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Effect of delay on children's delay-execute prospective memory performance

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ABSTRACT

To date, little work has been done investigating prospective memory in children, particularly using a delay-execute paradigm. Two experiments were conducted to investigate this issue with children aged 5–11 years. While playing a computer driving game, children's ability to carry out a delayed intention either immediately a target cue appeared or after an additional delay, was assessed. These findings supported the few previous studies in this area by showing that preschool children are able to perform event-based prospective memory tasks. The results also extended these findings by demonstrating the impact of briefly delaying the execution of a retrieved intention, and revealing that there were important improvements in prospective memory performance from early to late childhood. The suggestion is made that executive resources may be responsible for this pattern of performance.

Remembering to execute an intended action after a delay is a common real-world memory task that has been studied under the label of *prospective memory* (Kliegel, McDaniel, & Einstein, 2008). From early in childhood, prospective memory demands are made on children. For example, school-aged children frequently have to convey school messages to their parents, and even preschoolers have to remember to pick up their artwork to take home from preschool. Thus, prospective remembering is an essential skill children must acquire to attain the potential to live and act independently (Meacham & Colombo, 1980). Several studies however, have demonstrated that forgetting to carry out intended actions is one of the most common memory failures amongst both adults (Crovitz & Daniel, 1984; Kliegel & Martin, 2003) and children (Winograd, 1988).

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Ellis and Freeman (2008) have characterized prospective memory as an umbrella term to describe both a type of task and the processes underlying the performance of these tasks. At least three task attributes are accepted as characterizing a prospective memory task (Ellis & Kvavilashvili, 2000): (1) a delay between formation of the intention and the opportunity to carry it out, (2) absence of an explicit reminder to carry out the task at an appropriate moment, and (3) the need to interrupt one's ongoing activity in order to carry out the intention. Prospective memory has thus been characterized as high in self-initiated retrieval and, consequently, as highly susceptible to effects of developmental processes (Craik, 1986).

Surprisingly, however, in contrast to a large number of studies that have examined prospective memory development across adulthood (see Henry, MacLeod, Phillips, & Crawford, 2004; Kliegel, Jäger, & Phillips, 2008, for meta-analyses), only a few studies have explored prospective memory performance in children (see Kvavilashvili, Kyle, & Messer, 2008, for a comprehensive review). In this literature, children's performances on two major types of tasks have been investigated – event-based prospective memory tasks (i.e., remembering to perform a delayed intention when a specific event occurs, e.g., an alarm clock rings) and time-based prospective memory tasks (i.e., remembering to perform a delayed intention at a specific time, e.g., at 4 p.m.). Despite the relatively few studies, the available literature on prospective memory in children shows improvement in prospective memory performance across the age range from 2 to 12 years. Event-based prospective memory is evident in preschool children (Guarjardo & Best, 2000; Somerville, Wellman, & Cultice, 1983) and continues to develop as children become increasingly skilled at using external reminders to cue prospective remembering (Beal, 1988; Meacham & Colombo, 1980). Time-based prospective memory has been shown to develop between 7 and 12 years of age, as children become increasingly proficient at applying time-checking strategies (Ceci, Baker, & Bronfenbrenner, 1988; Kerns, 2000).

However, of particular relevance to the present study is Einstein, McDaniel, Manzi, Cochran, and Baker's (2000) claim that all of the tasks used in prospective memory research conducted up to the time of their writing may have failed to capture one crucial aspect of prospective memory in everyday life. In the paradigms used, the intended action always had to be executed immediately after encountering the appropriate target event or target time. (Einstein et al. labeled this paradigm *retrieve-execute* prospective memory.) Yet, as Einstein et al. pointed out, in many real-world situations, intentions that have been retrieved after the initial delay between the intention formation and the appropriate moment (be it a specific time or a specific event) often cannot be performed immediately but must be additionally delayed and thus maintained in working memory until there is an appropriate opportunity to perform them. (Einstein et al. named this task *delay-execute* prospective memory.) For example, a child is given a note by a parent and asked to give it to his or her teacher. The child remembers the task upon first seeing the teacher but is unable to give the note immediately and must wait until the teacher finishes a conversation with another child. To capture this task structure, Einstein et al. suggested a delay-execute paradigm that simulates this real-world situation by not allowing a delayed intention to be carried out on the initial retrieval of the intention. For this purpose, they created an *additional* delay, requiring the execution of the intention to occur in response to an additional cue. This additional delay was relatively short, for example, either 10 s, 30 s or 39 s. Studies examining this *delay-execute* prospective memory task in adults consistently showed that delaying the execution of an intended action requires a high amount of working memory capacity and efficient executive processes, especially divided attention, task switching and inhibition. Consequently, it has been predicted that individuals with limited working memory capacity and reduced executive functioning should have severe difficulties with this simulated real-world prospective memory task. This prediction has been confirmed in older adults, where the additional delaying of an intention to a subsequent critical moment has been shown to have a strong negative effect on prospective memory performance, even for a delay as short as a few seconds (Einstein et al., 2000; Einstein, McDaniel, Williford, Pagan, & Dismukes, 2003; Kliegel & Jäger, 2006; McDaniel, Einstein, Graham, & Rall, 2004; McDaniel, Einstein, Stout, & Morgan, 2003).

To the best of our knowledge, this task paradigm has not been studied in children and it was thus the aim of the present study to fill this gap. In two experiments, we explored three main questions: (1) Do children show similar detrimental effects of introducing an additional delay after initial retrieval of the intended action, as has been found in older adults? (2) Are children as young as preschoolers at