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Commentary

Ideas For Expanding Models of Event Perception to Support Intervention

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Interventions targeted at event perception are particularly promising because they have the potential to overcome limitations that have bedeviled previous cognitive interventions. As illustrated by the recent controversies about working memory training (Melby-Lervåg & Hulme, 2013; Shipstead, Redick, & Engle, 2012) and the cognitive benefits of video game playing (Boot, Blakely, & Simons, 2011), it can be extraordinarily difficult to demonstrate convincing broad training effects. These failures confront interventions with an important choice: should the training focus on specific tasks that are useful to patients, or should it address broader cognitive deficits that impair performance in many tasks, and that can make it difficult to learn new tasks? As the target article makes clear, one of the most promising elements of event perception interventions is the possibility that they can improve performance broadly while also helping patients perform useful tasks. In this response, we would like to add two basic ideas to those presented in Richmond, Gold, and Zacks's excellent article. First, it is likely that the cognitive processes that support event perception are more heterogeneous than current models of event perception imply. Second, it is likely that patient populations are similarly heterogeneous. In the former case, recent evidence suggests that the cognitive and perceptual processes that support event perception only sometimes derive from the elaborate representations and intensive predictions hypothesized in event segmentation theory. In the case of diagnostic heterogeneity, it is likely that variation within patient populations, even those with a common diagnosis, will modulate the effectiveness of cognitive interventions. We argue that many of these variations are important to understand because they may require that interventions be tailored not only for specific patient subpopulations, but also for the specific task domains that these patients have particular needs in. We suspect that understanding the combination of cognitive and diagnostic heterogeneity has the potential to improve interventions in many domains, but particularly for interventions that focus on event perception and memory in everyday settings.

Rich Representation and Intensive Processing

Zacks's event segmentation theory (Zacks, Speer, Swallow, Braver, & Reynolds, 2007) has been the dominant explanatory framework for visual event perception, and it has provided an excellent basis for research in this domain. Broadly, the theory proposes that segmenting continuous action into discrete events is the foundation of event perception. For present purposes, two properties of the theory are important. First, it proposes that event segmentation is guided by the default creation of a relatively rich hierarchical representation of the semantic and perceptual information necessary to guide perceptual processing. This representation includes lower-level representations of actions and movements along with more abstract representations of both short-term and longer term goals that give actions their meaning. For example, the act of driving to work includes simple movements such as extending one's fingers around the car key, which is part of the broader action of grabbing the key, which is in turn part of the action opening the car door, and so on, until one considers how actions exemplify the goals of getting to work and keeping one's job. According to event segmentation theory all of the levels in this hierarchy are associated with internal representations that include both abstract conceptual information and more concrete perceptual representations. Second, event segmentation theory proposes a relatively intensive prediction-and-comparison process whereby each level of the hierarchy generates a prediction about the next event, which is compared with incoming perceptual information, and if the two do not match a signal is generated that induces increased perceptual processing and a segmentation.

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There is clearly good evidence that event representations at a variety of levels of abstraction are created during naturalistic event perception and that predictive perceptual processing often occurs. However, we suspect that there is considerable variation in the prevalence of such intensive representational and predictive processing. Several lines of research suggest this possibility. For example, research exploring theory of mind in naturalistic settings demonstrates that although participants are able to predict another person's actions based on that person's beliefs and goals, participants often fail to do so (Barr & Keysar, 2005). Similarly, research exploring narrative comprehension suggests that predictive inferences do not consistently occur (Graesser, Singer, & Trabasso, 1994). Even less abstract representations and comparison processes may not consistently occur as a default. In the case of action-to-action predictions, participants often fail to detect reversals in visual actions sequences (for example, a person grabbing a screwdriver *after* they are seen using it; Hymel, Levin, & Baker, 2016), and simple forward predictions of object motion are not necessarily a useful basis for action guidance (McBeath, Shaffer, & Kaiser, 1995).

More generally, it is likely that visual event perception is similar to other forms of object and scene perception in that recognition must often be based on partial information. Just as we often see partially occluded objects and must identify objects from novel points of view, events are often only partially available to viewers. This is particularly likely given that events extend over time, especially in as much as they are processed at the most abstract goal-organized levels. Indeed, it would be inefficient to constantly monitor a series of actions when an occasional glance might be sufficient to identify an event based on characteristic actions (Levin & Saylor, 2008). Another important consideration is that viewers must often understand and execute multiple events in parallel. In such cases, it may be necessary to switch attention between events and to suspend expectations about the precise actions that one might expect to observe when looking back at a previously monitored event.

All of these considerations might be encompassed by an expanded theory of event perception that allows for substantial variation in the degree to which the full hierarchy of actions and goals is represented, and the degree to which predictions are constantly developed and checked against incoming information. In some cases, many of these processes are clearly necessary but perhaps not in all cases, especially when intensive representation and prediction is not possible. Accordingly, we would argue that a principled explanation for this variation is useful, as it might afford interesting predictions about the sorts of events that different cognitive limitations could interfere with. One approach might be to propose different models of processing similar to those proposed to explain different forms of executive function. For example, Braver (2012) proposes that people sometimes engage in proactive processing that defaults to richer representations and intensive processing, while in other cases, they rely more on reactive processing that involves more just-in-time representation and less prediction. Similarly, Sirigu, Zalla, Pillon, Grafman, Agid, and Dubois (1996) propose that narrative comprehension sometimes focuses on immediate interevent relationships while in other cases it is more hierarchical, focusing instead on the links between simple events and the more abstract semantics that organize them. This contrast is particularly relevant in the current setting because Sirigu et al. support their argument by demonstrating that patients with frontal lobe damage seem to have difficulty with event-sequencing tasks but retain the ability to identify events semantically.

Another alternative might be to propose that event perception varies by domain. For example, it might be interesting to assess the degree to which foundational contrasts between living things and nonliving things (Keil, 1989) are associated with events that differ in processing intensiveness. Another interesting contrast involving agents might compare cooperative versus competitive events, or rote, ritualized events versus more causally driven deliberated events (Harriman, Legare, Harris, & Whitehouse, 2013).

One interesting program of research that would seem to be useful given these considerations would be a descriptive analysis of the range of events people experience and must understand in their everyday lives. Developmental research on social-cognitive interaction can provide a good model for such work, and we note that in some cases this work as reached surprising conclusions about the prevalence of events. For example, observations of gaze following during naturalistic parent–child interaction are not based on the extensive observation of faces that is typically assumed (Deak, Krasno, Triesch, Lewis, & Sepeta, 2014). We would be remiss if we did not acknowledge work by Speer, Reynolds, Swallow, and Zacks (2009) who analyzed brain activations induced when participants read a log of events recorded by researchers who followed a child's activities over the course of a week, and we propose that it would be useful to extend the analysis from testing the role of event features that broadly signal new events to include possible variations in those features in different event categories.

From Heterogeneity in Events to Heterogeneity in Cognitive Dysfunction

One of the most important reasons to propose these extensions is that we suspect they will be useful in applying this work to interventions aimed at cognitive disabilities. We are very happy to have read about these interventions in the target article, and we were particularly interested to see strong emphasis of the value of teaching event conceptualizing for specific events that patients need to understand. In addition, however, recent research has demonstrated that many disabilities are associated with heterogeneous patterns of cognitive dysfunction and that these dysfunctions are modulated by medication status. Accordingly, it may be necessary to develop explanations of event perception that are flexible enough to tailor interventions to fit specific patients. For example, patients with Parkinson's disease experience difficulties with a variety of cognitive functions such as working memory, task switching, and learning, but those functions are differentially impacted throughout the disease due to a progressive and variable loss of dopamine across the striatum and due to effects of medication. Early in the disease, working memory and task switching are hampered whereas later in the disease outcome-based learning and decision-making are also