Autumn School and Workshop
'Multimodal Attention and Perception of Space'

1 – 6 May 2014

A joint initiative of the
Queensland Brain Institute
The University of Queensland
Australia
&
Graduate School of Systemic
Neurosciences / Munich Center for
Neurosciences – Brain and Mind Ludwig-
Maximilians-University
Germany

USEFUL INFORMATION

(1) The Jephson Hotel
www.jephsonhotel.com.au

63 Jephson Street (Cnr Sherwood Rd)
Toowong QLD 4066
Telephone: +61 7 3736 4400
Fax: +61 7 3736 4499

(2) Queensland Brain Institute (QBI)
www.qbi.uq.edu.au

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The University of Queensland, St Lucia 4072
Telephone: +61 7 3346 6300
Fax: +61 7 3346 6301

PDF version of campus map: http://www.uq.edu.au/maps/
Download an interactive map to your smartphone: http://uq.edu.au/uqnav/

(3) Customs House
www.customshouse.com.au

399 Queen Street, Brisbane
Telephone: +61 7 3365 8921
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(4) UQ Heron Island Research Station (HIRS)
www.uq.edu.au/heron-island-research-station

Heron Island
Great Barrier Reef
Queensland

Telephone: +61 7 4978 1399 or 4978 1642
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Workshop Program

Day 1 – Thursday 1 May 2014
Venue: Auditorium, Level 7, Queensland Brain Institute (QBI), The University of Queensland, St Lucia Campus

08.00	Visiting attendees depart hotel for QBI (Jephson Hotel, 63 Jephson Street (Cnr Sherwood Rd) Toowong QLD 4066, Tel. (+61 7) 3736 4400)
08.30	Registration
08.45	Welcome: Professor Perry Bartlett (Director, QBI, UQ) Professor Jason Mattingley (QBI/Psychology, UQ) Professor Heiner Deubel (Psychology, LMU)
09.00	**Talk 1 – Andrew King (University of Oxford, UK)** *Adaptive neural coding in the auditory system*
10.30	MORNING TEA Terrace, Level 7, QBI
11.00	**Talk 2 – Oliver Baumann (QBI, UQ)** *The navigating brain: neural mechanisms underlying encoding, storage and retrieval of spatial memories*
12.30	LUNCH Lawn and Garden, Ground Level, QBI
14.00	**Talk 3 – Donatas Jonikaitis (Psychology, LMU)** *Vision, memory and decisions: what eye movements can tell us about visual processing*
15.30	AFTERNOON TEA Terrace, Level 7, QBI
16.00	**Talk 4 – Naotsugu Tsuchiya (Monash University, Australia)** *On the relationship between consciousness and attention*
17.30	End of Day 1 Registered faculty and students assemble in QBI Foyer (Ground Level) Walk to UQ CityCat Terminal for transfer to Customs House
18.30	DINNER Customs House, 399 Queen Street, Brisbane (Tel. (+61 7) 3365 8999)

Day 2 – Friday 2 May 2014
Travel from Brisbane to UQ's Heron Island Research Station

06.30	International/interstate attendees assemble in foyer of Jephson Hotel Coach service to Brisbane Domestic Airport, via QBI
06.45	Local attendees assemble outside QBI Coach service to Brisbane Domestic Airport
09.05	Flight from Brisbane to Gladstone Airport (QF1704)
10.10	Arrive Gladstone Airport – transfer via coach to Gladstone Harbour
11.00	Catamaran departs Gladstone Harbour for Heron Island
13.00	Arrive Heron Island Transfer to UQ's Heron Island Research Station
14.00	LUNCH
15.00	Free time to settle in and explore the island
16.30	AFTERNOON TEA
17.00	**Faculty Talk 1 – Agnieszka Wykowska (Psychology, LMU)** *ERP studies of attention and space in social contexts*
18.00	**Faculty Talk 2 – Ross Cunnington (QBI/Psychology, UQ)** *Mirroring processes and the interaction of motor and visual areas in action perception*
19.00	DINNER
20.00	Open discussion/Free time

Day 3 – Saturday 3 May 2014
Venue: Seminar Room, UQ Heron Island Research Station

07.30 BREAKFAST

08.30 **Faculty Talk 3 – Tirin Moore (Stanford University, USA)**
The control of visual information processing by prefrontal cortex

09.30 **Faculty Talk 4 – Heiner Deubel (Psychology, LMU)**
Attention in goal-directed action

10.30 MORNING TEA

11.00 **Student Talk 1 – Anthony Harris (QBI, UQ)**
Eye fixation patterns support improved guidance as the source of reduced search times in contextual cueing

12.00 **Student Talk 2 – Saurabh Dhawan (Psychology, LMU)**
Proactive inhibition in cognitive control of saccades

13.00 **Student Talk 3 – Oscar Jacoby (QBI, UQ)**
Interactive effects of task set and working memory on attentional capture

14.00 LUNCH

15.00 Open Discussion/Free Time

16.30 AFTERNOON TEA

17.00 **Student Talk 4 – Pauline Popp (Neurological Clinic Grosshadern, LMU)**
Is attention affected in chronic vertigo patients?

18.00 **Student Talk 5 – Claire Naughtin (Psychology, UQ)**
Decoding object individuation across time and space

19.00 DINNER

20.00 Open discussion/Free time

Day 4 – Sunday 4 May 2014
Venue: Seminar Room, UQ Heron Island Research Station

07.30 BREAKFAST

08.30 **Faculty Talk 5 – Jason Mattingley (QBI/Psychology, UQ)**
What can evoked neural oscillations reveal about visual perception and selective attention?

09.30 **Faculty Talk 6 – Marta Garrido (QBI, UQ)**
Mechanisms of regularity learning and outlier detection

10.30 MORNING TEA

11.00 **Faculty Talk 7 – Stefan Glasauer (Department of Neurology, LMU)**
On the origin of systematic error in human navigation tasks

12.00 **Student Talk 6 – Dian Anggraini (DSGZ, LMU)**
Neural correlates of decision making during spatial navigation in humans

13.00 **Student Talk 7 – Christopher Roppelt (Inst. of Clin. Neurosci., LMU)**
Behavioural strategies and brain activity in human spatial exploration

14.00 LUNCH

15.00 Open Discussion/Free Time

16.30 AFTERNOON TEA

17.00 **Student Talk 8 – Chase Sherwell (QBI, UQ)**
Prediction and attention in the time domain: the roles of automatic and conscious expectations in perception

18.00 **Student Talk 9 – Michelle Hall (Psychology, UQ)**
Statistical processing in perception and cognition

19.00 DINNER

20.00 Open discussion/Free time

Day 5 – Monday 5 May 2014
Venue: Seminar Room, UQ Heron Island Research Station

07.30 BREAKFAST

08.30 **Faculty Talk 8 – Stefanie Becker (Psychology, UQ)**
Feature-based attention operates on relative features

09.30 **Faculty Talk 9 – Paul Dux (Psychology, UQ)**
Training the multitasking brain

10.30 MORNING TEA

11.00 **Student Talk 10 – Jairo Perez (Psychology, LMU)**
Gaze following in the context of complex action goals

12.00 **Student Talk 11 – Daina Dickins (QBI, UQ)**
Old dogs, new tricks, new tactics: Investigating age-related changes in the degree and distribution of neuroplasticity in the primary motor cortex

13.00 **Student Talk 12 – Andrea Lingner (Division of Neurobiology, LMU)**
Relative perception of sound location

14.00 LUNCH

15.00 Open Discussion/Free Time

16.30 AFTERNOON TEA

17.00 **Student Talk 13 – Amanda Robinson (QBI, UQ)**
Multisensory interactions between olfaction and vision: the influence of odours on visual perception and attention

18.00 **Student Talk 14 – Jessica Burgstaller (Max-Planck-Institute of Neurobiology, Martinsried, Germany)**
Drug discovery for psychiatric disorders in the depressed zebrafish

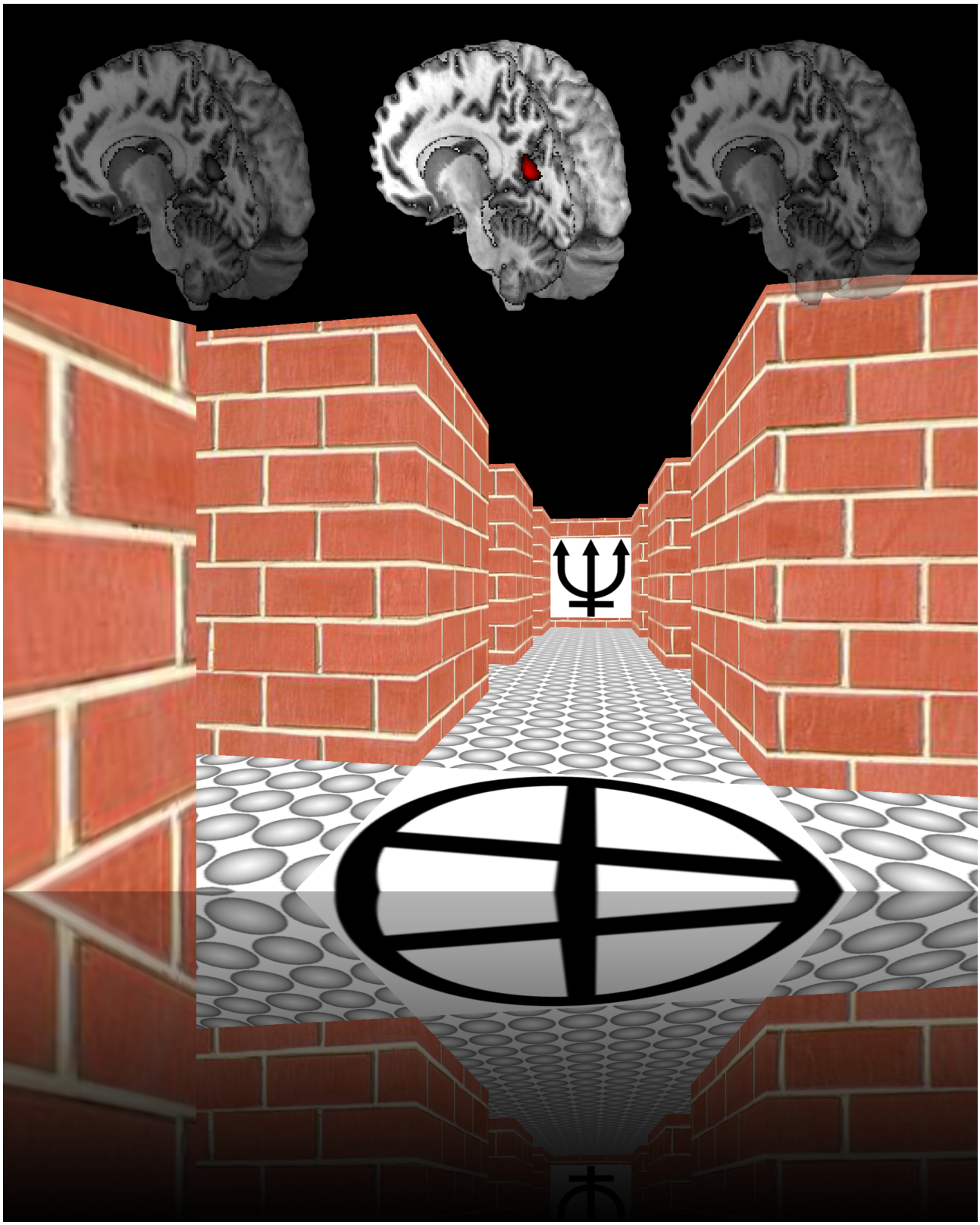
19.00 DINNER

20.00 Open discussion/Free time

Day 6 – Tuesday 6 May 2014
Travel from Heron Island Research Station to Brisbane

07.30	BREAKFAST
08.30	Clean and vacate accommodation
10.00	Official check-out from Heron Island Research Station
10.30	MORNING TEA
11.00	Open discussion/Free time
13.00	Catamaran departs Heron Island for Gladstone Harbour
15.45	Arrival into Gladstone Harbour
16.00	Coach transfer to Gladstone Airport
18.10	Flight from Gladstone to Brisbane Domestic Airport (QF1717)
19.15	Arrive Brisbane Domestic Airport END OF WORKSHOP Attendees make their own arrangements for onward flights or transfers to Brisbane

Abstracts



Day 1: Thursday 1 May, 2014

Adaptive neural coding in the auditory system

Andrew King
Auditory Neuroscience Group, Department of Physiology, Anatomy and Genetics, University of Oxford, UK

One of the most important functions of the auditory system is to help determine the whereabouts of objects and events in the surrounding environment. Accurate sound localization relies on the processing of spatial cues generated by the way sound interacts with the head and external ears. The neural mechanisms responsible for auditory localization are shaped by experience during development when the cue values corresponding to different directions in space change naturally as the head and ears grow. Recent studies have shown that the mature brain retains a surprising capacity to relearn to localize sound in the presence of substantially altered auditory spatial cues. In addition to the long-lasting changes that result from learning, behavioural and electrophysiological studies have demonstrated that auditory spatial processing can undergo rapid adjustments in response to changes in the statistics of recent stimulation, which help to maintain sensitivity over the range where most stimulus values occur. Through a combination of recording studies and methods for selectively manipulating the activity of specific neuronal populations, progress is now being made in identifying the cortical and subcortical circuits in the brain that are responsible for the dynamic coding of auditory spatial information.

Day 1: Thursday 1 May, 2014

The navigating brain: neural mechanisms underlying encoding, storage and retrieval of spatial memories

Oliver Baumann
Queensland Brain Institute, The University of Queensland, Australia

Humans, like many animals, possess a remarkable ability to navigate their way to a desired but currently unobservable location using an internal representation of the external world. Neurophysiological studies in animals have greatly advanced our understanding of how this core cognitive function is implemented at the neuronal level. By contrast, the neural systems supporting spatial navigation in humans are less well understood. In the last couple of years I have conducted a series of fMRI studies, which identified several key regions and mechanisms underlying spatial navigation in humans. For instance, we found that fMRI signals within the medial parietal cortex—specifically, Brodmann area 31—are modulated by learned heading, suggesting that this region contains neural populations involved in the encoding and retrieval of heading information in humans, akin to head-direction cells in rats. More recently, we showed that environmental size and complexity form part of the hippocampal representation of space, and that the spatial scale of an environment and its complexity are represented by different subregions, supporting the idea of information-rich but compartmentalized hippocampal representations of space. The aim of my research is to advance the development of a comprehensive model of human spatial navigation that will account for several unanswered questions regarding how spatial representations of the environment are established, maintained, expanded and accessed in the human brain.

Day 1: Thursday 1 May, 2014

Vision, memory and decisions: what eye movements can tell us about visual processing

Donatas Jonikaitis
Department of Psychology, Ludwig-Maximilians-University Munich, Germany

Eye movements serve to provide the high-resolution retinal image necessary for visual perception. However, rather than thinking of eye movements as movements of a passive camera delivering necessary visual detail, one better has to look at the oculomotor system as closely associated to perceptual, memory and decision making systems. In this talk I will focus on the relationship between neuro-cognitive systems associated with the control of eye movements , and systems involved in spatial attention, spatial updating, working memory, and cognitive control. First, I will discuss how eye movements bias the allocation of spatial attention. Second, I will present experimental findings showing how vision compensates for the retinal image shifts induced by eye movements. Third, I will show that the maintenance of an eye movement target in working memory is associated with spatial attention shifts. And last, I will discuss how tasks requiring cognitive control to allow or forbid eye movements can reveal links between target selection and decision making. Combined, these findings suggest a close link between eye movements, vision, memory, and cognitive control.

Day 1: Thursday 1 May, 2014

On the relationship between consciousness and attention

Naotsugu Tsuchiya
School of Psychological Sciences, Monash University, Australia

Over the last 20 years, our understanding of the neuronal basis of perceptual consciousness and selective attention has greatly progressed. This advancement was facilitated by research using visual illusions and task designs that keep sensory input constant yet vary internal factors such as top-down attention or subjective visibility. To isolate the neuronal mechanisms of consciousness and attention, however, it has become increasingly clear that keeping the input constant is not enough. Unless manipulated independently, consciousness and attention usually co-vary. Recent studies that independently vary both consciousness and attention have found that the behavioral and neuronal effects of consciousness and attention can be dissociated, implying that their neuronal mechanisms may be largely independent. Even if independent neuronal mechanisms underlie consciousness and attention, there remains a conceptual dispute over the exact relationship between these processes. One contentious issue is whether attentional amplification of the neural representation of an event or object is always necessary to experience it (i.e., is consciousness without attention possible?). We argue that attentional amplification is necessary to experience an object only when it needs to be 'selected' among other objects that compete with it in space and time. In a situation without any competition (e.g., an isolated object or a uniform texture), selective attention may not play any significant role. Accordingly, we argue that the neuronal mechanisms that directly support consciousness need to be investigated by carefully disentangling them from the neuronal mechanisms that resolve competition. Using an isolated-object paradigm, future studies may be able to test the possibility of consciousness with no top-down attentional amplification in mice or monkeys, by inactivating all synaptic inputs from fronto-parietal attentional areas to visual areas using the rapidly advancing technology of optogenetics.

Day 2: Friday 2 May, 2014

ERP studies of attention and space in social contexts

Agnieszka Wykowska
Department of Psychology, Ludwig-Maximilians-Universität München, Germany

In this lecture I will focus on the application of the EEG methodology to tackle questions related to attention and space in social contexts. The first part of the lecture will concentrate on the EEG methodology itself, with the focus on Event-Related Potentials (ERPs) of the EEG signal. I will briefly explain what the ERPs actually mean, and what conclusions can be drawn from ERP results. Subsequently, I will provide an overview of selected questions related to attention and space in social contexts that have been tackled with the ERP methodology. I will review selected ERP findings obtained in various paradigms pinpointing fundamental mechanisms of social cognition: social attention (Schuller & Rossion, 2001), spatial compatibility in joint action (Sebanz et al., 2006), and expectation effects in social attention (Tipples, Johnston & Mayes, 2012). The last part of the lecture will be devoted to our own research (Wykowska, et al., in press; Pérez-Osorio et al., in prep.), in which we used the EEG/ERP methodology to examine social attention in the context of attributing intentionality to the observed agent. We examined whether engagement in social attention is purely reflexive or rather modulated by top-down factors such as adopting the Intentional Stance (Dennett, 2003) towards the observed agent, or by expectations related to action sequences. Our data showed that attention mechanisms operating at even very early stages of processing (the sensory gain control) depend on higher-order cognitive mechanisms.

References

Dennett, D., C. (2003). True believers: the intentional strategy and why it works. In: O'Connor, T., Robb, D. (eds.). Philosophy of Mind: Contemporary Readings. London: Routledge. pp. 370-390.

Pérez-Osorio, J., Müller, H. J., Wiese, E., & Wykowska, A. (in prep.). Gaze following in the context of complex action goals

Sebanz, N., Knoblich, G., Prinz, W., & Wascher, E. (2006). Twin Peaks: An ERP Study of Action Planning and Control in Coacting Individuals. Journal of Cognitive Neuroscience 18:5, pp. 859–870

Schuller., A. M., Rossion, B. (2001). Spatial attention triggered by eye gaze increases and speeds up early visual activity. Neuroreport 12: 2381-2386.

Tipples, J., Johnston, P., & Mayes, A. (2012). Electrophysiological responses to violations of expectation from eye gaze and arrow cues. Social Cognitive and Affective Neuroscience, 8, 509-514.

Wykowska, A., Wiese, E., Prosser, A., & Müller, H. (in press). Beliefs about the minds of others influence our own mind! An EEG study on the modulation of sensory gain control by higher-order cognition. PLOS ONE

Day 2: Friday 2 May, 2014

Mirroring processes and the interaction of motor and visual areas in action perception

Ross Cunnington
Queensland Brain Institute & School of Psychology, The University of Queensland, Australia

Interactions between the visual system and the motor system are important for functions such as imitation and action understanding. We have previously shown how activity in the motor system associated with action plans or intentions can feed-forward and influence the visual processing of observed actions. More recently we have shown how this motor-visual interaction varies with task context, depending on which aspect of actions - observed or executed - are attended during task performance. This indicates that motor-visual interactions during action perception are flexible and depend on task requirements and attention. More broadly, we suggest that mirroring processes develop through associative learning between observed and experienced states and apply to other domains outside action, such as perception of others' touch and emotion (pain). We show how higher-order factors such as social group categorisation and race of the observer can affect neural responses involved in "empathic" mirroring processes for perception of others' pain.

Day 3: Saturday 3 May, 2014

The control of visual information processing by prefrontal cortex

Tirin Moore
Department of Neurobiology, Stanford University, USA

A principal function of the prefrontal cortex (PFC) is selective attention, and this function involves the top-down modulation of sensory signals during goal-directed behavior. I will talk about recent work demonstrating the involvement of the frontal eye field (FEF), an oculomotor area within PFC, in visual spatial attention in which relevant visual information is selected at the expense of potentially distracting information. This work not only implicates the FEF in the control of spatial attention but it exemplifies the profound influence that movement-related signals can have on processing within posterior sensory representations. I will describe recent evidence of this influence, its neural circuitry, and its relationship to perception and cognition.

Day 3: Saturday 3 May, 2014

Attention in goal-directed action

Heiner Deubel
Department of Psychology, Ludwig-Maximilians-Universität München, Germany

Planning and execution of goal-directed actions are closely related to visual attention. This lecture first gives an overview of current research on this relationship, focusing on the role of attention in the preparation of eye movements, manual reaching and grasping. The studies suggest that major functions of attention during motor planning are to select the spatial goals of the movement, and to prioritize those visual features that are important for the action. The second part of the lecture will discuss recent experiments from my lab in which we studied how attention is involved in the planning of movements that involve more than a single target location. The results show that action preparation in these more complex situations comes along with a temporally changing “attentional landscape” which includes multiple foci of attention.

Day 3: Saturday 3 May, 2014

Eye fixation patterns support improved guidance as the source of reduced search times in contextual cueing

Anthony Harris
Queensland Brain Institute, The University of Queensland, Australia

In visual search, participants report the identity of a target faster for search displays that are intermittently repeated than for those that are novel. This 'contextual cueing' benefit has been attributed to attentional guidance improvements, arguing that in repeated displays attention implicitly encodes the location of the target in relation to a constant distractor context. The guidance account has been challenged by evidence that contextual cueing still occurs when attentional guidance is optimal, more consistent with a facilitation of response selection. To further examine the mechanisms underlying contextual cueing we tracked participants' eye movements while they performed a spatially cued contextual cueing task. Repeated and novel search displays were preceded by a spatial cue at either the target location (valid trials) or at the location of a distractor item (invalid trials). Results demonstrated that participants were faster to report the target in repeated than in novel displays, but only when these displays were preceded by an invalid cue. No contextual cueing benefit was observed on valid cue trials, when target localization was already optimal. Eye tracking analyses showed that these reaction time results were due primarily to fewer fixations required for invalidly cued repeated compared to novel displays. No differences were found between repeated and novel displays in any other eye tracking measures (time from target fixation to response, dwell, initial eye movement latency). Taken together with the absence of an effect of display repetition on validly cued trials our results support the role of attentional guidance in contextual cueing.

Day 3: Saturday 3 May, 2014

Proactive inhibition in cognitive control of saccades

Saurabh Dhawan
Department of Psychology, Ludwig-Maximilians-Universität München, Germany

Existing studies of inhibitory control have left some very important questions relatively untackled – can our capacity to avoid doing an unwanted action be intentionally prepared in advance, can it be applied selectively, and can such a proactive intention of 'not doing a specific action' be sustained over time? By modifying a delayed oculomotor response task that allowed us to contrast spatial biases resulting from remembering a location as 'where to look' versus 'where not to look', we studied the processes underlying preparation, selectivity, maintenance and monitoring in inhibitory control. We found that while marking a location as a future saccade target, expectedly, resulted in a spatial selection benefit at that location, marking it as forbidden to saccades led to a cost in spatial selection specific to that location. We further show that the spatiotemporal dynamics of these amplificatory and inhibitory effects were characteristically different from each other. We also found that the visual and oculomotor systems interact differently with selection of wanted saccades and suppression of unwanted ones. Together, these findings outline the processes that enable us to selectively apply anticipatory top-down control over the representation of a specific saccadic plan in the bottom-up oculomotor planning networks, so as to allow that particular location to escape oculomotor capture without requiring global inhibition of all saccadic activity.

Day 3: Saturday 3 May, 2014

Interactive effects of task set and working memory on attentional capture

Oscar Jacoby
Queensland Brain Institute, The University of Queensland, Australia

When we search for objects with particular features, activity in brain networks is biased to preferentially process any objects possessing those features. Maintaining such biases, or *attentional sets*, may involve similar neural resources to those involved in working memory (WM). If so, taxing WM should reduce top-down influences on attentional capture. We used electroencephalography (EEG) to record brain activity while observers monitored dynamic stimulus streams at the midline for targets defined by a particular feature value (e.g., red), and ignored lateralized distractors. First, we replicated previous evidence for top-down modulation of attentional capture by demonstrating an enhanced N2pc component and slowed target responses when distractors possessed the target feature. We then investigated whether taxing WM reduces the effect of task set on attentional capture. A concurrent *n*-back task, which requires information to be maintained *-and* manipulated in memory, eliminated the influence of task set by reducing the N2pc associated with task-relevant distractors. By contrast, a concurrent digit rehearsal task, which only requires information maintenance, did not change the effect on task set on the N2pc. Neither WM load manipulation affected the extent to which distractors slowed target responses. These results indicate that some – but not all – WM load manipulations compromise set-related biases associated with visual search for specific object features. The findings support the notion that WM and selective attention compete for common neural resources.

Day 3: Saturday 3 May, 2014

Is attention affected in chronic vertigo patients?

Pauline Popp
Neurological Clinic Grosshadern, Ludwig-Maximilians-Universität München, Germany

So far many studies conducted on animals and humans suggest a strong evidence that damage to the vestibular system leads to impairments of the navigational skills. More recently, there are some indications that patients with a vestibular disorder exhibit a range of cognitive deficits, not only spatial but also non-spatial, like object recognition memory. It is a common complaint from patients who suffer from a chronic vestibular failure that they are troubled in their abilities to concentrate and sustain their attention. Until now, only few studies have examined this empirically. In this study, one control group and two groups of patients with a vestibular neuritis, underwent a series of attentional tasks. The vestibular neuritis is an inflammation of the vestibular nerve, that can eventually lead to a complete degeneration. Patients first suffer from severe vertigo, but symptoms can fully disappear due to central compensation. The first group suffered from an acute phase of neuritis (onset 3-5 days ago) and the second group were chronic patients, with a uni- or bilateral vestibular loss. Patients in an acute phase showed no impairment of their attentional skills compared to the control, whereas chronic patients were mildly affected in some aspects of attention. Interestingly, patients with a unilateral loss showed a significant shift of focus of their attention to one side, that did not correlate with the side of their lesion. There are some pathways from the vestibular nucleus to the limbic system and neocortex and non-spatial memory is likely related to the perirhinal cortex. The vestibular afferences might be used for many cognitive operations and could result in a complete reorganization after vestibular damage. Maybe this reorganization involves some cognitive compromises.

Day 3: Saturday 3 May, 2014

Decoding object individuation across time and space

Claire Naughtin
School of Psychology, The University of Queensland, Australia

To gain a sense of what, where and when visual information appears in our environment, we rely on two key processes known as object individuation and identification. In object individuation, spatial and temporal cues are used to register an object as a distinct perceptual event relative to other objects. In object identification, featural and related conceptual properties of a stimulus are extracted. While numerous neuroimaging studies have explored how object identities are represented in the brain, we know far less about object individuation and how this process interacts with object identification. I will present two studies in which I explored the neural underpinnings of object individuation across time and space. The first aimed to identify brain regions involved in individuating temporally distinct visual items. The second study examined object individuation in the spatial domain and assessed whether the brain regions that support this process could be dissociated from those involved in object identification. These research questions were assessed using functional magnetic resonance imaging and a combination of univariate and multi-voxel pattern analyses. Across these two studies, we find a common distributed set of frontal, parietal and occipital regions that are involved in object individuation across both time and space. In addition, the brain regions involved in individuation show a large degree of overlap with those involved in object identification, suggesting that these two processes are not dissociable in the brain. Our findings provide novel insights into the neural underpinnings of object individuation and identification, and challenge models of multiple object encoding in visual short-term memory.

Day 4: Sunday 4 May, 2014

What can evoked neural oscillations reveal about visual perception and selective attention?

Jason B. Mattingley
Queensland Brain Institute & School of Psychology, The University of Queensland, Australia

Perceptual, cognitive and motor processes often unfold over extended time periods, yet many studies in cognitive neuroscience are designed to measure brain activity in response to discrete and rather brief psychological events. Here I discuss various applications of an approach that uses electroencephalography (EEG) to measure steady-state evoked potentials (SSEPs) over prolonged timescales, from seconds to minutes. In a typical SSEP paradigm, several competing stimuli are flickered continuously, and their unique neural signatures are recovered from the EEG trace using frequency-based analyses. We have used such "frequency tagging" methods to assess various aspects of visual perception and selective attention, in health and disease. At the level of early visual perception, we have used frequency tagging to reveal the neural correlates of amodal completion of visual surfaces hidden behind occluding objects. We have used analogous approaches to show that feature-based attention spreads to ignored locations during conjunction search, but not during unique feature search, and that this spread of attention reflects active enhancement of target-coloured items at irrelevant locations. In more recent work we have employed frequency tagging to compare the influence of spatial attention on neural responses to visible and invisible phase-scrambled targets embedded in dynamic noise. Finally, we have adapted several of these paradigms to investigate anomalous visual processing in parietal lesioned patients with unilateral spatial neglect, and in macular degeneration patients suffering from visual hallucinations.

Day 4: Sunday 4 May, 2014

Mechanisms of regularity learning and outlier detection

Marta Garrido
Queensland Brain Institute, The University of Queensland, Australia

The ability to learn about, and detect changes to, patterns in the environment is fundamental for adaptive behaviour. Learning about regularities in our environment enables us to make predictions about what is likely to happen next and prepare ourselves for an appropriate and timely action. In this talk, I will show that 1) humans can learn about the uncertainty induced by apparently random distributions of events and that 2) the brain is sensitive to the likelihood of such events, as manifest in responses to outliers within a contextual background. Moreover, I will demonstrate that 3) the neurophysiological responses evoked by outliers are potential biomarkers of schizophrenia, a disorder characterised by aberrant learning and inferential processing. This work provides behavioural and neurophysiological mechanisms for the fundamental computations underlying learning and inference in an uncertain world.

Day 4: Sunday 4 May, 2014

On the origin of systematic error in human navigation tasks

Stefan Glasauer
Center for Sensorimotor Research, Dept. of Neurology, Ludwig-Maximilians-Universität München, Germany

One of the most basic navigation skills is path integration, the ability to infer one's own position and heading without landmarks from movement-related cues such as vestibular input, optic flow, or efference copies of motor commands. This ability is found in animals from desert ants and spiders to vertebrates. However, when performing path integration, errors are inevitable due to noisy inputs and error accumulation during the integration process. Indeed, both in animals and humans, systematic errors have been found for tasks depending on path integration. One popular hypothesis for these errors, formulated more than 20 years ago, proposes that systematic errors are due to leaky integration, i.e., a continuous 'forgetting' of distance travelled. In my presentation I will, however, argue that the usual errors observed in various simple path integration tasks are not due to leaky integration, but rather to a probabilistic estimation process. The errors are, in fact, beneficial in the long run, because they reduce the overall error. I will further show that the leaky integration hypothesis is hard to reconcile with contemporary ideas of the neural implementation of the path integration process. In contrast, probabilistic estimation can easily account for the various types of errors and is, at the same time, compatible with neural path integration.

Day 4: Sunday 4 May, 2014

Neural correlates of decision making during spatial navigation in humans

Dian Anggraini
German Center for Vertigo and Balance Disorders (DSGZ), Neurologisches Forschunghaus, München, Germany

Extensive research effort in the field of spatial orientation and navigation has conjectured that humans employ two general computational strategies to find ways in a novel environment namely the route-based and map-based navigation. These two strategies lie at the opposite end of a spectrum in term of the demands on memory and cognitive processing. Route-based strategy relies on consecutive events, i.e. turning a certain angle or moving toward a certain lad mark. Map-based navigation, on the contrary requires survey knowledge of the environment layout. Furthermore, in value based decision making, a comparable dual strategies exist. Subjects can either use model-free or model-based approach to evaluate which series of actions lead to higher reward. When model-free behavior is employed, subjects mainly rely on habitual system that employs prediction error to lead stimulus-response association. Model-based decision making, on the other hand, exploit a cognitive map of the environment for series of action that will advance to the desired outcomes. Since similarities between the dual processes in the cognitive faculties of decision making and navigation are apparent, this project aims to investigate the interplay between neural process involved in value-based decision making and spatial navigation. Using grid world task where subjects can navigate in a virtual environment with connected rooms, this project aims to first dissociate the navigation strategies on particular trials. Further work based on reinforcement learning algorithm will allow us to derive a computational model of subjects's choice behavior. In addition, neural correlates of route-based navigation and model-free decision making as well as map-based navigation and model-based decision making will be studied using functional magnetic resonance imaging (fMRI).

Day 4: Sunday 4 May, 2014

Behavioural strategies and brain activity in human spatial exploration

Christopher Roppelt
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Spatial exploration is an ecologically relevant behavior that uses sensory input and spatial memory to guide upcoming actions. It has been successfully used in rodents to discover spatial tuning in medial temporal lobe neurons. In humans, however, less is known about the neural underpinnings of spatial exploratory behavior. We therefore designed a flexible paradigm for human exploration, similar to what has previously been used in rodents. Participants (n=30) navigated freely via joystick in a virtual environment (VE) consisting of a randomly textured ground plane and a grey cylindrical wall while their hemodynamic activity was recorded with fMRI. A 100 degree black cue card was the only landmark. Their goal was to collect randomly distributed items that could only be seen within a certain radius around their current position in the VE. Participants were given 30 seconds in the SHORT condition and 180 seconds in the LONG condition to collect as many items as possible. In SHORT performance was limited by time and maximum speed, whereas in LONG, spatial memory became increasingly relevant during the task. All participants were trained to reach at least 80% collection rates in LONG before scanning. However, subjects showed a variety of strategies that we characterized using path-related measures. The hemodynamic signal differed between SHORT and LONG in a network of motor and posterior sensory areas. In addition, activity in the posterior hippocampus correlated with participants' performance. Our results support demand specific modulation of brain activity in a single spatial exploration task.

Day 4: Sunday 4 May, 2014

Prediction and attention in the time domain: the roles of automatic and conscious expectations in perception

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Time is a ubiquitous feature of our perceptual experience. Expectations about the relative timing of sensory events are used to facilitate sensory selection, constrain perceptual interpretation, and facilitate efficient perceptual processing. Temporal expectations can consciously direct top-down attention (the *temporal orienting of attention*), and also guide sensory processing through automatic prediction (*predictive timing*). Although it is understood that attention and prediction typically have opposite observable effects on early sensory processing, little is known about how these two mechanisms may interact. Indeed, many previous investigations into the effects of temporal expectations have failed to dissociate these two processes, leading to heterogeneous findings in the current literature. In this presentation I will discuss the importance of considering the separate contributions of attentional and predictive processes in perception, and point to strategies for manipulating these processes factorially. I will present my recent work applying this to the temporal domain, using EEG to investigate the effects of temporal attention and temporal prediction on early auditory processing. Finally, I will discuss plans to expand this concept to investigate the automaticity of predictive processing by varying the available cognitive resources to process task-irrelevant sensory information.

Day 4: Sunday 4 May, 2014

Statistical processing in perception and cognition

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Our sensory world is richly structured. Statistical learning allows spatial and temporal regularities between items in the environment to be learned, which in turn can facilitate behaviour. Intriguingly, statistical learning arises incidentally and without awareness, and interacts closely with other cognitive processes including language acquisition and attentional guidance. Research on statistical learning has investigated the units over which it operates (e.g., features, objects), the role played by attention in its generation, and the extent to which it truly reflects an unconscious operation. My research focuses on identifying the cognitive and neural mechanisms underlying statistical learning with a particular emphasis on investigating if a general resource gives rise to unconscious statistical effects across a range of psychological phenomena. In this talk, I present behavioural work investigating a reported failure to show statistical learning when participants simultaneously engage in estimating ensemble statistics over sets (e.g., mean orientation of a set of lines) containing regularities (e.g., pairs of orientations that appear together reliably). The locus of this interference could be process-specific; statistical learning and ensemble processing may rely on similar statistical computations and interact at a late, computational stage. Alternatively, early perceptual or attentional biases might account for the disrupted learning. We provide results that are consistent with an attentional biasing account. This work suggests that ensemble statistical processing and statistical learning reflect distinct cognitive operations.

Day 5: Monday 5 May, 2014

Feature-based attention operates on relative features

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Theories of attention universally claim that elementary features such as colors are all encoded independently of each other by separate feature maps. By contrast, Becker (2010) proposed a new relational account, according to which elementary features are encoded relative to the context of other elements in the context (e.g., redder, darker, larger). Recent findings show that the visual system has a strong preference for encoding features in a relative, context-dependent manner. One important implication of these findings is that feature similarity (e.g., Duncan & Humphreys, 1989) alone cannot accurately predict guidance or involuntary attentional capture. Another important implication is a change in our definitions of what constitutes an 'inconsistent mapping' (e.g., Shiffrin & Schneider, 1976). It is argued that the preference for encoding relative attributes underlies attentional guidance in a variety of tasks and requires re-modeling crucial aspects of feature-based attention.

Day 5: Monday 5 May, 2014

Training the multitasking brain

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Despite the immense processing power of the human brain severe **'**bottlenecks' of information processing are revealed when individuals attempt to perform two, even simple, tasks at once – multitasking. Under such conditions, performance of one or both tasks is impaired relative to when the tasks are performed in isolation and performance on the second task improves as the time between the tasks increases. Importantly, multitasking limitations are not only relevant for psychological theory, but these difficulties are exacerbated as humans age and in many psychiatric and neurological conditions. Thus, it is vital to understand the antecedents of multitasking costs and ways in which they can be alleviated. It has previously been shown that multitasking limitations can be drastically reduced with cognitive training. However, the neural basis for these training effects has not been elucidated. Here, I will present behavioural, brain imaging and brain stimulation data which shows that a network of frontal brain regions including posterior lateral prefrontal cortex, superior medial frontal cortex, and bilateral insula, are associated with capacity-limits in perception and decision-making. Further I will provide evidence that training reduces multitasking costs by increasing the processing efficiency of the posterior lateral prefrontal cortex rather than by funnelling information away from this bottleneck region.

Day 5: Monday 5 May, 2014

Gaze following in the context of complex action goals

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Social interactions require the ability to predict and understand others' behavior and its underlying intentions. In order to infer intentions and action goals, humans use various hints provided by others, such as gestures or gaze direction, which inform about others' focus of attention or intended action steps. The present study examined mechanisms of gaze following in the context of expectations related to actor's successive action steps. We designed a paradigm, in which a gaze-cueing procedure was embedded in an action-context provided by sequences of naturalistic photographs. Gaze-induced orienting of attention (gaze following) was analyzed with respect to whether or gaze was congruent with an overarching action-context. In Experiment 1, performance in a target discrimination task was dependent on whether the target was gazed-at by the observed agent or not (a typical gaze cueing effect demonstrating the gaze following mechanism); and on congruency of the gaze with respect to the action-context. Experiment 2 was conducted in order to examine whether effects of Experiment 1 were due to overt or covert attention. In Experiment 2 observers' gaze remained fixated on the center of the screen while being monitored with the use of eye tracking. Experiment 2 replicated the results of Experiment 1. Taken together, findings of the present study showed that participants attended where the actor gazed even when the gazed-at object was incongruent with the background action scenario. However, performance in the target discrimination task was also influenced by action context information, suggesting that violation of action expectancies had an impact on processing of targets incongruent with the context. The findings are discussed with respect to possible cognitive mechanisms underlying the pattern of behavioral results.

Day 5: Monday 5 May, 2014

Old dogs, new tricks, new tactics: Investigating age-related changes in the degree and distribution of neuroplasticity in the primary motor cortex

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The adult human brain is capable of ongoing adaptation in response to the demands of its environment, a characteristic termed 'neuroplasticity'. Evidence suggests that plasticity is reduced in elderly adults, moreover, may manifest over a more distributed neural network in elderly relative to young individuals. My thesis investigates whether the apparent reduction in plasticity in the elderly is associated with plasticity manifesting over a more distributed network. In addition, because cognitive factors have been shown to influence plasticity in young adults, my thesis also investigates how attention influences plasticity in the elderly. I shall discuss two experiments in which different methods were used to induce neuroplasticity in the motor cortices of young and elderly adults. The first employed non-invasive brain stimulation to induce plasticity in the functional representation of the thumb in the motor cortex, while the second experiment used a motor skill-training task to induce similar changes. The results of the transcranial magnetic stimulation experiment suggest that even in a healthy and active group of individuals, advancing age is associated with a reduction in the capacity for brain plasticity. Nonetheless, spatial attention appears to influence neuroplasticity in both young and elderly adults. Preliminary results from the motor training study suggest that plasticity manifests over a more distributed neural network in the elderly, but that such effects are modulated by task complexity. This research furthers our understanding of how neuroplasticity is altered in the aged brain, which is critical to promoting recovery from brain injury, such as stroke, in elderly adults.

Day 5: Monday 5 May, 2014

Relative perception of sound location

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In order to localize sounds, the mammalian auditory system can use two different interaural cues. Low-frequency sound sources are localized by means of arrival time differences (ITDs) at the two ears, whereas high-frequency sounds are localized by means of level difference (ILDs) at the two ears. Even though context-dependent adaptation is known in other modalities, the processing of ITDs is thought to be non-adaptive. Electrophysiological recordings in the Mongolian Gerbil, a well-known animal model of human hearing, showed that neurons in the medial superior olive (MSO), a key nucleus for analyzing ITDs, modulates its answers properties dependent on the context. This suggests a context-dependent perception of sound location. In human psycho-acoustical experiments, closely matching these electrophysiological recordings, we investigated the perception of sound source locations in different stimulus contexts. Therefore, we presented humans with a low-frequency test tone over headphones. These test tones were lateralized using ITDs and presented in different contexts. The subjects were asked to indicate the perceived position of the test tones via a touch screen. The data showed that the perception of sound location is strongly dependent on the stimulus history in human subjects. Thus, similar to other modalities our lab could show that there is a context-dependent adaptation of ITDs.

Day 5: Monday 5 May, 2014

Multisensory interactions between olfaction and vision: the influence of odours on visual perception and attention

Amanda Robinson
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Recent behavioural evidence suggests that odours can influence an early stage of visual perception but little is known about the neural mechanisms underlying olfactory-visual integration. In this talk, I will describe studies conducted to investigate how odours influence facets of visual attention and perception. In each study, participants were presented with odours and images that were either matching (e.g., orange odour and orange image) or non-matching (e.g., mint odour and orange image). In the first study, we found that discrimination of visual targets during the attentional blink was significantly better with matching odours relative to non-matching odours, indicating that odours enhance the salience of matching objects. Next, using EEG, we found that odours enhanced processing of matching visual objects at the N1 component of visual ERPs, an early stage of perception which likely represents discrimination processes. Finally, fMRI and multivariate pattern analysis methods were used to determine how odours influence decoding of brain activity when participants viewed living objects (e.g., oranges) or nonliving objects (e.g., boxes). Crucially, the living objects were paired with either a matching odour (e.g., orange odour and orange image) or non-matching odour (e.g., banana odour and orange image). In V1 bilaterally and in right lingual gyrus, living-nonliving decoding was significantly higher when living objects were paired with matching odours than with non-matching odours, indicating that odours boost the representation of matching visual objects in early visual brain areas. Overall, I will describe how multisensory interactions between olfaction and vision take place at an early stage of processing and serve to enhance object identification processes.

Day 5: Monday 5 May, 2014

Drug discovery for psychiatric disorders in the depressed zebrafish

Jessica Burgstaller
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Depression is a serious psychiatric condition affecting millions of patients worldwide. Depressive disorder is characterized by low mood, anhedonia, social withdrawal and other severely debilitating psychiatric symptoms. However, a hallmark in human patients is the dysregulation of the glucocorticoid stress axis. The identification of a zebrafish *(Danio rerio)* experimental model with a mutation in the glucocorticoid receptor provides an invaluable tool for research into the pathogenesis of depression, and for the development of potential drug treatments. Due to their high throughput value, genetic tractability, lowcost and quick reproductive cycle, zebrafish have emerged as a promising new model species for studying brain disorders. Zebrafish chemical screening allows for an in vivo assessment of small molecule modulation of biological processes. Compound toxicities, chemical alterations by metabolism, pharmacokinetic and pharmacodynamic properties can be studied with this method. Importantly, the zebrafish model opens up the possibility of high-throughput drug screens in search of new classes of antidepressants.