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The cognitive cost of event-based prospective memory in children

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ABSTRACT

Prospective memory is the act of remembering to perform an action in the future, often after the presentation of a cue. However, processes involved in remembering the future intention might hinder performance on activities leading up to and surrounding the event in which an intention must be carried out. The current study was designed to assess whether young children who were asked to engage in prospective memory do so at a cost to current cognitive processing. Participants (4-, 5-, and 6-year-olds) either performed a simple ongoing selection task only (control condition) or performed the selection task with an embedded prospective memory task (experimental condition). Results revealed that children in the experimental condition were slower in the execution of the ongoing task relative to children in the control condition, lending support to the theory that children as young as 4 years selectively allocate resources in an effort to succeed in multiple tasks.

Introduction

Prospective memory refers to the process of remembering to perform an action in the future (Kvavilashvili, 1992). This is a common challenge in our everyday lives because we are constantly planning events and need to act on them at the appropriate times. Although there has been some focus on time-based prospective memory that requires an action to occur after a specified amount of time has elapsed (e.g., Hicks, Marsh, & Cook, 2005; Park, Hertzog, Kidder, Morrell, & Mayhorn, 1997), the

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current investigation focused on event-based prospective memory that requires an intention to be carried out when a stimulus or cue is presented in the environment (McDaniel & Einstein, 2000). To mimic the real-life situation of needing to remember to perform an action in the future in the midst of performing other activities, most laboratory tasks require performance of an "ongoing task" that is interrupted to perform the prospective act (e.g., Kliegel, Mackinlay, & Jäger, 2008).

According to a number of event-based prospective memory frameworks, representations of both the cuing event and the intended action are made when forming a delayed intention (Einstein & McDaniel, 1996; Guynn, McDaniel, & Einstein, 1998). Based on their multiprocess framework, McDaniel and Einstein (2000) proposed that prospective memory retrieval can be automatic or effortful. The automatic processes can be driven either by an exogenous attentional system or by automatic memory processes. In contrast, the effortful processes rely on strategy selection and executive attention. Furthermore, McDaniel and Einstein argued that when retrieval is automatic, event-based prospective memory requires attentional processes when the cue is presented but not throughout the ongoing task (see also Gollwitzer, 1999).

One method that has been used to determine whether there is effortful (as opposed to automatic) processing associated with executing a prospective memory intention is to measure the costs to the ongoing task. Assessing ongoing task performance is important because it speaks directly to the debate of whether prospective memory can ever truly be automatic in the sense that it does not place a burden on other cognitive resources. There is evidence in adult populations that ongoing task performance suffers when a secondary prospective memory task is incorporated (e.g., Anderson, Craik, & Naveh-Benjamin, 1998; Craik, Govoni, Naveh-Benjamin, & Anderson, 1996; Park et al., 1997; Smith, 2003; Smith, Hunt, McVay, & McConnell, 2007). For example, Park and colleagues (1997) looked at performance on the ongoing task in a study where younger and older adults performed both time-based and event-based prospective memory tasks. In the ongoing task of Experiment 1, participants were shown words against a patterned background and were told to monitor continuously so that they could remember the last three words. Throughout the task, when participants saw the word "RECALL," they were to say aloud the last three words they saw. The event-based prospective memory task was that participants would press the "0" key when a specific pattern appeared as the background (e.g., plaid). In Experiment 2, participants were given the same ongoing working memory task but were instead given a time-based prospective memory task to perform (e.g., to pull a lever every 1–2 min). The findings suggested that both event-based and time-based prospective memory required allocation of cognitive resources, which posed a cost to the ongoing task, although the cost seemed to be more pronounced for event-based prospective memory. The authors speculated that event-based prospective memory may require continuous attention, whereas time-based prospective memory requires a central executive component to disengage from the ongoing task in a timely manner.

Smith (2003) also challenged the assumption that event-based prospective memory does not require cognitive resources during the ongoing task. Adult participants were given two blocks of a lexical decision task in which they were shown a string of letters and asked to determine whether the string was a word. Participants in the experimental condition performed the second block with the additional requirement of an event-based prospective memory task. Specifically, these participants were given a list of six words to memorize and were instructed to press the space bar when any of these words appeared. Participants in the control group were given the prospective memory instructions but were told that they would not need to follow those instructions for the current task. Smith found that participants in the control condition had shorter response latencies when completing the lexical decision task in the second block, which was attributed to practice effects. In contrast, participants in the experimental condition had longer response latencies in the second block, suggesting that prospective memory requires an allocation of resources that hinders performance on the ongoing task. Smith suggested that the allocation of resources when performing an event-based prospective memory task occurs because one is engaging in *preparatory attentional processes* that serve to maintain the goal over time.

The preparatory attentional and memory processes (PAM) theory contends that these attentional processes are not automatic (Smith, 2003; Smith & Bayen, 2005; Smith et al., 2007) but may be outside conscious awareness. In other words, an individual must maintain a state of readiness during the ongoing task, and individuals must monitor the ongoing task for the cues related to the prospective memory task to retrieve the intention successfully and perform the action (Einstein & McDaniel, 2005; Smith, 2003). Because individuals must monitor the ongoing task for the prospective memory cue, their performance on the ongoing task should suffer. In fact, Smith, Bayen, and Martin (2010) conducted their task with older children (7- and 10-year-olds) as well as young adults and found that the prospective memory demands elicited a cost on the ongoing task for all three age groups, providing evidence that ongoing task costs can occur in children as young as 7 years.

Interestingly, Smith and Bayen (2005) found that working memory capacity (WMC) predicts the extent to which one is engaged in preparatory attentional processes. The authors used a counting span task to measure WMC and then gave participants a sentence verification task with an embedded prospective memory task. In the sentence verification task, participants were instructed to indicate whether a statement was true. The embedded prospective memory task required participants to press the F1 key when they saw any of four specific words. Smith and Bayen found that participants with higher span scores were more likely than those with low span scores to exhibit greater costs to the ongoing task, which the authors interpreted as engaging in preparatory attentional processes. Furthermore, they found that retrospective memory performance that underlies prospective memory performance, measured by recalling the prospective memory targets at the end of the task, was not affected by span performance. Smith and Bayen suggested that the counting span measure actually taps into one's ability to divide attention and control attentional processes. Therefore, the ability to engage in preparatory attentional processes successfully and complete a prospective memory task may be accounted for by individuals' ability to allocate attention. Certainly, this finding may be considered counterintuitive from the perspective that those with greater WMC would be less impaired because they have a greater number of cognitive resources. However, it seems that individuals who have greater WMC allocate resources selectively at the time of encoding.

There is disagreement about the extent to which these preparatory attentional processes are involved in successful execution of a prospective memory task. The multiprocess framework (McDaniel & Einstein, 2000) proposes that under certain circumstances prospective memory should be automatic, posing no cost to the ongoing task. These conditions include when (a) the action associated with the intention is simple, (b) the action and target are sufficiently encoded in relation to each other, (c) the ongoing task requires that one process the relevant dimension of the target, and (d) the target is salient. To test whether salience of the target event decreased the cost to the prospective memory to the ongoing task, Smith and colleagues (2007) employed the same design as the Smith (2003) study; however, targets that were perceptually or personally salient to individuals were used. Throughout four experiments, Smith and colleagues (2007) demonstrated that salient events, such as recognizing one's own name, still slowed performance on the ongoing task compared with participants who were not given the prospective memory intentions. Smith and colleagues interpreted these findings as evidence against the multiprocess framework, which suggests that under certain conditions prospective memory intentions are automatic rather than effortful.

It is important to note that a number of studies with adult populations demonstrated that prospective memory can be successful without evidence of monitoring (Harrison & Einstein, 2010; Knight et al., 2011; Scullin, McDaniel, & Einstein, 2010; Scullin, McDaniel, Shelton, & Lee, 2010). This provides compelling evidence that, at least in adult populations, it is possible to have contexts where there are no costs to the ongoing task, which is inconsistent with the PAM theory (although arguments can be made that there is monitoring, but it is not captured by costs to the ongoing task). Even when costs to the ongoing task are found, Einstein and McDaniel (2010) argued that these might not necessarily be due to preparatory attentional processes but perhaps may reflect components of spontaneous retrieval that are not automatic (e.g., the reflexive associative process). Thus, retrieval costs, when they occur, may reflect effortful processing but cannot distinguish the multiprocess framework from the necessity to have preparatory attentional processes. In her reply to their commentary, Smith (2010) acknowledged the difficulty in distinguishing preparatory attentional processes from the reflexive associative process or other effortful retrieval strategies.

Although the differing theoretical perspectives of the multiprocess and PAM frameworks have inspired a rich body of research on ongoing task costs, it is clear that the presence or absence of these costs cannot be used to distinguish between the two theories. In fact, Hicks and colleagues (2005) suggested that interference on the ongoing task is an outcome of an allocation of resources to each task based on participants' prediction of how to complete both tasks successfully. According to this view, participants assess the difficulty in completing both tasks, and if they predict that it will be challenging to perform both tasks optimally, they might deemphasize one task by allocating resources toward the maintenance of the other task. This would explain why in some contexts there appears to be no decrement to performance on the ongoing task, whereas in other contexts the ongoing task is performed at a slower rate.

Cognitive costs in preschool-aged children

As with the adult literature, the majority of work with preschoolers and young children in prospective memory does not focus on ongoing task performance. In some cases, age differences in ongoing task performance have promoted using ongoing task performance as a covariate (Kvavilashvili, Kyle, & Messer, 2008). For example, Kliegel and Jäger (2007) investigated prospective memory in preschoolers ranging from 2 to 6 years of age. In the ongoing task, children were shown 10 cards of common objects and were asked to name each object, whereas the prospective memory instructions were to place the apple card in a box located behind them. The ongoing task was conducted three times, with the prospective target occurring on the eighth trial in the first block, the sixth trial in the second block, and the ninth trial in the third block. In the memory aid condition, an actual apple was placed on the table as a reminder. In the no memory aid condition, children did not receive a reminder. Kliegel and Jäger found age differences in the ongoing task performance and used it as a covariate in the analyses, which revealed that 4-, 5-, and 6-year-olds performed significantly better than 3-year-olds, who were significantly better than 2-year-olds. There was a main effect of memory aid but no interaction between age and the memory aid conditions (cf. Guajardo & Best, 2000). The 2-year-olds did not display significant levels of prospective memory, even for participants who were successful on the retrospective memory task.

One factor that is likely to be linked with successful prospective memory and its associated cognitive costs is the ability to maintain a goal over a period of time. There is evidence that goal maintenance increases between 4 and 6 years of age and that the skill is directly related to working memory capacity (Marcovitch, Boseovski, & Knapp, 2007; Marcovitch, Boseovski, Knapp, & Kane, 2010) and task switching ability (Towse, Lewis, & Knowles, 2007). According to Marcovitch and colleagues (2010), keeping a goal in mind is resource intensive, as evidenced by its positive association with WMC, and thus it is predicted that ongoing tasks may be compromised when 4- to 6-year-olds experience contexts that encourage goal maintenance.

The potential role of WMC in ongoing task costs (see also Smith & Bayen, 2005) renders it worthwhile to briefly review how developmental changes in working memory (and executive function more generally) affect prospective memory ability. The performance of 3-year-olds on prospective memory tasks increases significantly when the target item is presented as the last item (Kvavilashvili, Messer, & Ebdon, 2001; Wang, Kliegel, Liu, & Yang, 2008). In fact, Wang and colleagues (2008) argued that when the target item is last, children no longer need to inhibit the ongoing task to execute the prospective memory response (see also Kerns, 2000). Following similar logic, one can argue that cognitive flexibility is required to switch from the cognitive set of the ongoing task to the new demands of the prospective memory task. Both of these executive function skills have been shown to be related to WMC in children (see Carlson, 2005). In fact, it has been argued that these processes are not even separable in 3-year-olds (Wiebe, Espy, & Charak, 2008).

Ford, Driscoll, Shum, and Macaulay (2012) assessed both executive function and theory of mind abilities and how they related to prospective memory performance. They found that their theory of mind battery and inhibition task were significant predictors of prospective memory and that if either was excluded from the final model, WMC emerged as a significant predictor. This speaks to the shared variance of WMC with these other constructs and, more important, may offer alternative explanations as to why WMC has been found to relate to ongoing task costs with adults (e.g., perhaps it is advanced theory of mind or inhibition, neither of which was assessed directly, that accounts for increased costs in Smith & Bayen, 2005).

The current study

Overall, these studies provide mixed evidence for the claim that event-based prospective memory hinders performance on ongoing tasks. Ongoing task costs have been found only in adult populations and for children 7 years of age and older. In preschoolers, the cost of the ongoing task imposed by a prospective memory task has not been explored, and it is the primary focus of our current study. One possibility is that preschool-aged children should actually display a greater cost to the ongoing task because their cognitive capacities are relatively small compared with adults and even 7-year-olds (e.g., Gathercole, Pickering, Ambridge, & Wearing, 2004). From this perspective, however, we would expect that the magnitude of the cost will *decrease* as children get older because increases in working memory and cognitive flexibility should allow for a greater ability to allocate resources optimally between the two tasks. That is to say, whatever resources are needed to keep a goal in mind will not deplete the capacity, and thus sufficient resources will remain to execute the ongoing task efficiently.

A second possibility is that the magnitude of the cost will actually *increase* with age because increases in working memory will increase the possibility that the preschool-aged children will strategically engage their preparatory attentional mechanisms or other effortful strategies related to prospective memory retrieval. This would be consistent with Smith and Bayen's (2005) finding that the magnitude of costs is related to working memory capacity in adults because we expect the magnitude of working memory capacity to increase with age.

A third possibility is that preschool-aged children will show no costs to the ongoing task yet will still be successful in executing the prospective memory task. This could happen if (a) the children are not actively maintaining the prospective memory instruction and (b) the presentation of the prospective stimuli then activates the necessary reminder to perform the task. It is also consistent with the notion that a certain level of WMC is needed to induce processing costs, and even the oldest children in our study might not yet have the WMC to engage in strategic processes that would slow down performance on the ongoing task.

A final possibility is that preschool-aged children will show costs to the ongoing task but no age-related changes to the magnitude of the costs. This would be consistent with the notion that preparatory attentional mechanisms or other effortful strategies are used by children when they are maintaining the prospective memory instructions, but this is relatively independent of their overall cognitive capacity.

To test these hypotheses, 4-, 5-, and 6-year-olds received an age-appropriate analog of Smith's (2003) task. This novel paradigm included a computerized selection task in Phase 1. The selection task served as the ongoing task, requiring participants to select either animal or food pictures. In Phase 2, participants once again received the computerized selection task, but participants in the experimental condition received additional instructions for a prospective memory task that required them to perform a unique action when a special picture appeared. Children in the control condition only performed the ongoing task. Notably, unlike Smith (2003), we did not provide and then have children ignore the additional prospective memory instructions. The potential limitation that this imposes on our findings is addressed in the Discussion section.

In our task, we subtly encouraged children to engage in initiating and maintaining preparatory attentional processes by stressing the importance of the prospective memory task. There was an external reminder to the prospective memory task present on each trial (i.e., a smiley face in the corner of the screen) that was intended to create ideal conditions for succeeding on the prospective memory task because our primary focus was whether young children under these conditions would suffer costs to the ongoing task.

Method

Participants

The final sample consisted of 23 4-year-olds ($M_{\text{age}} = 4.6$ years, $SD = 0.3$; eight girls and 15 boys), 29 5-year-olds ($M_{\text{age}} = 5.5$ years, $SD = 0.3$; 12 girls and 17 boys), and 23 6-year-olds ($M_{\text{age}} = 6.4$ years, *SD* = 0.2; 11 girls and 12 boys) and had the following racial demographics: White (77.3%), Black (14.7%), other (2.7%), and not reported (5.3%). In addition, 52.0% of the sample had a family income

Fig. 1. Stimuli used for the ongoing selection task. Note that half of the participants in each condition saw the stimuli reversed (e.g., whale on the left for Trial 1).

over $60,000, 26.7% were between $40,000 and $60,000, 12.0% were between $20,000 and $40,000, 2.7% were under $20,000, and 6.7% chose not to report income.

Materials

The task was conducted on a Dell Latitude D600 laptop computer with a KeyTec touch screen and programmed with SuperLab Pro. The stimuli consisted of computer images of animals (approximate size: 7 × 7.6 cm), food items (approximate size: 7 × 7.6 cm), and a smiley face (5.1 × 6.4 cm). There were 15 different food items and 15 different animal pictures (see Fig. 1).

Procedure

Training

Children were trained on the selection task. Children were instructed to touch pictures from one category (food items or animals counterbalanced across children). Children were then asked what type of pictures they should touch and were reminded until the question was answered correctly. This was followed by three practice trials.

Phase 1

In Phase 1, each child completed 15 trials presented in a fixed order across all children (see Fig. 1). For all trials, a smiley face icon was positioned above the midpoint of the two stimuli pictures (see Fig. 2).

Phase 2

Participants in each age group were randomly assigned to either the experimental condition (i.e., prospective memory) or the control condition. Children in the experimental condition were instructed that they would be playing the selection game again, but this time they were also told that when they saw a special picture (i.e., duck for the animal category or apple for the food category) they should not touch the picture but instead should touch the smiley face at the top of the screen. Children were then shown the duck or apple screen, and the experimenter touched the smiley face to demonstrate the action that children should perform. Children were also told that it was very important that they remember to press the smiley face when they saw the special picture because they would see it only once. They were then asked how many times they would see the special picture and were corrected by the experimenter if the question was answered incorrectly. Children in the control condition were told

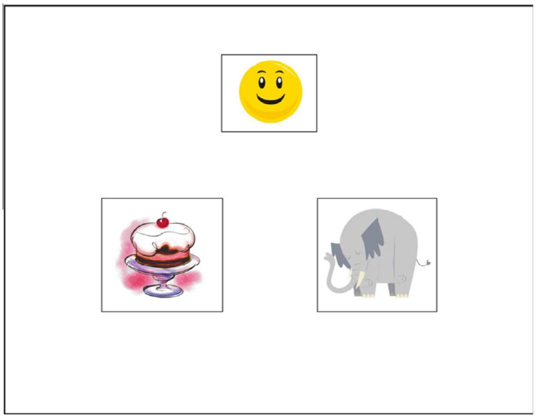

Fig. 2. Sample trial screen.

only that they would continue to play the selection game and were reminded of the instructions from Phase 1. All children then received the same 15 trials in the same order as in Phase 1. Note that the apple or duck screen appeared on the 12th trial (see Fig. 1). Finally, our pilot testing revealed that most children remember to execute the prospective memory task (and this was borne out in the experiment; see below). For this reason, we decided not to probe children as to whether they remembered the prospective memory instructions.

Results

For all analysis, the level of significance was set to .05, and p values between .05 and .10 were identified as marginal effects.

Performance on prospective memory task

In general, children performed very well on the prospective memory task: nine of 13 (69%) 4-year-olds, 11 of 13 (85%) 5-year-olds, and 12 of 12 (100%) 6-year-olds correctly pressed the smiley face on the prospective memory trial. As confirmed by the Cochran–Armitage test for trend, children performed better with age ($z = 2.11$, $p = .035$).

Accuracy on ongoing task

In this analysis, the prospective memory trial was excluded because executing the prospective memory task would affect performance on the ongoing task (Smith, 2003). Thus, accuracy scores were calculated as proportion correct out of the remaining 14 trials: across both conditions, 4-year-olds (91% on Phase 1, 87% on Phase 2), 5-year-olds (98% on Phase 1, 99% on Phase 2), and 6-year-olds (99% on Phase 1, 99% on Phase 2).

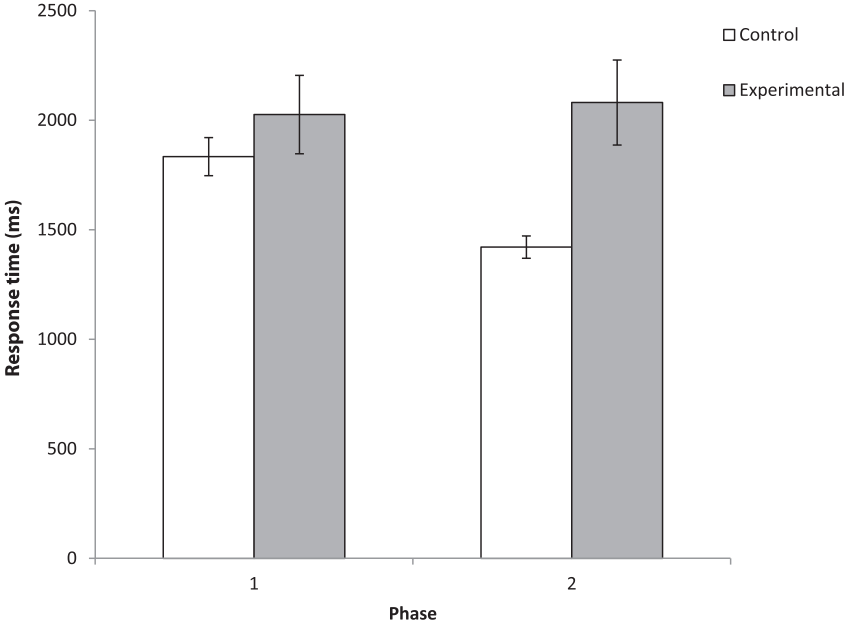

Fig. 3. Mean response times (and standard errors) on ongoing task by condition and phase.

Response times on ongoing task

The relatively high accuracy scores were expected because this was not considered to be a difficult task for children in this age range. For this reason, we focused our efforts on measuring efficiency in the execution of the ongoing task via response times. Analyses were conducted using only response times on correct trials because other processes are thought to be involved in incorrect trials that might slow down response times (cf. Smith & Bayen, 2005). Furthermore, trials immediately following the prospective trial tend to be slower because participants have heightened awareness of the task. Thus, we analyzed the average response times across the first 11 trials (i.e., all trials prior to the prospective memory trials), which were submitted to a 3 × 2 × 2 (Age × Condition × Phase) mixed analysis of variance (ANOVA), where phase was a within-participants variable. Not surprisingly, there was a main effect of age, $F(2,69) = 9.591$, $p < .001$. A post hoc LSD (least significant difference) test at the .05 level revealed that 4-year-olds were significantly slower on ongoing task trials than 5- and 6-year-olds. There was also a main effect of condition, $F(1,69) = 7.816$, $p = .007$. There was no main effect of phase, $F(1,69) = 2.195$, $p = .143$, but phase did interact marginally with condition, $F(1,69) = 3.673$, $p = .059$, indicating that children were significantly slower in Phase 2 in the experimental condition compared with the control condition, $t(73) = 3.178$, $p = .002$, whereas this difference was not apparent in Phase 1 ($t < 1$) (see Fig. 3).

The three-way interaction among age, phase, and condition was not significant ($F < 1$), indicating that the Phase × Condition interaction did not change with age. The a priori importance of this developmental question prompted us to probe further into this null effect. The effect size was small (Cohen's $f = .16$), and a much larger sample size ($N = 402$) would likely have been needed to reveal a significant effect. Thus, we are fairly confident that the Phase × Condition interaction does not differ with age.

Discussion

The development of prospective memory skills is an exciting and important area of inquiry because it speaks directly to emerging cognitive skills necessary for performing day-to-day actions. In adult populations, there is often a cost to ongoing task performance when prospective memory instructions are incorporated into the task (Smith, 2003), providing compelling evidence that prospective memory is effortful and resource demanding, at least in laboratory tasks. Studying the costs of prospective memory in 4- to 6-year-olds can be insightful. On the one hand, young children should be prone to similar (or perhaps greater) levels of interference as adults on the ongoing task when required to incorporate the prospective memory task. On the other hand, young children might not yet possess the working memory capacity needed to keep the prospective instructions in mind (Smith & Bayen, 2005), leading to unperturbed performance on the ongoing task.

The current study was designed to be an age-appropriate analog of the Smith (2003) paradigm, where 4-, 5-, and 6-year-olds would select items according to one category but needed to interrupt the ongoing task when shown the target item. At all ages, children in the control condition were faster in Phase 2 than in Phase 1, presumably due to practice and increased familiarity with the task that was identical across the two phases. In contrast, children in the experimental condition did not get faster in Phase 2 after they were given the prospective memory instructions, supporting Smith's claim that prospective memory impairs ongoing task performance. Importantly, using a task with dramatically different stimuli and response demands, we extended the finding of ongoing tasks costs to preschoolers. Furthermore, these results challenge Einstein and McDaniel's (1996) claim that a cost should be demonstrated only at the moment when the prospective memory cue (i.e., duck or apple) occurs and not throughout the ongoing task. Notably, however, the results are consistent with Einstein and McDaniel's (2010) argument that nonautomatic processes might be involved in spontaneous retrieval.

Children as young as 4 years did not benefit from practice effects when holding the prospective memory instructions in mind. Smith (2003; see also Smith et al., 2007) also found that adults holding prospective memory instructions in mind do not benefit from practice effects. This set of findings strongly suggests that by 4 years of age, children begin to engage in preparatory attentional processes or other effortful strategies in the same manner as adults, monitoring for the ongoing cue, resulting in a slight detriment to their ongoing task performance.

Our findings call into question the importance of WMC in the ability for young children to engage in preparatory attentional processes. We already know that WMC is related to the ability to carry out the prospective memory task in young children (Ford et al., 2012; Mahy & Moses, 2011; Yang, Chan, & Shum, 2011), but it is unclear what role it would play in the engagement of preparatory attentional processes. We hypothesized that if WMC played a role in the processing cost as has been reported in adults (Smith et al., 2007), young children whose WMC is compromised compared with that of adults should not show the processing costs; if they did, there should be age-related effects (i.e., older children showing more processing costs than younger children because older children have higher levels of WMC than older children). No such age-related effects emerged in our study.

It is important to keep in mind that there are a number of alternative reasons why this age-related effect was not found. Because the older children were performing at ceiling on the prospective memory task, they might not have needed to divert resources from the ongoing task, even though they were more than capable of doing so (Hicks et al., 2005). In addition, our age-appropriate version of the ongoing task is considerably simpler than the reading and judgment tasks used with adults. Furthermore, the children needed to remember only one cue, whereas adults typically remember many cues (e.g., six cues; Smith, 2003). These differences in methodology with the children might minimize the importance of WMC because the ongoing task was simpler to execute. Finally, we also cannot rule out the possibility that individual differences in WMC do account for performance variability because we did not assess WMC in this study.

It is worthwhile to speculate what the cost on the ongoing task may represent in young children.[1] One possibility is that young children can allocate their resources strategically and deliberately withhold effort from the ongoing task so as to free up resources that allow them to focus on the prospective memory instruction. Another possibility is that the cost is not a consequence of holding the prospective memory instruction in mind but rather is due to monitoring strategically on each trial whether it was appropriate to execute the alternative response. A third possibility is that the cost is due to the smiley face, which shifts from an unimportant background feature to become a constant physical reminder of the prospective memory instruction in Phase 2. Perhaps the visually appealing and now important smiley face elicits a distraction away from the ongoing task.

Limitations

There were a number of limitations in the current research. The prospective memory instructions did emphasize that it was very important to remember to press the smiley face, which may have increased the ongoing task costs compared with a situation where there was no emphasis on the importance of the task (and perhaps the implied emphasis that one task is more important than the other).

In addition, children in the control condition did not receive instructions for the prospective memory task. Therefore, the differences examined between the control and prospective memory conditions might have been due to the additional instructions about the prospective memory task rather than the intention to perform the task. However, evidence with adult populations suggests that the cost to the ongoing task is not due to participants receiving the instructions (Smith et al., 2007). The cost was demonstrated only when adult participants were given the instructions and told to carry out the prospective memory task. This still needs to be demonstrated with children to rule it out as a possible alternative interpretation.

Conclusions

The current study was designed to assess whether prospective memory in children imposes a cost to ongoing activities. Like adults, children 4 years of age and older demonstrate a cost to the ongoing

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[1] We thank Gil Einstein for suggesting different alternatives to what the cost represents in young children.

task. These findings add to a growing body of research on prospective memory in children and serve as a starting point to further research the potential sources and developmental implications of these costs.

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