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Commentary

# Event Perception: From Event Boundaries to Ongoing Events

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The idea developed by Richmond, Gold, and Zacks (2017) of using event segmentation as a tool for diagnosing and improving the life conditions of elderly people and humans suffering from diseases related to cognitive impairments (such as Alzheimer's disease) is intriguing. Based on propositions of event segmentation theory (EST; Zacks, Speer, Swallow, Braver, & Reynolds, 2007) and recent empirical findings, Richmond et al. (2017) propose that interventions focusing on normative event segmentation behavior (i.e. parsing naturalistic events into meaningful events similar to a comparative sample) might improve cognitive functions, which are important for tasks of everyday living.

## Shaping Segmentation Behavior

Using event segmentation as a means of both diagnosis and training requires that event segmentation behavior is a persistent indicator of event perception and is shapeable by interventions. The persistency of event perception can be assumed given the high alignment of fine and coarse event boundaries within participants (Zacks, Tversky, & Iyer, 2001) and the significant agreement in segmentation behavior across participants (e.g., Hanson & Hirst, 1989; Newtson, 1973; Zacks, Speer, Vettel, & Jacoby, 2006). Thus, there remains the important question of whether segmentation behavior is shapeable by means of interventions. Considering recent findings from our own lab presented in the following, we argue that event segmentation behavior might not easily be susceptible to top-down influences.

Event segmentation, which is typically measured with the event segmentation task (Newtson, 1973), can be influenced by instructions to a certain degree. Participants usually follow the experimental instructions to segment a dynamic activity into the smallest or the largest meaningful units. Thus, participants can adaptively change their segmentation grain size to the needs of a given task. However, given the strong alignment of fine and coarse boundaries (Zacks et al., 2001), such effects only demonstrate that participants can flexibly adapt to a new event hierarchy but gives no direct insights as to whether participants can adapt to new event patterns.

The story gets more complicated if one takes a closer look at parameter that (should) influence event segmentation patterns, such as top-down processes. Expertise and attitudes are two factors that seem reasonable candidates for top-down influences on segmentation behavior, although theories targeting event perception and event cognition processes (e.g., EST) are largely underspecified in that matter. Such top-down influences also seem reasonable given the findings of Gernsbacher, Varner, and Faust (1990) who demonstrated the existence of a general comprehension skill for understanding narrative events. According to the authors, less skilled persons develop more mental substructures of the observed event. Although only memory-related measures were reported in their study, it is reasonable to conclude that more mental substructures are related to more perceived event boundaries. This finding is corroborated by findings of Sebastian, Ghose, and Huff (submitted for publication) who asked skilled automobile workers (experts) and novices to learn the assembly of a door via an interactive, gesture-based learning environment. Memory for fine event boundaries was higher for experts than for novices, but there was no difference for coarse event boundaries. Because neither study measured event segmentation, it remains an open question whether expertise and comprehension skill are actually related to event segmentation behavior as measured with the event segmentation task (Newtson, 1973).

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Recent work from our own lab has shown that event perception as measured with the event completion paradigm (Strickland & Keil, 2011) does not differ across different levels of soccer expertise (FIFA referees, players, and novices). All three groups showed the event completion effect and falsely remembered having seen the causal link in a dynamic event that was not present in the critical conditions (Brockhoff, Huff, Maurer, & Papenmeier, 2016). Further, attitudes–in terms of being a fan of a sports club–also do not influence event segmentation behavior (Huff et al., 2017). In this study, we asked fans of two archrival soccer teams to segment the live broadcast of a highly significant match, the 2013 UEFA Champions League Final. Although the fans were highly involved and showed biased retrospective judgements, the two fan groups showed an unbiased perception of the game (including similar segmentation patterns). This falsifies the classical finding of Hastorf and Cantril (1954), who showed that fans showed biased memories and speculated that biased perception is causal for this effect. Thus, our findings suggest that event segmentation might not easily be susceptible to top-down influences.

## Measures of Normative Segmentation

For non-clinical populations, evidence for top-down influences on segmentation behavior is weak. Given the high relevance of the goal of Richmond et al. (2017)–namely, to improve life conditions–it is important to get sensitive measures for diagnosing purposes. In our opinion, normative segmentation performance should not be measured solely by segmentation agreement (Zacks et al., 2006) because this measure might be too coarse. Instead, we argue that re-analyzing existing data of segmentation behavior across multiple different populations (e.g., young and elderly, with and without dementia) can be useful in defining more sensitive measures that are better suited for individual diagnostics and identification of individual impairments. Furthermore, those re-analyses should not only consider segmentation behavior within each group of participants but compare segmentation behavior across groups as this provides further insights. For example, in one of our studies, we investigated event perception with audio dramas and found that event boundaries identified by non-native listeners are a subset of the event boundaries identified by native listeners, with the native listeners identifying additional fine event boundaries (Huff, Maurer, & Papenmeier, submitted for publication-a).

We suggest the following classification of segmentation errors in non-normative segmentation behavior: *omission* of event boundaries, *addition* of event boundaries, *temporal shift*, and *grain shift*. We define *omissions* of event boundaries as participants not segmenting at points in time where the normative sample identified an event boundary. In contrast, we define the *addition* of event boundaries as participants segmenting at points in time that were not identified as event boundaries by the normative sample. Note that the quantitative implementation of these two error measures needs to consider that the existence of normative event boundaries is probabilistic rather than deterministic. That is, event boundaries vary in their magnitude, as defined by the proportion of participants in the normative sample identifying them, and in their temporal precision, as defined by the temporal synchrony of participants' segmentation responses. The third error type we suggest is *temporal shift*. That is, a tested participant might well perceive the same event boundaries as the normative sample but shifted in time, for example due to some motoric impairments delaying event boundary responses. One method of compensating for such errors are cross-correlations that were also applied in previous research (Bailey, Kurby, Giovannetti, & Zacks, 2013). Considering temporal shifts can be crucial in preventing false diagnoses of individuals. The last error type we suggest is *grain shift*. Because event perception and segmentation are hierarchical, event segmentation behavior changes according to instructions, such as fine or coarse segmentation instructions. By grain shifts we define errors that result from participants segmenting at a different hierarchical level than the normative sample. In order to detect grain shifts, it might be necessary to collect normative segmentation behavior not only for smallest and largest meaningful events but also at more sensitive hierarchical levels. Finally, we suggest that in addition to the specification of segmentation errors, the diagnosis of non-normative segmentation behavior could benefit from the development of more implicit measures of event segmentation. Recent developments in eye-tracking research are a step in this direction (Eisenberg & Zacks, 2016).

## The Role of Suppression During the Perception of Ongoing Events

Classifying segmentation errors into omissions and additions will help in planning respective interventions. Whereas Richmond et al. (2017) focus on omissions and thus interventions such as the cueing of event boundaries, interventions in the opposite direction could be indicated for some people too. In particular, given the fact that impaired comprehension of discourse is associated with impaired suppression and thus too frequent shifts to new mental structures (Gernsbacher et al., 1990), it seems plausible that some observers might be too sensitive to irrelevant information during event perception, resulting in event boundary additions. Interventions for such persons might then focus on the suppression rather than the enhancement of shifting cues.

According to EST (Zacks et al., 2007) event perception can be described by a relatively stable state in which predictions about the future development of the observed action guide perception. In this case, participants perceive an ongoing event. In case these predictions fail, participants perceive an event boundary. At these time points, all available sensory information is used ("gating") to build up a new event boundary. In contrast, during the perception of an ongoing event, event models guide perception. Richmond et al. (2017) argue that at this state observers "filter out" features irrelevant to the current event that otherwise capture bottom-up attention, such as motion onset (Abrams & Christ, 2003) or visual pop-out (Treisman & Gelade, 1980). This raises an important question that we want to discuss in the following: What is the role of suppression during the perception of ongoing events and at what processing stage(s) does it operate?