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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 life conditions of elderly people and humans suffering from diseases related with 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 everyday tasks and 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 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 as to 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 by 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 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 top-down 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 (under review) 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 as compared to novices. There was no difference for coarse event boundaries. Because both studies did not measure event segmentation, it remains an open question whether expertise and comprehension skill is actually related with event segmentation behavior as measured with the event segmentation task (Newtson, 1973).

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 does not influence event segmentation behavior (Huff et al., revision under review). In this study, we asked fans of two archrival soccer teams to segment the live broadcast of a highly significant match (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 by 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 only be measured 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 such as 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 of native listeners with the native listeners identifying additional fine event boundaries (Huff, Maurer, & Papenmeier, under revision).

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 are *temporal shifts*. 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 are *grain shifts*. Because event perception and segmentation is 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 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 at 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?

From a theoretical point of view, we can distinguish (at least) two classes of suppression during event perception: perceptual suppression and conceptual suppression. The filtering process described by Richmond et al. (2017) refers to perceptual suppression. Because perceptual predictions guide event perception according to EST (Zacks et al., 2007), event perception is biased towards information relevant to the current event model. That is, we can think of this process as an attentional template being instantiated based on perceptual predictions, thereafter biasing the processing of incoming sensory information. In this view, information irrelevant to an ongoing event is not included in the attentional template and thus suppressed on a perceptual level. Based on a popular theory of discourse comprehension, the structure building framework (Gernsbacher, 1997), irrelevant information might also be suppressed on a conceptual level instead of perceptual level. That is, salient information might pass the perceptual level even when it is irrelevant to the ongoing event. However, on a conceptual level, perceived information not matching to the current event structure is suppressed.

Although not studied within the event perception framework, one line of research in favor of the existence of perceptual suppression during event perception is inattentional blindness. Research on inattentional blindness has shown that participants even miss to notice a gorilla walking through a basketball scene if the participants focus on counting the passes among the players of the basketball team (Simons & Chabris, 1999). However, visual attention might be attracted by unexpected stimuli even in the absence of noticing them (Most, Scholl, Clifford, & Simons, 2005). Therefore, it remains to be resolved whether perceptual suppression in the sense of “filtering out” irrelevant information otherwise capturing bottom-up attention (Richmond et al., 2017) truly prevents bottom-up attentional capture or rather prevents items capturing bottom-up attention from entering the awareness of the observer.

Conceptual suppression was found for the comprehension of written narratives where multiple meanings of read homonyms are initially activated and meanings inappropriate to the current context are quickly suppressed (Gernsbacher & Faust, 1991). It seems likely that such conceptual suppression exists also during event perception because suppression is formalized as a general cognitive mechanism within the structure building framework (Gernsbacher, 1997) and there is evidence that a general comprehension factor underlies the comprehension of written, auditory and picture stories (Gernsbacher et al., 1990). While we do not know of any study that tested for the existence of conceptual suppression during event perception, we consider its existence very likely, particularly because conceptual changes such as changes in situational dimension strongly affect event perception (Huff, Meitz, & Papenmeier, 2014; Zacks, Speer, & Reynolds, 2009).

To our knowledge, there is only one study within the event perception framework that investigated visual attention towards information unrelated to an ongoing event. In this study, we employed a probe detection as a secondary task while participants watched short soccer scenes and kept track of a subset of the players (Huff, Papenmeier, & Zacks, 2012). We showed that probe detection performance was higher during an ongoing event than at event boundaries (Huff et al., 2012). Because participants performed probe-detection as secondary task, we cannot infer whether abrupt probe onsets capture attention when watching ongoing events without this secondary task. However, these results demonstrate that participants had more free resources to detect information unrelated to the current event during an ongoing event than at event boundaries. Thus, if there was no suppression of irrelevant information during ongoing events, participants should be more distractible by the onset of irrelevant information during events than at event boundaries. This is one of many hypotheses regarding the existence and operation of suppression processes during ongoing events that should be tested in future experiments.

We are confident that exploring and understanding the existence and function of perceptual suppression and conceptual suppression during the perception of ongoing events will help in gaining a deeper understanding of potential deficits during non-normative event perception and segmentation. In particular, knowing what perceptual and/or cognitive suppression mechanisms contribute to normative event perception will also help in developing respective interventions for people suffering from non-normative event perception.

Conclusion

The idea of using measures of event perception for diagnosis and intervention for participants suffering from segmentation impairment as suggested by Richmond et al. (2017) is intriguing. In this comment, we argue that event segmentation measures need to be complemented by measures targeting processes affecting the perception of ongoing events. This shift is important because evidence for top-down influences (such as expertise or attitudes) on event segmentation behavior is weak. In our opinion, studying *perceptual and conceptual suppression* during the perception of ongoing events opens up new horizons for the understanding of event perception and, thus, new insights on methods of intervention.

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Author contributions

M.H. and F.P. contributed equally to this commentary.

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