Consciousness and Cognition 41 (2016) 72–82

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Occlusions at event boundaries during encoding have a negative effect on infant memory

Trine Sonne *, Osman S. Kingo, Peter Krøjgaard

Center on Autobiographical Memory Research, Department of Psychology and Behavioral Sciences, Aarhus University, Denmark

ARTICLE INFO

Article history:
Received 11 November 2015
Revised 8 February 2016
Accepted 10 February 2016

Keywords:
Event segmentation
Infant memory
Eye-tracking
Cartoons
Episode

ABSTRACT

The present study investigated the importance of Event Boundaries for 16- and 20-month-olds' (n = 80) memory for cartoons. The infants watched one out of two cartoons with ellipses inserted covering the screen for 3 s either at Event Boundaries or at Non-Boundaries. After a two-week delay both cartoons (one familiar and one novel) were presented simultaneously without ellipses while eye-tracking the infants. According to recent evidence a familiarity preference was expected. However, following Event Segmentation Theory ellipses *at* Event Boundaries were expected to cause greater disturbance of the encoding and hence a weaker memory trace evidenced by reduced familiarity preference, relative to ellipses at Non-Boundaries. The results suggest that overall this was the case, documenting the importance of Boundaries for infant memory. Furthermore, planned analyses revealed that whereas the same pattern was found when looking at the 20-month-old infants, no significant difference was found between the two conditions in the youngest age-group.

1. Introduction

When trying to understand how and what infants and young children remember from the first years of their lives, researchers have devoted considerable attention to mapping out and describing the development of episodic memory (e.g., Bauer, 2007; Howe, 2011). Surprisingly, whereas substantial interest has been devoted to the 'memory' part of the term 'episodic memory', very little is known regarding how people actually parse ongoing experiences into specific 'episodes' (Dahl, Sonne, Kingo, & Krøjgaard, 2013; Ezzyat & Davachi, 2011). Consequently, we only have limited knowledge concerning the actual phenomenon we are asked to recall, namely the episode. This is thought-provoking, because being able to single out episodes seems to be a necessary pre-requisite to form episodic memories in the first place (Dahl et al., 2013). To fully understand the concept 'episodic memory', the basic question "what is an episode?" can hardly be discarded. In research primarily focusing on adults we have recently witnessed an increasing interest in this topic. Most notably, Jeffrey Zacks and colleagues have developed a theory of *event segmentation*, suggesting that people automatically seem to make sense of the ongoing flow of experience by segmenting it into identifiable chunks or parts (Kurby & Zacks, 2008; Zacks, 2010).

Even though Zacks' theory also offers an account of how the development of event segmentation may take place (e.g., Kurby & Zacks, 2008; Radvansky & Zacks, 2014), the developmental part of the theory is less evolved. As recently stated by Radvansky and Zacks (2014, p. 189) "...we know approximately nothing about how infant segmentation develops into an

* Corresponding author at: Center on Autobiographical Memory Research, Department of Psychology and Behavioral Sciences, Aarhus University, Bartholins Allé 9, 1350-424, DK-8000 Aarhus C, Denmark.

E-mail addresses: trines@psy.au.dk (T. Sonne), osman@psy.au.dk (O.S. Kingo), peter@psy.au.dk (P. Krøjgaard).

http://dx.doi.org/10.1016/j.concog.2016.02.006
1053-8100/

adult-like capacity". Our objective was to contribute further to this theory by examining empirically whether some of the hitherto unexplored aspects of Zacks' theory of event segmentation would apply to infants. More specifically, the goal of the present study was to investigate whether event boundaries are as salient to infant memory, as studies on adults suggest they are (see e.g., Swallow, Zacks, & Abrams, 2009). Pursuing the possible origin of the relationship between event boundaries and memory is important for several reasons. First, as stated above very little is currently known about the development of the event segmentation ability we see in adults. The present study may contribute by bridging this gap in the event segmentation literature. Second, examining whether event boundaries are related to subsequent memory of events in infancy may contribute to our understanding regarding event memory development more broadly. We begin by outlining the theory on event segmentation as well as related research primarily focusing on adults.

1.1. Event Segmentation Theory

According to Event Segmentation Theory (EST) an event is defined as "a segment of time at a given location that is perceived by an observer to have a beginning and an end" (Zacks & Tversky, 2001, p. 2). The ability to segment perception streams into identifiable and meaningful chunks assists us in dealing with an otherwise chaotic and dynamic world. Event segmentation is described as a core component of perception, and is thus considered an automatic and effortless part of everyday perception and comprehension (Kurby & Zacks, 2008; Zacks & Swallow, 2007). Event segmentation facilitates transforming perceptual input into representations, allowing us to create predictions about future actions (Zacks, Kumar, Abrams, & Mehta, 2009; Zacks, Speer, Swallow, Braver, & Reynolds, 2007).

In order to segment perception streams people form *event models* (working memory representations, recently referred to as working models, see Radvansky & Zacks, 2014) of the present perceptual information allowing us to comprehend "what is happening now?" and to distinguish this from what just happened (Kurby & Zacks, 2008). As long as the event models reflect the current situation, they will remain relatively stable. This seems to be the case most of the time. While stable and valid, the event models will guide the perceptual processing and lead to accurate predictions. However, when prediction errors increase, the models need updating. This is assumed to lead to a transient increase in processing causing more robust encoding as well as increased focus on the information present at those times. The periods of time characterized by a transient increase in processing are also known as *Event Boundaries* (or breakpoints). Event Boundaries emerge at points of change, for instance if an agent shows a change in goals or intentions as well as in the context of physical changes, since this leads to an increased risk of prediction errors (Kurby & Zacks, 2008; Zacks, 2010). The identification of Event Boundaries seems to be affected by both bottom-up processing as well as top-down influence of knowledge structures (Zacks, 2004).

Event segmentation has been found to affect a wide range of our abilities, such as our ability to learn from and remember events (e.g., Radvansky, 2012; Swallow et al., 2009; Zacks, Speer, Vettel, & Jacoby, 2006; Zacks & Swallow, 2007). Studies show that event segmentation plays a pivotal role in the encoding of events and that the increase in processing at Event Boundaries should lead to a more detailed encoding of information present at those times, and hence also to a better recall of items visible at boundaries (e.g., Newtson & Engquist, 1976; Schwan, Garsoffky, & Hesse, 2000; Swallow et al., 2009; Zacks et al., 2006). Consequently, Kurby and Zacks (2008, p. 77) proposed that effective segmentation would facilitate subsequent memory of the activity. Moreover, as suggested by Zacks and Swallow (2007, p. 83) not only will identifying the 'right' events lead to superior memory and enhanced learning; identifying 'wrong' events may also lead to poorer memory and reduced learning. Information present at an Event Boundary is thus more likely to be captured into long-term memory (Radvansky & Zacks, 2014).

1.2. Event segmentation in infancy

Just like episodic memory research originates from literature concerning adults, research on EST has so far primarily focused on adults. However, given that the methods typically employed in event segmentation studies primarily rely on parsing visual information, as for example by presenting participants with movie clips (e.g., Newtson, 1973), EST seems to be a promising platform for investigating segmentation in infancy as well. Although one cannot simply ask infants to identify boundaries by pressing a button, as is typically done in research with adults, one can still take advantage of the frequently employed visual stimuli and convert this to a task more suitable for infants. By use of looking time as an indicator of infants' understanding of events it is thus possible to avoid some of the inherent problems in using verbal instruction when doing infant research. Below we describe studies investigating event segmentation by means of looking time paradigms.

The few studies conducted on event segmentation or event processing in infancy generally show that infants are capable of segmenting events, indicating that they too are making sense of an otherwise complex perceptual stream by dividing it into smaller parts or events (e.g., Baldwin, Baird, Saylor, & Clark, 2001; Friend & Pace, 2011; Hespos, Grossman, & Saylor, 2009, 2010; Meyer, Baldwin, & Sage, 2011; Pace, Carver, & Friend, 2013; Saylor, Baldwin, Baird, & LaBounty, 2007; Stahl, Romberg, Roseberry, Golinkoff, & Hirsh-Pasek, 2014). Two different lines of research have investigated event segmentation in infancy. Some researchers have examined how infants' understanding of objects and events may inform us about the development of event segmentation (e.g., Hespos & Baillargeon, 2001; Hespos et al., 2009, 2010). A different line of research has focused on how infants parse what may be considered the more intentional aspects of human behavior (e.g., goal directed behavior). In the following we briefly outline these two lines of research, one at a time.