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Event Cognition

Jeffrey M. Zacks¹

¹Washington University in Saint Louis

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Event cognition is the study of how minds and brains form, manipulate, store, and use representations of events. It encompasses *event perception*, *event memory*, and aspects of planning and action control. Events are a central feature of human experience, but they are somewhat under-studied compared to *objects* and *entities* (people and other animate agents). Event cognition has roots in philosophical investigations of actions and events, in ecological psychology, and in investigations of text processing by humans and computers. Natural activity is dynamic and continuous, but perception segments activity into discrete events, which bind together features in a common spatiotemporal framework. These events are simultaneously represented on multiple timescales. Event segmentation during perception determines the units of later long-term memory. A significant volume of the cortex appears to be involved in constructing and updating representations of events, which makes sense given the central role that events play in comprehension, memory, and action planning.

History

Event cognition has philosophical roots in two twin questions: “what is an event?” and “what is an action?” ([Casati & Varzi, 1996](#)). Philosophers have looked for analogies to objects, considering what constitutes the boundaries of events, their parts, their category structure, and their relations to other kinds of things. In psychology, one important basis for event cognition is [Gibson's \(1979\)](#) *ecological* approach to event perception, which emphasized analyzing the spatiotemporal structure of the environment in which an organism perceives and acts. Whereas Gibson's approach focused on the structure in the external world and avoided proposing structured mental representations, work on *scripts* ([Schank & Abelson, 1977](#)) and *schemas* ([Bartlett, 1932](#); [Rumelhart, 1980](#)) in psychology and computer science focused intensively on how structured knowledge representations contribute to understanding and remembering events. Another important basis for current thinking about events comes from [Darren Newton's \(1976\)](#) studies of how events are individuated in the stream of behavior; his research crystallized the problem of event segmentation as an important one for cognitive science.

After Gibson's and Newton's major works, work on events in perception waned for two decades, while research on comprehension and memory for events in narrative text picked up ([Bower & Morrow, 1990](#); [van Dijk & Kintsch, 1983](#)). Since about 2000, there has been a rekindled interest in event perception and its relationship to memory and other related phenomena ([Zacks, 2020](#)).

Core concepts

Segmentation

Imagine you are watching someone make banana bread. Their movements are continuous and dynamic, but you will likely have the sense that the continuous stream of behavior is segmented into a set of distinct events that follow one after the other: mashing the bananas, mixing the wet ingredients, adding the dry one, and so forth. The *segmentation* of the continuous stream of behavior into meaningful chunks

separated by *event boundaries* is a striking phenomenological feature of everyday experience, and it is accompanied by robust behavioral and neurophysiological correlates ([Zacks, 2020](#)). Event segmentation is consistent across observers and is accompanied by changes in eye movements ([Smith et al., 2024](#)), increases in brain activity in components of the brain's default mode network ([Zacks, Braver, et al., 2001](#)), and shifts in the local pattern of activity in regions of the cortex ([Baldassano et al., 2017](#); [Geerligs et al., 2021](#)). These findings converge on a conclusion that each experienced event corresponds to an *event model* constructed in working memory [see [Working Memory](#)] that represents the current state of affairs—for example, while watching banana bread being made, you might have an event model that includes information about the cook, the countertop, the ingredients, the actions being performed, and relations among these. Event boundaries are then the points at which comprehenders update their event models.

Spatiotemporal framework

Event models encode relationships between objects, people, and the actions performed by people by locating them within a shared *spatiotemporal framework* [see [Action](#); [Spatial Cognition](#)] ([Johnson-Laird, 1983](#); [Zwaan & Radvansky, 1998](#)). This form of representation facilitates inferences; for example, if someone reads that “the mixing bowl is to the left of the bananas” and “the spoon is in the mixing bowl,” they can verify that the spoon is left of the bananas. Abundant evidence indicates that viewers represent the locations of objects in a scene that are occluded from view and that readers represent mentioned objects and people in a common spatial reference frame. The representational framework is temporal as well as spatial, for example, tracking how the bananas move and are transformed over time.

Multiple temporal scales

Event models represent activity at multiple timescales. Brain systems specialized for representing events in working memory probably function at timescales from about one second to tens of minutes. Event boundaries are hierarchically nested, such that events on coarser timescales break down into subevents on finer timescales ([Zacks, Tversky, et al., 2001](#)). As information is taken in by the brain's sensory systems and passed forward through successive processing stages, the timescales of representation become increasingly long ([Baldassano et al., 2017](#)); this suggests that the outputs of fine-grained event processing provide inputs to coarser-grained event representations.

Perception and memory

During comprehension, event models in working memory support rapid access to potentially relevant event features. After an event boundary, information from the previous event is often less accessible ([Bower & Morrow, 1990](#); [Zwaan, 1996](#)). Event segmentation during perception also forms the units of episodic long-term memory. As a result, recalling some features of an event primes retrieval of other features of that event ([Ezzyat & Davachi, 2011](#)). It is also the case that individuals who segment activity more reliably during encoding show better subsequent memory for that activity ([Sargent et al., 2013](#)) and that interventions to improve event segmentation improve subsequent memory ([Flores et al., 2017](#)).

Finally, event models in working memory also form the substrate for thinking about events in the future [see [Episodic Future Thinking](#)].

Questions, controversies, and new developments

Functional MRI methods for studying the temporal and spatial structure of processing have revealed a temporal hierarchy of event representations distributed across the cortex, such that brain areas closer to sensory inputs update their spatial patterns frequently and association areas in later processing stages update infrequently ([Baldassano et al., 2017](#)). Returning to the banana bread example, an early-stage processing area might update its pattern as the cook switches from picking up a fork to mashing the bananas, whereas a later-stage area might maintain its pattern until the batter is completed. Event-specific cortical patterns that are instantiated during perception are reinstantiated during memory retrieval ([Chen et al., 2017](#)).

A current area of controversy is the nature of the control signals the brain uses to control the updating of event models. Some theories propose that the brain monitors errors in its predictions, or its uncertainty about predictions, and updates when these signals spike ([Nguyen et al., 2024](#)). Other theories propose that event models are updated when features change ([Newtson, 1976](#)), when the perceptual system infers that a new cause is driving the observed activity ([Kuperberg, 2021](#)), or when a script or schema indicates that a segment is coming to an end ([Baldwin & Kosie, 2021](#)). It is possible to generate intuitions supporting each of these possibilities: When a cook finishes mashing bananas, a viewer's event comprehension systems would likely have greater uncertainty and greater error in predictions about how the body will interact with objects. At the same time, more features are likely changing, including the actor's posture and the objects contacted. Comprehension systems might infer that the goal to mash the bananas is no longer driving the activity. Finally, if the viewer knows how to make banana bread, they might have a script that says that the next action will likely be to combine the wet ingredients. Quite possibly, multiple mechanisms collaborate to guide event segmentation.

Broader connections

Event cognition has roots in philosophy and computer science, and also has broad connections to contemporary research in multiple fields. Event representations are important for action planning and the control of robotic systems. Because event structure impacts learning and memory, it has important implications for education, including teaching students about processes in science and about events in history. Event representations may be affected by differences in language and culture, by development across the lifespan [see [Cognitive Development](#)], and by neurological injury and neuropsychiatric disease. Finally, event cognition has potentially important implications for robotics and human-computer interaction: In order to develop artificial agents that can collaborate effectively with human partners, it may be important for them to have an understanding of how humans represent events.

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