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Event perception as a control process for visual awareness

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ABSTRACT
We present evidence demonstrating that the structure of everyday events guides attention to and representation of visual properties. Incidental change detection increases dramatically at the boundaries between events, whereas individuals are largely unaware of the sequence of actions within a single event. Observers demonstrate a limited capacity for representing events, and inducing cognitive load by presenting two simultaneous events decreases detection of sequence errors. These studies support emerging evidence that the event perception network operates as a control process that guides attention and awareness in real-world settings.

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KEYWORDS Attention; inattention; event perception

Individual experience is fraught with failures of awareness. Demonstrations of inattention range from the innocuous misplacement of house keys while juggling groceries to more insidious failures to detect pedestrians while texting and driving. Although researchers have identified many capacity limits of attention, it is still not clear how individuals leverage their limited capacities in real-world settings. The relative ease with which individuals perceive and remember common events suggests that event structure exerts powerful constraints on everyday visual attention. We propose that the discrete structure underlying visual events guides attention to represent and track relevant properties at moments of transition, when representations are necessary to comprehend the changing world, thus optimizing attentional focus while minimizing representational load.

Research in event perception has demonstrated that individuals segment continuous activity as a series of discrete events (Newtson & Engquist, 1976). Visual and text-based analyses reveal that judgments of new events correspond with changes to a limited set of key properties, including time, space, agents, intentions and actions (Kives, Ware, & Baker, 2015). The primary model of event perception, Event Segmentation Theory (EST), proposes that these key properties are held in working memory for the duration

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of an event and are flushed at the onset of a new event (Zacks, Speer, Swallow, Braver, & Reynolds, 2007). Studies indicate that declarative episodic memory aligns with the boundaries between events (Ezzyat & Davachi, 2011). Conversely, individuals are more likely to forget old visual properties at the onset of a new event (Swallow, Zacks, & Abrams, 2009).

The relationship between event boundaries and episodic memory suggests that the perceptual system represents and tracks visual properties at relatively few but informative moments in time. We tested this hypothesis by creating live-action films depicting two clear events (Baker & Levin, 2015). Sixteen naïve viewers watched each film in its entirety, and then watched it again, pressing a key when they believed one event ended and another event began (summarized in the line plot of Figure 1). Viewers unanimously detected a new event at the midpoint of each film. Two conditions were then created by inserting large clothing changes during a single shot at either a consensus event boundary or two shots previous, at a point of no segmentation during the ongoing event. Participants recruited over Mechanical Turk were randomly assigned to watch a single video from either condition. Incidental change detection was assessed upon completion of the video. Participants detected significantly more changes on event boundaries (45.1%) than during ongoing events (16.2%), $\chi^2(1, N = 139) = 10.104$, $p = .0015$. Individuals preferentially attended to and compared properties on an event boundary but were ignorant of the same changes just five seconds before the boundary.

In addition to testing the tracking of properties between events, we also assessed the ability to detect reversals in the sequence of actions *within* an event. Previous research has demonstrated that individuals are relatively unaware of the sequence of actions leading to event boundaries and are

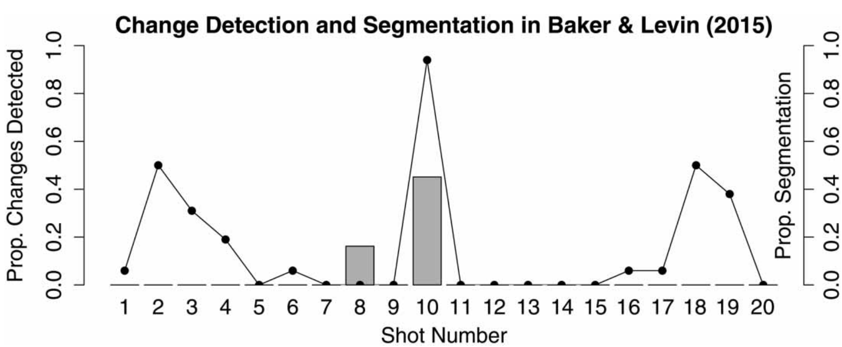

Figure 1. Raters pressed a key when they believed a new event began (solid line). Participants were more likely to detect property changes at new events (Shot 10) versus participants who viewed the same change five seconds earlier from the same viewpoint (Shot 8).

at chance at detecting sequence errors (e.g., stirring coffee before grasping a coffee stirrer) when performing a secondary task (backwards counting; Hymel, Levin, & Baker, 2015). In the current experiments, we tested whether increases in the complexity of events similarly decreased awareness of sequence errors. We adapted this paradigm to test whether monitoring multiple simultaneous event streams increases cognitive load and thereby lessens detection of misordered actions. The 12 movies from Hymel, Levin and Baker were edited into parallel sequences that alternated between events on each shot, in an A1-B1-A2-B2 fashion, or into "blank" sequences that interspersed a single event with time-matched blank shots (i.e., A1-__-A2_ …). Parallel events alternated between entirely different actions and spaces, such as sharpening a pencil and starting a car. Half of stimuli contained misordered actions within a single event (e.g., A1-B1-A3-B2-A2-B3 …). If participants maintain an event model for each open event, they should experience load when viewing multiple simultaneous events. In keeping with this hypothesis, Mechanical Turk participants detected fewer misordered actions in the parallel condition ($t_{198} = -8.363$, $p < .001$). A second experiment tested whether failures of awareness were due to representational load or to conceptual masking effects induced by rapidly alternating between event streams. We presented *pairs* of shots in parallel (i.e., A1-A2-B1-B2-A4-A3 …) or with blanks (i.e., A1-A2-__-__-A4-A3 …). Again, reversal detection was lower in the parallel condition ($t_{98} = -4.215$, $p < .001$).

Combined, these studies reveal a mechanism governing visual awareness during everyday event perception. Individuals demonstrate increased representation and comparison of visual properties on event boundaries and show little awareness of the sequence of subevents within events. The cognitive load generated by viewing multiple simultaneous events further decreases awareness. These results suggest that the perceptual system encodes relatively few properties at specific moments in time to offset a limited capacity. Increasing the number of event-relevant properties increases load and decreases awareness of changes to actions and properties. Inattention research often focuses on the features observers frequently overlook, whereas research on event perception highlights the basic features required to comprehend action. In bridging these literatures, we propose that the ability to comprehend and navigate everyday events reveals a powerful means of explaining when we do and do not track visual properties.

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