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Event-based prospective memory across the lifespan: Do all age groups benefit from salient prospective memory cues?

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ABSTRACT

The present study investigated effects of cognitive control demands on prospective memory (PM) performance across the lifespan. Four different age groups (children, adolescents, young adults, old adults) worked on a computer-based picture categorization task as ongoing activity, while PM cue salience was varied within-subjects. Results revealed significant main effects of age group and salience. The children group was outperformed by all other age groups, while those groups' PM performance did not differ significantly. Except for old adults, all age groups benefited from the presentation of salient PM cues. Further, age group and salience interacted significantly, indicating that the children group benefited most from the presentation of salient PM cues, while surprisingly the oldest group showed better results when PM cues were low-salient. Thus, results suggest that cognitive control demands differentially impact children's and old adults' PM and that different mechanisms seem to underlie PM development at both ends of the lifespan.

1. Introduction

Remembering to pass by the dry cleaning to pick up a dress on the way home or to attend a meeting in the afternoon are typical examples of everyday prospective memory (PM) tasks. In contrast to retrospective memory, which describes the memory for past events, PM represents the memory for future intentions and is defined as the ability to initiate and implement an intended action at an appropriate future time-point (time-based PM) or when a certain event is presented (event-based PM; e.g., Brandimonte, Einstein, & McDaniel, 1996). PM is crucial to develop independence across childhood and adolescence, and is essential to maintain an independent life in old age (e.g., Kliegel, Jäger, Altgassen, & Shum, 2008a; Kvavilashvili, Kyle, & Messer, 2008). Various studies investigated factors that influence successful prospective remembering and found cognitive control functions to be important correlates (e.g., Kliegel, Martin, McDaniel, & Einstein, 2002; Marsh & Hicks, 1998). Cognitive control refers to the ability of flexibly adapting one's own behavior to current task demands or internal goals (e.g., Botvinick, Braver, Barch, Carter, & Cohen, 2001). Typical examples of cognitive control functions are inhibition, updating and task switching (e.g., Miyake et al., 2000). Relations between cognitive control functions and PM have been found in a large number of correlative studies in different age groups (children: e.g., Atance & Jackson, 2009; Shum, Cross, Ford, & Ownsworth, 2008; adolescents: e.g., Ward, Shum, McKinlay, Baker-Tweney, & Wallace, 2005; older adults: e.g., Schnitzspahn, Stahl, Zeintl, Kaller, & Kliegel, 2013). For instance, Shum et al. (2008) found working memory,

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inhibition, switching and verbal fluency to significantly predict PM in children. Ford, Driscoll, Shum, and Macaulay (2012) reported inhibition, but not working memory to significantly impact PM in children aged 4–6 years, whereas Mahy and Moses (2011) found the reversed pattern in a sample of the same age groups. Also studies focusing on the other end of the lifespan found cognitive control functions to correlate with PM performance and to serve as significant predictors in regression analyses. For instance, Schnitzspahn et al. (2013) reported inhibition and switching, but not updating/working memory to be significant predictors of PM in older adults. Thus, while there is ample evidence that cognitive control functions are needed for prospective remembering, the extent to which specific functions are involved may depend on the respective task demands and the cognitive characteristics of the target population (Kliegel, Altgassen, Hering, & Rose, 2011).

1.1. Framework to address influences of cognitive control on PM

An influential theoretical model that systematically describes the role of cognitive control resources (and cognitive control demands) for event-based PM performance is the multiprocess framework by McDaniel and Einstein (2000). According to this model, the involvement of cognitive control functions in event-based prospective remembering depends on various factors such as characteristics of the PM and the ongoing task (e.g., focality of PM cues, difficulty of the ongoing task), the quality of intention formation (e.g., planning) and personal variables (e.g., personality traits, reduced cognitive resources). Thus, PM tasks can be initiated rather automatically (e.g., when PM cues are focal to the ongoing task and PM cue features are automatically processed while working on the ongoing task) or retrieval of the intended action may depend more on resource-demanding cognitive control functions (e.g., when non-focal PM cues are presented and processing of PM cue features is not involved in the ongoing task; here more monitoring for the PM cue is needed). Another factor that impacts PM performance is the salience of the PM cue relative to items of the ongoing task (McDaniel & Einstein, 2000). In previous PM studies salience has mostly been manipulated in terms of perceptual distinctiveness of the cue (e.g., Cohen, West, & Craik, 2001; Einstein, McDaniel, Manzi, Cochran, & Baker, 2000). According to the multiprocess framework highly salient PM cues require less cognitive control resources to be detected, as the delayed intention "pops into mind" due to the PM cue being distinct and standing out from ongoing task items. In contrast, low-salient PM cues blend in with ongoing task items and require more monitoring to be detected.

1.2. PM development and influences of cognitive control across the lifespan

Previous research tested the predictions of the multiprocess framework in various age groups. However, in contrast to the number of studies employing correlational designs, only few studies experimentally varied cognitive control demands of PM tasks. This was mainly done in older adults (e.g., D'Ydewalle, Bouckaert, & Brunfaut, 2001; Kidder, Park, Hertzog, & Morrell, 1997; Martin & Schumann-Hengsteler, 2001), while research in younger age groups only recently started to systematically manipulate the extent to which cognitive control resources are needed for PM task performance (preschoolers: Mahy, Moses, & Kliegel, 2014b; school-aged children: Kliegel et al., 2013; adolescents: Wang et al., 2011; Ward et al., 2005).

Even though the vast majority of studies point to an increase of PM across childhood (e.g., Guajardo & Best, 2000; Kliegel et al., 2013; Kvavilashvili, Messer, & Ebdon, 2001; Mahy & Moses, 2011; Shum et al., 2008; Wang, Kliegel, Liu, & Yang, 2008; Yang, Chan, & Shum, 2011; for a review see Mahy, Moses, & Kliegel, 2014a) until adolescence (e.g., Ward et al., 2005), the specific pattern of results seems to depend on certain task characteristics. For instance, Kliegel et al. (2013) compared 6- and 7-year-old with 9- and 10-year-old children and found ongoing task absorption, PM cue salience and the location of the PM cue (i.e., whether the PM cue appeared in the focus of attention or not) to affect age differences. In both age groups PM performance was found to be improved when the PM task was embedded in a less absorbing ongoing task and when PM cues were presented perceptually salient compared to ongoing task items. Importantly, when varying the location of the PM cue, age differences only appeared when the cue was presented outside of the center of attention. The authors explained this pattern with higher cognitive control resources (e.g., monitoring for the cue) needed to detect the PM cue in the latter condition. Ward et al. (2005) manipulated stimulus presentation times of ongoing task items, and with this varied the extent to which cognitive resources were available to perform the PM task. In the high-demanding condition stimuli were presented for 600 ms, in the low-demanding condition for 850 ms. Age differences in PM performance between children (7- to 10-year-olds), adolescents (13- to 16-year-olds) and young adults (18- to 21-year-olds) were more pronounced in the highly demanding condition. In general, studies point to an increase of event-based PM across childhood, but also show inconsistencies in this development, which might be due to differences in cognitive control demands of the specific PM tasks being used. In line with predictions of the multiprocess framework, age differences seem to be more pronounced in tasks requiring more cognitive control resources for successful prospective remembering as compared to tasks with low cognitive control requirements. These findings are in line with ample empirical evidence showing an increase of cognitive control functions across childhood (e.g., Huizinga, Dolan, & van der Molen, 2006; Lehto, Juujärvi, Kooistra, & Pulkkinen, 2003). Continuing in development, research shows that PM seems to increase throughout adolescence to young adulthood. Wang, Kliegel, Yang, and Liu (2006) compared 13- with 22-year-olds in their event-based PM performance and found young adults to perform significantly better than adolescents. Consistently, Altgassen, Vetter, Phillips, Akgün, and Kliegel (2014) reported significant age effects in PM when comparing adolescents with adults, and found switching to significantly predict adolescents' PM performance. However, not all studies found this pattern of increasing PM across adolescence. For instance, Ward et al. (2005) only found children to differ from adolescents and young adults, while there were no differences between