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Disentangling the effect of event-based cues on children's time-based prospective memory performance

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ABSTRACT

Previous time-based prospective memory research, both with children and with other groups, has measured the ability to perform an action with the arrival of a time-dependent yet still event-based cue (e.g., the occurrence of a specific clock pattern) while also engaged in an ongoing activity. Here we introduce a novel means of operationalizing time-based prospective memory and assess children's growing capacities when the availability of an event-based cue is varied. Preschoolers aged 3, 4, and 5 years ($N = 72$) were required to ring a bell when a familiar 1-min sand timer had completed a cycle under four conditions. In a 2×2 within-participants design, the timer was either visible or hidden and was either presented in the context of a single task or embedded within a dual picture-naming task. Children were more likely to ring the bell before 2 min had elapsed in the visible-timer and single-task conditions, with performance improving with age across all conditions. These results suggest a divergence in the development of time-based prospective memory in the presence versus absence of event-based cues, and they also suggest that performance on typical time-based tasks may be partly driven by event-based prospective memory.

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Introduction

Researchers typically distinguish between event-based prospective memory (PM), whereby people must act on an intention when prompted by a future external cue (e.g., "Buy milk next time you are at the shop"), and time-based PM, whereby people must act on an intention at a particular future point in time (e.g., "Get the washing out of the machine in two hours"). Nevertheless, the latter can also be conceived of as an event-based form of memory as long as there is an external means of tracking time (e.g., "Get the washing out of the machine when the clock shows 10 am"). Indeed, empirical time-based PM studies almost universally require participants to perform an action when a clock shows a specific pattern or when an alternative timing device has completed a cycle (for reviews, see Kvavilashvili, Kyle, & Messer, 2008; McDaniel & Einstein, 2007). Therefore, it remains unclear to what degree performance in time-based PM tasks is driven by internal tracking of time and self-initiated implementation of the intention and to what degree it is driven by the availability of event-based reminders. Furthermore, almost nothing is known about the development of time-based PM in the absence of event-based cues in children. Here we provide the first time-based PM paradigm that varies the availability of an event-based cue and is simple enough to be used with very young children (among other populations).

Development of time-based prospective memory

Event-based PM develops during the preschool years, with 3-year-olds and sometimes even 2-year-olds (Kliegel & Jäger, 2007) able to succeed at certain tasks (for a review, see Kvavilashvili et al., 2008). Time-based PM research, on the other hand, has typically focused on older school-aged samples (e.g., Ceci & Bronfenbrenner, 1985; Kerns, 2000; Mackinlay, Kliegel, & Mäntylä, 2009). The earliest reported success on a time-based PM task is by 5-year-olds, who could sometimes remember to turn a sand timer over whenever it had completed a cycle while also playing an unrelated card game (Aberle & Kliegel, 2010). Nevertheless, it should be noted that in this paradigm the visible passage of sand through the timer could act as an event-based reminder to perform the task. Indeed, the presence of the timer substantially reduces the need for the children to internally track the passage of time while deciding when to carry out the future intention.

Time-based PM studies with children do sometimes require participants to act purposefully in order to see the timing device, for instance, by turning their head or pressing a button (Aberle & Kliegel, 2010; Mackinlay et al., 2009). Interestingly, however, the level of self-initiation required to see the device appears to have little effect on children's ability to carry out the intended action. Voigt, Aberle, Schönfeld, and Kliegel (2011) gave 6- to 10-year-olds a PM task in which they needed to interrupt a computerized driving game to refuel. The fuel gauge depleted at a steady rate and was either continuously displayed on-screen or hidden until a button was pressed. The authors found no effect of gauge conspicuousness on children's ability to remember to refuel. Nevertheless, given that the gauge remained observable (albeit with more effort) in the hidden condition, the children still had the opportunity to off-load the need to internally track the passage of time and implement the intention to an external event-based source. The development of time-based PM in the complete absence of time-dependent event-based cues remains almost entirely unexamined.

The only study to assess this capacity in children used a school-aged sample of 7- to 12-year-olds, but the authors did not describe their task as a PM task nor did they report whether performance changed with age (Mackinlay et al., 2009). The children needed to tell an experimenter when they thought 2 min had elapsed while also engaged in an ongoing task that required them to trace tangled lines on a sheet of paper. Although useful for older child participants, however, such tasks would not be appropriate for preschoolers given their limited understanding of temporal terms such as "second" and "minute" (Busby Grant & Suddendorf, 2011). The very use of such cultural time instantiations also carries the risk that participants will internally count to the crucial time when deciding when to act rather than relying on their biological clock per se (as was self-reported by many adult participants in a similar task; Waldum & Sahakyan, 2013). A physical instantiation of time, such as a sand timer, might provide a more child-friendly and controlled means of conveying a specific temporal period