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Executive functioning and prospective memory in young children

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ABSTRACT

The current study examined the role of executive functioning (EF) in children's prospective memory (PM) by assessing the effect of delay and number of intentions to-be-remembered on PM, as well as relations between PM and EF. Ninety-six 4-, 5-, and 6-year-olds completed a PM task and two executive function tasks. The PM task required children to interrupt an ongoing card game to perform one action (single intention) or two actions (dual intention) with target cards after a short delay (1 min) or a long delay (5 min). There was no main effect of number of intentions or delay on the PM task. However, performance improved with age, and age and delay interacted such that 4-year-olds' performance remained the same after a long delay whereas 5-year-olds' performance improved after a long delay. We suggest that the age by delay interaction is a product of age differences in cognitive monitoring. Working memory but not inhibitory control predicted PM with age controlled. We argue that an executive function framework permits an integrative understanding of many processes involved in young children's prospective memory.

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Young children often need to remember to carry out an action at some point in the future, whether it is more or less immediately, as in putting the juice back into the refrigerator after pouring a drink, or at some later point in time, as in bringing a jacket to school. Actions such as these depend on successful prospective memory (PM), the ability to remember to perform intended activities (Kliegel & Jäger, 2007). Einstein and McDaniel (1990) described two distinct types of prospective memory: *time-based* prospective memory, where one must remember to perform an action at a certain point in

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time or after a certain amount of time has elapsed, and *event-based* prospective memory, where one must remember to perform an action when a specific event occurs.

The development of PM follows an inverted U-shape function from childhood to old age, with young and middle aged adults having peak PM (Kliegel, Mackinlay, & Jäger, 2008; Zimmermann & Meier, 2006). Much attention has been paid to this ability in older adults because declining PM compromises the ability to function independently (Einstein & McDaniel, 1990). The literature on PM during childhood is small compared to the literature on PM in older adults and also to the vast literature on children's retrospective memory (RM) (e.g., Farrar & Goodman, 1992; Peterson, 2002). Moreover, most developmental studies of PM have focused on school-aged children (e.g., Ceci & Bronfenbrenner, 1985; Kerns, 2000; Mackinlay, Kliegel, & Mäntylä, 2009; Martin & Kliegel, 2003). What research there is in early childhood has focused on event-based PM because of limited time reading abilities in children of this age.

Forgetfulness in young children might not be viewed as a serious problem because of the scaffolding presence of caregivers. However, once children enter preschool, they are increasingly asked to remember to do things. Parents, teachers, and memory aids such as reminder letters facilitate this remembering, but increasingly the burden of prospective remembering shifts to children as they develop, with important implications for academic functioning and interpersonal relations (McCauley & Levin, 2004).

1. An executive function framework for PM

Domain-general cognitive abilities likely have an impact on children's PM. One such ability, executive functioning (EF), has been argued to play a particularly important role in the development of PM (Atance & Jackson, 2009; Kvavilashvili, Messer, & Ebdon, 2001; Mackinlay et al., 2009; Rendell, Vella, Kliegel, & Terrett, 2009; Wang, Kliegel, Liu, & Yang, 2008; Ward, Shum, McKinlay, Baker-Tweney, & Wallace, 2005; West, 1996). EF, the conscious control of thought and action, develops rapidly in early childhood (Zelazo, Carlson, & Kesek, 2008), and various components of EF including planning, monitoring, working memory, and inhibitory control have all been suggested as important for successful PM (Marsh & Hicks, 1998; West & Craik, 1999). PM has both a retrospective and prospective component (Brandimonte, 1991). For example, remembering the content of the intention relies on retrospective memory whereas remembering to perform the action at the appropriate time relies on a prospective component. Executive processes may be especially involved in the prospective component of PM (Burgess, 2000).

Two influential models of PM that implicate EF are the preparatory attentional and memory processes (PAM) model and the multiprocess model. In the PAM model, controlled processes that are working prior to the presentation of cues to the prospective action are necessary components of successful event-based prospective memory (Smith, 2003; Smith & Bayen, 2004). These controlled processes, referred to as preparatory attentional processes in the PAM model, carry out effortful monitoring of the environment for the appearance of the prospective cue. In the multiprocess model it is argued that PM does not necessarily require effortful strategic processes but that specific PM task attributes determine whether such processes are likely to be engaged (Gynn, McDaniel, & Einstein, 2001; McDaniel, Robinson-Riegler, & Einstein, 1998). For example, McDaniel and Einstein (2000) have suggested that strategic, effortful processes are more likely to occur under conditions where there is: higher perceived task importance, a weaker association between the triggering cue and the action, and a more engaging, attention-demanding ongoing task. These two theories differ in the suggested role of automatic processes but are similar in recognizing the role of controlled processes at least under certain conditions. If such capacity-consuming processes are potentially important in PM as both theories suggest, individual differences in EF may play a role in PM especially during early childhood when the abilities needed to consciously control thoughts and actions are still developing (Zelazo et al., 2008).

A typical event-based PM task involves a prospective action (e.g., placing a card of a certain type in a box) that must be completed in the future after a specific event occurs. This prospective action typically interrupts an ongoing task (e.g., card sorting) that must be paused and then resumed after the prospective intention has been carried out (Kvavilashvili et al., 2001). Four features of event-based PM tasks that might pose difficulty for children are: (1) the nature of the prospective intention, (2) the

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