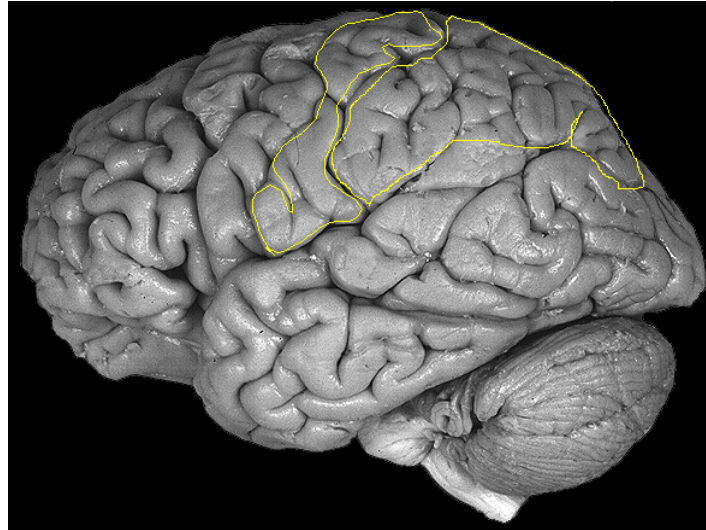


International Conference on Parietal lobe Function

**Artis Zoo, Amsterdam,
20-21 September 2010**



The aim of this symposium is to bring together experts from the fields of neurophysiology, neuroimaging, and (neuro)psychology in order to define the research agenda for parietal lobe function for the next decade.

The challenge is to disentangle the different functions assigned to the same anatomical regions (i.e. what does the posterior parietal lobe do?), the role of the different subareas within a single processing stream (i.e. what is the functional architecture of the somatosensory system?), and the role of the different research methodologies.

The programme focuses on four major issues (Physiology and Anatomy, Visuomotor Function, Somatosensory Function, and Time, Space and Numbers).

Organization

This conference is funded by a European Science Foundation grant for the European Research Network for Investigating Human Sensorimotor Function in Health and Disease.

Organisers:

Edward de Haan, University of Amsterdam

Chris Dijkerman, Utrecht University

Programme

Keynotes

Mick Rugg	(UC, Irvine, USA)	Episodic memory
Masud Husain	(UCL, London, UK)	Spatial attention

Monday 20 September 2010

10.00 - 12.00	Symposium I: Physiology and anatomy
10.00-10.30	Jon Kaas: The evolution of dorsal stream somatosensory networks in primates
10.30-11.00	Claudio Galletti: Reaching and grasping activities in the medial posterior parietal cortex of the primate brain
11.00-11.30	Alexandra Battaglia Mayer: The role of parietal cortex in the on-line control of hand Movement: a comparison with frontal cortex.
11.30-12.00	Mathew Rushworth: Parietal-frontal interactions in people and macaques
12.00 - 13.00	Lunch
13.00 - 15.00	Symposium II Visuomotor function
13.00-13.30	Stephen Jackson: Parietal contributions to the planning and control of reaching movements
13.30-14.00	Ivan Toni: How many brain areas does it take to grasp a light bulb?
14.00-14.30	Laurel Buxbaum: Form and Function: Interactions and conflicts between actions associated with objects
14.30-15.00	Jody Culham: Parietal coding of movement components and object properties in reaching and grasping
15.00 - 15.30	Tea
15.30 - 16.30	Poster Session I: Posters 1-21
16.30 - 17.30	Keynote I: Mick Rugg: What is the role of lateral parietal cortex in episodic memory retrieval?

Tuesday 21 September 2010

10.00 - 12.00	Symposium III: Somatosensory processing
10.00-10.30	Chris Dijkerman: Somatosensory representations of the fingers. Evidence from finger agnosia and spatial directional judgements
10.30-11.00	Salvador Soto Faraco: The remapping of tactile space
11.00-11.30	Ellen Poliakoff: Investigating Somatic Perception and Misperception
11.30-12.00	Brigitte Röder: Crossmodally generated shifts of auditory localization
12.00 - 13.00	Lunch
13.00 - 15.00	Symposium IV Time, space & numbers
13.00 – 13.30	Vincent Walsh: t.b.a.
13.30-14.00	Brian Butterworth: Numbers and space in the parietal lobes and elsewhere
14.00-14.30	Martin Fischer: From sensory-motor associations to embodied numerical cognition
14.30-15.00	Rainer Goebel: Disentangling the functional role of the left and right parietal lobe in spatial mental tasks using fMRI and TMS
15.00 - 15.30	Tea
15.30 - 16.30	Poster Session II: Poster 22-41
16.30 - 17.30	Keynote II: Masud Husain: Attention, working memory and parietal cortex

ABSTRACT TALKS

Keynote I:

What is the role of lateral parietal cortex in episodic memory retrieval?

Michael D. Rugg

University of California, Irvine, USA

Since the earliest functional neuroimaging studies of human memory it has been apparent that the lateral parietal cortex is consistently activated during retrieval of episodic memories. Given the paucity of neuropsychological evidence pointing to a role for this region in memory these findings are unexpected, and their interpretation remains controversial. This presentation will review evidence indicating that memory retrieval activates at least two functionally dissociable regions of the lateral parietal cortex: the middle segment of the intra-parietal sulcus (IPS) and the posterior aspect of the angular gyrus. The relative merits of two approaches to the interpretation of these findings – one based on the role of the lateral parietal cortex in attention, and the other proposing a more direct involvement in memory – will be discussed in light of the experimental evidence. Recent findings concerning the consequences for memory function of lateral parietal damage, and the use of functional connectivity analyses to segregate lateral parietal cortex, will also be discussed.

Keynote II:

Attention, working memory and parietal cortex

Masud Husain

UCL Institute of Cognitive Neuroscience & Institute of Neurology, London.

One important way to examine the contribution of parietal cortex to cognitive functions is by observing the deficits that follow lesions to this region. In humans, damage to the parietal lobe, particularly in the right hemisphere, leads to the syndrome of neglect or inattention to objects in contralesional space. Recent studies have begun to dissect the interacting, cognitive mechanisms that might underlie neglect, providing important insights into the role of posterior parietal cortex (PPC) in directing spatial attention, maintaining vigilance or sustained attention and in visual working memory. For example, although the deployment of spatial attention is known to be impaired in neglect there has been relatively little investigation of whether the deficit is stimulus-driven or goal-directed. We probed the nature of the attention deficit using eye movements to measure bottom-up capture by irrelevant stimuli while patients *were* performing a goal-directed search. Our findings reveal similar, graded deficits across space for both stimulus-driven and goal-directed attention, consistent with the view that PPC makes a crucial contribution to both these processes. Separate experiments also reveal that neglect patients have difficulty maintaining attention to spatial locations over time. A vigilance decrement was observed in such individuals when they were required to maintain attention to spatial locations, but not verbal or pattern material. Finally, recent findings have begun to show impairments in the precision of visual working memory – for object orientation as well as for spatial locations – in neglect, even when stimuli are presented centrally at fixation.

In this talk, I'll review these findings and consider what they might reveal about the contributions of the human right PPC to attention and working memory.

Symposium I: Physiology and anatomy

The evolution of dorsal stream somatosensory networks in primates.

Jon H. Kaas

Vanderbilt University, Nashville, TN, USA

Comparative studies of cortical organization in mammals allow the evolution of the complex organization of parietal cortex in humans to be reconstructed. Early mammals had small brains with little neocortex. They likely had a primary somatosensory area, S1, adjoining rostral and caudal somatosensory belts, and one (S2) or more (S2 and PV) higher-order somatosensory areas, but little that could be called posterior parietal cortex (PPC), and no motor cortex, and a narrow region of PPC emerged with placental mammals, providing substrates for a dorsal stream sensorimotor network that included both somatosensory and visual inputs. The immediate ancestors of primates had an expanded region of visual cortex, and possibly more visual input into the still small PPC. By comparison, PPC is greatly expanded in all extant primates. Early primates likely resembled present-day prosimians in having little change in the organization of anterior parietal cortex, while having much more PPC, which was divided into a rostral half dominated by somatosensory inputs and a caudal half dominated by visual inputs, which were then relayed to the rostral half. In present-day prosimian galagos, rostral PPC contains crude representations of body movements from limbs to forelimb and hand, to face in a mediolateral sequence, as revealed by electrical stimulation with microelectrodes. Subregions can be defined that produce reaching, grasping, and defensive movements, and similar movement regions exist in motor and premotor cortex. These frontal and parietal subregions are preferentially interconnected. Similar subregions have been demonstrated in New World monkeys, and in motor and premotor cortex of Old World monkeys, and they likely exist in all primates. Yet, the somatosensory cortex of anthropoid primates has changed from that of prosimian-like ancestors in a number of ways, including a more differentiated anterior parietal region with a complex body representation in Area 2, expanded lateral parietal cortex with additional areas, and a variably larger PPC with additional subdivisions, especially in humans. Overall, the expanded and functionally subdivided PPC of anthropoid primates is thought to mediate the intentions for specific motor behaviors, as well as use sensory information to guide performance. We propose that interconnections between functional subdivisions of PPC allow a single behavior to emerge in response to sensory stimuli while inhibiting others.

Reaching and grasping activities in the medial posterior parietal cortex of the primate brain

Claudio Galletti and Patrizia Fattori

University of Bologna, Italy

Recording from single neurons in the macaque brain in the last decades has provided an useful tool to get insights on how the brain organises complex processes. The dorsal visual stream, involving superior and inferior parietal lobules, is strongly involved in object location and in control of reach-to-grasp actions (Goodale and Milner, 1992). The superior parietal lobule in particular is thought to be involved in the on-line processing of visual information for the purpose of directing the hand towards objects to be reached and grasped. Area V6A is a visuomotor area of the caudalmost part of the superior parietal lobule that shows interesting functional properties to this respect. Single V6A cells are modulated by visual and oculomotor signals, as well as by somatic signals from the upper limbs and by arm-reaching movements. V6A neurons use a complex frame of reference that encompasses both spatial and retinotopic coordinates. V6A cells are likely involved in the neural computations needed to guide the entire act of prehension, from the transport of the hand towards the object in the peripersonal space, to the hand orientation and preshaping to align it and shape it correctly to acquire the object. According to these findings, reaching and grasping would be processed by the same population of posterior parietal neurons. This could shed new light on the way the brain plans and executes visually guided action.

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The role of parietal cortex in the on-line control of hand Movement: a comparison with frontal cortex.

Alexandra Battaglia-Mayer

University of Rome, Italy.

An important aspect of the control of hand movement is the capability to quickly update the hand trajectory, whenever requested by the external environment, such as when an unexpected change of target location occurs during planning and execution of hand movement. There is evidence that this ability is affected after disruption of parietal neural mechanisms, e.g. as a consequence of cortical lesions or of transient cortical inactivation. To understand the role of the posterior parietal cortex (PPC) within the parieto-frontal network, we have recorded neural activity in PPC (area 5), as well as in dorsal premotor cortex (PMd) of macaque monkeys, trained to make reaches to visual targets in 3D space and on-line corrections of movement trajectory, after sudden change of target location in space. It was found that both parietal and premotor activity are highly correlated with the changes in hand kinematics, although this correlation remains higher for parietal than for premotor cortex during trajectory correction. However, another differential roles of these areas emerge when looking at the timing of their activation, in particular the time of signalling the change of motor intention. In such a case, PMd activity leads parietal activity, suggesting that the former is mainly involved in encoding the higher-order instruction to initiate a new motor plan, while the latter is more involved in the current state estimation of motor periphery during planning an initial hand movement and updating his trajectory.

Parietal-frontal interactions in people and macaques

Matthew FS Rushworth, Erie D Boorman, Rogier B Mars

University of Oxford, UK

The similarity between the parietal cortex in the human brain and in the brains of other primates has been questioned. There has been a particular focus on the possibility that the human inferior parietal lobule (IPL) might differ from the IPL in other primate species. To better characterize the human parietal cortex we used diffusion weighted magnetic resonance imaging (DW-MRI) and probabilistic tractography to estimate connectivity profiles between each voxel in the human parietal cortex and the rest of the brain and then used similarities in the patterns of connexions to parcellate the parietal cortex into component regions. Ten regions were consistently identified in all subjects using this approach and most of the areas corresponded to cytoarchitectonically defined parietal regions. Patterns of correlation between the resting state BOLD signal in the parietal areas and areas known to be interconnected with the parietal cortex in the macaque were then examined in both humans and macaques. The resulting resting state “functional connectivity” patterns in the macaque reflected the known structural connexions of the parietal cortex. Moreover, there were clear similarities between the functional connectivity patterns associated with both human and macaque parietal cortex that suggested fundamental similarities between parietal cortical organization in the two species. It was notable, however, that activity in the human mid-IPL was strongly correlated with activity in a very anterior prefrontal brain region and a similar pattern was not easily discerned in the macaque. A functional magnetic resonance imaging (fMRI) study suggested that activity in the two areas reflected evidence in favour of an alternative course of action that might be taken each time a subject made a choice. Functional connectivity between the two areas was enhanced as the subjects switched to alternative courses of action.

Symposium II: Visuomotor function

Parietal contributions to the planning and control of reaching movements

Stephen R. Jackson

University of Nottingham, UK and Korea University.

Computational theories have proposed that the brain uses internal models of the body to ensure accurate control of movement. Specifically, forward ‘dynamic’ models are thought to generate an estimate of the next motor state for an upcoming movement: thereby providing a dynamic representation of the current postural configuration of the body that can be utilised during movement planning and execution.

It has been suggested that a representation of the current state estimate of the arm is maintained in the superior lobule of the posterior parietal cortex [SPL] and consistent with this view, damage to the SPL often leads to an impairment of reaching movements. In this paper I review recent neuropsychological, transcranial magnetic stimulation, and fMRI studies that have investigated the contributions of the SPL to the planning and control of reaching movements.

How many brain areas does it take to grasp a light bulb?

Ivan Toni

Radboud University, Nijmegen, the Netherlands

Until recently, our understanding of reaching-to-grasp behavior was one of the success stories of neuroscience, with a detailed characterization of the control variables, neuronal structures, and cerebral circuits supporting it. In short, visuospatial information about the spatial location of a grasped object relative to the subject would be processed along a dorso-medial parieto-frontal circuit, whereas visuospatial information about the size, shape, and orientation would be processed along a dorso-lateral parieto-frontal circuit. However, the lack of an expected event has started to cast doubts on this success story. Despite the supposedly anatomical and functional segregation between these two parieto-frontal circuits, no clear double dissociation between reaching and grasping deficits following localized lesions has been found, to date. Furthermore, in the traditional model of reaching-to-grasp, it remains unclear how reaching and grasping components could be seamlessly coordinated and integrated with perceptual information.

In this talk, I will use recent neurophysiological findings on reaching-to-grasp behavior to suggest a revision of that traditional model, and more generally to provide an example of how the primate brain integrates perceptual and motor processes.

Form and Function: Interactions and conflicts between actions associated with objects

Laurel J. Buxbaum

Director of Cognition and Action Laboratory, Moss Rehabilitation Research Institute
Associate Research Professor of Rehabilitation Medicine, Thomas Jefferson
University, Philadelphia PA, USA

A number of lines of evidence suggest that the parietal cortex is the locus of two distinct types of object-related action systems. The first is a bilateral system calculating movements of the arm and hand based on currently-visualized structural information about object shape, size, and location. The second is a left-lateralized system richly informed by object semantics, which retrieves representations of skilled actions in the service of functional goals. These two systems, while strongly interactive, display different characteristics in terms of temporal persistence of activated information, and thus have different propensities to participate in between- and within-object priming and interference. Moreover, they are differentially damaged in patients with action disorders (apraxias), resulting in difficulties with resolution of response conflict that lead to action errors. Review of these findings and directions for future research will be discussed.

Parietal coding of movement components and object properties in reaching and grasping

Jody Culham, Simona Monaco, and Jason Gallivan

University of Western Ontario, London ON, Canada

Functional magnetic resonance imaging of human parietal cortex has identified two key areas involved in reach and reach-to-grasp movements. The anterior intraparietal sulcus (aIPS) codes the hand grip and is affected by object properties such as size. The superior parieto-occipital cortex (SPOC) codes the transport of the arm and orientation of the wrist. Recent multivoxel pattern analysis results show that information from aIPS and SPOC can be used to decode grasping vs. reaching movements during movement planning as well as action execution. Information from other parietal and frontal areas can be used to decode precision grips on large vs. small objects. Taken together, these results suggest although information about movement components (arm, hand, wrist) and the target object (size, location) must ultimately be integrated to produce seamless reach-to-grasp actions, various subregions of parietal and frontal cortex may code different types of information.

Symposium III: Somatosensory processing

Somatosensory representations of the fingers. Evidence from finger agnosia and spatial directional judgements

Chris Dijkerman

Utrecht University, the Netherlands

Several authors have proposed that fingers are represented differently to other body parts. Evidence for this notion comes from neuropsychological studies of patients with finger agnosia as well as from psychophysical studies. In this talk I will focus on how tactile input from different fingers is processed in healthy individuals and in patients with finger agnosia. First, finger agnosia affects identification of the touched finger, but not goal-directed movements towards that finger. In a second study we observed that finger agnosia does not affect the ability to integrate tactile input from different fingers into a coherent percept or to make spatial judgements about them. Finally, a study of spatial directional judgements with healthy individuals reveals somatotopic mapping of tactile input when the fingers have been crossed. Together, these findings suggest different levels of processing tactile input from the fingers. Finger agnosia is an impairment of finger identification, however the ability to distinguish between tactile input from different fingers is not impaired at all levels. Indeed spatial judgements about tactile stimuli are spared, which may depend particularly on somatotopic representations.

The remapping of tactile space

Salvador Soto-Faraco

Universitat Pompeu Fabra & ICREA, Spain

Reacting to sensation on the skin, like when we swat a mosquito from our forearm, requires a spatial transformation from a skin-centered spatial representation to an external reference frame. I will present data from several studies addressing the nature of the representations involved in this process of spatial remapping, its time course and its potential neural underpinnings. First, we have found that two different spatial frames of reference are available at different times during the encoding of touch. In particular, a fleeting representation linked to anatomically-based space is quickly followed by a more stable, abstract representation based on an external spatial frame of reference. This reference-frame transformation turns out to be relatively automatic and independent of the spatial requirements of the task. Second, we have investigated the time course of tactile remapping by means of somatosensory evoked potentials (SEPs) and saccadic responses. In both cases, we compared participants' reactions to a single tactile event at one hand under crossed- and uncrossed-hands posture. SEPs revealed effects of posture on somatosensory processing as early as ~80 ms post stimulus, thus suggesting an onset time of remapping. Saccadic RTs and trajectories, on the other hand, confirmed that an external representation about touch location is already available ~270 ms after stimulus presentation. Finally, we used transcranial magnetic stimulation (TMS) to investigate the involvement of the human homologue of ventral intra parietal (hVIP) area in tactile remapping. Participants compared the elevation of arm taps with respect to face taps across different postures, a task that requires the use of an external representation of tactile location. Our results revealed that single-pulse TMS targeted at the right hVIP disrupted performance in this task, but not in other tasks which could be resolved on the basis of purely somatosensory or proprioceptive information. Therefore, hVIP seems to play a causal role in high-level spatial transformations leading tactile information from a primary, anatomically based representation, to a more abstract externally based coordinate system.

Investigating Somatic Perception and Misperception

Ellen Poliakoff

University of Manchester, UK

When detecting the presence or absence of weak tactile targets, people frequently miss targets and falsely report a tactile sensation in the absence of a stimulus (false alarms). In the somatic signal detection task (SSDT), we have observed that tactile false alarms increase in the presence of a concurrent light (Lloyd et al., 2008). I will present results from two recent studies in which we have recorded brain activity using functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) whilst participants performed the SSDT task. Specifically, we have examined how brain activity differs when participants i) correctly report versus miss a weak touch; ii) falsely report versus correctly reject an absent touch. We predicted that we would observe activity in somatosensory and parietal areas and the medial prefrontal cortex, which has been linked to subjective reports of vibration detection in non-human primates (de Lafuente & Romo, 2005). Results will be discussed in terms of the similarities and differences between tactile experience in the presence and absence of a stimulus.

Crossmodally generated shifts of auditory localization

Brigitte Röder, Patrick Bruns

Biological Psychology and Neuropsychology, University of Hamburg, Germany

When an auditory and a visual event are presented from two different locations, people often report to hear the sound close to the location of the visual stimulus, a phenomenon well known as the ventriloquist effect. As we showed, a similar ventriloquist effect exists for audio-tactile stimuli. By systematically varying the hand posture (uncrossed vs. crossed) we were able to conclude that tactile stimuli modulate auditory localization base on external rather than anatomical coordinates. An event-related potential study further suggested that the audio-tactile ventriloquist effect, similar as has been reported for the audio-visual ventriloquist effect, is predominantly mediated by feedback connections from multisensory cortex to auditory cortex. A repeated presentation of spatially discrepant audio-visual stimuli results in a shift of auditory localization, a phenomenon known as the ventriloquist aftereffect, which can last for tens of minutes after the visual stimuli were removed. Using event-related potentials we tested whether the ventriloquist aftereffect results from a prevailing activity of feedback connections from multisensory regions to auditory cortex or whether a change of auditory spatial representations involved in bottom up processing mediate the ventriloquist after effect. We interpreted the finding that the N1 amplitude to sounds was altered by a preceding repetitive ventriloquist experience as evidence for the second hypothesis.

Taken together these findings might reflect a general principle of crossmodal adaptations in adulthood: Crossmodal learning experience modulates sensory cortex via feedback connections. These changes prevail and result in a change of unisensory perception.

Symposium IV: Time, space & numbers

Numbers and space in the parietal lobes and elsewhere

Brian Butterworth

University College London, UK

Although it is well-established that the parietal lobes are a core locus for numerical processing, there are two important unanswered questions. First, do both left and right parietal lobes do the same job? There is now evidence that lateralization of function changes in the course of development, and that the left hemisphere is more engaged in calculation while the right more in estimation. There also appear to be regional differences of function within each lobe, with left angular gyrus being involved arithmetical fact retrieval (no surprise there) and the right temporo-parietal junction supporting subitizing. Second, are spatial models of numerical magnitude part of that job? Evidence from lesion studies and TMS suggest that both right inferior frontal gyrus and frontal eye fields are contributors to the task-specific creation of a spatial model of numbers.

From sensory-motor associations to embodied numerical cognition

Martin H. Fischer

University of Dundee, Scotland, UK

Numbers are no longer thought of as abstract and amodal concepts that we manipulate to compute quantities. Instead, number concepts have specific sensory and motor associations. I will review recent support for such sensory and motor biases in numerical cognition, focusing largely on behavioural evidence. To account for these findings I propose a theoretical framework for an embodied representation of number magnitude, according to which numerical concepts are grounded, embodied and situate

Disentangling the functional role of the left and right parietal lobe in spatial mental tasks using fMRI and TMS

Rainer Goebel

Maastricht University, the Netherlands

The capacity to generate and analyze mental visual images is essential for many cognitive abilities. A series of fMRI and TMS studies will be presented that support the notion that the left parietal lobe is predominant in generating mental images, whereas the right parietal lobe is specialized in the spatial comparison of the imagined content. Furthermore, our TMS studies indicate that the right, but not left, parietal cortex is able to immediately compensate a left parietal disruption by taking over the specific function of the left hemisphere. We found a similar hemispheric specialization for visuospatial judgement tasks, i.e. impairments in task performance were only observed when stimulating the right parietal lobule. Finally network analyses revealed significant correlations between induced behavioral impairment and neural activity changes in both the directly stimulated parietal as well as remote ipsilateral frontal brain regions. This corroborates the notion that visuospatial deficits following parietal damage are brought about by a perturbation of activity across a specific frontoparietal network, rather than the lesioned parietal site alone. Our experiments furthermore show how sequential and concurrent fMRI and magnetic brain stimulation during active task execution hold the potential to identify and visualize networks of brain areas that are functionally related to specific cognitive processes.

POSTER ABSTRACTS

1. Shared representations of touch: Sensory specific effects of viewing others in pain **Adams, W. L.¹, Bach, P.², Morrison, I.³ & Tipper, S. P.¹**

¹ Bangor University, Wales, ² University of Plymouth, England, ³Göteborg University, Sweden

Previous research has demonstrated that somatosensory cortical regions are active during the observation of both touch and pain. However, the functional role of such shared representations is largely unknown. In a series of three experiments, we aimed to investigate whether viewing others in pain influences tactile processing. In Experiment 1, participants detected threshold level vibrotactile stimuli, delivered to their right index finger, whilst viewing hands either grasp, or withdraw from, potentially painful or non-painful objects. When observing painful grasps, participants detected more tactile stimuli, but were also more biased to report touch. In Experiment 2, a control experiment, participants detected threshold level auditory stimulation whilst viewing the hand-object interactions. Importantly, no effects of viewing painful grasps on auditory detection rates were found. In a final experiment, to confirm the somatosensory specific effects of viewing others in pain, participants made a speeded response to above threshold tactile stimuli. Participants were faster to respond to touch when they observed hands grasping painful objects, in comparison to all other conditions. These data demonstrate, for the first time, that observing others in pain selectively effects tactile processing.

2. Non-retinotopic representations of egocentric space in visual cortex are modulated by internal representations of eye position in somatosensory cortex

Daniela Balslev, Tanja Kassuba, Finn Årup Nielsen, Hartwig Siebner

Danish Research Centre for Magnetic Resonance, Denmark

The eye position signal combines the oculomotor command and proprioceptive information from the extraocular eye muscles. While there is convincing evidence that oculomotor commands cause attention shifts, it is unknown whether the proprioceptive eye-position signal in the somatosensory cortex (S1) also modulates the spatial allocation of attention. We have previously shown that 1 Hz rTMS over S1 alters the eye proprioceptive signal, inducing an illusory perception of gaze position (Balslev and Miall, *J Neurosci*, 2008). This is accompanied by a pseudoneglect further from the perceived direction of gaze for targets presented at equal retinal eccentricity (Balslev, Gowen and Miall, *JoCN*, 2010).

Here we manipulated neural processing in left S1 with 1Hz rTMS and used fMRI to investigate how a lasting suppression of S1 alters the responsiveness of early visual cortex to lateralized visual input.

Compared to rTMS of left M1, rTMS of left S1 altered the cortical response to lateralized visual stimuli in relatively early visual areas producing opposite effects depending on the lateral direction of gaze. The present results have two implications: (i) They provide evidence for non-retinotopic representations of egocentric space at a relatively early stage of visual processing. (ii) The rTMS-induced effect on the visually evoked BOLD response shows that non-retinotopic representations of

egocentric space in visual cortex are modulated by internal presentations of eye position in the S1.

This modulatory interaction between the eye proprioceptive representation in S1 and the visual cortex may serve the allocation of attention in the body-centered space.

3. Dissociation between implicit and explicit anosognosia

Nicoletta Beschin, Gianna Cocchini, Aikaterini Fotopoulou, Sergio Della Sala
Gallarate Hospital, Italy and University of Edinburgh, UK

When asked directly, anosognosic patients deny or seriously underestimate their motor difficulties. However explicit denial does not necessarily imply a lack of insight of the deficit. In this study we explored explicit and implicit awareness for upper limb motor impairment in a group of 30 right-brain damaged patients whose lesion was centred on the right parietal lobe. Implicit awareness was assessed by means of a newly developed test (BMT – Bimanual Task). This test requires the performance of a series of bi-manual tasks that can be better performed using two hands, but could also be performed using one hand only. With the BMT, patients' actual performance rather than their verbal reports is evaluated and scored as an index of awareness. Paretic patients with anosognosia tend to approach these tasks as if they could use both hands. Explicit awareness was assessed using a questionnaire (the VATAm) in which patients are asked to rate their motor abilities. Our findings show that explicit and implicit awareness for motor deficits can be dissociated, and they may be differently affected by feedback suggesting that different underlying mechanisms may account for the multifactorial phenomenon of anosognosia.

4. An fMRI study of parietal cortex involvement in the visual guidance of locomotion

Jac Billington¹, David T. Field², Richard M. Wilkie³, and John P. Wann¹

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²University of Reading, Reading, RG6 6AL, UK; ³University of Leeds, Leeds LS2 9JT, UK.

Navigating through the environment typically involves anticipating impending changes in heading trajectory in addition to maintaining the current direction of travel. We explored the neural systems involved in the “far road” and “near road” mechanisms proposed by Land and Horwood (1995) using simulated forwards or backwards travel. During forwards egomotion the distant road edges provided future heading information, which participants used to improve their heading judgments. During backwards egomotion the road edges did not enhance performance because they no longer provided prospective information. This behavioural dissociation was reflected at the neural level, where only simulated forwards travel increased activation in a region of the superior parietal lobe and the medial intraparietal sulcus. Providing only near road information during a forwards heading judgment task resulted in activation in the motion complex (MT+). We propose a complementary role for the posterior parietal cortex and MT+ in detecting future path information and maintaining current lane positioning respectively.

5. Spatial attention in Visual Neglect: Dissociation between Overt Manual and Covert Saccadic Inhibition Of Return in Left Unilateral Neglect

Alexia Bourgeois^{1,2}, Ana B. Chica¹, & Paolo Bartolomeo^{1,3}

¹INSERM-UPMC UMR-S 975, Groupe Hospitalier Pitié-Salpêtrière, F-75013 Paris, France. ²Université Paris VI, Paris, France. ³AP-HP, Groupe Hospitalier Pitié-Salpêtrière, Fédération de Neurologie, Paris, France.

Inhibition of Return (IOR) refers to slower reaction times to targets presented at previously stimulated or inspected locations. This effect biases orienting towards novel locations to efficiently explore our environment. Patients with right brain-damage and left unilateral neglect explore their environment asymmetrically, with strong difficulties to orient attention to the left part of space. The present study shows that neglect syndrome may be, at least in part, a consequence of inhibitory mechanisms. Replicating previous studies, neglect patients showed facilitation instead of IOR for repeated right-sided events when manual responses were required under covert orienting situations. However, we demonstrate here for the first time that these patients present a normal IOR for right-sided events when the task involved saccadic responses (overt orienting). A precise characterization of manual and saccadic IOR may help in understanding left unilateral neglect and devising rational strategies of rehabilitation. Furthermore, this dissociation between manual and saccadic IOR in neglect is crucial for the understanding of the mechanisms underlying IOR.

6. Visual perception without awareness: A case-study

Elliot C. Brown¹ & Gianna Cocchini²

¹University of Hertfordshire, UK, ²Goldsmiths University of London, UK

Blindsight refers to some sparing of the ability to detect, localise and discriminate visual stimuli in the blind field, without awareness, following destruction of the cortical visual pathway or primary visual cortex. Blindsight with blindness of the whole visual field is a rare occurrence, and usually the patients' performance consists of a rough approximation. We report a singular case of a 67-year-old right-handed woman (AG) who suffered from diffuse bilateral parieto-occipital infarcts with more pronounced damage to the left hemisphere. AG came to our attention approximately 12 months following the brain injury consistently and repeatedly claiming she could not see at all. However, on a visual recognition task, where she was obliged to guess the drawn objects presented, she provided 40 out of 84 correct object identifications, while also correctly guessing the colour in 51 out of the 84 objects. On all these occasions, AG denied any consciousness of seeing. When asked to double check the correctness of her responses to visual identification of actual objects via tactile exploration, she recognised the stimuli and showed a strong emotional response asking how she could have provided the correct response "if I see nothing". A number of ad-hoc tests were used to explore the hypothesis that AG used unconscious elaboration of incomplete visual information.

7. Reaching in Optic Ataxia: new insights from brain tumour patients

Tania Buiatti¹, Alessandro Mussonia², Miran Skrap² and Tim Shallice^{1,3}

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Damage to the posterior parietal cortex (PPC) has been found to lead to optic ataxia (OA), a neuropsychological disorder in which patients usually show reaching impairments in extra-foveal conditions. Recent lines of research suggested that the PPC might be not only involved in simple reaching tasks toward peripheral targets, but also in monitoring the hand movement trajectory in real time, a condition which usually occurs in central vision. The main strands of the present study was to investigate whether patients with a lesions arising from operation of prefrontal, premotor or parietal tumours might be selectively impaired in three experimental pointing conditions: i) extrafoveal pointing, ii) foveal pointing toward stationary targets and iii) automatic motor hand corrections. We used an anatomically based group study approach together with Lesion Behaviour Mapping (LBM) analyses. We were able to confirm the importance of the parietal cortex in all the experimental conditions, but with the existence of somewhat different lateralization effects across the three conditions and dissociations at the individual patients level.

8. The role of the parietal lobes in stimulus-driven and goal-driven saccadic visual selection

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Short latency saccades are predominantly stimulus-driven, whereas longer latency saccades are increasingly goal-driven. The parietal lobe may play an important role in this time course. We investigated how stimulus salience dynamically affects saccadic target selection in patients with unilateral or bilateral parietal lesions. Participants were asked to make a saccade to one of two oriented lines amongst homogeneous background lines. We varied salience by changing the background orientation. We found that contralesional target selection of unilateral patients was purely salience-driven. However, ipsilesional target selection was comparable to healthy, age matched controls. Saccadic target selection of bilateral patients was purely salience-driven in both hemi-fields. This supports the hypothesis that salience- and goal-driven processes interact in the parietal lobes. In unilateral patients both processes interact normally in the unaffected lobe. The interaction is disrupted in bilateral patients, such that their saccades become completely contingent on salience representations in earlier visual areas.

9. Horizontal-Vertical length comparison and the perceptual symmetry law in left visual neglect

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Left unilateral neglect usually arises after right parietal damage and is characterized by a left-right imbalance in sensory processing. Typically, neglect patients deviate rightward when bisecting lines. An underestimation of the left portion of the line and/or a right overestimation could explain this effect. We aimed at dissociating their respective contribution to patients' performance, by using a line length comparison

task in which participants compared a vertical segment to an horizontal segment either left or right-sided. Based on recent evidence that normals underestimate lines symmetrically bisected as compared to lines asymmetrically bisected, the present study also aimed at testing whether this symmetry law was preserved in neglect. We tested 8 patients suffering from left unilateral neglect and 8 control participants. The results showed that controls and patients underestimated symmetric as compared to asymmetric bisections, and confirmed that neglect patients both underestimate left-sided stimuli and overestimate right-sided stimuli. Our results support the ideas that left unilateral neglect might reflect a deficit in attentional orienting to the left coupled with a disengagement deficit from right-sided stimuli, and that the symmetry law is driven by pre-attentive mechanisms.

10. Anatomico-functional dissociation between bimanual symmetric and bimanual asymmetric movements: evidence from motor neglect

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Previous neuroimaging studies have claimed a functional asymmetry between the two hemispheres during the execution of bimanual movements. The dominant hemisphere would play a predominant role in performing bimanual symmetric movements, whereas the non-dominant hemisphere would have its key role during the execution of bimanual asymmetric movements. In particular, a right fronto-parietal network it is hypothesized to be the candidate structure for the integration of sensory-motor information when directionally incompatible movements (i.e., asymmetric) are performed. Here we report the results of an experiment on two left-motor neglect patients (i.e., underutilization of the left arm in absence of motor or sensory deficits) with damages affecting those structures of the non-dominant hemisphere which mediate directional interferences that emerge during asymmetrical bimanual movements, which are strictly consistent with that model. Patients were administered a battery to assess the ability to execute bimanual movements (eight symmetric and eight asymmetric). Both of them resulted to be significantly impaired in executing asymmetric movements but unimpaired in executing symmetric movements. We argued that in these patients when the requested movement is symmetric the (healthy) dominant hemisphere would allow the movement, whereas when the movement is asymmetric the (lesioned) non dominant hemisphere would not be able to plan correct movements. These results strengthen and confirm previous evidence suggesting distinct neural networks underpinning bimanual symmetric and bimanual asymmetric movements.

11. Awkward actions require an expert: the left human anterior intraparietal area (aIPS) shows greater fMRI activation for less-practiced actions.

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In behavioral grasping studies using visual illusions, we have shown that, unlike pincer grasps (i.e. thumb and index finger) made with the right hand, pincer grasps made with the left hand or awkward grasps (i.e. thumb and ring finger) made with either hand are susceptible to illusions. We advanced the hypothesis that the more practiced actions, right hand pincer grasps, were more accurate because they reflected the left hemisphere expertise in computing the real size of the objects regardless of the illusory background (Gonzalez et al., 2006; 2008). We now follow-up on these findings using an event-related fMRI experiment focusing on an established grasping-related area in the anterior portion of the intraparietal sulcus (aIPS). Participants were asked to grasp three-dimensional objects with the right or left hand using either a pincer grasp or an awkward grasp. We found that regardless of the hand used, aIPS in left hemisphere showed overall higher activation than right aIPS. While left aIPS responded comparably to grasps made with either hand, right aIPS responded preferentially to grasps made with the contralateral left hand. Interestingly, we also found that awkward grasps resulted in higher activation than precision grasps, and this difference was greater in left aIPS than right aIPS. These results suggest that less familiar grasps, whether they are made with the left hand or are a less practiced awkward grasp with either hand, are associated with higher aIPS activation in the left hemisphere. These results are in line with our behavioural findings in that they suggest that the more expert left hemisphere plays a special role in the visual control of grasping.

12. Strategic control versus sensorimotor recalibration: the role of the superior parietal lobule in non-standard reaching

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We typically reach directly towards a viewed object, a type of sensorimotor transformation referred to as “standard”. However, humans are also skilled in situations where the spatial correspondence between gaze direction and reach goal is not congruent, a type of sensorimotor transformation referred to as “non-standard”. Non-standard mappings can be further divided into “strategic control” (explicit use of rules) and “sensorimotor recalibration” (implicit remapping between, e.g., proprioception and vision). Our group’s previous work on patients with optic ataxia (OA) has revealed the importance of an intact superior parietal lobule (SPL) for successful planning and execution of non-standard reaches. In the present study, we expand on these findings by examining whether an intact SPL is required in situations where cognitive strategies can be utilized versus situations where online sensorimotor recalibration is required. We tested a bilateral OA patient (IG) and aged-matched controls on a centre-out look-and-reach task to ordinal and oblique targets. Movements were made with two cursor feedback rotations, and in two spatial planes. IG’s performance decrements were greater during visuomotor rotations requiring sensorimotor recalibration relative to those requiring explicit strategic control. These decrements were in the form of increased planning and execution time, increased gaze-biased undershoot of the target, increased path curvature. Our results suggest that an intact SPL is required for non-standard situations when implicit sensorimotor recalibration is required. These deficits were markedly smaller for mappings involving explicit rule integration, suggesting an independent pathway for processing strategic control in non-standard visually-guided reaching.

13. Directional bias of proprioceptive hand position information – evidence from a patient with unilateral damage of the postcentral gyrus

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Sensory representations of the hand in the postcentral gyrus are supposed to be strictly lateralized and to allow a spatially unbiased representation of the position of the contralateral limb. We report a patient whose behavior suggests a different organization of proprioceptive representations. Patient R.W. demonstrated an isolated proprioceptive deficit after a lesion of the right postcentral gyrus. We examined her limb position sense in a finger position matching task.

Target locations were defined by passively positioning the index finger of one hand beneath a table surface. With the other hand above the table R.W. indicated the perceived position of the finger below the table. Without visual feedback of either hand, we observed a leftward shift of perceived locations when reaching with the right hand and an opposite rightward shift when reaching with the left hand in comparison to age-matched healthy controls. These errors improved when vision of the active hand was allowed. However, position errors were significantly different from controls even with free view of the contralesional hand. Pointing to visual targets without

feedback, R.W. revealed significant errors with both hands. However, pointing to visual targets with full visual feedback, R.W. was as accurate as controls with either hand.

Thus we can exclude a contribution of visual or motor deficits. Our data show a contralesional shift of the perceived position of the contralesional hand suggesting a directional bias of proprioceptive representations. Furthermore, our data reveals an effect of the right hemisphere lesion on proprioceptive information processing for the ipsilateral hand.

14. Neural correlates associated with visual perspective in action imitation

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Movement imitation requires complex visuomotor transformations to map the visual model on action representations. These transformational requirements differ depending on the availability of stored movement representations. Imitation of meaningless movements depends on online dynamic coding of body part positions of self and others (body schema). Visual perspective is of relevance in such a process. In contrast, imitation of meaningful movements should not make a distinction between viewing a model from a first or third person perspective due to the availability of stored representations. In this fMRI study (n=16) we report activation in imitation of meaningful and meaningless tool-use viewed from first or third person perspectives. Results confirmed the hypothesis that the observer's perspective affects imitation of meaningless but not meaningful movements. Significantly stronger activation was found for the first person perspective during imitation of meaningless but not meaningful tool-use in several left hemisphere regions: the primary sensory-motor cortex (SI and MI), the inferior parietal lobe (IPL), the superior parietal area 5, and the extrastriate body area (EBA). In contrast, the third person perspective did not show significant differences for either action. These findings suggest that a preference for a match between the model and one's own body position (first person perspective) in imitation is reflected not just in primary sensory-motor processes, but also in high-order body schema mechanisms. We speculate that only the observer's first-person perspective prompts embodiment simulation processes during imitation of novel tool-use actions, with possible implications for motor learning and neuro-rehabilitation contexts.

15. Imitation learning of sequences and rhythms – An event related fMRI study

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Imitation learning involves the acquisition of novel motor patterns based on action observation. Previous studies demonstrated that the inferior parietal lobule (IPL) and ventral premotor cortex (PMv) are involved in the imitative learning of configural hand actions. In addition, IPL, PMv, and dorsolateral prefrontal cortex (DLPFC) were activated more strongly for novel as compared to practiced actions (Vogt et al., 2007 NeuroImage). In the present event-related fMRI study, we explored whether these findings can be generalised to sequence and rhythm imitation when both were closely matched for difficulty and visual appearance.

The design included observation, preparation and execution events of sequential or rhythmical finger movements (each consisting of eight keypresses).

We found that the observation and execution of sequences engaged fundamentally the same areas as imitation learning of configural hand actions, plus the SMA. In contrast, common activations between rhythm observation and execution were largely confined to BA44, posterior SMA, insula and cerebellum. Large parts of posterior parietal cortex, including IPL, were more strongly activated for the sequences than for the rhythms. Importantly, this dissociation indicates that the putative human mirror neuron system does not represent any observed action in the same cortical network.

Rather, our data show that this network is highly task-specific.

DLPFC was involved in both tasks, but it tended to be more strongly activated for the sequences than for the rhythms.

One possible explanation for the latter finding is that rhythms are encoded in a specialised subsystem which requires less supervisory control than spatially oriented actions.

16. Somatosensory perception in Anorexia Nervosa patients

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One of the main characteristics of Anorexia Nervosa (AN) is a disturbance in body image, meaning that AN patients experience their body shape and weight in a distorted way. In a series of studies we focused on somatosensory perception in AN patients. Extensive research on the visual component of body image shows that AN patients overestimate their body size in visual tasks, however research on the tactile aspects of body image in this population is scarce. Using a Tactile Estimation Task we asked blindfolded participants to estimate the distance between two simultaneously applied tactile stimuli by varying the separation between their right thumb and index finger. The results showed that, compared to healthy controls, AN patients overestimated these tactile distances. To further investigate the nature of this disturbance in tactile perception we administered the Two Point Threshold task and Von Frey task. The results indicated no differences between the AN patients and

controls in Two Point Threshold, but AN patients appeared to have a VF lower detection threshold on the belly, implying that AN patients show a disturbance in receptor sensitivity but not in tactile acuity.

17. Verbal Short-Term-Memory and the Intra-Parietal Sulcus

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The intraparietal sulcus (IPS) is one of the most consistently activated regions during verbal short-term-memory (STM) tasks. Majerus, Poncelet, Van der Linden, Albouy, Salmon et al. (2006) reported in an fMRI study, that both item and order verbal STM tasks activated left IPS but only the order STM task showed activation in the right IPS. The order STM task is a better predictor for vocabulary acquisition. IPS's precise role still remains a matter of debate. To help clarify its role, we report two studies. One study used repetitive transcranial magnetic stimulation (rTMS) to determine the role of the IPS in serial order and item STM. For 9 monolingual, right-handed participants (4 male) T1-weighted MRI scans were obtained which were then converted into MRICro files. The images were used in a neuronavigation technique, the MINIBIRD magnetic tracking system (www.ascension-tech.com), to identify the left and right anterior IPS and Vertex. rTMS was performed off-line at a fixed level of 60% of maximum stimulator output for 6 min train at 1Hz. Participants then immediately performed an item or order STM task. We found significant differences between TMS and SHAM conditions ($p < .05$). A second study used electroencephalography (EEG) with an event related potential (ERP) design. We compared mono- and bilingual adults and monolingual children. Significant differences between parietal sites were found. The results indicate that the intra parietal sulcus plays an important role in verbal STM tasks and hence in the acquisition of new vocabulary.

18. Magnitude Interference between Number Processing and Response Force Planning

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The current research investigates the cognitive mechanisms underlying the representation of semantic knowledge about numbers. We will present behavioral data suggesting that mathematical cognition and the control of motor actions are two processes that are functionally linked by a common cognitive metric for magnitude information. As one example, participants were required to judge the parity status (i.e., odd or even) of Arabic digits and to indicate their decision by pressing a button with either a weak (<600 cN) or strong force (>600 cN). The RT analysis indicates that actions with a high force level were initiated faster if the presented number was relatively large, whereas actions with a low force level were initiated faster in response to small numbers. The observed interference effects between numerical magnitudes and size-related aspects of motor actions (e.g., response force) are discussed in the context of an embodied approach to mathematical cognition.

19. Correlated deficits of perception and action after dorsal stream lesions

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Optic ataxia, following dorsal stream lesions, is characterised by impaired visuomotor guidance. Recent studies have found concurrent perceptual deficits in optic ataxia, but it is unclear whether these can explain the visuomotor symptoms. We studied visuomotor and perceptual abilities in a patient (IG) with bilateral optic ataxia. Visuomotor reactions to target jumps were measured in a double-step reaching task. A matched perceptual task was also performed, requiring speeded discrimination of the jump direction. IG had impaired visuomotor reactions, especially for jumps to the visual periphery, and was similarly slow to discriminate peripheral jumps in the perceptual task. Across different target conditions, the pattern of IG's discriminations mirrored that of her visuomotor reactions. These data confirm that dorsal stream lesions can produce perceptual deficits. Crucially, these perceptual deficits may help shape the visuomotor symptoms of optic ataxia.

20. Ipsi- and contra-lateral effects of rTMS over the parietal cortex: an EEG study with healthy subjects.

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Spatial neglect consists in a disorder in which patients fail to perceive, orient or respond to stimuli in the contralesional space. Transcranial magnetic stimulation (TMS) over the right parietal cortex is capable to induce neglect-like and extinction-like impairments of performance in healthy subjects. In neglect patients, TMS over the left, unimpaired, parietal cortex results in an improvement of the contralesional visuo-spatial processing. The most influential model to the interpretation of these effects invokes "hemispheric rivalry", with the activation of each hemisphere counterbalancing the activation of the other. While many studies have invoked this explanation, very few if any studies directly tested the effects of a lesion or TMS over one hemisphere on the activation of the other hemisphere.

Here, healthy subjects performed a simple reaction time task consisting of the detection of checkerboards presented either to the left or to the right of a central fixation point. While performing the task EEG responses to visual stimuli were recorded. This task was repeated before and immediately after right or left parietal cortex repetitive TMS (rTMS). rTMS was applied at stimulus parameters (1Hz, 30 min, 90% of motor threshold) shown to reduce cortical excitability for several minutes beyond the duration of the TMS trains. Reaction times, visual-induced alpha desynchronisation (VID) and visual-evoked potentials (VEPs) were recorded in both sessions (i.e. before and after rTMS). We found that behavioural and electrophysiological measures were reliably modulated by rTMS, both ipsilaterally and contralaterally to the stimulation. Implications for the "hemispheric rivalry" model are discussed.

21. Parietal Hyporesponsiveness and Cognitive Impairment in Breast Cancer Survivors Ten years after Chemotherapy

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Adjuvant chemotherapy is associated with long-term cognitive impairment in a subgroup of breast cancer survivors. Both executive functioning and episodic memory have been reported to be affected (Schagen and Vardy, 2007). The neural circuitry underlying these impairments is largely unknown.

Functional MRI was performed in breast cancer survivors almost ten years after finishing treatment with high-dose adjuvant chemotherapy (CT group, n=16, mean age 56.9 ± 5.1 years) and in breast cancer survivors for whom systemic therapy had not been indicated (non-CT group, n=15, mean age 58.2 ± 5.8 years). BOLD activation and performance were measured during an executive functioning task (Tower of London) and a paired associates task inducing memory encoding.

Changes in BOLD signal were found in the dorsolateral prefrontal cortex (DLPFC) for the planning task and in the parahippocampal gyrus for the encoding task.

Bilateral hyporesponsiveness of the lateral posterior parietal cortex was found during planning as well as memory encoding in the CT versus the non-CT group.

Planning performance was significantly impaired in the CT group. A correlation between BOLD signal in the DLPFC and parietal cortex and planning performance was found.

In the present study, high-dose adjuvant chemotherapy was associated with long-lasting cognitive impairments. A general dysfunction of (visuo-spatial) attention located in the lateral posterior parietal cortex may underlie these impairments. This dysfunction may be caused by direct and/or indirect neurotoxicity of the applied cytotoxic regimen (Ahles and Saykin, 2007). Hormonal treatment may also have contributed to these effects.

22. Planning rotations elicits mental rotation: an ERP investigation

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Mental rotation is frequently investigated using a task where participants decide whether rotated letters and digits are normal or have been mirror-reversed. Typical findings suggest that people mentally rotate along the shortest trajectory to the upright, thus indicating that the direction of the shortest trajectory should be available before mental rotation (MR) begins. We wished to examine whether this is indeed the case by comparing the event-related potentials (ERPs) evoked by decisions about the direction of shortest trajectory (planned rotation: PR) and MR. For the MR task, participants decided whether the characters were normal or mirror-reversed. For the PR task, we asked the participants to decide whether the characters should be rotated in clockwise or anticlockwise direction to make them upright. Both tasks elicited orientation-dependent increases in ERP negativity over parietal areas. The magnitude of these orientation effects was smaller for the PR task than the MR task, but the scalp distribution (and by inference distribution of underlying sources) was similar. Furthermore, more fronto-parietal negativity overall was elicited by the PR than the MR task. One interpretation is that both tasks elicit mental rotation, but planned rotation also poses a higher load on the fronto-parietal network, reflecting increased attentional or working-memory demands. Therefore, we may use MR to observe the outcome of dorsal-stream processing. This interpretation would depend on the idea that dorsal-stream processing is largely unconscious, and may require action, be it physical or imaginary action, for the information to be brought into our consciousness.

23. The continuous updating of grasp in response to dynamic changes in object size, hand size and distractor proximity

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Reaching out to pick up an object seems a trivial matter, but selecting the appropriate hand configuration requires a series of complex computations that process the object's dimensions, orientation and environment. A current debate in motor control concerns how and when the motor system responds to unexpected changes in the visual and spatial properties of objects to be grasped. In the current experiment, visual manipulations that increased either target size, distractor proximity or hand size were applied gradually and continuously throughout reach to grasp movements. All manipulations were associated with early and continuous modifications of the grasping component, but only an increase in hand size affected transport characteristics. This suggests that visual information of both the object and the effector are continuously processed in movement computations, in keeping with models of motor control that posit high weighting for online sensory feedback.

24. Repetitive long-term prism adaptation permanently improves detecting contralesional visual stimuli in a patient with chronic neglect

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The aim of the current study was to investigate long-term effects in spatial awareness after daily exposure to prism adaptation during three months in a patient with hemispatial neglect. Results showed improvement in the detection of stimuli in the contralesional visual field, as measured with perimetry, in the contralesional visual field up to 24 months after ending prism adaptation. These perimetrical results suggests that compensatory eye movements are an unlikely candidate for an underlying mechanism.

25. The influence of motor-related experience on perceptual processing of visual objects

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Introduction: Motor-related regions in the brain have been shown to selectively activate when observers passively view objects that afford manual grasping (implicit processing). Handy et al. (2006) reveal in their fMRI study that prior motor-related experience with the observed object leads to reduced implicit processing in the motor-related regions of cortex, and interestingly, also in the visual-related cortex. The aim of this study was to replicate these results by means of EEG recordings.

Methods: 13 participants we submitted to a signal-detection task, that required them to view two objects types: 'Climbing Holds' and 'Blocks', both associated with no self-reported motor experience. EEG was measured during this task. Of interest were the P1 and N1 components, that capture perceptual processing, and the N250, that indexes familiarity. A 5-week training followed to gain motor-experience with the Climbing Holds. Post training, participants were again submitted to the signal-detection task and EEG measurements. The data was analyzed using repeated measures ANOVA with Object type (Climbing Holds and Blocks) and Session (before and after training) as within subjects factor. Results: There appeared to be no effect of motor-experience on perceptual processing of visual objects as indicated by the P1 and N1. Unexpectedly, participants showed larger negative deflections at the N250 to Climbing Holds than Blocks prior to, and after the training Conclusion:

Our EEG study does not provide evidence for an effect of motor-training on perceptual and cognitive processing experience. Interestingly though, this study suggests that N250 activation is not necessarily dependent on familiarity.

26. (Non) interactions between numerical and visual space: evidence from unilateral neglect

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The notion that in left neglect the pattern of error for visual and numerical lines (i.e., progressive rightward displacement of the midpoint as the interval size increases) are homologous is still debated. As first, here we further examined the degree of association between numerical errors and visual neglect by administering to thirty-two right brain-damaged patients a number bisection task and a battery to assess neglect. As second, we reasoned that if the two representations (i.e., numerical and visual) are homologous, they should interact when concurrently activated (i.e., number processing should affect spatial orienting and viceversa). Thus, we analyzed whether the size of the numerical interval modulates both visual and numerical errors when visual and numerical space are activated at the same time. Eighteen patients displaying the aforementioned pattern of numerical error in the number bisection task were administered a visual-number bisection task, that consisted of two conditions: a) marking the midpoint of the empty space enclosed between two numerical extremes; b) Same as a), but here patients were asked to mark the midpoint by writing down the number that is numerically halfway between the two numerical extremes. The results showed that numerical errors are dissociable from visual neglect, and that the size of numerical intervals equally influenced numerical errors (both number bisection and visual-number bisection tasks), but not the visual errors (in visual-number bisection task), defined as the spatial position of the bisector. These findings suggest that attention shift along internal and external representations might be underpinned by different mechanisms.

27. Mapping between fingers and numbers is topological

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There is a vast amount of research showing that small numbers are associated with the left part of space and large number with the right part of space. It has also been shown that brain areas involved in number processing overlap with areas involved in finger movements. In the present study we investigated the spatial mapping between numbers and fingers. Subjects were asked to name random numbers between 1 and 30 paced by a metronome at 1 Hz. With every number they had to tap a random finger. The hands were placed either directly next to each other, 30 cm apart or 30 cm apart with the arms crossed. The results show that in each of the conditions smaller numbers were associated with tapping a finger to the left of the previous finger, while for larger numbers a finger more to the right was tapped. This mapping was independent of the distance between the fingers involved and was therefore not metrically scaled. We conclude that there is a topological mapping from left to right between the fingers and small to large

28. Anosognosia for hemiplegia as a global deficit in motor awareness: evidence from the non-paralysed limb

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The current study adds to the growing empirical research into the mechanisms underlying unawareness of paralysis following stroke (anosognosia for hemiplegia or AHP) by investigating action awareness for the non-paralysed limb in a single AHP patient. Visual feedback representing patient GG's goal-directed reaching movements was either modified by a computer or left unperturbed. Unlike healthy and brain-damaged controls, GG was unable to detect computer-generated visual perturbations as large as 20 degrees. GG also failed to report awareness of the large on-line corrective movements that he made when compensating (often unsuccessfully) for the visual perturbations. These results suggest that the motor comparators implicated in AHP are functioning, but not at optimum levels. Moreover, because the current findings reveal a deficit in awareness for reaches with the unimpaired limb, it is suggestive of common right hemisphere networks for motor awareness in both limbs and that AHP may be a global deficit in motor awareness as opposed to a specific lack of awareness for a particular motor deficit.

29. The blurring of body time after right IPL tumour resection.

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In the Libet's task subjects are asked to push a button at the time of their own choosing and to report the position of a clock's hand when they first make a decision to move. This task can thus tap the ability to consciously identify the instant in time when an intention to move emerges.

Again, if a rubber-hand and the subject's (hidden) hand are stroked, repeatedly and synchronously, the subject feels as if the rubber-hand were part of her/his own body. Importantly, this effect disappears if the stimulation is asynchronous, indicating a strict time window for this illusion to emerge.

Here, a 43 years old right-handed woman was asked to perform both tasks before and after resection of a right inferior parietal lobe glioma.

With the Libet's task, before surgery the patient estimated the time she first intended to move 306 ms in advance of the movement onset (estimate of movement execution - 73 ms); after surgery, however, the time of the intention to move (-96 ms) and the time of the movement execution (-68 ms) were estimated close to that of movement onset.

With the rubber-hand illusion (RHI), before surgery a RHI for both hands was found for synchronous stimulation only. However, after surgery, for the left (contralesional) hand the illusion was also present for asynchronous stimulation.

These data show that a right IPL lesion can affect body time, both in terms of awareness of motor intentions and of the integration in time of visual and somatosensory information.

30. Local field potentials during decoupled visually-guided reach movements in the superior parietal lobule

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The objective of our research is to understand how the brain plans and executes movements when a rule dictates the relationship between perception and action. Such cognitive motor integration is often necessary for movements in which the motions of the eye and hand must be decoupled. Our previous research has demonstrated that these decoupled movements are associated with activity in a network of brain regions that includes the superior parietal lobe (SPL) and dorsal premotor cortex (PMd)^{1,2}. Here we examine the contribution of the local cell assemblies in SPL during a cognitive-motor integration task. Monkeys (*macaca mulatta*) were trained to move their eyes and displace a cursor reflecting finger position from a central to a cued peripheral target under standard (direct interaction) and non-standard (eye-hand decoupled) conditions. We analyzing local field potentials (LFP) recorded simultaneously from multiple electrodes and measured the full hand and eye trajectories. We observed both changes in LFP spectrograms and coherency between task conditions during the cue and early reaction time period. Our observed changes in SPL between standard and non-standard conditions may reflect a signal allowing gaze and hand to decouple. Previously we have observed similar task dependent spectrogram changes in PMd³. Taken collectively, these data suggest that communication between local cell assemblies in SPL and PMd comprise a necessary part of a frontoparietal network for visuomotor transformation during cognitive motor integration. References: 1. Gorbet et al (2004) *Neuroimage* 23:1100-1111. 2. Granek et al (2010) *Cortex* in press. 3. Sayegh et al (2009) *SFN* 455.10

31. What role does the PPC play in episodic memory?

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fMRI studies addressing healthy subjects pointed towards posterior parietal cortex (PPC) involvement in episodic memory tasks. However, neuropsychological studies usually do not connect parietal lesions to episodic memory impairments. We systematically evaluated the literature on this apparent paradox. Our literature survey indicates that PPC activation in fMRI studies do not appear to be attributable to confounding cognitive/psychomotor processes, such as button pressing or stimulus processing. What may be of more importance is the extent to which experimental episodic memory tasks load on three closely related cognitive processes: effort and attention, self-related activity, and scene and image construction. It could be that these cognitive processes account for the paradox between lesion and fMRI results. These processes are strongly intertwined with episodic memory and may determine in how far the PPC is activated in a given memory task. We are currently addressing these issues in a study that involves patients with and without cerebral infarctions in the parietal cortex. These patients will participate in an extensive neuropsychological assessment of episodic memory and related cognitive domains. This way we want to

relate possible episodic memory disturbances with for instance attention deficits, visuo-perception and construction. This information will also be related to the known location(s) of the cerebral lesions. This design will give us insight in both the relation of the neuropsychological domains as in the role the PPC plays. At the meeting we will present our systematic literature survey, probably augmented with empirical data from the recently started patient study.

32. Parieto-frontal network in peripersonal space representation

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In order to interact with the external world, our brain integrates multisensory cues about environmental stimuli with information about the body in a coherent representation of the Peripersonal Space (PPS). Here we provide evidence that a network of fronto-parietal regions, involving the ventral premotor cortex (vPMc) and the posterior parietal cortex (PPc), is necessary for PPS representations.

In a first experiment, we investigated the role of vPMc and PPc in sensory representation of the PPS. Using low-frequency repetitive TMS, we transiently suppressed the activity of PPc, vPMc (targets) and V1 (control site) and tested audio-tactile interaction in the near and far space. Suppression of PPc and vPMc, but not of V1, selectively affected multisensory interaction within limits of PPS.

In a further series of experiments we explored the motor counterpart of PPS representation. Using single-pulse TMS, we first showed that auditory stimuli presented near or far the hand differentially modulated the excitability of the hand cortico-spinal representation, suggesting that processing of stimuli potentially approaching the body automatically triggers motor preparation. Then, using tDCS, we demonstrated that suppression of vPMc, but not of PPc, nor of V1, selectively abolished the space-specific modulation of the hand motor representation.

These findings suggest that vPMc and PPc have a critical role in representing (multi)sensory and motor properties of PPS. Moreover they suggest a partial dissociation within the fronto-parietal PPS network, with vPMc, but not PPc, being involved in transforming sensory representations of stimuli around the body into appropriate motor responses.

33. Working memory processes for numeric information dissociate in parietal cortex

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In essence all number processing tasks, for instance mental arithmetic, require at least two cognitive stages in working memory: (1) the temporary storage of numbers; and (2) applying operations on this stored information. Using a new paradigm, we aimed at determining the neural organization of these two different cognitive stages in a number comparison task.

Twenty subjects performed the following experiment in an NMR-scanner. First two reference numbers, left and right of fixation, were presented for a brief duration. Following a retention interval of variable duration, a target number was centrally presented. Subjects had to determine whether it was numerically closer to one or the other number. To isolate regions that are specific to number processing, we compared

these activations to a similar task with symbols with a different amount of luminance. Each target stimulus was presented in an ellipsoid. In a baseline condition with the same visual input that required no maintenance, subjects decided if the ellipsoid was a circle or an ellipse.

Areas in the (pre)frontal cortex seemed involved both in the temporary storage and the manipulation of numeric information. However, in the parietal cortex we observed a dissociation. The maintenance of numeric information recruited an area in anterior IPS corresponding to hIPS that is known to represent numbers, but the number comparison recruited posterior parietal areas.

While hIPS has previously been associated with the manipulation of numbers, our results suggest that at least number comparison relies on more posterior parietal areas.

34. Prism adaptation influences perception but not attention: evidence from antisaccades

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Prism adaptation has been shown to successfully alleviate symptoms of hemispatial neglect, yet the underlying mechanism is still poorly understood. In this study, the antisaccade task was used to measure the effects of prism adaptation on spatial attention in healthy participants. Results indicated that prism adaptation did not influence the saccade latencies or antisaccade errors, both strong measures of attentional deployment, despite a successful prism adaptation procedure. In contrast to visual attention, prism adaptation evoked a perceptual bias in visual space as measured by the landmark task. We conclude that prism adaptation has a differential influence on visual attention and visual perception in healthy participants as measured by the tasks used.

35. Working memory, attention, and executive function in Alzheimer's disease and frontotemporal dementia

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Working memory deficits are a recognised feature of Alzheimer's disease (AD). They are commonly ascribed to central executive impairment and assumed to relate to frontal lobe pathology. Performance failures on standard tests of attention and executive function reinforce this interpretation. Nevertheless, the characteristic neuroimaging change in early onset AD is in posterior hemispheres rather than frontal lobes. We explored this anomaly through comparison of working memory, attention and executive test performance in patients with AD (a 'typical' early onset and an 'amnesic' group) and frontotemporal dementia (FTD). Typical-AD and FTD patients both showed impaired performance, whereas amnesic-AD patients performed well. Despite similar quantitative performance measures, typical-AD and FTD patients showed qualitatively distinct performance profiles. Whereas the FTD patients showed 'frontal' features of inattention, poor response inhibition, and disregard of rules, AD patients' performance was influenced more by information load. In keeping with these differences, neuroimaging showed characteristic frontal lobe abnormalities in FTD and temporoparietal change in typical-AD. The findings highlight the importance of the posterior hemispheres in working memory and point to a need for caution in the interpretation of working memory, attention and executive test failures in AD. They underline also the phenotypic variation within AD.

36. Touching a misoplegic arm

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Background: Misoplegia is a rare disorder that is characterized by a dislike or even hatred towards the paralyzed limb. Studies of misoplegia are scarce and limited to symptom descriptions in case studies. In this study, a patient with misoplegia in remission was assessed to investigate whether self touch alters symptoms of body ownership and misoplegia.

Case: A 60-year old woman with a right hemispheric stroke reported subtle problems in identifying her own hemiplegic hand (asomatognosia) and she occasionally attributed her hand to someone else or vice versa (somatoparaphrenia). In addition, she reported having misoplegic symptoms in remission.

Method: The patient was asked to stroke for 90s alternating on her left (hemiplegic) arm and on different sham arms counterbalanced order. During and after stroking, the patient was asked to rate whether the stroked arm was hers, the likeableness (affect) of her arm and whether the arm could belong to someone else.

Results: After stroking her arm, there were no signs of body-ownership problems. Stroking the sham arm resulted in a feeling that her own hand was not hers, and sometimes a feeling that her hand belonged to someone else. Also, the dislike of her own left arm increased. This effect was present after all different sham arms, but stroking time that was needed varied.

Conclusion: These observations showed that stroking a sham arm caused reappearance of misoplegic symptoms. In addition, self-touch resulted in an improved positive affect and sense of body ownership towards the arm.

37. Dissecting the landmark task

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The aim of this work was to investigate the cognitive strategies involved in the Landmark task, in which subjects estimate the position of a landmark across a horizontal line.

Twenty-nine participants had to (i) decide which of the two line segments generated by the landmark was the shorter (left-right decision, LRD), or to (ii) decide whether the two segments were of equal or different length (same-different task, SD). The shape of the two segments was manipulated, by varying orthogonally Symmetry – whether the two segments were the reflection of one another with respect to the landmark, and Translatability – whether the two segments perfectly overlapped by horizontally shifting one over the other (Fig. 1). The landmark could be at line centre, or in one of four eccentric positions. Response times (RT) were recorded.

We reasoned that if subjects solve the task by mentally overlapping the two segments, Translatability should influence RT; else, if subjects use the (a)symmetry of the figure taken as a whole, Symmetry should be the crucial predictor.

We found the expected effects of landmark position, with RT reflecting the degree of uncertainty induced by each position in the two tasks. For the crucial stimuli (central landmark), there was a significant effect of Symmetry on both tasks; an effect of Translatability was only found in the SD task (Fig. 2).

These results support the view that the main cognitive strategy involved in the Landmark task extracts information from the left-right (a)symmetry of the overall stimulus pattern; a mental shift of one line segment over the other plays a less important role and is specific of the SD task.

38. Contraversive Neglect? A potential modulation of spatial neglect in association with contraversive pushing

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Patients with spatial neglect usually show a postural deviation towards the ipsilesional side. However, in some cases neglect can be accompanied by contraversive pushing (CP), which is characterized by a postural deviation towards the contralesional side. In the present study, we compare neglect performance between neglect patients with and without CP.

Our hypothesis is that patients with CP show ‘contraversive neglect’ (CN), i.e. a spatial shift consisting of a cross-over effect on line bisection and a decreased contralesional neglect, in comparison to neglect patients without CP.

First, neglect patients with and without CP are compared on the Schenkenberg’s Line Bisection Test and the Bells Test. Subsequently, the evolution of spatial neglect is observed in relation to postural characteristics in a follow-up case study.

Significantly less contralesional neglect and more contraversive cross-over is demonstrated on line bisection in neglect patients with CP compared to neglect patients without CP. This trend also is reflected in the case study. With respect to cancellation performance, no significant relation with postural characteristics was found.

The outcome of this study gives initial indications for the presence of CN in association with CP.

39. Causal contributions of hV6A and hAIP to goal-directed behavior – a TMS-EEG study

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The dorsal visuomotor pathway supports goal-directed behavior and is anatomically subdivided in two streams, but their functional role remains unclear. An influential account distinguishes between transport and grip components of prehension movements, and it associates these components with medial and lateral streams of the dorsal visuomotor pathway, respectively. Another proposal associates these two streams with advance planning and online motor control. Here, we test these functional-anatomical dichotomies by measuring EEG responses to single pulse TMS perturbations delivered at critical nodes of these two streams, hV6A and hAIP. We also manipulate reliance on perceptual depth cues and visuospatial accuracy requirements, asking subjects to grasp an object under monocular or binocular viewing conditions, while parametrically varying the slant of the grasped object. Planning of grasping movements induced sustained desynchronization in the alpha (9-12 Hz) and beta band (18-24 Hz). TMS over hV6A, compared to vertex stimulation, led to stronger alpha desynchronization over the hAIP region, irrespective of viewing conditions and accuracy requirements. Yet, there were no changes in the prehension kinematics. This suggests that hAIP could compensate for transient alterations in hV6A, providing evidence against the notion of independent neural channels for reaching and grasping during the planning of prehension movements. TMS over hAIP led to reduced beta desynchronization over C3 early in planning, i.e. at a stage when the motor system is most likely to rely on prior motor experience and on perceptual cues of depth, rather than online motor control. This finding confirms that hAIP is necessary for integrating perceptual information into the prehension plan, and provides evidence against the notion that hAIP is necessary specifically during online control of motor behavior.

40. Goal discrimination of observed prehensile actions activates bilateral intraparietal sulci (IPS)

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Thus far, studies on goal representations have defined action goals based on target identity. But the way we grasp an object also varies as a function of how we intend to use that object. The present study tests this more subtle aspect of goal representation.

Fourteen right handed volunteers participated in the study (mean age: 22,2; 9 women and 5 men). Our stimuli consisted of videoclips showing grasping movements of single tool objects that were grasped by an actor with the intention to use or to displace the tool. By observing the way in which the object was grasped, participants had to predict the intention of the actor. Scanning was performed at 3.0 T on an MRI scanner. The main contrasts between control and experimental tasks were performed on the whole-brain, using a threshold of $p < .01$ corrected for multiple comparisons using FDR-correction.

We found that discrimination of action intention elicited activation in three roughly symmetrical foci in aIPS, mIPS, and cIPS. aIPS activation has been associated with the representation of target goals (object specific) and the present findings extend its involvement to functional goals (use specific). Activation in mIPS during intention discrimination was very similar to the activation elicited in a saccadic localizer task, suggesting a relation with spatial attention and eye movements. The cIPS region has been associated with visuospatial guidance of reaching, and its activation during action intention discrimination indicates that the visuospatial properties of the observed reaching movement contribute to action understanding.

41. Support for a state estimate in SPL from imagined grasping

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An important aspect of motor control involves the maintaining of a representation of the limbs position and constellation to each other, as well as predicting future body positions based on motor commands [1]. The parietal cortex and cerebellum have been suggested to be involved in this process, with the posterior parietal cortex (PPC) especially involved in maintenance of the state estimate.

We made use of a well-controlled motor imagery task to investigate how one's own body posture facilitates or interferes with planning of goal-directed motor actions. Here we show that activity in the anterior part of Brodmann area 7 of the superior parietal lobe (SPL) in PPC is modulated by an actor's body posture during motor imagery of grasping movements. If there is incongruency between actual posture and the posture adopted during the imagined grasp, activity in this region is increased. The observation of latency differences in the BOLD response of that region during imagery of sequential movements of changing postures (e.g. early congruency vs. late congruency) further supports the idea that PPC/SPL is a key structure in the state estimation process. More precisely, we suggest that in SPL an estimate of the current (imagined) body state is maintained and continuously compared with incoming proprioceptive feedback.

References:

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