Gaze Bias Learning

Linking neuroscience, computational modeling, and cognitive development

London

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Workshop schedule

12:00pm	*Lunch*
13:00pm	Gaia Scerif
13:30pm	Rachel Wu
14:00pm	*Break*
14:15pm	Thomas Hannagan
14:45pm	Eddy Davelaar
15:15pm	*Tea/Coffee Break*
15:30pm	Jochen Triesch
16:00pm	Jan Lauwereyns
16:30pm	*Discussion*
18:30pm	*Dinner at Giraffe*
20:00pm	*Drinks at The Friend At Hand*

Gaia Scerif

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How does attentional control constrain visual short-term memory? Developmental and neural mechanisms

Visual short-term memory (VSTM) is limited in capacity, and differentially so over the lifespan. The neurodevelopmental mechanisms by which attentional control constrains the limits of VSTM remain poorly understood, but assessing how participants of different ages orient attention to mnemonic contents can elucidate this interplay. In a series of complementary experiments, we asked: 1) whether, and if so, how, attentional orienting facilitates encoding into and maintenance in VSTM; 2) whether attentional constraints on VSTM are also influenced by the nature of the to-be-remembered items; and 3) about the neural mechanisms through which we orient attention in preparation of encoding as well as during VSTM maintenance. Our basic paradigm required participants to encode an array of items, followed by a probe stimulus whose presence in the array had to be reported. Memory arrays could be either preceded or followed by attentional cues. We targeted 6-7-year-olds, 10-11-year-olds and adults across experiments and measured event-related potentials locked to attentional cues and target items. Although age groups differed in their basic memory ability in the absence of attentional cues, performance was significantly improved by orienting their attention in service of memory and, during maintenance, differentially more so for older participants. In addition, all groups were influenced by the semantic and perceptual relatedness of the to-be-remembered items, suggesting that the nature of the representations on which attentional control operates is also critical to attentional benefits in VSTM. Thirdly, electrophysiological markers locked to attentional orienting cues and target stimuli indicated both similarities and differences in the mechanisms through which younger and older participants orient attention to representations in memory. Collectively, these studies elucidate how attentional control boosts encoding and maintenance in VSTM and throw light onto the mechanisms driving improvements in VSTM limits from childhood into adulthood.

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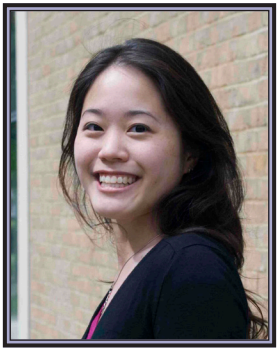

Top-down attentional selection as a marker of learning: An ERP study

Attentional target selection is based on top-down search templates when target-defining features are specified in advance. However, little is known about how observers learn what to look for. The present ERP study investigated how known or newly learned perceptual categories affect the emergence and speed of spatially selective processing in perception (N2pc component) and working memory (SPCN component). Adult participants had to select targets among distractors in a familiar (digits and letters) and a novel context (Chinese characters – numbers and non-numbers). On each trial, targets were specified by a preceding prime array. Identity prime arrays (two identical items) instructed participants to simply select the physically identical target item (if present) in the next search array. Category primes (two different items belonging to the same category) instructed participants to select a category-matching target in the next search array. As expected, all targets triggered N2pc and SPCN components in the familiar context. In the novel context, targets specified by identity primes or by physically matching category primes also triggered N2pc and SPCN components, as participants could again base target selection on physical identity on these trials. However, when targets were specified by non-matching category primes, and this strategy was not available, target selection required the prior learning of the relevant category. On these trials, a reliable N2pc and, in later trials, an SPCN were triggered once participants learned the targets' category membership, demonstrating that these components are a marker of successful category learning. Our study provides new insights into the real-time dynamics of top-down attentional selection guided by physically or categorically defined attentional templates, and into the acquisition of new perceptual categories.

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Thomas Hannagan

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Modelling cued infant learning: Information or Activation?

I will present a model of cued learning in infancy. After reviewing the extant computational studies bearing on the subject, I will describe the connectionist architecture and hypotheses by which the model can accommodate behavioural findings from Wu & Kirkham (2010), who reported differences in learning with social and non-social cues in 8 months-old. I will outline the strengths and limits of this model, in lights of its ability to make falsifiable predictions and its explanatory power, especially regarding new evidence that infants can generalize across learning cues. Finally I will point to new insights on cued infant learning that become available when one considers the relationship between activation and information in this model.

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Eddy Davelaar

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ADHD is associated with deficits in cognitive control. Or is it?

In this talk, I will address the issue of interpreting data from the Eriksen flanker task. Apart from merely focusing on mean response times, researchers have focused on the entire response time distributions. This research has yielded great insights into possible cognitive deficits in children with ADHD. In particular, whereas the mean of the entire distribution is longer in ADHD, its locus lies in the elongated tail of the distribution. This has been interpreted as demonstrating a deficit in maintaining attention and completing the task. In the Eriksen flanker task, a response has to be given on presentation of a target stimulus, which is flanked by distracting stimuli. These distractors may help or hinder the response to the target. By analysing the entire response time distributions in this task, researchers have found that children with ADHD are at best slow in triggering control processes that help in focusing on the target stimulus. However, there is a caveat. It is now well-established that there exist cross-trial effects, where the response time on the current trial is partly dependent on the previous trial type. Although this has also been interpreted as an indicator of cognitive control, the leading alternative explanation is based on associative learning. I will present data showing that the response time distributions are sensitive to cross-trial effects and present a computational account of what might be going on in children with ADHD. The conclusion is that based on the arguments presented the research using Eriksen flanker task does not provide evidence for a deficit in cognitive control in ADHD, but instead provides evidence for a deficit in associative learning.

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Jochen Triesch

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Looking for reward: from gaze following to gaze contingency

The primate eye movement system is closely intertwined with systems for reward-based learning, suggesting that infants' looking behavior may be shaped by internally generated reward signals. In this talk I will first present a model describing how reward-mediated learning mechanisms may contribute to the development of gaze following. Our model explains key findings about the development of gaze following and predicts the existence of a new class of mirror neurons for looking behaviors. The existence of such mirror neurons has recently been confirmed in monkeys. In a second part, I will present recent results with a novel gaze-contingent paradigm allowing 6- and 8-month-old infants to control their environment through their eye movements. Our data show that infants quickly make use of this new form of agency and that they rapidly anticipate the consequences of their actions. I suggest that gaze contingency holds great promise for studying various aspects of infant cognition and speculate that it could also be used for early diagnosis and treatment of developmental disorders.

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Jan Lauwereyns

Kyushu University

Eye movements and the intrinsic attraction of information

Eye movements are a type of observer behavior intrinsically devoted to the acquisition of real-world information. Yet, our eye movements perform the task of information gathering in a decidedly biased fashion: not random, not systematic or machine-like, but chaotic, exhibiting a form of "bounded unpredictability." Here, the concept of informativeness will be introduced as a key player in the attractor dynamics of perception. The brain is organized in such a way as to facilitate pervasive interaction between various polarities in perception, including center and surround, figure and ground, object and context, fovea and parafovea, and ventral and dorsal processing. The polarities entail components of bias and sensitivity that determine the effort, speed, and accuracy of information processing. The biases and sensitivities determine the economy of perception in the critical currency of information value, implying different levels of priority for different types of information. Value-rich information, here, may be considered as an intrinsic attractor; that is, curiosity and exploration would be oriented to such information as a goal in itself. In line with this view, I will present a series of five studies that chart the active boundaries of semantic influences on overt and covert attention. In all of these cases, we can trace the intrinsic attraction of certain types of information that are irrelevant to the task at hand. The data call for a unifying framework that connects the concept of informativeness and its intrinsic attraction to formal models of the observer's knowledge of "things as they are."

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