Thursday 11th

Keynote Session

Dissociating Presaccadic attention from Covert attention

Marisa Carrasco
Psychology and Neural Science
NYU

Selective attention is essential for visual perception. Spatial attention allows us to grant priority and selectively process information at a given location. In this talk, I will compare and contrast two kinds of spatial attention: presaccadic (allocated to the location of the upcoming saccade's target) and covert (allocation to the target location while maintaining fixation).

First, I will highlight some research on endogenous (voluntary) and exogenous (involuntary) covert spatial attention, which has shown to alter performance and subjective appearance in many basic visual tasks mediated by contrast sensitivity and spatial resolution. Moreover, I will present a study revealing that covert attention modulates performance even at the center of gaze without any accompanying eye movements.

Second, I will present studies showing that while planning a saccadic eye movement, presaccadic attention: (a) improves performance and concurrently increases perceived contrast at the saccade target location; (b) alters the processing of feature information by narrowing orientation tuning and enhancing the gain of high spatial frequency information at the upcoming saccade landing location; (c) increases sensitivity for high spatial frequencies automatically, even when it is detrimental to the task at hand; (d) improves contrast sensitivity via response gain, regardless of the size of the presaccadic attention window. All these modulations are time-locked to saccade onset, peaking right before the eyes move. We propose that saccade preparation may support transaccadic integration by reshaping the representation of the saccade target to be more fovea-like just before saccade onset.

Finally, I will compare these studies on presaccadic attention with corresponding studies of endogenous (voluntary) or exogenous (involuntary) covert attention. I will discuss their similarities and dissociations with regard to their effects on performance, subjective appearance, gain and tuning properties, flexibility/automaticity, and temporal dynamics, which suggest different underlying mechanisms. Systematically investigating these common and differential characteristics furthers our understanding of the pervasive selective processing of information, which enables us to make sense of our complex visual world.

Friday 12th

Keynote Session

Visual Working Memory for Action

Christian Olivers
Institute for Brain and Behaviour Amsterdam
Section Cognitive Psychology
Vrije Universiteit Amsterdam

Like attention, working memory eventually serves action. Yet, the bulk of visual working memory research focuses on sensory storage in service of single delayed match-to-sample tasks. I present work based on a more dynamic approach, where visual working memory flexibly adapts in response to changing task demands. I will show how oculomotor and EEG responses reveal which of multiple memory representations is currently active, and how switching between memory representations is controlled, when observers perform sequences of visual tasks. I will also present a study showing how the same stimulus is represented differently in working memory depending on the action required at test. Finally, time permitting, I will present a gated neural network model that uses action-based systems in combination with attention-driven reinforcement learning in order to acquire flexible control over working memory representations.

Thursday 11th **Talk Session 1 / 13.30 – 15.00**

Selective processes for perceptual continuity in active vision

Martin Rolfs
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Humboldt-Universität zu Berlin

Saccadic eye movements rapidly shift our point of regard thousands of times every waking hour, allowing us to see every aspect of the visual scene at the highest resolution. Psychophysical studies suggest that vision undergoes turbulent changes every time the eyes shoot to a new location: we mislocalize flashed stimuli in space and time, visual sensitivity is notably hampered across the visual field, and visual sensory memory is wiped out as the saccade imposes drastic displacements of the image on the retina. I will present research showing how the active visual system tightly coordinates selective processes—eye movements, visual attention and visual short-term memory—to bridge the abrupt discontinuities accompanying saccades. I will argue that a prime function of this tight coordination is to shape a seamless perceptual experience of the visual world.

Decision theoretic models of fixation control and target selection

Casimir Ludwig
School of Psychological Science & Bristol Vision Institute
University of Bristol

Limitations in the resolution of human vision mean that we have to be selective in our visual processing, and attend or fixate objects of interest sequentially. Selecting the next fixation location is typically thought of as a competition between multiple candidate targets in peripheral vision. One particularly popular instantiation of this idea is that motor programmes associated with fixating different candidate targets are engaged in a competitive "race to threshold". Whichever motor programme reaches a decision threshold first, is executed. This decision theoretic model provides an elegant, integrated account of *what* target is fixated and *when* that target is fixated. This model also has considerable neurophysiological support. I will evaluate the utility of this decision theoretic framework. Specifically, I will focus on the following questions. Is target selection controlled by a "race to threshold" between competing motor programmes in the presence of a foveal load? To what extent is fixation duration controlled by the foveal processing demands and the selection of the next target? Although target selection may be thought of as a dynamic competition between alternative motor programmes, the resolution of this competition does not determine fixation duration. Fixation duration is primarily determined by the foveal processing demands. The presence of even a simple foveal task seemingly alters the way target selection operates, and I will outline different possible models of the relation between foveal analysis and peripheral target selection.

What does Alzheimer's Disease reveal about the relationships of attention, working memory and the inhibitory control of saccadic eye movements?

Trevor Crawford
Department of Psychology
Faculty of Science and Technology
Lancaster University

Several theories of visual search and inhibitory control have proposed a strong contingency between spatial attention, working memory and inhibitory control. For example, Vogel et al. stated, "Selection efficiency varies substantially across individuals and is strongly predicted by the particular memory capacity of each person" (Nature, 2005). Patients with early dementia due to Alzheimer's disease (AD and Mild Cognitive Impairment (MCI)) provide an ideal opportunity to evaluate the potential limitations of these theories, given their impairment of working memory. In this talk I will present a series of eye-tracking studies that we have conducted in my lab over the last 15 years on Alzheimer's disease. Large group studies have revealed that patients with AD have a reliable impairment of inhibitory control in the anti-saccade task (AST). Patients with AD (but not Parkinson's Disease) and patients with *amnesic* MCI (but not non-amnesic MCI) generate a high proportion of uncorrected errors in the AST. Trial-by-trial analyses reveal that the frequency of past errors increases the probability of future errors; conversely the frequency of past successes reduces the probability of future errors. These errors present early during the course of the disease, and correlate with the severity of the memory dementia. Detailed single case studies show that the impairments of inhibitory control can be clearly dissociated from the impairment of working memory, which presents a challenge for theories that have argued that the constructs of inhibitory control and working memory are one and the same. Curiously, using the recent distractor task (Crawford et al 2005; Wilcockson, 2019) that demands the spatial inhibition of a visual distractor, we have found no impairment in AD or MCI. The well-known "gap" effect is also well-preserved in dementia. Similarly, we find a clear preservation of bottom-up and top-down eye gaze control during a visual search task using TV video footage and during an every-day task, such as making a cup of tea. Together these findings reveal that a dysfunction of working memory can co-exist with the preservation of selective attention tasks in the laboratory and top-down control during more naturalistic every day behavior. In addition to the clinical relevance, these findings have implications for cognitive control theories of active vision.

Visual attention at the edge of the oculomotor range

Nina Hanning
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Ludwig-Maximilians-University

Neurophysiological studies demonstrated that attentional orienting is performed by fronto-parietal brain areas which also play an important role in oculomotor control (e.g. LIP and FEF). Accordingly, several studies claimed that exogenous attention can only be deployed to where we can potentially make an eye movement, i.e. within the oculomotor range (OR). This assertion was based on the finding that patients with eye movement disorders as well as participants whose oculomotor range had been experimentally reduced show no pronounced reaction time benefit at exogenously cued locations that were not reachable by their eyes. Deducing the allocation of visual attention from reaction times (stimuli appearing in the focus of attention are detected faster) is a popular approach in vision science, however, reaction times reflect the time for detecting the stimulus as well as decision- and response-dependent processes. Furthermore, a neurophysiological link between manual response times and oculomotor selection or activity is not established. In contrast, it is well known that spatial attention improves visual perception via oculomotor feedback projections converging onto earlier visual areas. We therefore tested the assumption that attention is limited to the oculomotor range by assessing visual sensitivity before saccadic eye movements and during fixation at locations within and beyond participants' oculomotor range. Participants rotated their heads to prevent them from performing large rightward saccades. In this posture, an attentional cue was presented inside or outside their oculomotor range. Participants either made a saccade to the cue or maintained fixation while they discriminated the orientation of a visual noise patch. In contrast to previous reports, we found that the cue attracted visual attention regardless of whether it was presented within or beyond participants' oculomotor range during both fixation and saccade preparation. Moreover, when participants aimed to look to a cue that they could not reach with their eyes, we observed no benefit at their actual saccade endpoint. Our results demonstrate that spatial attention is not coupled to the executed oculomotor program but instead can be deployed unrestrictedly also toward locations to which no saccade can be executed. This shows that the coupling of attention and eye movement control is not as tight as the prominent "Premotor Theory of Attention" suggests. Rather, attention can be shifted freely over the entire visual range, independent of pathological and physiological limitations of the eye movement system.

The reference frame of action-effect prediction

Thérèse Collins
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Université Paris Descartes

An essential aspect of voluntary action control is the ability to predict the perceptual effects of our actions. The influence of action-effect prediction on behavior and perception has been shown in many studies. Participants generate an action and observe its consequences, usually the appearance of a particular visual stimulus on a computer screen. Following this acquisition phase, participants give a perceptual report about a stimulus that appeared as the result of their action. Studies have shown that sensitivity is greater when the effect is congruent with the previously learned association than when it is not. In the present experiment, we examined the spatial reference frame of action-effect prediction by changing either the spatiotopic or retinotopic location of the effect relative to the acquisition phase. Results show that action-effect predictions occur in both reference frames, arguing in favor of the involvement of multiple levels of visual brain processing.

Attentional template activation in preparation for search

Anna Grubert
Department of Psychology,
Durham University

Attentional templates (mental representations of target defining features) are activated prior to search to guide spatial attention to target-matching events in the visual field. To investigate the temporal dynamics and organisational flexibility of preparatory template activation, we recently developed a new rapid serial probe presentation protocol (RSPP; Grubert & Eimer, 2018). In the basic version of this paradigm, circular search displays (presented every 1600ms) contained a colour-defined target among five differently coloured distractors. Brief circular probe displays that included a target- or distractor-colour singleton among grey items were flashed (50ms) in rapid succession (every 200ms) throughout each block, at a different eccentricity than the search displays. N2pc components, as electrophysiological markers of attentional capture, were measured in response to each successive probe in the interval between two search displays. Distractor-colour probes did not trigger any N2pc components, indicating that they were not systematically attended. However, target-colour probe N2pc amplitudes increased during the preparation period and were largest for probes directly preceding the next search display. This pattern of results indicates that attentional templates are activated (colour) selectively and transiently during the preparation for individual search episodes. In my talk, I will present a series of experiments in which we employed (variants of) this RSPP protocol and found that top-down controlled search preparation is modulated in line with temporal task parameters (during shorter versus longer and fixed versus variable inter-search intervals), that multiple preparatory target templates can be activated simultaneously (during multiple-colour search), but that such multiple template activation states are surprisingly inflexible and are not subject to strategic top-down adjustments (when the respective target colour is more versus less predictable).

Friday 12th **Talk Session 1 / 9.00 – 10.30**

Perception and action in parietal patients

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We recently investigated whether attention and remapping deficits are possibly dissociated in patients with Balint syndrome following stroke or posterior cortical atrophy. We identified an impairment to deploy attention (shrinked attentional field) as a bilateral covert attention deficit. Disorganized ocular exploration appears to be independent and is hypothesized to result from processes maintaining a salience map over time (spatial working memory) and especially across saccades.

Trans-saccadic memory after right parietal brain damage

Teuni ten Brink
Department of Psychology
University of Bath

Spatial remapping, the process of updating information across eye movements, is an important mechanism for trans-saccadic perception. The right PPC is a region that has been associated most strongly with spatial remapping. We studied whether this right-hemispheric dominance translates into enhanced trans-saccadic memory for locations that are remapped into the right compared to the left hemisphere in healthy participants, and whether damage to the right PPC affects direction specific trans-saccadic memory.

Spared Action and Non-Invasive Brain Stimulation Training in Stroke Patients with Hemispatial Neglect

Monika Harvey
School of Psychology
University of Glasgow

A significant number of stroke patients with right hemisphere lesions show hemispatial neglect, a severe visuospatial impairment, where they fail to perceive/misperceive items presented in the contralesional part of space. I will present data showing that immediate on-line actions are relatively unimpaired in these patients, and further discuss two recent rehabilitation studies where we assessed whether these spared actions could be exploited for neglect rehabilitation a) via behavioural training and b) in a clinical trial using non-invasive brain stimulation.