1.1. Temporal Attention

Auditorio Hall

Chair:

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The brain constantly makes predictions about when, where and what sensory information is about to hit the retina. While previously the focus was on "where in visual space" attention needed to be directed, very recently the focus has shifted to "when in time" attention is needed. Temporal attention is about how the brain uses temporal and statistical regularities to guide behavior. The basic notion is that expectations in time help to set attention optimally for the incoming information thus providing optimal sensitivity for perception and action.

Speakers:

Sander Los
Antonino Vallesi
Freek van Ede
Bettina Rolke
Jan Theeuwes

1.1.1. The long and the short of temporal preparation

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In a warned reaction time task, the warning stimulus (S1) initiates a process of temporal preparation, which promotes a speeded response to the impending target stimulus (S2). When the S1-S2 interval (the foreperiod) is varied within blocks, past foreperiods affect preparation on subsequent trials at different time scales. An immediate effect on the next trial; an intermediate effect of the current foreperiod distribution, and long-lasting transfer effects after the distribution is changed. Classical models of temporal preparation (hazard function or trace conditioning) fail to account for all these effects. This inspired us to develop the multiple trace theory of temporal preparation (MTP). MTP assumes that each timing experience forms a unique memory trace, whose strength gradually dissipates toward an asymptote. On each trial, traces contribute to preparation proportional to their strength. We will show that these assumptions suffice to account for the complete family of foreperiod effects.

1.1.2. Bayesian modeling of temporal expectations in the human brain

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We used computational Bayesian modelling to quantitatively describe temporal expectations and to functionally disentangle belief updating from information surprise in order to best pinpoint the distinct functional anatomy (fMRI study) and electrophysiology (EEG studies) of cognitive processes associated with these two types of information. The fMRI results showed that specific regions belonging to the fronto-parietal and cingulo-opercular cognitive-control networks were differentially modulated by belief updating and surprise. The EEG results confirmed that updating and surprise could be functionally distinguished at the electrophysiological level, with relevant implications for the functional interpretation of the P3 within the framework of the Bayesian brain hypothesis. Overall, our findings contribute to enrich our current knowledge about the neural mechanisms underlying the deployment of temporal expectations.

1.1.3. Temporal anticipation in visual working memory

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Foreknowledge of when sensations and actions are likely to occur or become relevant enables us to guide our attention toward them. To date, the influence of such 'temporal anticipation' has been most clearly demonstrated in the cognitive domains of perception and action. Little remains known about the role and mechanisms of temporal anticipation in working memory – despite the prospective purpose of this memory function and its proven susceptibility to other forms of attention. In my talk, I will use both behavioural and EEG data to highlight the mechanisms by which temporal anticipation ensures optimal working-memory-guided behaviour. These initial studies underline the important role of temporal anticipation also in the domain of visual working memory, and highlight the dynamic and pro-active nature of this core memory function.

1.1.4. The benefit of being in time: Does temporal attention selectively boost relevant stimulus features?

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Various studies have shown that temporal attention accelerates responses to a stimulus or enhances its discrimination. In two event-related potential studies, we addressed the question whether temporal attention fosters specific and task-relevant stimulus features. In Study 1, temporal attention was task-irrelevant, but other stimulus dimensions as the spatial position and the color were task-relevant. In Study 2, we defined the temporal occurrence of a stimulus itself as a task-relevant feature. We observed that temporal attention modulated stimulus processing in both studies, but that the interactive pattern of results differed between the studies. Temporal attention did not interact with the effects of other task-relevant dimensions when it was task-irrelevant (Study 1), but when it was task-relevant (Study 2). These results suggest that the influence of temporal attention on visual stimulus processing depends on its specific role in the task to be performed.

1.1.5. Anticipatory distractor suppression elicited by statistical regularities in visual search

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Salient yet irrelevant objects often capture our attention and interfere with our daily tasks. Recent research has shown that implicit statistical regularities present in the display will bias attention. In the present talk, I will show that in anticipation of the stimulus, this attentional bias is already implemented before display onset. Using electroencephalography (EEG), we recorded cortical activity of human participants searching for a target while ignoring a salient distractor. We found

that more than 1 sec prior to display onset, there was enhanced power in parieto-occipital alpha oscillations contralateral to the location where observers anticipated the occurrence of distracting information. After display onset, an early lateralized P1 component (~100 ms post-stimulus onset) was observed as an early anticipatory attentional index. Later in the trial, this was followed by distractor-related PD component suggesting suppression of the location where observers anticipated the presentation of a distracting information.