ERNI-HSF Science Meeting

Orienting of Attention

Neural Implementation, Underlying Mechanisms and Clinical Implications

November 2nd-3rd 2012, Tuebingen, Germany

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Intention

To encourage discussions on the topic of spatial attention we are organizing a workshop that addresses recent developments in understanding its neural substrate and its mechanisms in health and disease.

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Organization

Daniela Balslev / Hans-Otto Karnath
Division of Neuropsychology
Center of Neurology
University of Tuebingen

Conference Venue

Evangelisches Stift, Klosterberg 2, 74072 Tübingen, Germany

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The impact of eye position on the prioritization of visual space
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12:30 - 14:00 Lunch break

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Charles Spence *(Department of Experimental Psychology, Oxford University, UK)*

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Emotion, attention and neglect
Patrik Vuilleumier *(Department of Neuroscience, University Medical Center & Department of Neurology, University Hospital, Geneva, Switzerland)*

Neural basis of visual attention in the primate brain

Sabine Kastner

Princeton University, Princeton University, Princeton, USA

Our natural environments contain too much information for the visual system to represent. Therefore, attentional mechanisms are necessary to mediate the selection of behaviorally relevant information. Much progress has been made to further our understanding of the modulation of neural processing in visual cortex. However, our understanding of how these modulatory signals are generated and controlled is still poor. In the first part of my talk, I will discuss recent functional magnetic resonance imaging and transcranial magnetic stimulation studies directed at topographically organized frontal and parietal cortex in humans to reveal the mechanisms underlying space-based control of selective attention. In the second part of my talk, I will discuss recent monkey physiology studies that suggest an important function of a thalamic nucleus, the pulvinar, in controlling the routing of information through visual cortex during spatial attention. Together, these studies indicate that a large-scale network of high-order cortical as well as thalamic brain regions is involved with the control of space-based selection of visual information from the environment.

Anatomy of spatial attention − Evidence from stroke patients

Hans-Otto Karnath

Center of Neurology, Division of Neuropsychology, Hertie-Institute for Clinical Brain Research, University of Tübingen, Tübingen, Germany

Homologous neural networks seem to exist in the human left and right hemispheres tightly linking cortical regions straddling the sylvian fissure. It is argued that in humans these perisylvian networks serve different cognitive functions, a representation for language and praxis in the left hemisphere and a representation for processes involved in spatial orienting in the right. The tight perisylvian anatomical connectivity between superior/middle temporal, inferior parietal and lateral prefrontal cortices might explain why lesions at these distant cortical sites around the sylvian fissure in the human right hemisphere can lead to the same disturbance of orienting behavior, namely to spatial neglect. It will be argued that for undisturbed attentional orienting the functioning of the perisylvian cortical areas is critical, not the mere disconnection of their white matter interconnections. Moreover, it will be demonstrated that the physiological changes and corresponding interhemispheric imbalance detected by fMRI BOLD in acute neglect patients − particularly those observed close to the lesion border − may not necessarily reflect changes in the neural function, nor necessarily influence the individuals' attentional behavior.

Functional dissociations within parietal cortex: Patient lesion studies and fMRI of the intact brain

Rik Vandenberghe

Laboratory for Cognitive Neurology, University of Leuven, Belgium

On the basis of a series of behavioral and fMRI studies in cognitively intact individuals and patients with focal lesions following stroke, we will illustrate how human lesion studies continue to provide invaluable insights into the critical contribution of specific parietal regions to attentional processing (selection between competing stimuli and spatial shifting). In our presentation we will mainly focus on the cross-talk between 'multiple single-case' studies and models of functional specialization of parietal cortex for selective attention. A critical feature of such single-case studies in the modern era is the use of both structural and functional measures to thoroughly document the anatomical extent as well as the functional consequences at a network level. We will also emphasize the utility of a subtractive approach when cognitive functions are studied in patients, akin to the subtraction methodology that is common in functional imaging studies. Finally, we will put forward a model of functional specialization in parietal cortex that is firmly grounded in empirical evidence from patients and studies of the intact brain.

Primate models for disorders of spatial attention

Melanie Wilke

University of Medicine Goettingen, Department of Cognitive NeurologyGoettingen, Germany

TBA

Spatial attention networks studied with large-scale high-resolution electrocorticography.

Prof. Dr. Pascal Fries

Ernst Strüngmann, Institute (ESI) for Neuroscience in Cooperation with Max Planck Society, Frankfurt, Germany

Activated neuronal networks typically engage in rhythmic synchronization. We have hypothesized that synchronization subserves efficient communication. In particular, in the visual system, multiple simultaneously present stimuli activate multiple neuronal groups, but only the behaviorally relevant, attended signals are communicated to higher brain areas. I will show that this selective communication is supported by selective interareal gamma-band synchronization. This routing between visual areas is most likely controlled by top-down influences from frontal and parietal areas. I will show that these top-down influences are subserved by beta-band synchronization between corresponding brain areas. The experimental results were obtained with large-scale high-resolution electrocorticography, which combines millimeter spatial and millisecond temporal resolution with coverage of large parts of a hemisphere.

Computational models of spatial attention and visual stability

Prof. Fred H. Hamker

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

Cells in many visual areas are retinotopically organized and thus shift with the eyes, posing the question of how we construct our subjective experience of a stable world. While predictive remapping (Duhamel et al., Science, 1992, 255, 90-92; Melcher & Colby, Trends in Cog. Sci., 2008, 12, 466-473) and the corollary discharge (CD) to move the eyes (Sommer & Wurtz, Nature, 2006, 444, 374-377) have been proposed to provide a potential solution, there exists no clear theory let alone a computational model of how CD and predictive remapping contribute.

After a brief overview of attentional models and how they relate to behavioral and physiological observations, I introduce a realistic systems neuroscience model of area LIP, using CD of eye displacement and proprioceptive eye position as inputs. I show that predictive remapping emerges within a model of coordinate transformation by means of the interaction of feedback and CD. Moreover, I demonstrate the influence of predictive remapping on visual stability as objectified by a suppression of saccadic displacement task (Deubel et al., Vis Res, 199, 36, 985-996). The model predicts that an absent CD signal leads to a bias negative to saccade direction in SSD. Remapping introduces a feedback loop which stabilizes perisaccadic activity and thus leads to the typical increase in displacement detection threshold.

The body's functional space in allocation of attention

Catherine Reed

Claremont McKenna College, Department of Psychology, Claremont, USA

Theories of embodied cognition emphasize the importance of sensorimotor experience and the interaction of the body with the world. Our own bodies perform important everyday movements and actions. It stands to reason that the actions of bodies may also prioritize specific regions of space to help us respond to important events. One of the primary functions of spatial attention is to select objects and locations in space that are functionally relevant to what an organism's current and future actions. However, most theories do not address the role of the body's and its actions on spatial attention. In this talk we present research demonstrating that the functions of the hand and body influence the allocation of attention. Attention is influenced not only by current actions but also by intended actions. Further, the allocation of attention can be altered when the perceived function of the hand is changed. These results, in addition to EEG studies, suggest both bottom-up and! top-dow
n influences of the body's actions and intended actions on attention. An embodied model of attention that integrates current biased competition models of visual attention with multisensory body-based inputs provides a theoretical framework to account for these findings.

Motor intention and the allocation of attention

Heiner Deubel

Department Psychologie, Ludwig-Maximilians-Universität München, Germany

It is now well established that goal-directed movements are preceded by covert shifts of visual attention to the movement target. I will first review recent evidence in favour of this claim for eye movements, manual reaching movements, and combined eye-hand movements, demonstrating that the planning of some of these actions establishes multiple foci of attention which reflect the spatial–temporal requirements of the intended motor task.
Recently our studies have focused specifically on how finger contact points are chosen in grasp planning, and how this selection is related to the spatial deployment of attention. Subjects grasped cylindrical objects with thumb and index finger. A perceptual discrimination task was used to assess the distribution of visual attention prior to the execution of the grasp. Results showed enhanced discrimination for those locations where index finger and thumb would touch the object, as compared to the action-irrelevant locations. A same-different task was used to establish that attention was deployed in parallel to the grasp-relevant locations. Interestingly, while attention seemed to split to the action-relevant locations, the eyes tended to fixate the centre of the to-be-grasped object, reflecting a dissociation between overt and covert attention. A separate study demonstrated that a secondary, attention-demanding task affected the kinematics of the grasp, slowing the adjustment of hand aperture to object size.
Our results highlight the import role of attention also in grasp planning. The findings are consistent with the conjecture that the planning of complex movements enacts the formation of a flexible “attentional landscape” which tags all those locations in the visual lay-out that are relevant for the impending action.

Update on the premotor theory of attention

Daniel Smith

Princeton University, Princeton University, Princeton, USA

The Premotor theory of attention (Rizzolatti, Riggio & Sheliga, 1994) has been enormously influential and contributed significantly to the understanding of the mechanisms underlying spatial attention. However, some of the claims of the Premotor theory are also highly controversial. In particular, the claim that covert spatial attention (the ability to orient attention independently of gaze direction) is dependent on motor preparation has been hotly debated. In this talk I will present data from a series of behavioural and neuropsychological experiments which investigate the role of motor preparation in spatial attention. These studies show that oculomotor preparation is required for exogenous attention, but independent from covert endogenous attention. It is argued that although the Premotor theory offers a reasonable account of exogenous attention, the relationship between motor control and endogenous attention is better understood in terms of a biased competition model of attention. In this model activity in the motor system contributes to competition between different sensory representations, biasing the cognitive system towards the saccade goal. However, contrary to the predictions of the Premotor theory, motor activation does not guarantee attentional selection and the absence of motor preparation does not necessarily rule out the possibility of attentional selection.

The impact of eye position on the prioritization of visual space

Daniela Balslev

Center of Neurology, Division of Neuropsychology, Hertie-Institute for Clinical Brain Research, University of Tübingen, Tübingen, Germany

Spatial attention can be defined as the selection of a location for preferential processing. The last decades of neuroscientific research have established that this function is implemented at cortical level by networks linking the posterior parietal cortices, frontal eye fields and the right temporo-parietal junction. The somatosensory cortex, which processes sensation from the body, is not among the nodes of these networks. Therefore it is intriguing that repetitive transcranial magnetic stimulation (rTMS) over the postcentral gyrus alters visual detectability to favor some visual targets over others, despite their equal retinal eccentricity (Balslev et al., JoCN, 2011). In my talk I will present evidence that a somatosensory gaze direction signal, eye proprioception, shapes the allocation of attention in space and discuss possible mechanisms for this effect.

Controlling spatial attention in a multisensory world

Prof. Charles Spence

Crossmodal Research Laboratory, Oxford University, Department of Experimental Psychology, Oxford, UK

The last 30 years or so have seen a rapid rise in research on attentional orienting from a crossmodal perspective. The majority of this research has tended to focus on the consequences of the covert orienting of attention (either to a sensory modality or spatial location) for both perception and neural information processing. The results of numerous studies have highlighted the robust crossmodal links that exist in the case of both overt and covert, and both exogenous and endogenous spatial orienting. I will highlight how such laboratory-based research findings are increasing informing the design of multisensory warning signals and interfaces in real-world settings (including driving, air traffic control, and military applications). Neuroimaging studies have now started to highlight the neural circuits underlying such crossmodal effects. Researchers are now using transcranial magnetic stimulation in order to temporarily lesion putative areas within these networks; their aim being to determine whether attentional orienting is controlled by supramodal versus modality-specific neural systems. The available research demonstrates that crossmodal attentional orienting (and multisensory integration – from which it is sometimes hard to distinguish) can affect the very earliest stages of information processing in the brain.

Emotion, attention and neglect

Patrik Vuilleumier

Laboratory for Neurology and Imaging of Cognition, Department of Neurology & Department of Neuroscience, University Medical School and Hospital; Center for Neuroscience, University of Geneva, Switzerland

Past research on attention and its disorders (such as spatial neglect) indicates that spatial orienting is controlled by both endogenous top-down signals related to task goals and exogenous bottom-up effects driven by stimulus saliency, but evidence suggests that attention may also be modulated by affective factors related to intrinsic or learned value of stimuli. Functional neuroimaging and behavioral studies show that attention is preferentially biased towards emotionally significant information (e.g. either threat or reward related), with enhanced activation of perceptual processing at various stages along sensory pathways. These effects may persist in patients with damage to fronto-parietal systems involved in the control of patient and may depend on distinct modulatory signals from limbic systems that boost, or interact, boost, or compete with other modulatory signals from fronto-parietal networks. In particular, the amygdala appears to play a central role in such affective influences on attention through both direct projections to sensory areas as well as indirect influences on fronto-parietal systems.

1 Improved simultaneity judgment after TMS over the left parietal lobe in right unilateral parietal lobe patients

Sara Agosta, Florian Herpich & Lorella Battelli

Center for Neuroscience and Cognitive Systems@UniTn, Italian Institute of Technology, Corso Bettini 31, 38068 Rovereto (TN), Italy

The loss of timing functions in right parietal lesion patients showed a specialization of this area in attention-based time computations (Battelli et al, 2008). In the present study we tested right parietal patients on a judgment of simultaneity task (JOS) where subjects were asked to discriminate whether two flickering dots (two in each hemifield) were flickering out-of or in-phase. Patients were tested using a staircase procedure to determine the alternation frequency rate threshold for left and right visual field. Right parietal patients showed a severe bilateral impairment, discriminating the out-of-phase target only at a flickering rate of 3 Hz, while left patients and controls' average threshold was 7/8 Hz. We hypothesized that the bilateral deficit might be due to an excessive inhibition of the healthy hemisphere upon the damaged homologous. Consequently, not only the left hemisphere cannot time objects properly but also prevents the right hemisphere from recovery. In order to relieve the deficit we used TMS on the healthy left hemisphere. We predicted that by temporary inhibiting the left hemisphere, patients' performance on the JOS would have improved.
Patients underwent two counterbalanced sessions: low frequency TMS over the left parietal lobe and sham control stimulation. We compared their performance before and after TMS in the same JOS task.
Patients' performance significantly improved immediately after TMS. Improvement was selective for the visual field ipsilateral to TMS.
TMS temporary re-established the balance between hemispheres and improved patients' performance. Our study showed the potentiality of TMS for cognitive recovery after cortical lesion.

2 Effects of spatial attention on neural processing in rhesus' V1: a simultaneous electrophysiology and fMRI study

Frederico Azevedo, Leonardo Azevedo, Nikos K. Logothetis, Georgios A. Keliris

Max Planck Institute for Biological Cybernetics, Tuebingen, Germany

Attention is a cognitive function thought to enhance our ability to select, process, and perceive only a behaviorally relevant fraction of the immense sensory input impinging on our receptors (Knudsen, 2007). Early electrophysiological studies in primates demonstrate that attention can modulate substantially the firing rate of single cells in extrastriate visual areas but has no or little impact in the primary visual cortex (Moran & Desimone, 1985). In contrast, attention has been linked to strong bloodoxygen-level-dependent (BOLD) signal modulations in human subjects (Gandhi et al., 1999). Our goal is to understand how selective visual spatial attention modulates the neuronal activity in primary visual cortex (V1) and how these effects are reflected in the different signals (single unit activity, local field potentials, and BOLD). To this end, we have trained two rhesus macaques to perform an orientation-change detection task in high field fMRI scanners (4.7T, 7T) while we can simultaneously acquire high-resolution fMRI maps and electrophysiological signals. Preliminary results suggest that attention modulates the BOLD and electrophysiological signals in distinct ways. We are currently trying to address the layer specificity of the effects by using MRI compatible multicontact probes and implanted RF coils that provide ultra-high resolution maps of the fMRI activations.

3 Cross-modal Integration in Anticipation of Table Tennis Strokes

M. Bischoff [1,2], K. Zentgraf [1,2], B. Lorey [3,2], S. Pilgramm[3,2], R. Stark[2], D. Vaitl[2] & J. Munzert[3]

[1] *Department of Psychology and Sport Sciences, University of Muenster, Germany*
[2] *Bender Institute of Neuroimaging, University of Giessen, Germany*
[3] *Department of Psychology and Sport Sciences, University of Giessen, Germany*

Action representations are coded in different sensory modalities. The manipulation of congruency between these domains should influence action anticipation. Different levels of audiovisual congruency should differenially influence attention to kinematics of movement. We investigated (A) whether auditory information affects anticipation of ball flight direction (cross or long-line) and (B) whether sensorimotor areas are susceptible to audiovisual congruency.
A table tennis player who observes his opponent striking uses the moment of the racket-ball contact for evaluation of the stroke. In this study the visual motion information was degraded in the form of point-light displays (PLD) without presentation of the ball and the racket. Twenty-six observers were examined with fMRI while they watched PLDs of an opposing table tennis player. Task was to predict the direction of the resultant ball flight (the alternative was "Cross field" or "Long Line"). The racket-ball contact (RBC) was marked by a sound which was either decoupled, i.e. presented 120 ms after the start of the movement and about 500 ms before the RBC (overt incongruence), or shifted 120 ms prior to the actual RBC (covert incongruence), or presented congruently in time to RBC (congruence), or was skipped completely (unimodal visual).
(A) Participants performed best in the congruent condition, overt and covert incongruence showed no behavioral effect compared to the unimodal stimulation. (B) Using a ROI approach, fMRI data showed that multisensory integration areas in the temporooccipital middle temporal gyrus and the anterior intraparietal sulcus were sensitive to congruency. The ventral premotor cortex and the pars opercularis of the inferior frontal gyrus (BA44) showed higher activation in congruent than in covert incongruent stimulation. We suggest that multisensory action representations are functionally relevant for anticipation of action effects.

4 A reversal of the same-object benefit in visual attention

Luc Boutsen

School of Life and Health Sciences, Aston University, Birmingham, United Kingdom

Studies of divided attention have often demonstrated a benefit in reporting multiple visual features when these are perceived as part of the same perceptual object. This within-object benefit may be evidence for visual selection being object-based, in contrast to location-based selection. Here we report a reversal of this effect: a benefit in detection of features belonging to different objects (between-object benefit). In both enumeration and matching tasks, observers responded to multiple visual features (e.g., 1 or 2 notches) that appeared either on one or on two rectangular shapes and in one or in two hemifields. Responses to two features showed a benefit when they belonged to different objects rather than to the same object. This between-object benefit was stronger when the features appeared in different hemifields, compared to when they appeared in the same hemifield. These results are discussed with regard to the interaction between location-based and object-based selection mechanisms.

5 Prestimulus oscillations reflect gating in sensory and motor reference frames

Verena N. Buchholz, M. Bonnefond, O. Jensen, W. P. Medendorp

Donders Institute Center for Cognition and Behaviour, The Netherlands

Previously, we reported body- and gaze-centered power modulations in central beta (18-30 Hz) and posterior alpha band (10 Hz), respectively, during saccade planning to tactile targets. Further studies have shown a suppression of these rhythms in anticipation of sensory events, which is associated with increased excitability. Here we tested the role of alpha and beta band activity in gating upcoming sensorimotor transformations that involve conflict between different reference frames. With a crossed hands posture, subjects had to saccade as fast and accurate as possible toward a tactile stimulus delivered to one of the two non-visible index fingers, located to the left or right of gaze. We provided auditory probabilistic cues (80 % validity), which indicated which finger is most likely to be stimulated. Using magneto-encephalography, we recorded anticipatory power modulations and their effect on behavioral performance, dissociating modulations consistent with body- or gaze-centered stimulus anticipation. Significant anticipatory body-centered modulations were found in the beta band at central sensors, while alpha oscillations at posterior sensors showed anticipatory gaze-centered modulations. Regarding behavioral effects, beta band power contralateral to the finger in anatomical coordinates showed a positive correlation with saccade reaction times (SRT). In contrast, alpha band power ipsilateral to the finger in gaze-centered coordinates showed a negative correlation with SRTs. These results are consistent with 1) somatosensory gating by beta oscillations, increasing excitability in contralateral somatosensory cortex and 2) oculo-motor gating by posterior alpha oscillations (ipsilateral to the target in gaze-coordinates), inhibiting the oculo-motor regions that could interfere. We discuss these results in terms of potential roles of these rhythms in gating information flow across spatial maps of different formats.

6

Amygdalo-medial OFC functional connectivity during emotion and attention processing: insights from time-integrated phase synchronizations in human intracranial recordings

Andy Christen [1,2] Lucas Tamarit [2], Laurent Spinelli [3], Margitta Seeck[3], Didier Grandjean [1,2]

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[3]*Department of Neurology, Hôpitaux Universitaires Genevois, Geneva, Switzerland*

The detection of potentially threatening information appearing within or outside of our attention is crucial in daily life. Amygdalae and orbitofrontal cortex (OFC), two anatomically interconnected brain areas, are strongly involved during these processes, but their underlying neuronal dynamics and their functional connectivity have not yet been directly investigated. By using intracranial recordings in humans, we show that the processing of auditory angry stimuli enhances the power of low-frequency bands within both regions and entrained distant and early neuronal synchronizations restricted to them in theta and alpha rhythms. However, voluntary attention focused on the angry voice induces an increase of neuronal activity in gamma oscillations, early within the amygdala as well as sustainably within the medial OFC. In contrast, the processing of unattended anger information yields to a massive enhancement within amygdala medium and high frequencies as well as lately within the medial OFC. Moreover, unattended anger as compared with attended angry prosody appeared to enhance the coupling between amygdalo-medial OFC in theta oscillations. We propose that the perception of emotional stimuli and its interaction with attention is achieved through long-range and functional amygdalo-medial OFC coupling in low frequencies range.

7 Experimental Manipulation of Visual Saliency Processing

Ben Cowley

Cognitive Science Unit, University of Helsinki, Finnland

We investigate the role of visual salience processing in attention deficit disorders using a novel Event-Related Potential (ERP) paradigm, with healthy control group comparison. Saliency refers to an order of importance attached to features of the (in this case) visual scene by the visual attention system, making certain features ‘stand out’. Order of processing is ~25-50ms. Task-related or top-down visual attention can modulate attention but the order is much slower, ~200ms or more.
The protocol uses primers to reinforce or interfere with illusory contour Kanizsa shapes or non-shapes in a choice-response task, and tests interference inhibition at the task-response level, and saliency-processing at the pre-attentive level. We will thus address a number of open questions with regard to attention deficit disorder:
1. How is the performance (accuracy, response time) deficit of low-performing subjects affected by the difficulty of the task - i.e. do 'interference' trials incur a penalty compared to 'reinforcer' trials? Such a result would suggest that the long-term attention deficit is in part driven by deficient saliency processing.
2. Do ERP recordings validate the performance data? We would look for early components that differ between ADHD and controls, namely, that ADHD N1 and N2 should be reduced in amplitude (and possibly delayed). Also, we predict the delayed P3a would be more strongly represented in the right hemisphere, presumably in response to the gestalt nature of the stimuli.

8

Attending to multiple spatial locations simultaneously and detecting information presented at multiple spatial locations simultaneously is governed by distinct areas in the right IPS.

Bianca de Haan

Division of Neuropsychology, Center of Neurology & Hertie-Institute for Clinical Brain Research, University of Tuebingen, Germany

The ability to attend to and detect multiple, simultaneously presented sources of relevant visual information is an essential human skill, as is dramatically demonstrated in stroke patients suffering from visual extinction who have lost this ability. The neural correlates underlying this ability are the topic of continuing debate, with some studies pointing towards the (right) TPJ whereas other studies suggest a role for the IPS. We performed an fMRI study to test the hypothesis that whereas the TPJ is more strongly associated with bottom-up detection of multiple targets simultaneously, the IPS is more strongly associated with top-down attention to multiple targets simultaneously. Specifically, we used a cued target detection task with a high percentage of catch trials that allowed us to separate top-down neural activation associated with the presentation of a cue from bottom-up neural activation associated with presentation of a target. Both cues and targets could be presented unilaterally or bilaterally and we performed conjunction analyses to determine the areas of the brain specifically associated with bilateral situations. We hypothesized that neural activation in the TPJ would be uniquely time-locked to bilateral target presentation onsets whereas neural activation in the IPS would be uniquely time-locked to bilateral cue presentation onsets. Whereas we found no evidence for an association between neural activation in the TPJ and the ability to either attend to or detect multiple targets, we found neural activation associated with both cue presentation and target presentation in the right IPS that was specific to bilateral situations. Moreover, whereas cue-driven attention to multiple targets was associated with neural activation on the lateral wall of the IPS, target-driven detection of multiple targets was associated with neural activation on the medial wall of the IPS. Thus, extending previous studies, we conclude that attending to multiple spatial locations simultaneously and detecting information presented at multiple spatial locations simultaneously is governed by distinct areas in the right IPS.

9 Affective Spatial Compatibility task (AffS-Ct): Fearful face reverses S-C compatibility effect

Gawryszewski, LG [1]; Jazenko, F [1]; Torro-Alves, N [2]; DeCarvalho, LF [1]

[1]*Neurobiology Department, UFF*
[2]*Psychology Department, UFPB, Brazil*

Emotion has a strong effect on decision making, both by conscious and non-conscious mechanisms. It affects overt and covert processes involved in perception, orienting of attention and sensory-motor integration. Facial expressions are considered an especially important source of social information, being processed very quickly and efficiently, with or without awareness, influencing physiological and behavioral responses. The non-conscious processing of facial expression has been observed in patients with cortical blindness due to lesions of striate cortex (Affective Blindsight). Moreover, in normal people, occurrence of non-conscious stimulus may influence perception and/or motor response to consciously perceived stimulus. Here, we employed supraliminar Fearful and Happy faces in a modified Spatial Compatibility (SC) task (Affective Spatial Compatibility task – AffSCt) in order to investigate whether affective facial valence influences S-C effects. For Fearful face, S-C effect reverses and the incompatible response becomes faster than the compatible one. Our results are in agreement with the effects of emotional stimuli on orienting of attention and saccadic eye movements. Furthermore, AffSCt can be another approach for studying Affective Blindsight, and, as well as, a way to integrate two process that are, usually, considered apart, that is, the non-conscious processing of emotional stimuli and the covert and overt orienting of visual attention. Finally, we suggest that AffSCt can be a powerful tool for investigating approach/avoidance effects and that it may be useful for diagnosing and following up the treatment of anxious, phobic and panic disorders.

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10 Mechanisms underlying efficient inhibition in old and young individuals

Linda Geerligs

University of Groningen, The Netherlands

As people age they experience increasing difficulties with suppressing irrelevant information (inhibition). The goal of the current study was to investigate the neural correlates of variability in inhibition between individuals, using phase locking analyses; a measure of functional connectivity between different brain areas. We found that participants who were better able to suppress irrelevant information showed more connectivity between frontal and occipito-parietal electrodes in the alpha band before stimulus onset. This appears to reflect a top-down mechanism facilitating inhibition of irrelevant information in both young and elderly. In addition, increased connectivity between frontal and occipital electrodes in the beta band was related to better performance only in elderly, indicating compensation mechanisms employed by high performing elderly. Elaborating on these findings, we have now acquired data with simultaneous EEG and fMRI measurements, allowing us to identify the brain structures implicated in these processes, more precisely.

11 The Interaction between Stimulus likelihoods and Rewards Modulates Spatial Attention

Rong Guo, Klaus Obermayer

TU Berlin, BCCN Berlin, Germany

The ability to adapt visual attention to suit the current environment is central to survival in a changing world. Much of past work has addressed issues concerning the allocation of spatial attention. One way is to modulate attention with the upcoming stimulus likelihoods. Another way is to modulate attention with the reward estimation. Here we report results from an attention-related discrimination task, which shows that stimulus likelihoods are weighed against reward estimation on the spatial attentional modulation. The task included two possible target locations, where subjects were responsible of reporting the target status on the vertical periphery of the central fixation. The discrimination performance at a target location is a close indicator of attention allocation. Shifts in attentional focus were induced by linking one location with a higher expected value than the other location, where expected value is given as the product of the stimlus likelihoods and rewards. Larger expected value should then increase the likelihood that subjects focus their attention on that location. However, subjects tend to allocate their attention more according to the stimulus likelihoods rather than expected reward. Behavioral results were analyzed on a single trial basis using a reinforcement learning model, where spatial attention is modulated separatedly by stimulus likelihoods and expected rewards. We anticipate our results to be a starting point for model-based brain imaging study of both bottom-up and top-down attentional modulation.

12 Body motion influences spatial attention: Evidence from the mental number line

Matthias Hartmann

University of Bern, Switzerland

We investigated the role of body motion in spatial attention by means of a motion platform. Given the close link between spatial attention and number representation, numerical tasks were used as indicator for shifts in spatial attention. We asked participants to generate random numbers or to categorize numbers according to their magnitude or parity during passive whole-body motion. Following the orientation of the mental number line, participants generated smaller numbers during leftward when compared to rightward, and during downward when compared to upward motion. Moreover, participants tended to process smaller numbers faster during leftward when compared to rightward motion. These results suggest that body motion shifts spatial attention in the direction of motion, and can influence higher order spatial cognition. These findings highlight the role of sensory self-motion information, e.g., vestibular cues, in the allocation of spatial attention.

13

Perceptual learning effects on word recognition in Latvian children with reading difficulties

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In Latvia approx. 15-20% of school-aged children are with reading difficulties. Latvian is complicate language. There are many neural processes which participate in text decoding during reading. The aim of the study was to determine perceptual learning effects on word recognition in children with reading difficulties.
Forty-one children from Grade 3 (n=17) and Grade 4 (n=14) took part in the study. Children with reading disabilities were selected using One minute reading test. The same stimulus set was shown three times with different intervals. The stimulus set for word recognition contained 150 words. The length of the words varied from four to ten letters. Each word was shown on a computer screen for 500 ms. Answers were expected verbally. Correct and incorrect answers were recorded. Each word length was shown 15 times. Letter size corresponded to 6 cycles/ degree.
Data of correctly named words for children with reading difficulties in Grade 3 and Grade 4 were significantly different ($p<0.05$) for all word lengths. The study confirms that children in Grade 3 in perceptual learning process continues to use letter-by letter reading pattern, when older children in perceptual learning process starting to use parallel letters activation. Word recognition and processing speed improves with age, perceptual learning or lexical experience.
Key words: reading difficulties, word recognition, attention, processing speed, word length, perceptual learning.

14 Attentional gain control and competitive interactions influence visual stimulus processing independently

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We tested two assumptions of a biased competition account of human visual attention: 1) An attended stimulus is released from a mutually suppressive competition with concurrently presented stimuli and 2) an attended stimulus experiences greater gain in the presence of competing stimuli than when it is presented alone. To this end, we recorded frequency-tagged potentials elicited in early visual cortex that index stimulus-specific processing. We contrasted the processing of a given stimulus when its location was attended or unattended and in presence or absence of a nearby competing stimulus. At variance with previous findings, competition similarly suppressed processing of attended and unattended stimuli. Moreover, the magnitude of attentional gain was comparable in the presence or the absence of competing stimuli. We conclude that visuospatial selective attention does not per se modulate mutual suppression between stimuli but instead acts as a signal gain, which biases processing toward attended stimuli independent of competition.

15 Effects of visual attention of BOLD signal variance

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The responses of sensory neurons are noisy, and laboratory studies typically deal with this variability by averaging responses to many stimulus presentations. Recently, it has been observed that the noise signals carry important information about the brain activity, especially by observing the trial-to-trial noise correlation of spiking activity across populations of neurons (Ecker et al. 2010). The trial-to-trial fluctuations in the responses of pairs of neuron are affected by attention, and this has influence on behavior (Cohen et al. 2009, Mitchell et al. 2009). In particular, it was found that attention decreased the noise correlation of neural responses in V4, indicating a more efficient encoding or an increase of information content. Yet the results of these electrophysiology studies left it unclear whether such effects would also occur elsewhere in the cortex, and whether similar effects can be observed in the BOLD signal.
In the present study we asked human participants to perform a difficult, attention-demanding task on a complex visual motion display during a prolonged period of time, alternated by equally long periods of visual stimulation without any task. Brain activity was recorded using fMRI. We then analyzed changes in the mean BOLD signal during both conditions, as well as the signal variance within the time-series of each condition.
During attention, the BOLD signal variance decreased in several regions, including V5/MT, the temporal parietal junction, and in additional medial-frontal regions. Mean BOLD signal increased in early visual cortex, V5/MT, and in the parieto-frontal attention network. The results demonstrate firstly that the variance of BOLD activity can be altered by visual attention. Secondly they show that there is only a partial overlap between regions whose BOLD signal increases and those whose BOLD signal variance changes. This suggests that changes in variance and in net amplitude may reflect distinct brain processes related to attention.

16 Attention Samples Rhythmically

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Overt exploration or sampling behaviors, such as whisking, sniffing, and saccadic eye movements [1, 2], are often characterized by a rhythm. In addition, the electrophysiologically recorded theta or alpha phase predicts global detection performance [3, 4]. These two observations raise the intriguing possibility that covert selective attention samples from multiple stimuli rhythmically. To investigate this possibility, we measured change detection performance on two simultaneously presented stimuli, after resetting attention to one of them. After a reset flash at one stimulus location, detection performance fluctuated rhythmically. These findings show that selective attention samples multiple stimuli rhythmically, and they position spatial attention within the family of exploration behaviors [1,5]. In the current presentation different psychophysical protocols for producing this rhythmic performance patterns will be discussed as well as MEG data linking neural oscillations to the behaviorally measured rhythms.

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17 Distraction by deviant stimuli: Contrasting the sensory modality of distractors and targets

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Participants performing a visual categorization task do so slower following the presentation of a sound differing from an otherwise repetitive stream of auditory distractors (deviant among standards). We examined this deviance distraction in conditions where the sensory modality of the distractor and target were contrasted orthogonally (auditory/visual). In Experiment 1, participants categorized digits presented auditorily or visually in the face of visual or auditory standard and oddball distractors. The results showed significant deviance distraction in the presence of auditory deviant stimuli, irrespective of whether the targets were visual or auditory, but no distraction when distractors were visual. Experiment 2 only used visual distractors, a reduced temporal interval between distractor and target, and forced participants to attend to the distractors. Deviance distraction now appeared when targets were auditory but not when they were visual. In summary, auditory distrac tors yielded deviance distraction even when participants were instructed to ignore them while visual distractors did not produce deviance distraction unless participants voluntary attended to the distractors, the temporal interval between distractor and target was reduced and targets were auditory. This pattern of data suggests that deviance distraction is not independent of sensory modalities.

18 Modulations of lateralized alpha and gamma activitiy in a visuo-spatial working memory task

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Oscillatory brain activity has been implicated in cognitive processing. While previous research has shown the importance of alpha (8-13 Hz) and gamma (30-100 Hz) oscillations for working memory capacity (Sauseng et al. 2009 Curr. Biol.) the specific roles of these rhythms remain to be further elucidated. One possible hypothesis is that information is gated by top-down controlled alpha activity, whereas bottom-up processing is reflected in the gamma band. We measured oscillatory magnetic activity with MEG during a visuo-spatial working memory task. Participants had to allocate their attention covertly to the left or the right visual hemifield according to a cue (1.5 s) before an array with colored dots (load individually adjusted to achieve an accuracy of 75%) appeared briefly (100 ms). Subjects had to retain the attended array (1.5 s) until probed by a second array (2 s). In our preliminary analysis, we observed a sustained hemispheric alpha lateralization during the spatial cueing and delay interval. The alpha activity decreased in the hemisphere contralateral to the cue, while it increased relatively in the ipsilateral hemisphere. In addition we observed a clear stimulus driven gamma band activity in response to the memory and probe arrays. These data suggests that the alpha oscillations reflect top-down cognitive control: alpha increases and decreases reflect respectively inhibition and release from inhibition. Gamma oscillations on the other hand reflect bottom-up processing of the stimulus sample encoding and probe comparison. To identify the involvement of GABAergic interneurons responsible for producing these effects we are currently investigating how the alpha and gamma activity in this task is modulated by the benzodiazepine lorazepam.

19 Action execution impairs visual search of action-congruent objects

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It has been previously shown that planning or performing an action can affect visual processing. In studies reporting partial repetition cost or inverse-compatibility effects the detection of the target is impaired if the target is congruent with the action (inhibition effect). However, in more complex designs (visual search or change detection) a facilitation effect is observed (target processing is enhanced if it is compatible with the action). The present study investigated how a recently executed grasp affects the visual search for a target object whose size is congruent or incongruent with the grasp type. In Experiment 1 the subjects were instructed to perform a pre-search grasp, which had an inhibitory effect on their search in congruent objects. We found a similar pattern in early fixations, which were slower if they targeted an action-congruent object. In Experiment 2 we tested whether the inhibitory effect can be achieved in simple object detection task. We presume that the pre-search action affects the object selection in periphery since there was no action effect in Experiment 2. In Experiment 3 no action was performed before the search (action was still performed when target was found) and no action-effect was observed. We conclude that a recently executed action can impair the perceptual processing of action-congruent objects in a visual search task.

20 The impact of the background on the recognition of road signs

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The aim of the study was to determine the influence of the background on the visibility of road signs.

Method: A computer program for registration of detection time intervals of road signs on different backgrounds was created. 14 types of road signs and 7 types of false stimuli were assessed on 22 different backgrounds.

12 subjects (aged 21- 25 years of age) participated in the psychophysical study and 500 participated in survey.

Results: The study shows that certain combinations of road sign colour design significantly reduce the detection time interval of the road sign. The role of the background under given experiment circumstances does not show a significant impact, and the role of background on road sign detection must be explored in more detail in the future.

21 Better but not faster: Video game players show increased performance but not faster shifts of attention

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Nowadays, video games are an omnipresent medium. A survey1 showed that 60% of the teenagers in the U.S. are consuming video games on a daily basis. The ramifications of these games remain unclear. Negative effects like increased aggressive behavior2 have been shown as well as beneficial outcomes like generally faster reaction times (RTs)3.
In our own study we correlated video game consumption to shorter eye movement RTs4. As a follow-up study, we now posed the hypothesis that this decrease is due to faster attentional processing, rather than an adjustment of the motor program.
We used Nakayama's5 visual search task, where test persons (TPs) have to report the presence and orientation of an oddball. By varying the cue lead time (CLT) in respect to the search array, the CLT with the TP's maximum detection performance can be used as measure of speed for covert attention shifts, without resorting to manual RTs. A total of 116 TPs aged 15 to 27 years were measured. TPs that played more than 4 hours per week were classified as players.
Contradictory to our hypothesis CLTs of peak performance were not shorter in players (171 vs. 169 ms, $p=0.9613$). But they showed higher peak (79 vs. 72 %, $p=0.001$) and mean (62 vs. 54%, $p=0.0007$) performances.
Our results suggest that not the actual attention shift is faster in players, but that they deploy a more efficient strategy to assess the stimulus relevance. This would fit to other findings6,7 which imply that players are better in processing task relevant information.

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22 Does fMRI-guided Thetaburst Stimulation of Frontal Eye Fields Disrupt Top-Down Modulation of Posterior Alpha Rhythms?

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The human frontal eye field (FEF) is part of the frontoparietal attention network, which controls covert spatial attention in a top-down manner, possibly through the lateralisation of posterior alpha oscillations. Previous research indicates right-hemisphere dominance of this network: Damage to right parietal cortex can lead to spatial hemineglect. Furthermore, Transcranial Magnetic Stimulation (TMS) of right FEF has been shown to have perceptual consequences for both hemifields, while left FEF TMS affects the contralateral hemifield.

These findings are commensurate with a model in which right FEF modulates alpha in both hemispheres, whereas left FEF modulates alpha only in the left hemisphere. Accordingly, right FEF TMS should prevent counterbalancing of left FEF, resulting in a dysfunctional shift of attention to the right hemifield reminiscent of hemineglect. In contrast, disruption of left FEF should reduce the capability to direct attention to either hemifield. To test this model, we applied fMRI-guided continuous theta-burst TMS (cTBS) to right FEF, left FEF, or vertex with and assessed its consequences on posterior alpha by recording magnetoencephalography (MEG) data whilst participants performed a cued visual spatial attention task.

We have demonstrated that the FEF can be reliably localized and disrupted using our paradigm. We are currently investigating whether right FEF cTBS causes an alpha lateralisation bias towards the right hemisphere (leading to contralateral perceptual impairment), whereas left FEF cTBS disrupts the ability to lateralise alpha (reducing the spatial cueing effect). We will use functional connectivity measures to determine whether cTBS disrupts long-range coupling between frontal- and visual- cortex.

23 ERP evidence for visuospatial processing deficits during movement preparation in individuals with Developmental Coordination Disorder

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Individuals with Developmental Coordination Disorder (DCD) show impaired motor functioning that affects learning, social functioning, self-esteem and quality of life (Hill, Brown, & Sophia Sorgardt, 2011). It has been suggested that motor performance in the absence of visual feedback is particularly affected in DCD (Mon-Williams, Wann, & Pascal, 1999), which may be related to problems with spatial processing of information about limb position and positions in personal and extrapersonal space. We investigated visuospatial processing by recording the EEG of both individuals diagnosed with DCD, and a group of age and IQ-matched controls, whilst they completed a movement task.

On a trial-by-trial basis, participants were cued either to reach directly forward or to cross their midline, into the side of space opposite to their cued hand. Event-related potentials (ERPs) were used to measure visual processing elicited by task-irrelevant visual probe stimuli presented near the participants' hands or near the movement target.

In the control group, the amplitude of the visual N1 component was larger for probes presented near the hand or the goal that was involved in movement, compared to the hand or goal that was not, in line with the predictions of the Premotor Theory of Attention (Rizzolatti, Riggio, Dascola, & Umiltá, 1987; Rizzolatti, Riggio, & Sheliga, 1994) and the Visual Attention Model (Schneider, 1995). In the DCD group this pattern was not evident. These results demonstrate atypical visuospatial processing during motor preparation in DCD and may be related to the difficulties inidivuals with DCD experience in their daily life.

24 The effect of MAE on OMR of Zebrafish

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Motion aftereffects (MAE) in primates and humans have been discussed in the neuroscience literature. MAE occurs after viewing a moving stimulus as an apparent movement in the opposite direction and provides an excellent tool for investigating properties of visual motion perception. Zebra fish is an important model that swims in the same direction as moving stimuli, a response called optomotor response (OMR). This study was designed to investigate MAE in both adult and larvae zebra fish. Simple square wave gratings moving in a specific direction were shown to a test group. After an adapting phase, the last frame, a static grating, was shown for a short time during which the movement of the fish was recorded. In a control group, the same procedure was applied but the grating pattern was shown moving bidirectionally with a random frequency followed by a static grating. Time spent swimming to either the right or the left side of the grating pattern was recorde d as right and left indices (RI and LI). The results indicate that RI for left adapting motion was more than LI and LI for right adapting motion was more than RI, while there was no significant difference between RI and LI in the control group. The results suggest that MAE occurs in zebra fish causing OMR.

25 Increased susceptibility to peripheral distractors in simultanagnosia

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Patients with simultanagnosia (SA) have no problem in detecting single local elements of objects or scenes, however the global picture stays for them unclear. Because similar behavior in healthy subjects could be induced by restricting vision to a small window around gaze, Dalrymple et al. (2009) proposed, that this impairment is due to a constriction of the visual "window" of attention.
To test this hypothesis, we conducted two experiments in two SA-patients: a letter-discrimination-task including distractor letters (exp.1) and an object-recognition-task with overlapping objects (exp.2). In exp.1, SA-patients discriminated foveal presented letters slower and less accurate than a group of age-matched controls (N=10) in presence of a distractor at 8° eccentricity. When the target was presented in periphery and the distractor was foveated, SA-patients performed in the same way or significantly better than controls. This argues in favor of a larger window of attention around fixation in SA. In exp.2, participants had to recognize two overlapping objects presented briefly (120ms) either at foveal position or 8° in periphery. SA-patients showed better performance in recognizing peripheral against foveal presented objects. In all controls (N=7) the opposite was the case. These results suggest an interaction between the gaze and both attention and object recognition. We did not find evidence for a constricted window of attention, but rather an enhanced susceptibility to peripheral distractors and an improved object recognition in the visual periphery.

26 Functional neuroimaging of sound motion in the macaque dorsal stream.

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The macaque ventral intraparietal area (VIP), located in the fundus of the intraparietal sulcus (IPS), is considered a polymodal association area that responds to visual, tactile, vestibular and auditory stimuli. VIP receives projections from multiple visual areas and from auditory regions in the posterior superior temporal (pST) cortex. In humans, several studies have reported activation of the pST and IPS to sound source motion confirming the existence of a dorsal processing stream for spatial aspects of sound in humans. In order to bridge the gap between single-unit recordings in monkeys and neuroimaging studies in humans, we used high-resolution fMRI in monkeys to further investigate these results.
First, we created a virtual acoustic space environment using binaural sound recording techniques with miniature microphones inserted into a macaque head cast. We validated the acoustics of the technique and by measuring saccadic eye movements during playback to sound sources we were able to confirm a behavioral response to different locations. We then performed fMRI to identify cortical areas sensitive to sound motion in azimuth of the left and right hemifields. Preliminary results showed that all moving sounds activated areas MT, MST and the IPS. Contrasting left and right sound-motion conditions against center yielded greater activation in contralateral VIP. These results suggest that interaural information induced by lateralized sounds is processed along a dorsal cortical processing stream comprising VIP in the respective contralateral hemisphere.

27 Modelling Embodied Attention from Vision based Mapping

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Computer Vision has made tremendous progress over the last few years. Systems that can recognise (specific) objects in real-world scenes at real-time are now becoming within reach. A technique called Simultaneous localization and map-building (SLAM) achieves results with cameras that are comparable to systems using highly sophisticated (and expensive) sensors. We present results on how object detection, tracking and recognition as well as visual positioning and SLAM can be used for the semantic mapping of visual attention in arbitrary environments. Vision togetehr with wearable sensors on positioning, acceleration and posture provides an alternative / complementary set of cheap and easy to deploy sensors that can facilitate large user studies on multisensor aspects of human attention. For positioning and SLAM we provide an integated system that includes eye tracking glasses, Kinekt and SLAM modelling to achieve a high accuracy on the mapping of human gaze. Based on these innovative mapping technologies, we propose a framework on how to define embodied attention, i.e., a computational model that includes factors of human mobility and vision for the distribution of human attention in its situated environment.

28 Where is the chocolate? Emotional attention towards reward-associated stimuli

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Some particular stimuli can access to awareness even if they appear outside of the focus of the voluntary attention. This phenomenon is termed attentional capture and is extremely important, because it rapidly orients the attentional resources independently of voluntary controlled processes. It has been proposed that two different characteristics allow stimuli to capture attention: the low-level perceptual salience (i.e., exogenous attention) and the relevant properties for the current concerns of the organism (i.e., emotional attention). Here, we investigate if stimuli without perceptual salience can modulate rapid orientation of attention based exclusively on their emotional relevance, by using a spatial cuing task. The evaluation of the emotional relevance is manipulated through a pavlovian conditioning paradigm in which an arbitrary perceptual stimulus is associated with a primary reward (i.e., a chocolate odor). We show that attentional resources are rapidly orientated toward perceptually neural stimuli that have been previously associated with reward. The modulation of the rapid initial orienting depends on the strength of the stimulus-reward association. The findings show that stimuli evaluated as emotionally relevant modulate early stages of visual processing, independently of the low-level perceptual characteristics of the stimulus.

29 Keeping focused: spatial selective attention in healthy old age

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Attention plays a key role in several theories of cognitive ageing, and cognitive decline has been explained as a result of failures in selection at different levels of cognitive processing including early, sensory processing. However, it is not yet clear whether healthy ageing leads to a pervasive decline in selective attention. In a series of experiments, we used the steady-state visual evoked potential (SSVEP) to compare the effects of top-down selective attention on sensory processing in younger and older adults. The first experiment required spatial selection of one of two simultaneously presented letter streams, which were centrally located but differed in spatial extent. Perhaps surprisingly, no age differences in performance were found and the pattern of attentional modulation for SSVEP responses to large and small letters did not differ between age groups. We could not rule out the presence of age-related change in the timing of selective attention effects, so the second experiment was designed to allow time-course analysis of spatial attentional enhancement of sensory processing. Subjects covertly shifted attention to one of two flickering dot clouds presented at the left and right of fixation, after the relevant direction was cued by a fixation cross colour-change. A comparison of the two age groups found no evidence for age-related slowing in behavioural and SSVEP time-courses. Together, these results strongly suggest that the control of spatial attention is preserved in healthy old age. Moreover, the timing of the behavioural and neural facilitation conferred by spatial selective attention appears to be largely unchanged.

30 Self-regulation of differential visual cortex activity with real-time fMRI neurofeedback

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Recent advances in neurofeedback based on real - time functional magnetic resonance imaging (rtfMRI) offer the advantage of learning to control spatially localized brain activity in the range of millimeters across the entire brain. Here, we used differential feedback between a visual ROI and its contralateral homologue to train participants to voluntarily imbalance their visual cortex activity between the left and right hemispheres. Learning to control such a differential feedback signal can be achieved by up-regulating the visual target ROI, by down-regulating the contralateral homologue ROI, or by a combination of both. In order to shed light on possible models of how neurofeedback learning is accomplished, we evaluated these three alternatives on a per participant basis. Further, we hypothesized that voluntarily unbalancing the activity between the left and right visual cortices causes specific behavioral consequences that resemble symptoms of hemispatial neglect, e.g. increased visual extinction on the hemisphere that is less activated.
We showed that control over differential feedback from two homologue visual ROIs can be learned. Voluntarily controlling the balance of visual cortex activity between the left and right hemispheres may be of direct relevance for medical conditions which are associated with asymmetric top - down influence on visual areas such as hemispatial neglect. Interestingly, some participants achieved control over the differential feedback signal by down - regulating the contralateral ROI rather than by up - regulating the target ROI.. Hence, our findings suggest that the neurofeedback learning might be accomplished by more implicit conditioning based reinforcement for some participants, as well as explicit cognitive control for other participants. Behaviorally, increasing the differential activity showed an influence on visual perception on both visual hemi-fields.

31 Oscillatory correlates of bound and unbound feature representations in working memory are differentiated in young but not in older adults

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Aging is associated with a deficit in remembering feature-bound representations in working memory. However, whether aging alters oscillatory brain activity underlying memory for bound representations is unknown. This study examined age-related differences in theta and alpha oscillations, during performance on a working memory task with two versions (identity and integrated). Both versions contained identical perceptual components; single letters presented at different locations. In the identity version, only the identity of the letter was relevant for task performance, whereas in the integrated version, both the identity and the location of a letter were relevant. In general, young adults outperformed the elderly. Moreover, young adults were as fast and as accurate in both versions, whereas old adults were slower in the integrated than in the identity version. Despite comparable performance levels in both task versions, young adults had enhanced theta and alpha oscillatory brain activity in the integrated compared to the identity version. These results suggest that remembering verbal and spatial feature combinations in working memory requires more effort than remembering verbal features alone. In contrast, the elderly had similar oscillatory brain activity in the identity and in the integrated version. These results seem to suggest that similar neural correlates in old adults support the processing of different types of information.

Keywords: aging, feature-bound representation, working memory, oscillatory brain activity, EEG

32 The ventral stream and visual illusions

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It has been argued that the visual system comprises two different streams: a ventral stream for perception and a dorsal stream for action. Evidence for this thesis comes also from the study of visual illusions. It has been demonstrated that such illusions frequently will have less of an effect on visuomotor acts as compared to perceptual judgments. It is assumed that these illusions originate in the ventral stream. Their failure to affect visuomotor tasks is therefore seen as evidence for the two-visual streams hypothesis. However, there are exceptions. One such case is an orientation illusion which affects the posting performance of healthy subjects. Dyde and Milner (2002) explain this finding by assuming that this illusion originates in the dorsal stream. One would therefore predict that DF - a patient with extensive damage to the ventral stream but a largely preserved dorsal stream - would also fall prey to this illusion. We examined this claim and found that DF's visuomotor performance is not affected by the presence of the illusion. We therefore conclude that the ventral stream is critical for this illusion and that the influence of this illusion on the visuomotor performance of healthy subjects suggests that contrary to the two visual stream hypothesis ventral stream representations affect the visual guidance of motor behaviour.

33 Parietal cortex codes for egocentric space beyond the field of view

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Our subjective experience links covert visual- and egocentric spatial attention seamlessly. However, the latter can extend beyond the visual field, covering all directions relative to our body. In contrast to visual representations, only little is known about unseen egocentric representations in the healthy brain. Parietal cortex appears involved in both, as lesions in it can lead to deficits in visual attention, but also to a disorder of egocentric spatial awareness, known as hemi-spatial neglect. Here, we used a novel virtual reality paradigm to probe our participants' egocentric surrounding during fMRI recordings. We found that egocentric unseen space was encoded by patterns of voxel activity in parietal cortex. Intriguingly, the brain regions with best decoding performances comprised two areas known to be involved in visual covert attention and reaching as well as a region in inferior parietal cortex that coincided with a lesion site associated with spatial neglect.

34 Visual attention in dual-task with central and peripheral stimuli

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An individual had to performing a visual search task by counting a specific letter from a 27° set of letters on white background in central visual field. This task was performed with no noise, small noise or big noise in peripheral visual field. Additional peripheral stimuli appeared 44°±2°either to the left or to the right from the center of a projection screen. Peripheral stimuli that had to be named by an individual – a circle or a square – appeared one at a time for 500 ms. Each stage of the experiment consisted from randomly repeated ten central tasks and only one peripheral stimulus size out of six was used at a time – from 0,5° to 3,5°.
As seen from the results, noticing peripheral stimulus is significantly affected by peripheral noise ($p<0.05$) due to a masking effect. For three out of five individuals central task with different peripheral noise and peripheral stimuli size was performed significantly differently ($p<0,05$). Four out of five individuals were able to accomplish central task faster with big peripheral noise comparing with no noise or small noise. All the individuals demonstrated that there were more errors in central task performance as the peripheral stimulus size increased on a background without noise or with small noise. As it was hard to notice and discriminate peripheral stimuli with big noise in periphery, central task performance was not significantly affected ($p<0.05$).

35 Texture segregation depends on right-hemisphere attention-related brain areas

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Whether perceptual organization requires attention is still uncertain. Extinction patients who have problems in attending to a contralesional stimulus when two competing stimuli are presented, provide us with the opportunity to study the role of attention-related brain areas in the presence of intact low-level visual areas. Although we know that a wide range of perceptual grouping processes are unimpaired in these patients, texture segregation and contour integration are unexplored.
In this study, four right and five left extinction patients, as well as twelve healthy controls, were presented with texture and contour stimuli consisting of oriented elements. We induced regularity in the stimuli by manipulating the element orientations resulting in an implicit texture border or explicit contour. Subjects had to discriminate curved from straight shapes without making eye movements while stimulus presentation time was varied according to a QUEST procedure.
Results show that for textures but not for contours, the left extinction patients need a longer presentation time to determine the shape of the border/contour on the contralesional side. These results indicate that texture segregation is modulated by attention-related brain areas in the right hemisphere, such as the right temporo-parietal junction (TPJ), which is typically damaged in extinction.

36 The role of the frontal eye fields in oculomotor competition: image-guided TMS enhances contralateral target selection

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In order to execute a correct eye movement to a target in a search display, a saccade program towards the target element must be activated while saccade programs towards distracting ele-ments must be inhibited. The aim of the present study was to elucidate the role of the frontal eye field (FEF) in oculomotor competition. fMRI-guided single-pulse transcranial magnetic stimulation (TMS) was administered over either the left FEF, the right FEF or the vertex (con-trol site) at three time intervals after target presentation, while subjects performed an oculo-motor capture task. When TMS was applied over the FEF contralateral to the visual field where a target was presented, there was less interference of an ipsilateral distractor, compared to FEF stimulation ipsilateral to the target's visual field or TMS over vertex. Furthermore, TMS over the FEF decreased latencies of saccades to the contralateral visual field, irrespective of whether the saccade was directed to the target or to the distractor. These findings show that single-pulse TMS over the FEF enhances the selection of a target in the contralateral visual field and decreases saccade latencies to the contralateral visual field.

37 Anticipation increases tactile stimulus processing in the ipsilateral primary somatosensory cortex

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Stimulus anticipation improves perception. To account for this, we investigated how stimulus processing is altered by anticipation, focusing on stimulus-induced changes in oscillatory neuronal activity. We recorded magnetoencephalography in 19 humans while they performed a cued somatosensory identification task in which unilateral tactile stimuli occurred at various intervals following a symbolic attentional cue. Because anticipatory processes build up over time, this manipulation of the cue-target interval allowed us to investigate the processing of the target as a function of the degree of anticipation. To our surprise, we observed that (1) anticipation increases the target-induced response (suppression of beta-band oscillations, occurring 300-600 ms post-target) originating from the ipsilateral primary somatosensory cortex (S1), and (2) this is associated with improved perceptual accuracy. We hypothesize that this increased ipsilateral response reflects more distributed sensory processing across bilateral primary sensory cortices as anticipation becomes stronger. This constitutes a conceptually new and potentially important mechanism underlying the improvement in perception following anticipation.

38 The functional organization of dorsal and ventral attention systems as revealed by dynamic causal modelling

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Research over the last decades has identified two functionally and anatomically distinct attention networks in the human brain. The voluntary deployment of attention (e.g. after a spatial cue) engages a bilateral dorsal frontoparietal network which comprises the intraparietal sulcus (IPS) and the frontal eye fields (FEF). This network may modulate visual cortex in preparation for upcoming stimulation. A right-lateralized ventral frontoparietal network, comprising the temporoparietal junction (TPJ) and ventral frontal cortex, mediates reorientation of attention after invalid cueing. By characterizing effective connectivity during lateralized orienting and reorienting of attention, respectively, the present fMRI study investigated the functional architecture of these two attentional systems. Subjects performed a modified version of Posner's location-cueing paradigm. Dynamic causal modelling (DCM) of regional responses in the dorsal and ventral network was used to compare different functional architectures. For the dorsal network, Bayesian model selection showed that top-down connections from left and right IPS to left and right visual cortex, respectively, were modulated by the direction of attention. Moreover, model evidence was highest for a model with directed influences from bilateral IPS to FEF, and reciprocal coupling between right and left FEF. In the ventral network, valid cueing enhanced forward connections from visual areas to right TPJ, and directed influences from right TPJ to right IPS and inferior frontal gyrus (IFG). These findings shed further light on the functional organization of the dorsal and ventral attentional network and support a context-sensitive lateralisation in the top-down mediation of attentional orienting and the bottom-up effects of invalid cueing.

39 The Influence of Hand Position and Response Complexity on the Allocation of Visual Attention in Depth Space

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The speed of response to targets appearing at unattended depth locations varies relative to the position of the observers' initial point of focus; i.e. reaction times (RTs) to targets appearing closer than previously attended are significantly faster than those to targets appearing further away from this 'expected' location. This phenomenon; the 'Near-Far effect' (NFE), exists when the participant's responding hand (RH) is placed at the 'near' target location, but eliminated when this hand is positioned at the 'far' target location; a finding attributed to attentional facilitation around the RH, that signifies a close interplay between visual attention and RH position. To investigate this relationship further, the present research manipulated RH position and response complexity during a visual cueing paradigm conducted across the depth plane. In this manner, RH position varied such that responses were made at either the site of the 'target' or 5" to its right, whilst the complexity of the unimanual responses varied between 'low', 'moderate' and 'high'. Two key findings have emerged from these studies: firstly, an identical pattern of RT data was seen regardless of whether the RH was placed at the site of the targets, or 5" adjacent to it; suggesting the utilisation of a space-based attentional mechanism. Secondly, the attentional facilitation around the RH varies according to the complexity of the response; i.e. the NFE was present at both target locations during low complexity responses, only the 'near' location during moderate complexity responses, and at neither location when responding in the most complex manner.

40 Parietal cortex mediates perceptual grouping across space

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One of the key real-world challenges to our visual system is posed by cluttered scenes and occluded objects. To make sense of such scenes, local elements belonging to the same object need to be perceptually grouped, also referred to as spatial binding problem. However, it remains unknown how and where in the brain the local information is grouped together to give rise to a holistic percept. In the current study we addressed this question with a novel bistable motion stimulus developed by Anstis and Kim (2011) that consists of four pairs of dots coherently moving on a circular path. The stimulus causes perception to alternate spontaneously between two interpretations: local dot motion and global motion of two imaginary squares. Using functional magnetic resonance imaging (fMRI), we found that activity in the right parietal cortex correlated specifically with global as compared to local perception periods. To test for a causal role of parietal function in perceptual grouping, we used transcranial magnetic stimulation (TMS) to temporarily disrupt activity in two subregions of the parietal cortex. TMS over one of the subregions - the right anterior intraparietal sulcus (IPS) - specifically affected the global percept durations without affecting the local ones. Our results provide causal evidence that IPS may play a crucial role in perceptual grouping of local elements into a holistic percept, suggesting it to be a common anatomical locus of attention, perceptual grouping and perceptual selection processes.

Reference:
Anstis S, Kim J. (2011). Local versus global perception of ambiguous motion displays. J Vis. 11(3):13.

41 Gating of information to downstream visual areas by alpha activity: a simultaneous EEG-fMRI study

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Increased alpha power has been proposed to gate information by selectively inhibiting task-irrelevant regions. We here ask if the alpha shifting with spatial attention in visual regions gates the information to, thus modulating activity in, downstream regions. We test this with simultaneous EEG-fMRI using faces and scenes, which are known to selectively increase BOLD activity in ventral stream FFA and PPA.

The task required left/right cued attention to faces or scenes: within each trial, a left or right cue appeared, followed by a face and scene on either side. Maintaining central fixation, the subject must remember the cued image during a 10s delay and respond if the cued image on the next trial is an exact match (14% matches).

Both the alpha lateralization index (ALI) and the BOLD within FFA and PPA were significantly modulated with spatial attention ($p<0.005$). The correlation between ALI and the difference of FFA-PPA over trials was 0.09 ($p<0.001$; over subjects). For example in an attend-left-face trial, greater left-minus-right alpha correlated with greater FFA-minus-PPA BOLD.

In conclusion, alpha modulation in visual areas correlates with category-specific ventral stream BOLD modulation. This provides direct support for the hypothesis that alpha activity gates information flow.

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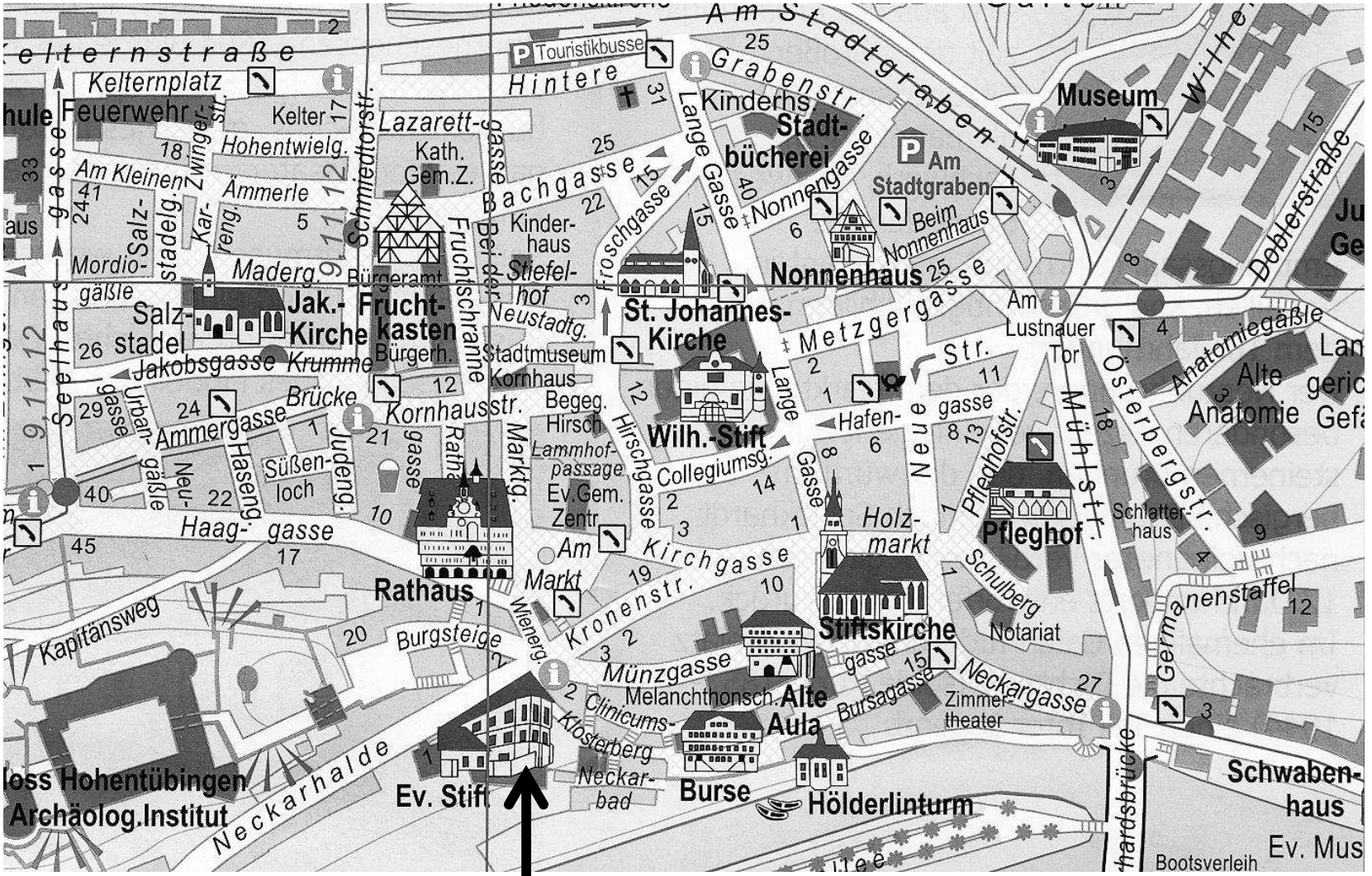

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