# 3.1. Recent advances in cognitive control research

## Auditorio Hall

Chairs:

Evie Vergauwe
*Université de Genève*
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Cognitive control refers to the higher-order processes that allow for goal-directed and adaptive behavior. Traditional theories mostly understand cognitive control as originating from a set of supervisory, independent, executive control systems, which are often seen as diametrically opposed to low-level learning processes. Similarly, cognitive control is traditionally studied in isolation from other mental concepts, like emotion or social cognition. In this symposium, however, we bring together different speakers that deviate from these traditional definitions and research lines, by taking into account factors such as the need for instructions, its relation to emotion, its role in social cognition, or its sensitivity to contextual features in our environment. In doing so, they provide new insights into the underlying processes and neural mechanisms of cognitive control.

Speakers:

Noga Cohen
Baptist Liefooghe
David Dignath
Yu-Chin Chiu
Richard Ridderinkhof

### 3.1.1. Cognitive control training enhances emotion regulation

Noga Cohen
*University of Haifa*

Adaptive behavior depends on the ability to effectively regulate emotional responses. Failure in the regulation of emotional arousal can result in heightened physiological reactions and disruptive behavioral performance. In turn, these behavioral and physiological alternations can lead to various psychopathologies. In several studies we demonstrated that training cognitive control, an attentional mechanism that enables goal-directed behavior, lead to reduced emotional interference by aversive pictures. This training was also associated with a reduction in amygdala activation to aversive pictures and with an increase in amygdala-prefrontal connectivity. Moreover, we showed that training individuals to recruit cognitive control prior to the presentation of unpleasant pictures enhances their ability to regulate an upsetting personal event using reappraisal. These findings suggest that the interplay between emotion and cognitive control is essential for maintaining adaptive behavior and may be impaired in individuals with emotion regulation deficits.

### 3.1.2. On the demystification of instructions as the source of cognitive control: Where do we stand?

Baptist Liefooghe
*Universiteit Gent*

The ability to share and use verbal instructions is thought to separate humans from other animal species. Using language, we can bypass trial-and-error learning and verbal instructions are omnipresent both in daily life as well as in psychological research. Many accounts consider instructions as the mythical source of cognitive control. However, the mechanisms via which instructions set-up cognitive control are still poorly understood. These mechanisms have gained prominence in research focusing on automatic effects of new instructions that were never overtly practiced before. Following a quick tour of the current status of this research, a critical analysis is presented of the many theoretical gaps that still need to be filled in. The thesis is defended that a narrow focus on automatic effects of instructions may be detrimental when trying to understand how instructions control cognitive control.

### 3.1.3. Binding of control-states into event-files

David Dignath
*Albert-Ludwigs-Universität, Freiburg*

How do we manage to shield our goals against distraction? Traditionally, this ability has been attributed to top-down cognitive control, which is assumed to monitor for, and intervene in case of response conflicts. However, this account has been challenged by episodic-retrieval views, which attribute sequential modulations of conflict effects to bottom-up memory for stimulus and response features. In this talk, I will present evidence suggesting that control and retrieval accounts are no alternatives but, rather, two sides of the same coin. Following recent theorizing, I will argue that control parameter can become stored in event files, together with stimulus, response, and context codes, so that cognitive control operations, independently from the stimulus-response codes the operate on, can come under mnemonic control. As a consequence, memory aids control operations by automatizing and tailoring them to the situational circumstances.

### 3.1.4. Stimulus-control learning in task switching

Yu-Chin Chiu
*Purdue University*

Cognitive control is a top-down process that overcomes automatic response tendencies primed by the environmental stimuli. Recent empirical evidence suggests that interference control can be instantiated automatically by stimuli in a bottom-up manner based on prior associations between the stimulus and a particular control state. We (Chiu & Enger, 2017) further tested this learning hypothesis with the control processes mediating task switching. We found that items that are frequently associated with switching incur a smaller switch cost than items associated with a low probability of switching, i.e., an item-specific switch probability (ISSP) effect. However, whether ISSP learning also influences people's voluntary choice to switch task remains unknown. To address this question, we combined an ISSP manipulation and a hybrid protocol with 75% cued switch trials and 25% voluntary switch trials, allowing us to assess the effect of ISSP on both switch costs and voluntary switch rate (VSR). We observed robust ISSP effects on cued trials as well as a greater VSR for items associated with a high than a low switch probability. Our results thus show that ISSP learning not only improves the efficiency of switching but also increase people's willingness to switch voluntarily.

### 3.1.5. Predictive processing and cognitive control in action: The case of inferring action intentions

Richard Ridderinkhof
*Universiteit van Amsterdam*

Cognitive control in action rests on the ability to (learn to) adequately predict the consequences of actions. Predictive processing theories assume that inferring another's action intentions requires a forward model of that agent's action, which can be obtained through learning by simulation. Based on this notion, we ran a

series of studies on goalkeepers in soccer and handball, who try to infer the intended direction of a penalty being kicked or thrown at them. We've run behavioral training studies, an fmri-mvpa study, and currently an eeg-mvpa study to grasp the mechanisms underlying the ability to predict (i.e., inverse model the sensory consequences of) penalty's. Results suggest that goalkeepers do engage in motor imagery to infer action intentions of penalty kickers/throwers, and use the ensuing predictions to make successful saves.