Journal of Experimental Child Psychology 127 (2014) 52–64

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

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

The impact of age, ongoing task difficulty, and cue salience on preschoolers' prospective memory performance: The role of executive function

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ARTICLE INFO

Article history:
Available online 7 March 2014

Keywords:
Prospective memory
Cue salience
Ongoing task difficulty
Executive function
Inhibition
Preschoolers

ABSTRACT

The current study examined the impact of age, ongoing task (OT) difficulty, and cue salience on 4- and 5-year-old children's prospective memory (PM) and also explored the relation between individual differences in executive function (working memory, inhibition, and shifting) and PM. OT difficulty and cue salience are predicted to affect the detection of PM cues based on the multiprocess framework, yet neither has been thoroughly investigated in young children. OT difficulty was manipulated by requiring children to sort cards according to the size of pictured items (easy) or by opposite size (difficult), and cue salience was manipulated by placing a red border around half of the target cues (salient) and no border around the other cues (non-salient). The 5-year-olds outperformed the 4-year-olds on the PM task, and salient PM cues resulted in better PM cues compared with non-salient cues. There was no main effect of OT difficulty, and the interaction between cue salience and OT difficulty was not significant. However, a planned comparison revealed that the combination of non-salient cues and a difficult OT resulted in significantly worse PM performance than that in all of the other conditions. Inhibition accounted for significant variance in PM performance for non-salient cues and for marginally significant variance for salient cues. Furthermore, individual differences in inhibition fully mediated the effect of age on PM performance. Results are discussed in the context of

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http://dx.doi.org/10.1016/j.jecp.2014.01.006

the multiprocess framework and with reference to preschoolers' difficulty with the executive demands of dividing attention between the OT and PM task.

Introduction

How does a young boy remember to retrieve his art project from his teacher when he is engaged in a cognitively demanding task such as completing a complex puzzle? This ability to carry out intended activities in the future is defined as prospective memory (PM; Einstein & McDaniel, 1990) and is an essential skill for young children to develop in order to establish independence from their parents and caregivers (e.g., Kvavilashvili, Messer, & Ebdon, 2001; Meacham, 1982). PM develops markedly during early childhood (e.g., Kliegel & Jäger, 2007; Kvavilashvili et al., 2001; Mahy & Moses, 2011; but see Somerville, Wellman, & Cultice, 1983), preparing children for carrying out tasks associated with school entry and allowing them to become increasingly responsible for fulfilling their intentions without external help. In the current study, we examined some of the factors that might be implicated in these developments within an executive function (EF) framework.

In a typical event-based PM laboratory paradigm, children must carry out an ongoing task (OT) while also remembering to perform a prospective action when they encounter a specific cue embedded within the OT (see Kvavilashvili et al., 2001). For successful PM, a child must appropriately divide attention between performing the OT and detecting the PM cues. Thus, a young girl who is engrossed in an ongoing activity not only must remember *what* she must do and *when* she must do it but also must disengage attention from the OT in order to detect PM cues (see Maylor, 1996).

Given the need to allocate attention to both the OT and cue detection (and to carrying out the PM task), such PM paradigms can be conceptualized as dual-task procedures that require significant executive resources (e.g., Bisiacchi, Schiff, Ciccola, & Kliegel, 2009; Einstein, McDaniel, Smith, & Shaw, 1998; Ihle, Hering, Mahy, Bisiacchi, & Kliegel, 2013; Smith, 2003). If so, then preschool-aged children in particular may struggle with PM because they are known to struggle with EF more broadly (e.g., Anderson, 2002; Hongwanishkul, Happaney, Lee, & Zelazo, 2005; Jones, Rothbart, & Posner, 2003; Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005; Zelazo, Carlson, & Kesek, 2008; Zelazo, Carter, Reznick, & Frye, 1997). Substantial developmental improvements occur during this period in EFs such as working memory, inhibition, shifting, and planning (e.g., Carlson, 2005). Moreover, studies that use dual-task procedures have documented 3- to 8-year-old children's difficulty in allocating executive resources to two tasks simultaneously (e.g., Gordon & Olson, 1998; Halford, Maybery, & Bain, 1986; Irwin-Chase & Burns, 2000). Because PM paradigms involve dual tasks (PM and OT), executive abilities could play an important role in PM in young children and should be associated with age-related improvement in PM. The current study set out to test this hypothesis, extending previous work on PM in young children suggesting a role for EF in the development of PM (Ford, Driscoll, Shum, & Macaulay, 2012; Mahy & Moses, 2011).

Taking a task analysis approach, dividing resources between the OT and PM task requires inhibition to pull attention away from the one task, set shifting to switch flexibly between the two tasks, and working memory to keep in mind the rules for each of the tasks. Thus, EFs such as working memory, inhibition, and shifting are candidate developmental mechanisms of PM. Conceptual support for this task analysis comes from the multiprocess framework of PM (Einstein & McDaniel, 2005; McDaniel & Einstein, 2000). This framework suggests that both controlled and automatic processes can contribute to PM and that controlled, executive processes are more likely to be required under cognitively demanding conditions. The multiprocess framework suggests that characteristics of the ongoing task and the PM cue affect whether such controlled processes are necessary for PM retrieval (McDaniel & Einstein, 2000). For example, controlled processes may be necessary for PM in the context of a demanding OT but may be less critical in the context of an easy OT. Working memory and inhibition