Symposium on Event Predictive Cognition

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This symposium on Event-Predictive Cognition (EPCog) will scrutinize the apparent strong linkage between events and predictions. Events, characterized as "a segment of time at a given location that is conceived by an observer to have a beginning and an end" (p.3, Zacks & Tversky, 2001), seem to be predictively encoded in our minds, linking and temporarily binding the essential aspects that constitute an event. However, in different disciplines the concept of an event as well as of predictions and predictive encodings has been treated from different perspectives and by means of different paradigms.

The EPCog symposium brings together cognitive scientists, who are experts in developmental, cognitive, and neuro-computational psychology, linguistics, machine learning, and neuroscience. The overall goal is to foster an interdisciplinary knowledge exchange about the connections between predictions, event processing, event encodings, including their development, as well as closely related computational modeling approaches. Questions addressed to varying extents from different (inter)disciplinary perspectives in all talks are:

- Is there a common principled encoding of events?
- How do predictions unfold while processing events?
- Are predictions critical for developing event encodings and hierarchical encodings thereof?
- How do non-linguistic event encodings interact with language?
- How are predictive event encodings related to working and long-term memory?
- How do predictive event encodings interact with anticipatory behavior and cognition?

Event-related cognitive science questions, such as how humans apprehend, perceive, encode, and process events as well how events interact with behavior and cognition, have been addressed by cognitive scientists for decades. The perception of simple behavioral events, such as walking, grasping, or throwing, has been studied with biological motion perception paradigms beginning in the 1970s, if not earlier (Johansson, 1973). Similarly, linguistics has acknowledged from early on a close relation of sentences as event descriptors – with agents and patients constituting the main involved entities and the verb describing an event progression or an event situation (cf. e.g. Jackendoff, 2002). In fact, it appears that language is closely related to how we structure events cognitively (Papafragou, 2015). Language abilities seem to be grounded in and develop from pre-linguistic, conceptual structures of events, including implicit knowledge about our own body, our own behavioral abilities, physics and particularly objects, the abilities of others, and social behavior.

Somewhat more recently, these conceptual analyses have developed into deeper theoretical analyses and cognitive theories. Two influential theories in cognitive psychology have focused on the behavioral and perceptual relevance of events. Closely related to the ideomotor principle, which dates back to the 19th century, the *theory of event coding* (Hommel, Müsseler, Aschersleben, & Prinz, 2001) postulates that our mind tends to develop common codes between motor activities and their contingent sensory effects. These event codes then enable the goal-directed motor activation when desiring the associated sensory effects – essentially developing compact sensorimotor event codes. Focusing more on the perceptual side, *event segmentation theory* postulates that humans encoded events compactly in memory and somewhat differentiate event encodings from event transition encodings, which link events to each other over time (Zacks, Speer, Swallow, Braver, & Reynolds, 2007). Over the last two decades, these two theories have intensively studied, verifying the high adaptability and flexibility of event codes as well as its relevance with respect to memorization and prediction.

Concurrently, the predictive mind, predictive encodings, and anticipatory behavior have been studied as key concepts for the development and pursuance of higher level cognitive abilities, including action and language (cf. e.g. Butz & Kutter, 2017; Cooper, 2010; Engel, Friston, & Kragic, 2016). This *predictive mind* perspective essentially suggests that we develop abstract thoughts and language from systematically and actively exploring and processing continuous sensory and sensorimotor streams of information. Moreover, we do so in an active, anticipatory manner, in that desired anticipated future states selectively invoke those actions and (believed) consequences, where "desired" refers to both, a motivational desire towards internal homeostasis as well as an information-theoretic desire towards improved world knowledge (cf e.g. Friston, 2009).

It remains unclear, however, how our mind properly abstracts these streams of information into symbolizable, conceptual units of cognition. How are these units encoded to enable their recombination in compositionally meaningful manners? Contemporary models of action selection that consider event knowledge for invoking control (e.g. Cooper, Ruh, & Mareschal, 2014; Gumbsch, Otte, & Butz, 2017) only provide limited solutions. Yet understanding the involved abstraction processes, the resulting abstract encodings, and their compositional recombination is critical when aiming to understand the human mind.

Putting this together, *event-predictive cognition* (EPCog) may be a key to develop compositionally recombinable conceptual structures as well as to understand the development of the human mind from a functional and computational perspective (Butz, 2016; Butz & Kutter, 2017). Event-predictive encodings may enable higher-level cognition, such as episodic memory and language, integrating various percepts, dynamics, and actions into consistent wholes. EPCog may explain how a continuous sensorimotor stream can be transformed into discrete, high-level, conceptual representations, which are compositionally recombinable.

Our four renowned contributing speakers will set the stage for a highly interesting and productive knowledge exchange and discussion on events, predictions, and cognition as well as their close interrelations.

- Rick Cooper will apply a neurocomputational modeling approach to address the challenge of abstracting conceptual event structures from sensorimotor information. He will argue that a fundamental purpose of such event structures is to preempt errors of action, and will demonstrate how abstracted event structures may be used by cognitive monitoring processes to trigger proactive control and replanning, thereby avoiding error.
- Jeff Elman has studied language processing and modeled it with recurrent neural networks for several decades. In his presentation with Ken McRae (based on Elman & McRae, 2017) he will focus on the temporal structure of events representations, its potentially hierarchical nature, and underlying common encodings using modeling and large-scale norming studies of event protocols.
- Anna Papafragou focuses on cognitive and linguistic aspects of event representations, as well as on the development of event perception and processing in children. She will address the nature of event representations while processing particular events as well as while producing linguistic event descriptions.
- Jeff Zacks relates the perception and processing of events directly to prediction error processing, episodic memory, and action planning (Richmond & Zacks, 2017). An event is viewed as a currently active (predictive) code in working memory, which is updated when error spikes are detected. Moreover, he addresses the potential for applying the gained theoretical insights for treating memory disorders.

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