 09:40 | Martin Eimer  
*Parallel Attentional Object Selection in Visual Search* |
| 09:40 – 10:15 | Coffee Break |
| 10:45 – 11:55 | **Session 3: Attention and Consciousness (continued)**  
*Chair: Ralph Weidner*  
Rafael Malach  
*Localized Neuronal "Ignitions" Underlying the Content-Specificity of Visual Awareness* |
| 11:20 – 11:55 | Frank Tong  
*Neural Mechanisms of Object-Based Attention* |
| 11:55 – 12:10 | Concluding Remarks |
| 12:10 – 13:00 | Lunch |

Departure

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Workshop supported by the

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Abstracts
Recent years have seen many demonstrations of unconscious vision but its explanation in terms of the underlying processing pathways is still debated. Whereas early theories emphasized mid-brain contributions by subcortical structures, like the superior colliculi, many demonstrations in recent years highlighted the role of cortical areas for unconscious vision. However, up until today, the mid-brain hypothesis has been defended to some degree. In my talk, I will present evidence from our laboratory in favor of the mid-brain hypothesis. The corresponding behavioral research draws on the known visual processing characteristics of the mid-brain pathway, and it covers two forms of unconscious vision: attention capture by subliminal abrupt onsets and priming by subliminal faces. In the concluding discussion, I will discuss the role of this research in another ongoing debate concerning the bottom-up versus top-down nature of unconscious vision.
Hierarchies of the Visual Unconscious?

Bruno G. Breitmeyer
Department of Psychology, and Center for Neuro-Engineering and Cognitive Science,
University of Houston, USA

Currently, at least 18 experimental methods for transiently “blinding” the visual system have been employed to explore unconscious or implicit visual processing. Previous studies using one or other of these methods have noted that while the results of a particular blinding method reveal a functional stage or level of unconscious vision, they do not specify at what levels of unconscious processing these methods effect their temporary blinding. Nonetheless, extant results of psychophysical blinding methods used in our and in other laboratories can be compared to establish relative functional levels of unconscious processing. Based on a survey of published work we propose the following properties of the hierarchy of unconscious processing: binocular-rivalry (BR) suppression taps into the lowest level of unconscious processing whereas, at least up to now, object-substitution masking (OSM) points to the highest level. We also present evidence showing that backward pattern masking and metacontrast suppression reveal levels of unconscious processing that not only fall between the levels revealed by BR and OSM suppression but also occur before the levels revealed by crowding and the attentional blink, which in turn appear to occur before OSM. These findings are discussed in a wider context of i) functional levels of unconscious processing revealed by additional blinding methods and ii) their importance for unravelling cortical correlates of conscious vision from those of unconscious vision.
On the Temporal Dynamics and the Trial-by-Trial Variability of Conscious Visual Perception

Niko Busch
Charité - Universitätsmedizin Berlin, Institute of Medical Psychology,
Berlin School of Mind and Brain, Berlin, Germany

According to our current understanding of the visual system, visual perception is based on the interplay between feedforward and reentrant processing. Visual information is initially passed from lower-level to higher-level visual areas in a feedforward sweep that enables a rapid extraction of visual features. Feedback from higher back to lower areas (also known as reentrant processing) is deemed essential for more complex visual functions such as figure-ground segregation, feature binding, and visual awareness. Visual masking is thought to impair target visibility by disrupting this feedback loop, while the initial feedforward sweep may be left intact. A corollary is that masking does not impair behavioral performance if the behavioral response is already triggered during the initial feedforward sweep prior to the interruption of feedback. We demonstrate that object substitution masking and backward masking have little effect on the accuracy of the fastest responses in a saccadic choice task, while accuracy of slower responses is strongly reduced. This finding supports the view that masking leaves early feedforward processing largely intact and interferes mostly with reentrant processing at later stages. However, the question ensues why observers do not produce correct, feedforward-triggered behavior on every trial. In a similar vein, one can ask why near-threshold stimulation leads to a conscious percept on some trials, but not on others, even though the physical stimulus remains identical. We demonstrate that one source of this trial-to-trial variability of visual perception and behavior is due to spontaneous fluctuations of cortical excitability as indicated by ongoing EEG oscillations.
Is Consciousness Graded or All-or-None?

*Axel Cleeremans*

*Institute of Neurosciences Université Libre de Bruxelles, Brussels, Belgium*

Is our visual experience of the world graded or dichotomous? Opposite pretheoretical intuitions apply in different cases. For instance, when looking at a scene, one has a distinct sense that our experience has a graded character: One cannot say that there is no experience of contents that fall outside the focus of attention, but one cannot say that there is full awareness of such contents either. By contrast, when performing a visual detection task, our sense of having perceived the stimulus or not exhibits a more dichotomous character. Such issues have recently been the object of intense debate because different theoretical frameworks make different predictions about the graded vs. dichotomous character of consciousness. Here, we review both relevant empirical findings as well as the associated theories (i.e., local recurrent processing versus global neural workspace theory). Next, we attempt to reconcile such contradictory theories by suggesting that level of processing is an oft-ignored but highly relevant dimension through which we can cast a novel look at existing empirical findings. Thus, using a range of different stimuli, tasks and subjective scales, we show that processing low-level non-semantical content results in graded visual experience, whereas processing high-level semantical content is experienced in a more dichotomous manner. We close by comparing our perspective with existing proposals, focusing in particular on the partial awareness hypothesis.
Neural Correlates of Spatial Attention and Target Detection in a Multi-Target Environment

**Bianca de Haan, Maria Bither, Anne Brauer & Hans-Otto Karnath**
Center of Neurology, Division of Neuropsychology, University of Tübingen, Tübingen, Germany

Our ability to attend and respond in a multi-target environment is an essential and distinct human skill, as is dramatically demonstrated in stroke patients suffering from extinction. We performed an fMRI study to determine the neural anatomy associated with attending and responding to simultaneously presented targets. In healthy subjects, we tested the hypothesis that the right intraparietal sulcus (IPS) is associated both with the top-down direction of attention to multiple target locations and the bottom-up detection of multiple targets, whereas the temporo-parietal junction (TPJ) is predominantly associated with the bottom-up detection of multiple targets. We used a cued target detection task with a high proportion of catch trials to separately estimate top-down cue-related and bottom-up target-related neural activity. Both cues and targets could be presented unilaterally or bilaterally. We found no evidence of target-related neural activation specific to bilateral situations in the TPJ, but observed both cue-related and target-related neural activation specific to bilateral situations in the right IPS and target-related neural activity specific to bilateral situations in the right inferior frontal gyrus (IFG). We conclude that the IPS and the IFG of the right hemisphere underlie our ability to attend and respond in a multi-target environment.
Parallel Attentional Object Selection in Visual Search

Martin Eimer
Department of Psychological Sciences, Birkbeck College, University of London, UK

During visual search for known targets and unknown locations, spatial attention is guided towards visual objects that match current target-defining features. This talk will discuss recent electrophysiological studies that employed the N2pc component as an on-line marker of spatially selective attentional processing to reveal the time course of object selection in visual search. One study demonstrated that attention can be allocated in parallel to multiple visual objects, with each selection process following its own independent time course. Another study showed that object selection is initially guided independently and in parallel by different task-relevant features, before feature integration begins to control spatially selective attentional processing. These findings are discussed in the context of a general processing model of attentional object selection in visual search.
Intrinsic Coupling Modes and Consciousness

Andreas K. Engel
Dept. of Neurophysiology and Pathophysiology, University Medical Center Hamburg-Eppendorf,
Hamburg, Germany

It has been proposed that functional coupling of neural signals may be involved in several processes indispensable for consciousness, including integration, selection and routing of relevant information. Evidence is accumulating that these processes are strongly determined by the intrinsic dynamics of the brain, reflected in specific coupling patterns that can also be observed in the absence of stimuli or tasks. The presentation will discuss recent studies on changes of such intrinsic coupling modes under anesthesia and in bistable stimulus paradigms. While the former suggest that intrinsic coupling modes may be important in regulating levels of consciousness, the latter demonstrate that they also predict changes in the contents of conscious states.
The visual guidance of skilled movements requires transformations of incoming visual information that are quite different from those required for visual perception. For us to grasp an object successfully, our brain must compute the real size of the goal object, and its orientation and position with respect to our hand, ignoring the relative size or distance of the object with respect to other elements in the visual array. These differences in the required computations have led to the emergence of dedicated visuomotor modules in the dorsal visual stream that are quite separate from the networks in the ventral visual stream that mediate our conscious perception of the world. Although the dorsal stream receives prominent inputs from primary visual cortex, visual information also reaches this region of the brain via subcortical pathways outside the geniculo-striate route. Individuals with large lesions of primary visual cortex can perform a broad range of skilled visually guided movements including scaling the hand in flight for the size of goal objects and avoiding obstacles in the workspace of the hand. Moreover, these ‘blindsight’ patients continue to show task-related activation in dorsal-stream areas that have been implicated in the visual control of reaching and grasping. Taken together, these results suggest that extra-geniculo striate projections to the dorsal stream are capable of mediating the processing of object features such as size, shape, and orientation for the control of visually guided grasping – but also raise questions about what the role the inputs from primary visual cortex play in visuomotor control.
Neuro-Computational Mechanisms of the Transition from Unconscious to Conscious Processing

Fred Hamker

Artificial Intelligence, Department of Computer Science, Chemnitz University of Technology, Chemnitz, Germany

The mechanisms responsible for the transition from unconscious to conscious processing are poorly understood. I will address the putative neural correlates of object substitution masking and distractor-induced blindness by means of neuro-computational models. While object substitution masking can be well explained by competitive mechanisms in visual perception that also subserve visual attention, distractor-induced blindness may rather occur at the level of cognitive control mediated by cortico-basal ganglia-thalamo-cortical loops that control the gate to a global workspace.
The Role of Awareness in Perceptual Decision Making

John-Dylan Haynes
Bernstein Center for Computational Neuroscience, Berlin, Germany

Human perception depends heavily on the quality of sensory information. When objects are hard to see we often believe ourselves to be purely guessing. In several experiments involving pattern masking and motion coherency detection we investigated whether guesses use brain networks involved in perceptual decision making or independent networks. We used a combination of fMRI and pattern classification to test how visibility affects the signals, which determine choices. We found that decisions regarding clearly visible objects are predicted by signals in sensory brain regions, whereas different regions in parietal cortex became predictive when subjects were shown invisible objects and believed themselves to be purely guessing. This parietal network was highly overlapping with regions, which have previously been shown to encode free decisions. Thus, the brain might use a dedicated network for determining choices when insufficient sensory information is available.
Visual Attention in Unconscious Vision

Robert Kentridge
Department of Psychology, University of Durham, Durham, UK

It is often assumed that attention is the gateway to consciousness – that when we attend to something we inevitably become aware of it. I review a series of experiments that show that this is not the case. First, a patient with the neurological condition ‘blindsight’ made faster and more accurate decisions about a stimulus he could not see when cued to the likely location of the stimulus. Second, attentional cueing in normal observers enhanced processing of masked stimuli as revealed through their priming effect on subsequently presented visible stimuli. In both of these cases a selective enhancement of processing, which we interpret as attention, occurs despite the fact that subjects remain unconscious of the attended stimuli. This interpretation has recently been challenged on the grounds that the basis of attentional selection (spatial location) remains consciously accessible and that purely spatial selection may be mediated by processes other than attention, such as orienting responses. In a final series of experiments I show that object-based attention can selectively enhance processing of seen stimuli even when the objects that form the basis of selection themselves remain unseen. This final finding is incompatible with both the ‘selection’ and ‘orienting’ challenges to the claim that attention is not a sufficient precondition for visual awareness.
In classical theories of automaticity and attention, unconscious automatic processes are thought to be independent of higher-level attentional influences. However, refined theories assume that the cognitive system has to be configured in a certain way for automatic processes to occur. In our attentional sensitization model, we propose that automatic processing depends on attentional enhancement of task-congruent processing pathways. An unconsciously perceived stimulus is only processed along the neural pathways, which are sensitized by the active attentional set. In order to test these assumptions, the induction task paradigm has been developed: Before masked prime presentation, participants attended in an induction task either to semantic or perceptual stimulus features, which should activate a semantic and perceptual task set, respectively. In line with the attentional sensitization model, unconscious semantic processing is enhanced by a semantic and attenuated by a perceptual task set. In contrast, unconscious visuo-motor processing of shapes and emotional priming of pictures is boosted by a perceptual task set, but abolished by a semantic task set. Functional connectivity analyses of neuroimaging data suggest that attentional control of unconscious semantic processing is established by a temporary and dynamic integration of brain areas into different functional networks depending on the active task set. Hence, task sets orchestrate the flow of unconscious information in the processing streams to support goal-related interactions with the dynamically changing challenges of the environment.
Localized Neuronal "Ignitions" Underlying the Content-Specificity of Visual Awareness

Rafael Malach
Weizmann Institute of Science, Rehovot, Israel

The search for the neuronal processes that underlie human conscious perception has proven to be a major challenge mired by deep controversies. Here I will focus on one critical aspect of this research- mapping the neuronal mechanisms that endow each visual precept with its unique content. A useful approach to identification of such neuronal process is the classification of perceptually related phenomena into three main categories: content invariant phenomena, content-specific non-perceptual processes, and content-specific perceptual ones. Using this classification I will review evidence from large scale intra-cranial recordings in human patients implanted for diagnostic purposes. Our results reveal high amplitude, content-specific, "Ignitions" of broad band ECOG power, localized to occipito-temporal visual cortex that are linked to perceptual awareness. These "ignitions" are followed by an ultra-fast spread of low-amplitude non-specific activations into fronto-parietal cortex. Importantly, the fronto-parietal activations display clear differential modulation by task demand but not by perceptual content. Our results thus support the notion that content specificity of conscious percepts is likely mediated by "ignitions" of neuronal activity localized to high order visual cortex. In contrast, rapid fronto-parietal activations, which are tightly linked to visual perception, mediate either post-perceptual or content-invariant processes.
One approach to determine the role of consciousness consists in the analyses of the limits of effects of unconscious stimuli. Various studies reported that semantic priming effects increase with increasing stimulus awareness, indicating that consciousness contributes to semantic processing. Motor priming effects, in contrast, do not necessarily depend on conscious awareness of the effective stimuli. From this pattern of results it has been speculated whether semantic processing requires consciousness whereas simply responding does not. Here we show that this difference between motor priming and semantic priming results from differences in masking procedures. We examined motor priming and semantic priming effects with the same stimuli that were either masked by metacontrast or pattern masking. We found priming effects independent of prime visibility when metacontrast masking was used with both motor and semantic priming. With pattern masking, however, priming effects with motor and semantic priming increased with prime visibility. Rather than a fundamental distinction between semantic and motor processing our data suggests that dense pattern masks can reduce bottom up signals to an extent that bottom up signals produced by the prime is insufficient for both, priming and prime visibility.
From Distractor-Induced Blindness to Attentional Blink

Michael Niedeggen, Lars Michael* & Gesche Winther
Dept. of Experimental Psychology and Neuropsychology, FU Berlin, Berlin, Germany
*Department of Human Sciences, Medical School Hamburg, Hamburg, Germany

The detectability of a visual target (T) embedded in a rapid serial visual presentation (RSVP) stream can be significantly reduced if its onset is preceded by visual distractors sharing the features of the target. Behavioral and electrophysiological data indicate a cumulative suppression process: Increasing the number of distractors affects the detection rate, and triggers a frontal ERP negativity starting at about 250ms (Niedeggen et al., 2012, JOCN 24(6)). The frontal suppression process did not affect the visual processing of the upcoming target, but appears to prevent its updating the working memory. In this talk, the phenomenon of distractor-induced blindness (DIB) will be compared with the established attentional blink (AB). First, we will focus on the pre-target brain activity. In contrast to the AB, target detection in DIB is not determined by the level of EEG alpha activity, but primarily depends on the state of the frontal suppression system. Second, the behavioral and electrophysiological correlates of distractor processing will be examined in the AB. In a standard AB setup (T1= single white letter, T2=letter “X”), occasional presentation of the letter "X" preceding the onset of T1 served as distractor: Repeated presentation of the distractor activated a frontal negativity and reduced the detectability of T2 – but primarily at early lags (0-200 ms). The results reveal that the DIB can contribute to the expression of the AB, but relies on a different suppression process.
Consciousness and Cognitive Control: A Closer Look at Unconscious Conflict Adaptation

Heiko Reuss, Andrea Kiesel, Wilfried Kunde
Department of Psychology III, Julius-Maximilians-University Würzburg, Würzburg, Germany

First, we investigated how accumulation of conflict information plays a role in the adaptation to recent unconscious conflict. We used a masked priming paradigm that featured short fixed sequences of all-congruent or all-incongruent trials. While no adaptation was observable after only a single trial, congruency effects were reduced when a preceding four-trial-sequence was incongruent rather than congruent. This indicates an accumulation of unconscious conflict information over time. Inconsistent previous findings regarding unconsciously induced conflict adaptation might be explained by allowing or preventing such an accumulation in the respective experiments. Second, we investigated how context-specific conflict adaptation depends on both awareness of the conflict and awareness of the context, and how timing of conflict and context is crucial. We used a priming paradigm in which we varied the visibility of the prime and whether a context of high or low interference was represented by the format (word vs. number) of the target or of the prime. By implementing inducing trials and test trials, we controlled for mechanisms of event learning. When the context was signalled by the target, no context-specific adaptation was observable with masked primes. Strikingly, when the prime signalled the context, context-specific adaptation processes were now observed even with masked primes, that is, even when both the conflict and the context were presented unconsciously. These results show that the cognitive control system is able to detect subtle regularities that we are not necessarily aware of, and uses this information to improve performance by adapting swiftly to changing contextual demands.
How do we attend to a complex object in the presence of visual clutter or competing overlapping stimuli? Does such object-based attention simply involve the biasing of activity in object-selective visual areas, or might feedback to early visual areas be important? Through fMRI studies and computational modeling, we show how attentional feedback to early visual areas leads to the selective enhancement of the attended object, and how this in turn can improve visual discrimination performance. When participants view objects embedded in visual noise, attending to these objects leads to active ‘de-noising’ of the visual input, enhancing the cortical representation of that object. By applying a perceptual template model to our fMRI results, we show that attentional feedback to V1 leads to external noise-filtering. In studies of object-based attention, we show how activity patterns evoked by single faces and single houses can reliably predict which of the 2 overlapping stimulus types is being attended with high accuracy (80–90% correct). Moreover, the attentional bias signal in early visual areas strongly predicts the degree of attentional bias in high-level object areas, implying that pattern-specific attentional filtering at early sites can determine the quality of object-specific signals that reach high-level visual areas. Through computational modeling, we show how feedback of an average template to V1-like units can nonetheless improve the discrimination of individual exemplars belonging to the attended category. Our findings provide a mechanistic account of how feedback to early visual areas can contribute to the attentional selection of complex objects.
Everyday experience suggests that people are equally aware of events in both hemi-fields. However, when two streams of stimuli are rapidly presented left and right, the second target (T2) is better identified in the left than in the right hemi-field.

We had hoped that this might be evidence for a right-hemisphere advantage in synthesizing conscious percepts. But an extraordinary patient taught us otherwise. Moreover, directing attention by salient cues turned out to be one of the few mechanisms that could modify the left-hemifield advantage in this paradigm. These results confirm the notion of a right-hemisphere advantage in directing attention to salient events.

Several topics were studied on the way toward this conclusion, among others: Mutual inhibition of hemispheres, cooperation of hemispheres in perceiving midline stimuli, and asymmetries of emotional impact.

From a neurophysiological point of view, we had devised this paradigm with lateral streams in order to complement ERP evidence of target-evoked P3 by measuring N2pc. We were learning how to separately measure left- and right-hemisphere N2pc on the background of the 8 Hz streams of distractors. The most robust result was a delay of N2pc evoked by right T2 compared to left T2, suggesting that the left-hemifield advantage is due to an advantage of the right hemisphere in speed of access to salient information.
Functional Mechanisms of Top-Down and Bottom-Up Control in Selective Visual Attention

Ralph Weidner¹, Sabine Bertleff¹ & Gereon R. Fink¹,²

¹ Cognitive Neuroscience, Institute of Neuroscience and Medicine (INM-3), Research Center Jülich, Jülich, Germany
² Department of Neurology, University Hospital Cologne, Cologne University, Cologne, Germany

Selective visual attention is either externally guided by salient visual features (bottom-up) or, alternatively, by internal settings of an observer (top-down). It is still a matter of debate how these two control systems interact and whether or not salient stimuli can be voluntarily ignored. Visuo-spatial attention has been suggested to play an important role in coding salient but irrelevant distractor information. Hence, we explored three aspects of visuo-spatial attention orienting and its effects on selective visual attention. First, we investigated the neural mechanisms involved in (re)-orienting visuo-spatial attention in 2- as well as in 3-dimensional space. Secondly, we tested the effects of spatial attention orienting on the neural coding of salient but task irrelevant information. Thirdly, we used transcranial direct current stimulation (tDCS) over right intraparietal sulcus (IPS) to alter selective visual attention. Our first experiment confirmed the involvement of the fronto-parietal attention network for (re)-orienting visuo-spatial attention in 2- and 3-dimensional space and additionally identified bilateral premotor cortex as being specifically involved in shifting attention between different depth planes. Our second experiment revealed functional markers for salience coding in visual cortex. Salient but irrelevant distractors enhanced BOLD signals at their respective retinotopic representations. However, we found no evidence for a differential coding of salience inside and outside the attentional spotlight. Finally, our third experiment revealed that top-down control of selective visual attention can be significantly modulated using 2 mA cathodal tDCS over right IPS, hence emphasizing its role as a central mediator for attentional top-down control.
Poster
Presence or Absence of Blindsight Affects Sensitivity of V5/MT+ to Speed of Motion

Sara Ajina¹², Holly Bridge¹²
¹FMRIB Centre, ²Nuffield Department of Clinical Neurosciences, University of Oxford, UK

Visual information presented in the blind field of patients with V1 damage can influence behaviour, even when the individual has no conscious awareness of the stimulus. We determined detection and direction discrimination thresholds for complex motion, using a forced-choice paradigm in 13 patients with unilateral adult-onset V1 damage. Functional MRI responses for the same stimuli were measured in sighted and blind hemifields, and age-matched controls. Stimuli consisting of an aperture (5° or 8° diameter) containing coherently moving black dots on a grey background were presented within the scotoma. Speed was varied parametrically, with stimulus blocks at speeds of 0°/s (static), 4°/s, 8°/s, 20°/s, 32°/s.

Seven patients showed motion detection significantly above chance, and four could discriminate motion direction. All speeds were detected significantly above chance, with optimal performance for 8 and 20°/s in both tasks.
Implicit Learning: A Stimulus-Response Framework

Andrea Alamia¹, Etienne Olivier¹, Alexandre Zenon¹

¹ Université Catholique de Louvain, Institute of Neuroscience, Bruxelles, Belgium

Several aspects of implicit learning have already been explored since Reber first defined it in 1967, from sequence to statistical learning and from artificial grammar learning to contextual cueing in visual search. In the current study, our aim was to investigate a new facet of implicit learning based on a stimulus-response association. Particularly, the participants had to report the motion direction of a single patch of dots, either left/right in a first experiment or top/down in a second one. In each trial the patch can be of three different colors, and unbeknownst to the participants, two of these colors were always associated with the same direction/response, while the third color was completely uninformative. In the first experiment, using the performance of the participants trial by trial, we fitted a Bayesian model in order to assess the level of implicit learning of information conveyed by the color. In the second experiment, using the same model, we disentangled the association between color and motion, and color and response, in order to test which association was actually learnt by the participants. The results highlight, despite a high interindividual variability, a robust implicit learning of the stimulus-response association, both in the first and second experiment. In addition, the second experiment shows how the participants independently learn stimulus-response and stimulus-stimulus associations. Future studies will focus on the neural correlates of this type of learning, and on the causes of such variability between subjects.
On the Relationship Between LVF Advantage in Identification of Stimuli and Their Subjective Visibility in the Lateralized Two-Stream RSVP Task

Dariusz Asanowicz1,2, Kamila Śmigasiewicz1 & Rolf Verleger1
1Department of Neurology, University of Lübeck, Germany
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Recent studies using a lateralized RSVP task demonstrated a left visual field (LVF) advantage in target identification, presumably reflecting right hemisphere dominance in attention. In the present study, we investigated whether this asymmetry is related to subjective awareness of targets. It seems that identification rate should correlate with stimulus awareness, as attention does not only enhance efficiency of processing but also increases spatial resolution and perceptual contrast, providing a clearer subjective visibility of stimuli. However, several experiments have demonstrated weak relationships between attention and subjective visibility of stimuli or subjective confidence about stimulus visibility.

In the present experiments, the lateralized RSVP task was used, in which participants identify two consecutive targets, T1 and T2, embedded in two streams of successive distractors. Participants rated awareness of T2 using one of two ordinal four-point scales: Perceptual Awareness Scale (Experiment 1, N=18: "How well did I perceive the target?"), and Confidence Rating scale (Experiment 2, N=18: "How confident do I feel about my decision?"). The results showed, first, the expected LVF advantage in T2 identification, and second, a LVF advantage for T2 awareness in both PAS and CR ratings. Besides, correlation with accuracy was higher for PAS than CR, which suggests that confidence of responses might be somewhat underestimated, possibly due to worse subjective visibility. Taken together, the results suggest that right-hemisphere dominance in attention results in a LVF advantage in quality of subjective perceptual awareness.
The Role of Visuo-Spatial Attention in Bottom-Up Salience Coding

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Attentional selection can be guided by specific features of the sensory stimulus (bottom-up) and/or, by internal settings of the observer (top-down). How these two control systems interact is still a matter of debate and there is controversial evidence on whether or not a salient but task irrelevant distractor can be ignored based on top-down control settings (Theeuwes, 1992; Bacon & Egeth, 1994).

In order to account for these controversial findings, Theeuwes (2004) emphasized the role of spatial attention suggesting that salience calculation occurs within but not outside the spatial focus of attention. Accordingly, only a salient item within this attentional window will capture attention automatically whereas stimuli outside the spatial focus cannot attract visual attention at all.

The current study investigated the role of visuospatial attention in calculating salience using functional magnetic resonance imaging (fMRI) and a variant of the irrelevant distractor paradigm (Theeuwes, 1992). The attentional window was experimentally varied by either presenting a perfectly valid cue (100 %) hence generating a small attentional focus around the target location or alternatively an unpredictable circle. Although located outside the spatial focus of attention, an irrelevant distractor induced significantly higher signal changes bilaterally in temporal and medial parietal regions. Additionally, functional position localizers allowed extracting estimates of BOLD-amplitudes for each experimental condition at specific retinotopic locations. BOLD amplitudes were generally higher at distractor locations irrespective of the spatial attentional focus, suggesting that salience calculation is not restricted to regions within the focus of attention.

References
A Unified System-Level Model of Visual Attention and Object Substitution Masking (OSM)

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The phenomena of visual attention (Hamker, 2005, Cerebral Cortex) and object substitution masking (OSM; DiLollo and Enns, 2000, Journal of Experimental Psychology) are supposed to rely on different processes. However, Pöder (2012, Journal of Experimental Psychology) already suggested that attentional gating is sufficient and reentrant hypothesis testing is not required to explain OSM. However, present computational models have not been demonstrated to account for both phenomena at the same time. Based on a previous model of the frontal eye field (FEF) and the ventral stream (Zirnsak et al., 2011, European Journal of Neuroscience) we developed a novel neuro-computational model that allows to simulate OSM and common visual attention experiments, like biased competition and visual search. In biased competition and in OSM setups, multiple stimuli or the target and the mask compete for a visual representation by means of inhibitory connections. This competition mechanism accounts for the mask duration dependency in OSM. OSM also requires a high number of distractors (set size effect) like in visual search paradigm. Our model explains this because spatial attention, which is necessary to preserve the neuronal trace of the target, is diminished by a high number of distractors. In the model, spatial attention emerges from the recurrent processing between FEF and V4. We conclude that OSM can be accounted by well-known attentional mechanisms within a unified model.
Dissociating Electrophysiological Correlates of Physical and Perceived Brightness Using Metacontrast Masking

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In a classical metacontrast design we presented luminance-defined disks and surrounding annuli for 33 ms, each with their onsets separated by 50 ms. Disks and annuli were always darker than the mid gray background. We varied the physical luminance of the target disk in five steps, realizing luminance contrasts between target and background of 6.25 to 100%. Additionally, we varied the masks’ contrast in two steps (12.5% and 100%). 23 subjects took part in an EEG study where we first obtained behavioral visibility ratings then recorded VEPs presenting target-mask-sequences without requiring the subjects to respond, and finally obtained behavioral visibility ratings again. The behavioral data of Phases I and III showed the desired pattern: with low contrast masks, visibility ratings increased linearly with physical contrast. With high contrast masks, visibility increased only slightly for target contrasts between 6.25% and 50% and then increased more rapidly. This behavioral pattern was used to dissociate EEG signals correlating higher with subjective visibility from those correlating higher with physical contrast. Based on the theory of recurrent feedback in a widespread cortical network as a necessary condition for conscious stimulus representations we hypothesized that early components (C1, P1) reflected physical contrast, especially over occipital regions, whereas later components (N2, P3) correlated better with subjective visibility, especially over temporal regions. The results clearly show the early components’ dependency on physical contrast. Later components show a mixed pattern, providing some support for the hypotheses but also exposing methodological limitations of the dissociation approach.
Object substitution masking (OSM) occurs when a briefly presented target in a search array is surrounded by small dots that remain visible after the target disappears. The reduction of target visibility occurring after OSM has been suggested to result from a specific interference with reentrant visual processing. Here, we tested a prediction derived from this hypothesis: responses fast enough to have been triggered before the beginning of reentrant processing should escape this interference, and thus not be affected by masking. To this aim, we combined an OSM paradigm with a saccadic choice task, in which the fastest saccades occur as early as 120 ms after target onset, allowing to study the effect of masking at an early phase of visual processing.

In a first experiment, we manipulated target visibility using either OSM, backward masking, or low stimulus contrast and compared their effect on accuracy over time. A general reduction of performance was observed in all three conditions. The analysis of accuracy as a function of response time revealed that the fastest saccades (120-150 ms time-window) were virtually unaffected by both OSM and backward masking, while performance was strongly reduced for saccades slower than 150 ms. A second experiment with EEG recordings revealed that pre-stimulus oscillatory activity influences the accuracy of the saccade to come, especially for the fastest responses. These findings provide further evidence that masking interferes mostly with reentrant processing while leaving early processing largely intact, and bring new insights into the trial-to-trial variability of reaction times and accuracy.
Unconscious Priming, Says Who? Stimulus Perception and Metacognition

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For decades, research in cognitive sciences has tried to unravel the function and neural correlates of consciousness. One major approach has been to look at differences between clearly visible and imperceptible stimuli. This focus on so-called stimulus awareness has shown that even completely invisible stimuli can be processed up to the motor cortex. This has led to the idea that presenting masked stimuli is sufficient to examine the neural correlates of unconscious processing. In the current study, we argue that this sole focus on stimulus awareness disregards the existence of metacognitive awareness. Completely imperceptible stimuli can have openly observable consequences (i.e., error tendency) which participants can potentially access through introspection. Using a priming paradigm, we showed that even when participants are completely insensitive in responding to masked stimuli, they can nevertheless reliably dissociate trials where masked stimuli facilitate responding to a visible target from trials where masked stimuli interfere with this response. Our EEG recordings showed a fronto-central negative deflection around 200-300ms post-stimulus which was modulated by the compatibility between masked stimuli and visible targets. This N2 did not appear to be dependent on the subjective experience. In contrast, a more central positive deflection around 300-400ms was modulated by both objective difficulty and the subjective experience. In line with our hypothesis, we conclude that the cognitive system first makes a rapid evaluation of trial difficulty, independent of subjective experience or stimulus awareness. Subsequently, in a second phase participants can introspect the consequences of this first phase. Our results pose a challenge for studies assuming that masked stimuli suffice to examine unconscious processing. We conclude that a clear distinction should be made between stimulus awareness and metacognitive awareness.
Conflicts between conscious and nonconscious perception are likely to occur around the threshold of awareness. Such conflicts could produce nonmonotonic relationships between priming and prime visibility. The objective threshold/strategic (OT/S) model predicts a U-curved relationship between priming and prime visibility for semantic priming of primes whenever the semantic prime-target relationship is salient to observers. We tested this prediction using trial-wise assessment of subjective prime awareness. Semantic and repetition priming was measured in a lexical decision task in which masked word primes were shown for durations ranging from 16.7 to 83.3 ms. Subjective perception of the prime’s letters was assessed in each trial of the priming test, and objective prime identification threshold (OIT) was measured after the priming test. In trials where participants did not perceive any prime letter, semantic priming increased with prime duration but there was a trough for primes shown for 50 ms, which was slightly above OIT. Repetition priming did not vary with prime duration. These results support the OT/S model.
Egocentric Processing and the Contents of Experience

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The two visual systems hypothesis (TVSH) has been criticized as being implausible on the basis of perceptual experience: that the dissociation of function between the ventral and dorsal streams cannot account for our visual experience. According to this argument:

- The dorsal stream processes visual information egocentrically.
- The ventral stream processes visual information allocentrically.
- The contents of the ventral, but not the dorsal, stream contribute to the contents of visual experience.
- Therefore, according to the TVSH, the contents of visual experience must be entirely allocentric.
- However, goes the argument, this is clearly wrong because we clearly do not visually perceive the world in only allocentric terms: we also experience objects and scenes relative to us.

However, this challenge is based on a conflation of two notions of “egocentric” that are entirely separate:

- Dorsally mediated egocentric processing (E1)
- The perceptual notion of egocentric processing (E2), appealed to in the argument above.

The argument against the TVSH is based on the false assumption that the latter depends on the former, and thus dorsally processed visual information must contribute to the contents of visual experience.

A distinction, in the scene perception literature, between (1) ‘prominent object’ or ‘surface’ representation; (2) ‘multiple-component’ representation; and (3) ‘global emergent features’ representation; can illustrate why this is wrong:

- (1)+(2) are the appropriate level to talk about allocentric ventral stream processing.
- E2 is best considered as being a feature of (3), not (1) or (2).
- But (3) is not constituted out of the processing at levels (1)+(2).
The Role of Response Speed Awareness for Conflict Adaptation

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Evidence from masked priming suggests that awareness of conflict in a trial n-1 plays a crucial role for conflict adaptation in a subsequent trial n (Desender et al., in press). However, how the influence of conflict is brought about remains unclear. Maybe conflict delays responding, and a passive carry-over of slower responses from trial n-1 to trial n compromises quick reactions in congruent trials n, and, hence, congruence effects (cf. Kinoshita et al., 2011). Therefore, we tested the connection between carry-over and speed awareness. Are participants aware of their response speed? Is this awareness crucial for a conflict adaptation? To answer this question, we used masked semantic priming, in which participants judged their response speed in each trial, immediately after their response to the target. We found a reliable congruency effect, with faster responses to congruently than incongruently primed targets, but no conflict adaptation. Instead, a linear mixed-model analysis revealed a main effect of response time in trial n-1 that interacted with congruency in trial n, and that was independent of the participants’ awareness of their response speed.
Neural Evidence for Subliminal Emotion Processing in Infancy

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Emotion perception is a fundamental aspect of social interaction and as such operates extremely fast and efficient. Increasing evidence suggests that emotional information can influence neural and behavioral responses even in the absence of conscious awareness. While this subliminal emotion perception has been studies extensively in adults, its development in ontogeny is poorly understood. The present event-related potential (ERP) study therefore investigated the brain responses to subliminally presented eyes in 7-month-old infants.

Infants were presented with fearful and happy eyes, as well as a polarity-inverted version of these stimuli. All stimuli were displayed for 50 milliseconds, which is well below the perceptual threshold established for this age group, and followed by a mask consisting of a neutral facial expression.

We observed differential brain responses for fearful and happy eyes within 200 milliseconds at occipital electrodes, suggesting an emotional distinction early in visual processing. Furthermore, neural response at frontal electrodes clearly differed between happy and fearful eyes from 500 milliseconds onwards, which points to an influence of subliminal emotional content on the allocation of attention. Crucially, both effects were only observed for the original stimuli and not for the polarity-inverted control condition.

Our results therefore highlight the role of eyes in emotion perception by showing that they are sufficient to elicit emotion specific neural activations, even when not consciously perceived. The present study is the first to show that this mechanism operates not only in adults, but that subliminal emotion processing can already by observed in infants.
Saccadic Eye Movements Reveal Stronger Attention Capture by Fearful Than Neutral and Disgusted Faces

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Immediate threat might capture attention rapidly and automatically, a phenomenon called threat advantage. Using saccadic eye movements we compared capture by fearful, disgusted, and neutral faces in an exogenous cuing experiment. The different emotional face images were carefully equated for their spectral power and their contrast. Per each trial, one face was presented as a task-irrelevant cue. It was shown for 20 ms prior to the target at either the target’s position (valid condition) or away from the target (invalid condition). We expected a cuing effect, with more saccadic distraction away from the targets in invalidly than validly cued conditions. Also, a threat advantage should show in a stronger cueing effect of the fearful faces. Our results showed a cueing effect and a threat advantage. Saccades were generally more accurate in valid than invalid conditions but this cuing effect was weaker with neutral and disgusted faces than with fearful faces as cues. In addition, control conditions with inverted faces as cues confirmed that the threat advantage was face-specific and that it was only found with upright but not with inverted faces. Our results confirmed the rapid attention capture by brief fearful faces. Results are discussed in light of existing theories.
Surface Area of Early Visual Cortex Predicts Individual Speed of Traveling Waves During Binocular Rivalry

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Recent research has demonstrated that people show a large degree of variability even in very basic sensory functions. Brain-imaging studies have related this variability to the anatomical and functional characteristics of the associated neural structures. We investigated a stimulus based on binocular rivalry, a paradigm that has been extensively studied in consciousness research. The 'traveling wave' of binocular rivalry uses competing presentations of separate, specially designed stimuli to the two eyes that lead to spontaneous switches in conscious perception spreading in a wave-like manner across the visual field.

Observers show a large degree of variability when the speed of the traveling wave is assessed. In order to identify the anatomical source of the interindividual differences, we used anatomical and functional magnetic resonance imaging to localize different visual areas and estimate their respective surface sizes. Our results showed that the size of V1 and V2, but not V3, predicted the speed with which participants experienced the switch between the alternative interpretations propagate around the visual field. The findings reveal a high degree of specificity in the anatomical basis of subjective experience.
Research on Inattentional Blindness (IB) has been always interesting from the physiological point of view: are there any neural correlates of the information that surprisingly cannot be reported verbally but still produces priming effects, both positive (Mack, Rock, 1998) and negative (Kuvaldina, 2011)? fMRI studies of IB either substantially changed the original paradigm (Thakral, 2011; Rees et al., 1999) or didn’t measure the IB effect while scanning (Todd et al., 2005; Matsuyoshi, Ikeda, 2010) due to technical limitations. Our research was aimed at investigating sustained IB in multiple object tracking task. In the scanner participants traced the moves of 8 white and black circles and counted bounces of the white objects off the edges of the window. In experimental group, an extra item (a dark grey square) moved on the screen for 7 sec. It was not verbally reported and not recognized by 74% of 23 observers (the IB effect). BOLD signal evoked by the unnoticed stimulus in subjects who have demonstrated IB was compared with the signal in the control group who were not presented with an extra item. In the IB subjects, greater activation in the right inferior parietal cortex and left thalamus and lesser activation of the right frontal eye field and right anterior cingulate cortex was revealed (p<0.005 uncorrected, 5 voxels cluster threshold). This could be interpreted as markers of different allocation of spatial attention in non-noticers although behavioral analysis of efficiency in the main task didn’t result in any differences between non-noticers, noticers and control group.
A widely accepted theory in vision science concerns the specialization of the visual system into a dorsal “vision-for-action” and a ventral “vision-for-perception” stream. As opposed to the dorsal stream, ventral stream processes are thought to be closely associated with visual awareness.

To resolve conflicting results in recent neuroimaging work concerning this differential link to consciousness, we investigated category-selective BOLD activity in both streams as a function of stimulus visibility and depth of interocular suppression achieved by continuous flash suppression (CFS) with different mask contrasts using univariate and multi-voxel pattern analyses (MVPA).

Additionally, we asked whether dorsal stream responses to tool stimuli were related to their connection to visually guided action or rather to their specific (elongated) shape, as suggested by recent priming studies. Therefore, we compared responses to tools that were clearly manipulable but not elongated to activation evoked by elongated tools.

We observed reduced responses/decoding accuracies to tools and faces for all levels of suppression compared to the visible condition and no dissociation between dorsal and ventral regions.

Our univariate results support the notion that the dorsal activation reflects genuine tool category specific processes since there was no significant effect of shape. The MVPA showed enhanced decoding of elongated relative to non-elongated tools (vs. faces), in both ventral and dorsal ROIs.

Together, our data do not support the dissociation between dorsal and ventral stream concerning their link to awareness and further suggest that activity patterns in both visual streams underlie the priming effects observed for elongated shapes under CFS.
Blindsight is classically defined as the ability shown by some hemianopic patients to detect, localize and discriminate visual stimuli in their blind field, without consciously experiencing any visual percepts. In spite of definition, the literature documents cases of blindsight patients who demonstrated a preserved degree of awareness in their blind field.

The aim of this study was to investigate the correlation between discrimination ability and awareness in the blind field of a hemianopic patient. A 45-years old right-handed woman (S.L.), with a right homonymous hemianopia caused by a complete destruction of the left primary visual cortex, was tested.

The patient was asked to discriminate a feature (orientation, color, contrast, or motion) of different stimuli presented in her blind field in a two alternative forced-choice task. Subsequently, the patient had to report her subjective experience: in the first experiment as "seen" or "guessed", whereas in the second experiment as the degree of clearness of her experience according to the Perception Awareness Scale (PAS). The first experiment showed that S.L. demonstrated a performance above chance level in the contrast discrimination task for "guessed" trials, thus showing blindsight when the classic binary methodology (seen/guessed) was applied. The second experiment, however, showed that PAS ratings correlated with discrimination accuracy, thus revealing that S.L.'s above chance performance was due to a certain degree of awareness.

In conclusion, patient's preserved discrimination ability seemed to rely on conscious, although degraded, vision rather than unconscious vision.
Unconscious Semantic Processing? No Evidence for Extracting the Semantics of Words During Interocular Suppression

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Continuous Flash Suppression (CFS) has been used as a method to probe unconscious processing of visually suppressed stimuli. One line of research pertains to the extent to which semantic information of words is processed in the absence of awareness. It has been reported that neutral words break suppression faster than negative words (and vice versa) and that congruent prime-target relations influence suppression time, but do not influence electrophysiological correlates of semantic congruency. In this study, we used the breaking CFS paradigm to probe whether words break suppression faster than pseudo words and whether suppression time of words is influenced by its word frequency. In Experiment 1, we found neither evidence for word type nor word frequency influencing suppression time. In Experiment 2, we scrambled pseudo words to eliminate readability of pseudo words, included an inverted condition (to control for familiarity) and used a test-retest design (to examine the consistency of suppression times). Again, no effect of word type nor word frequency was found. Moreover, no effect of inversion was found and test-retest reliability was low.

A control experiment was conducted to verify that reliable data could be obtained with this CFS paradigm. The target was a white disc of which the radius was manipulated. Bigger discs broke suppression faster than smaller discs indicating a basic stimulus manipulation can indeed yield reliable results in the predicted direction. In conclusion, our results provide no evidence for the extraction of semantic information in the absence of awareness induced by interocular suppression.
Biased Competition and Predictive Coding – How Feedforward and Modulating Feedback Streams Disambiguate Visual Form and Motion Representations

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Visual stimuli are rapidly processed along bottom-up feedforward pathways. Cortical mechanisms at early stages recruit cells with small receptive fields suffering from high ambiguity and noisiness. We investigate, how lateral and feedback pathways integrate context with the local measurements to change the tuning properties and response gains of cells in primary visual cortex, V1. A dynamic circuit model at a mesoscopic scale level of description is suggested that considers the firing-rates of groups of cells and that subdivides a multi-layer cortical area into three main compartments. The three-compartment architecture is composed of an initial filtering stage (signal integration) and followed by lateral and feedback integration that enters via level I axonal arborizations where cells in the upper as well as the lower compartments are contacted.

We demonstrate that such interactions reproduce neurophysiological single cell data that has been measured in pyramidal cells integrating coincident signals at the soma and distal dendrites. We demonstrate that modulatory feedback and pool normalization increase the tuning selectivity of cells if the driving signal is matched by the top-down feedback signal. A reduced circuit analysis yields dynamic input regimes which yield to signal integration while others lead to competition. Furthermore, specific coupling structures and feedback lead to a reduced signal response due to the dynamic properties of excitatory and inhibitory units.

Thus, modulating feedback as a mechanism associated with gain enhancement shows properties of predictive coding in which response reduction is predicted for increasingly similar sensory and predictive signals.
Is "Affective" Blindsight Really "Relevance" Blindsight

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Destruction of the brain’s primary visual areas leads to blindness of cortical origin. Following destruction of this region, some patients remain capable of correctly guessing certain visual features even though they claim not to have seen the stimuli. More puzzling still, a form of “affective blindsight” has been described in which emotional qualities are guessed above chance.

The current study investigates a patient with so-called affective blindsight following bilateral damage to his primary visual cortices.

The patient was presented with different categories of stimuli that varied in terms of their behavioural relevance. This included stimuli such as faces with an averted or direct gaze, as well as moving light points that presented as looming, receding or spiralling movements.

The patient's performance was above-chance when guessing both direct gaze and looming motion. Functional MRI revealed that both direct gaze and looming produced amygdala activity, in the absence of any visual awareness.

The results suggest that it may not be the "affective" aspects of stimuli as much as their behavioural relevance that are essential for this form of blindsight.
Personality and Visual Search

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We assess the contribution of personality on visual search performance. In particular, the study investigates the relationship between information processing speed, personality dimensions (introversion–extraversion) and autistic-like personality traits. In Experiment 1 items were homogenous in color, whereas the target differed from distractors in one dimension, i.e. a different orientation (feature search). In a second condition, conjunction search was assessed by asking observers to look for one stimulus which differs from distracters on both orientation and size. In Experiment 2, three block of trials display paired strokes varying in color, orientation, size, or luminance. Difficulty increases linearly with each following block as an extra dimension is added. Experiment 3 employed all these distracter/target dimensions but in a random sequence, thus enforcing unpredictability. We expect high-scoring extroverts to outperform introverts in sensory decisions (feature search), thus predicting better performance when bottom-up rather than top-down processing is required. A positive relationship between task-difficulty and performance is expected for introverts when task difficulty is gradually increased, but not when it is unpredictable. In contrast, extroverts would be less irritated by unpredictability. We expect individuals in the autistic spectrum to excel in search tasks when top-down processing is required and also to be faster in conjunction searches (perceptual superiority). However, like introverts, we predict that their performance in Experiment 3 will be affected because of unpredictability of task difficulty. Results will be available in early May.
Research on consciousness often contrasts objective and subjective measures of consciousness, but subjective measures are often considered to form one coherent category. Based on findings from psychophysical, neuroscientific, and aging experiments, we propose that subjective measures should be differentiated into reports of subjective experience of the stimulus, and reports referring to confidence in discrimination.

Behaviourally, we found decisional confidence being associated with lower psychophysical threshold. Confidence measures were also more efficient in predicting discrimination performance than ratings of visual experience. Neurally, event-related potentials (ERPs) of the EEG signal associated with reports of confidence preceded ERP correlates of a clear visual experience. In addition, subthreshold transcranial magnetic stimulation of the occipital cortex interfered with visual experience during a broad time window, but decisional confidence was modulated only during a focused point in time. With respect to aging, we observed that older adults reported higher levels of confidence after incorrect discrimination decisions than younger adults; however they did not report higher levels of visual experience in incorrect trials than younger adults.

Taken together, these studies provide converging evidence that visual experience and confidence are distinct measures of the subjective aspects of consciousness, and a complete study of the neural correlates of consciousness requires the assessment of both.
I will review a series of experiments using two powerful tools to investigate processing of physically identical conscious and unconscious visual stimuli.

1. To make a stimulus conscious or unconscious to a viewer, without changing the input to the eyes, I used binocular rivalry. This phenomenon occurs when each of the eyes views a different image: at any time only one image is visible and visibility switches between the two images about every second.

2. To examine the neural processing of such conscious and unconscious stimuli I used event-related brain potentials (ERPs) from electroencephalography. ERPs show brain processing with high temporal resolution and with reasonable spatial resolution.

I found:

1. The earliest neural correlate of consciousness to occur about 100 ms after a change in stimulation.
2. The timing of this neural correlate of consciousness to depend on the stimulus property that yielded the (in)visible change: shortest for orientation, longer for colour, and even longer for motion.
3. The magnitude of the ERP amplitude 180 ms after onset of stimuli to predict the contents of consciousness about 1000 ms later, consistent with adaptation.
4. Violations of rules during the presentation of unconscious stimuli to be as well detected as rule violations of conscious stimuli.
5. The brain regions in which processing of conscious and unconscious stimuli occur to be around the temporal-parietal-occipital junction.

I conclude that visual consciousness critically involves early stages of the visual system processing shortly after stimulus onset and being affected by adaptation.
Conscious perception of near-threshold (NT) stimuli does highly dependent upon the local excitability state of sensory areas as well as global network states. Here we presented visual NT stimuli at a slow rate, within the inter-trial interval range of 3-6 sec, omitting any further information about the on- and offset of trials. Within this, thus, continuous appearing task set, participants were asked to respond upon detection. We measured magnetencephalographic (MEG) data in 20 young subjects during an NT presentation (gabor patches). Our analysis focused on the spectral power in the prestimulus time window (starting 1 second before the stimulus). Remarkably, trials containing hits as compared to misses showed increased beta band power. The neural generators of this effect were localized (using a frequency domain beam-former) to parietal areas, including post-central areas and precuneus. The beta band has been related to the maintenance of a cognitive/motor set. This notion could also serve as interpretation of our data: enhanced beta activity for hit as compared to miss trials could thus be an indicator for a better maintained task set in trials in which an NT target was detected. Interestingly, we found no alpha activity (8-14 Hz) differences in the prestimulus period as opposed to previous studies. This indicates that temporal expectation, which was not present here due to the continuous presentation, plays a crucial role in the modulation of cortical alpha.
A Computational Model of Conscious Perception in the Distractor-Induced Blindness Paradigm

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How the brain decides which information to process 'consciously' has been debated over for decades. A prototypical paradigm to investigate gating into consciousness is the distractor-induced blindness task. In this paradigm, two rapid serial visual presentation (RSVP) streams are simultaneously presented to subjects: a ‘local’ color stream shows rapidly changing color stimuli, while a ‘global’ motion stream presents randomly moving dot patterns, interrupted by intervals of coherent motion. Subjects are asked to report coherent dot motion (T2), but only those intervals that occur after presentation of a particular color stimulus (T1). If distractors (i.e., intervals of coherent dot motion prior to T1) are shown, subjects' abilities to perceive and report T2 decrease, particularly with short delays between T1 and T2.

We propose a biologically plausible neuro-computational model of how information is gated into consciousness which explains how distractor-induced blindness may originate from information processing in the cortex and basal ganglia. The model suggests that conscious perception requires reverberation of activity in cortico-subcortical loops which can facilitated or inhibited by the activities of different basal ganglia pathways. In the distracter-induced blindness paradigm, the inhibitory hyperdirect basal ganglia pathway is proposed to suppress inadequate response tendencies induced by distractors. Impaired conscious perception of T2 is explained to arise from aftereffects of this suppression occurring within a particular time window. The model reproduces experimental data on how delays between T1 and T2 affect the probability of T2 detection.
Temporal Attention Alters the Speed of Perception

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According to the Law of prior entry, attended stimuli are consciously perceived earlier than unattended ones, due to an acceleration of early sensory processing. This facilitatory effect on perception has been investigated in numerous studies and for different types of attention. So far, however, the role of temporal attention has undergone only little observance in the prior entry literature. In two studies, we investigated whether attention to the time point of stimulus occurrence affects perceptual processing speed, as indexed by latency modulations of early event-related potentials. In Study 1 (auditory modality), we measured the latency of the auditory N2 in an oddball paradigm. In Study 2 (visual modality), we measured the latency of the N2pc in a pop-out visual search task. Temporal attention was varied by presenting a warning signal in each trial and manipulating the time between warning signal and a subsequent target stimulus. In both studies we observed that high temporal attention led to shorter ERP latencies, thus indicating faster perceptual processing. This finding is in line with the prior entry hypothesis and underlines the important role of time on perception of auditory and visual stimuli.
Endogenous and Exogenous Cuing of Attention in Rapid Serial Visual Presentation: Consequences for the Left Visual Field Advantage

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When two streams of stimuli are rapidly presented left and right, the second target (T2) is better identified in the left (LVF) than in the right visual field (RVF). This asymmetry may reveal easier voluntary allocation of attention or easier involuntary attraction of attention by targets events to the LVF. To test these hypotheses, in Study 1 explicit information (endogenous cue) indicated T2 location, and in Study 2 a visual cue presented shortly before T2 onset (exogenous cue) attracted attention to the T2 stream (valid cue) or to the other stream (invalid). Both attentional mechanisms contributed to different degrees to changes in the LVF advantage. Endogenous cues only slightly reduced the LVF advantage by uniquely improving the identification of right T2. Exogenous valid cues completely eliminated the asymmetry, causing almost perfect T2 identification in both visual fields. In contrast, invalid cues increased the asymmetry by impairing identification of right-T2 more than left-T2. ERP analysis revealed that endogenous cues decreased the amplitude of T2-evoked N2pc. Furthermore, exogenous valid cues speeded up and invalid cues delayed T2-evoked N2pc Both, cue- and T2-evoked negativity, were earlier when evoked by stimuli in the LVF suggesting a predisposition of the right hemisphere in detecting the relevant events. Overall, these data provide behavioral and neurophysiological evidence that the LVF advantage is due to different abilities of the hemispheres in shifting attention to relevant events in their contralateral hemi-field.
Modulation of Subliminal Semantic Priming by Task Sets and Subliminal Task Cues

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Previous studies showed that task sets can be activated unconsciously. Based on the attentional sensitization model of unconscious cognition, the present study investigated whether such unconsciously activated semantic or perceptual task sets modulate subsequent masked semantic priming. To this end, we combined the induction task paradigm, in which participants attended either to semantic or perceptual stimulus information prior to the masked priming procedure, with masked task cue presentation. Participants were presented in half of the trials with a visible task cue (“B”/”A”) indicating the type of the subsequent induction task (Is the shown object living or non-living/round or elongated?) followed by masked semantic priming within a lexical decision task (word/pseudoword decision). In the other half of the trials, participants performed the subliminally primed lexical decision task preceded only by a masked task cue. In the reaction time data both the induction tasks with visible task cues as well as subliminal presentation of task cues specifically modulated subliminal semantic priming effects. This pattern was also reflected in the electrophysiological data. The present results show for the first time that unconsciously activated task sets have the ability to specifically modulate subsequent unconscious processes.
Orientation-Specific Perceptual Suppression

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Perceptual suppression phenomena are frequently used to study the concept of consciousness in general and, more specifically, the mechanisms involved in perceptual selection. Here we are interested in common mechanisms underlying monocular and binocular suppression. We previously obtained evidence for feature-selectivity in binocular suppression (Vergeer and van Lier, Vis Res 2010). Here we focus on feature-selectivity in Motion-induced Blindness (MiB) and classic perceptual fading. In both paradigms, a peripherally presented target disappears perceptually after prolonged fixation. In perceptual fading the target is commonly presented on a static homogenous background, whereas in MiB competition for awareness occurs between a static target and a dynamic mask moving across the visual field, although they never physically overlap. In grouping effects found in these phenomena, as in binocular rivalry, it is difficult to distinguish the role of attention from a possible intrinsic stimulus-specific suppression mechanism. Here we look at feature-based effect in a more direct manner. In both tasks, a peripherally presented oriented Gabor was removed from the screen after its perceptual disappearance and a test grating appeared left or right of the previous target location. For both phenomena, an adaptive QUEST procedure revealed significant elevated contrast detection thresholds when the test and target stimuli had the same orientation compared to when they were orthogonal, indicating feature-specificity. These results emphasize the similarity between different monocular and binocular bistable phenomena. We argue that common perceptual mechanisms are in place at the monocular and the binocular level.
Distractor-Induced Blindness: A Special Case of Contingent Attentional Capture?

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The detection of a salient visual target embedded in a rapid serial visual presentation (RSVP) can be severely affected if stimuli sharing the targets’ visual features are presented previously. This phenomenon - known as “distractor induced blindness “(DIB) - shares the prerequisites of contingent attentional capture (Folk et al.,1992). In both, target processing is transiently impaired by the presentation of distractors defined by similar features.

In the present study we investigated whether the speeded response to a target in the DIB setup can be predicted on the basis of a contingent attentional capture process. In a first experiment, multiple distractors were embedded in the RSVP stream. Distractors either shared the target’s features (experiment Ia) or differed from them (experiment Ib).

Congruent with hypotheses drawn from contingent attentional capture, response times (RTs) were found to be significantly impaired in conditions with target-like distractors as compared to conditions with different or without distractors. This effect was transient, and depended on the temporal proximity to a cue preceding the target. In contrast to contingent attentional capture, the RT effect in the DIB setup relies on the repeated presentation of distractors: RTs were accelerated if only one distractor was presented in temporal proximity to the target (experiment II), and RTs were not affected if the onset of the distractor provided no information on the onset of the target (experiment III). In conclusion, DIB is not due to contingent attentional capture, but may rely on a central suppression process triggered by multiple distractors.
The ability to perceive composite objects as a whole is fundamental for visual perception. Theoretical accounts and experimental evidence suggest that this ability is mediated by increased communication between neural representations of object elements, and may involve long-range coupling between lower and higher visual areas. To test this hypothesis we used a bistable stimulus that causes the viewer to perceive either motion of local elements or a global motion of an illusory shape. We recorded oscillatory brain activity with EEG, while human participants viewed the stimulus and reported changes in their perception. The two percepts differed in the power of the beta-band, which was lower during perception of Gestalt compared to that of local elements. Two independent source localization approaches suggest that these differences are most prominent in the posterior parietal cortex, the region that we previously showed to exhibit changes in fMRI signal in the same task. In contrast to our prediction, we did not find evidence for increased communication between the parietal cortex and other brain areas. The findings of this study point to a role of parietal beta oscillations in the spatial binding process that groups local elements into a percept of global Gestalt. In addition, the anatomical similarity between the locus of beta-band decrease in the present experiment and the sites known to be important for attention adds to the body of evidence for the shared neural substrates between these two processes.
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<td><strong>Weidner, Ralph, PD Dr.</strong></td>
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<td><strong>Wernicke, Martina</strong></td>
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<td><strong>Zaretskaya, Natalia, Dr.</strong></td>
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