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Do verbal reminders improve preschoolers' prospective memory performance? It depends on age and individual differences

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ABSTRACT

Prospective memory (PM) involves both a retrospective memory component (i.e., remembering the content of a future intention) and a prospective component (i.e., detecting the appropriate cue and carrying out that intention). The current study was the first to test the effect of a single verbal reminder on 4- to 6-year-olds' PM performance. Children were randomly assigned to: (1) a reminder about the content of an intention (retrospective memory reminder), (2) a reminder to pay attention (executive reminder), or (3) no reminder to test the predictions of the Executive Framework of PM Development (Mahy et al., 2014b) that posit a key role for executive function in PM development once retrospective memory reaches a sufficient level. Children also completed independent measures of retrospective memory and executive control. We predicted that an executive reminder should help children's PM by increasing cue detection, whereas a retrospective memory reminder should not affect PM because by 4 children should be able to encode and store simple future intentions. Results showed that: (1) PM performance improved with age, (2) age interacted with the reminder condition, and (3) children with better executive functioning had better PM after receiving an executive reminder. These results suggest that age and individual differences play an important role in the impact reminders have on children's PM performance.

1. Introduction

Young children often have difficulty remembering to carry out their future intentions, an ability known as prospective memory (PM; Einstein & McDaniel, 1990). For example, a preschooler might have difficulty remembering to bring an item to show-and-tell the following day. While most children can report the general intention to bring a show-and-tell item to school, the main challenge for preschoolers lies in *acting* on the intention at the appropriate time (such as placing the item in their backpack before leaving for school; Kliegel & Jäger, 2007). Being able to successful act on future intentions has important consequences for children's independence as they develop (see Mahy, Moses, & Kliegel, 2014b). For example, a forgetful child is less likely to be able to function without adults' reminders and input and thus, reliable PM is a critical developmental achievement. Importantly, young children still rely on parents, teachers, and other caregivers to scaffold their PM by providing reminders (see Kliegel & Jäger, 2007; Mahy et al., 2014b; Somerville, Wellman, & Cultice, 1983). Children who are able to take advantage of these reminders to the benefit of their PM might be able to avoid some of the negative consequences associated with forgetting future intentions.

There are two main types of PM: event-based PM involves an intention that must be accomplished after a certain event has occurred (e.g., feeding a pet goldfish after school) whereas time-based PM involves an intention that must be accomplished at a

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particular time or after a certain amount of time has passed (e.g., feeding a pet goldfish at 5 pm or in 20 min). Given young children's difficulty with telling time, most studies with preschoolers have focused on event-based PM, which is also the focus of our current study.

How do we capture young children's event-based PM ability in the laboratory? Typically, an event-based PM paradigm includes: (1) an ongoing task, and (2) a PM task (see Kvavilashvili, Messer, & Ebdon, 2001). First, a child is provided with instructions for an ongoing task such as sorting cards based on their colour or size. Once the child has demonstrated an understanding of the ongoing task rules, they are given instructions about the PM task that needs to be carried out when a specific cue appears (e.g., put specific card into a box). After the ongoing and PM instructions, a delay period is introduced when the child engages in a distractor task. Once this delay period is over, the child begins the ongoing task and has the opportunity to carry out the PM task at the appropriate time. After performing (or forgetting to perform) the PM task, the child is asked a control question to ensure that he or she remembers the task instructions (the retrospective memory component of the PM task).

If the child forgets to perform the PM task at the appropriate time, it is likely for two main reasons: (1) due to a retrospective memory failure (i.e., where the child has forgotten what they were supposed to do when the PM cue appears) or (2) due to a true prospective failure which we suggest are mostly executive failures (i.e., where the child remembers what they were supposed to do, but fails to do so at the appropriate time perhaps because of a failure of attention, inhibition, or working memory; see Mahy et al., 2014b). Typically, PM studies focus on children with true PM failures (where children can remember what they have to do but do not carry out the intention at the appropriate time) rather than those with retrospective memory failures for the intention (who are often excluded from the analyses). Thus, in order to successfully complete a PM task, young children's retrospective memory ability must at least support memory for the content of their intention over a short period of time.

Past research has shown that two thirds of 2-year-old children's PM failures are due to difficulty remembering the content of their future intention (Kliegel & Jäger, 2007). However, by the time children reach the age of 3 or 4, their ability to remember what they have to do greatly improves (e.g., Ford, Driscoll, Shum, & Macaulay, 2012; Guajardo & Best, 2000; Mahy & Moses, 2011). For example, in Mahy and Moses (2001) only 10% of children aged 4 to 6 had difficulty reporting the content of the PM intention. However, despite that the vast majority of children are able to remember the prospective intention, preschoolers still have trouble carrying it out at the appropriate time (e.g., Kvavilashvili et al., 2001; Kerns, 2000). Thus, timely and relevant reminders provided by caregivers might allow children to have more successful PM performance. Next, we review the literature on the effect of reminders on children's PM.

1.1. *Effect of reminders on children's prospective memory*

Most studies that have examined the effect of reminders on young children's PM have focused on reinforcing the retrospective memory content of the intention (i.e., reminding children what they have to do or what cue they are looking for). Research on the impact of visual reminders on children's PM, however, has revealed mixed findings. For example, Kliegel and Jäger (2007) found that visual reminders based on the content of the intention (e.g., an apple to remind children to look for an apple cue) were effective in helping 2- to 6-year-olds remember to carry out their intention. Similarly, the presence of a visual cue depicting the PM target (i.e., a picture of a frog) during the ongoing task improved 3- to 7-year-olds' PM (Cheie, Miclea, & Visu-Petra, 2013). Further, Meacham and Colombo (1980) showed that a clown cue helped 6- to 8-year-olds remember to open a surprise box. In contrast, Guajardo and Best (2000) found no effect of visual reminders (a picture of the target cue) on 3- and 5-year-old's PM performance. Given the limited research on the effect of visual reminders on young children's PM, this area is in need of further exploration.

In comparison to explicit reminders focusing on the content of the intention (i.e., the retrospective component of PM), little is known about the effect of more subtle reminders such as implied memory strategies (e.g., executive planning or monitoring) on PM performance. However, Kvavilashvili and Ford (2014) examined the effect of two implicit verbal reminder stories on 5-year-olds' PM performance after children made predictions about whether they would remember to carry out the PM intention. Prior to completion of the PM task, children either heard a story about a forgetful spider (reminder story) or a clumsy alligator (neutral story). Results revealed that children who received the reminder story and who also predicted that they would remember to carry out the PM response had marginally better PM than children who received the neutral story. This suggests that reminder stories with implied memory strategies might have a less powerful effect on PM performance (given the marginal result) compared to explicit visual reminders, yet still boost PM performance.

In adult samples, explicit visual reminders (Einstein & McDaniel, 1990), some explicit verbal reminders (Guynn, McDaniel, & Einstein, 1998), and self-initiated reminders (Henry, Rendell, Phillips, Dunlop, & Kliegel, 2012) have been found to improve PM performance. Guynn et al. (1998) found that reminders that referred to only the intended activity did improve PM but verbal reminders that referred to the target event *and* the intended activity (i.e., participants were reminded of the words that were the PM cues and the button they should press if they saw any of those words) were most helpful to PM performance. Interestingly, reminders that referred only to the target event failed to improve adult's PM.

To date, however, no research has examined the effect of *explicit verbal reminders* from an experimenter on young children's PM performance (e.g., "remember to put the card in the box when you see an animal on it"). Moreover, no study has provided children with verbal reminders that specifically target the retrospective and prospective/executive components of PM. Thus, an unanswered question is, do *explicit verbal* reminders focusing on the retrospective memory or executive components of PM improve preschooler's PM performance?

1.2. Executive framework of children's prospective memory development

Preschoolers' difficulty carrying out PM tasks despite being able to report what they were supposed to do (intact retrospective memory) together with positive relations between their PM and executive function (Ford et al., 2012; Mahy & Moses, 2011) led Mahy, Moses, and Kliegel (2014b) to propose the Executive Framework of PM development.

According to the predictions of this framework, retrospective memory is necessary to remember the content of one's intentions and is sufficiently developed to do this by the time a child is around 4 years old (see Kliegel & Jäger, 2007). In fact, 2- and 3-year-olds often fail PM tasks due to an inability to remember the content of their intention (Kliegel & Jäger, 2007) whereas 4-years-olds have much less trouble with remembering the content of the PM intention but nonetheless still often forget to carry out the PM intention. This finding does not mean that older children or adults never experience PM failures due to forgetting the content of an intention, but rather suggests that after 4 years of age PM errors are more likely to be due to a failure to carry out the intention at the appropriate time (a prospective or executive failure) rather than a failure to remember one's intention.

Another prediction of the Executive framework is that executive functioning should be positively related to PM performance in early childhood when success seems to rely more on detecting the PM cue at the appropriate time and then carrying out the PM action. This prediction is supported by a number of studies documenting positive relations between PM and executive function across childhood (e.g., Kerns, 2000; Mahy & Moses, 2011; Mahy et al., 2014b). Overall, this framework posits that given sufficient levels of retrospective memory (that we expect to be in place by around 4 years of age) children with better executive functioning ability will also have better PM performance.

One way to examine the impact of retrospective memory and executive functioning on children's PM is to use different reminders that focus on these different aspects of PM. For example, once retrospective memory reaches a sufficient level to support the encoding and storing of a simple PM intention, a reminder focusing on the content of one's intentions should not increase PM (since the content of the intention was already remembered). However, because executive functions are predicted to positively correlate with children's PM once retrospective memory has reached a sufficient level (by around 4 years old), a reminder focusing on paying attention should boost PM performance via promoting PM cue detection in young children. As retrospective memory increases across early childhood, executive functions might play an increasingly important role in carrying out the PM task.

1.3. Current study

The current study tested the predictions of the Executive Framework of PM development (Mahy et al., 2014b) by examining the effect of retrospective memory and executive reminders on 4- to 6-year-olds' PM performance. Children were randomly assigned to a reminder condition where they were either given: no reminder (control condition), a retrospective memory reminder, or an executive reminder. Each reminder was given verbally once before the onset of the ongoing task and a few seconds prior to the appearance of the first PM target. The reminder was given only once in order to approximate daily life where often young children are given a single reminder in close proximity to the time where they are required to carry out their intention (e.g., a parent reminding a child not to forget their lunch on their way to the school bus). The retrospective reminder was designed to promote retrospective memory for the intention, whereas the executive reminder was designed to promote PM cue detection via an increase in monitoring and attention during the ongoing task. Individual differences were examined by condition because we expected children with better executive monitoring abilities to better take advantage of reminders targeting that particular ability, which in turn would benefit their PM performance.

Based on the Executive Framework of PM Development, we predicted that: (1) there would be age-related increases in PM performance (see Guajardo & Best, 2000; Kvavilashvili et al., 2001; Mahy & Moses, 2011), (2) compared with the no reminder condition, the executive reminder would benefit PM (by promoting monitoring and cue detection) whereas the retrospective memory reminder would not benefit PM (because it will reinforce the intention that preschoolers generally already remember), (3) age group and reminder condition would interact such that older children's PM would benefit from an executive reminder compared to younger children since older children should be better able to implement a strategy of paying attention given higher executive abilities, (4) PM performance would be positively correlated with executive function after controlling for age, and (5) children with better executive functioning would be able to take advantage of the executive reminder specifically in order to improve their PM performance. This prediction is in line with previous research showing that preschool-aged children's executive ability is often related to PM performance especially more cognitively demanding conditions (Mahy & Moses, 2015; Mahy, Mohun, Mueller, & Moses, 2016).

2. Method

2.1. Participants

One hundred and twenty-three 4- to 6-year-old children participated in the study. Ten participants were not included in the final analysis due to the following reasons: repeated participation ($N = 2$), presence of a developmental disability ($N = 2$), inability to follow task instructions ($N = 2$), failure to finish the PM task ($N = 4$). Although standard practice is to exclude children who cannot report the content of their intention in the analyses, given that we were interested in the effects of reminders on children's PM, data from five children who did not report the content of their intention was retained. The final sample was 113 children: 40 4-year olds (23 girls, $M = 52.53$ months, $SD = 3.25$), 37 5-year-olds (19 girls, $M = 65.68$ months, $SD = 3.77$), and 36 6-year-olds (19 girls, $M = 78.06$ months, $SD = 3.88$). Children were predominantly Caucasian (88%) and middle class (66% family incomes over $75,000

per year), consistent with the population from which the sample was drawn from. Children were recruited from a developmental psychology participant database and from preschools and daycares in the Niagara region.

2.2. Procedure

Informed consent was received from parents and verbal assent was obtained from children prior to participation in the current study. Children were tested individually in 30-minute sessions. All tasks were administered in the following fixed order, as is standard procedure in individual differences research (see Carlson & Moses, 2001): PM task, Episodic Memory Recall task, Track-It task, and Grass/Snow task. For the PM task, children were randomly assigned to one of three experimental conditions: no reminder, retrospective memory reminder, or executive reminder. At the end of the session, children were given a small toy and the families or daycare staff was thanked for their participation. The Research Ethics Board at Brock University approved all procedures.

3. Measures

3.1. Prospective memory task

In this measure of PM (adapted from Kvavilashvili et al., 2001), children were introduced to a stuffed animal named Morris the Mole, who had poor daytime vision and a fear of other animals. For the ongoing task, participants were instructed to help Morris by verbally labeling the location of a red-sticker on stacks of cards (e.g., top or bottom of the card) that depicted concrete nouns. They were also told to hide any cards with an animal on them in a box located approximately 3 feet behind them (PM task). The experimenter demonstrated the action by placing a card into the box behind the child as he or she watched. To ensure children understood the ongoing task (where they had to indicate the position of a red dot sticker on each card), they were given three practice trials.

Once children demonstrated an understanding of the ongoing task and its rules, the experimenter re-stated the rules of the PM task. Then a 3-minute delay was imposed where children were asked to draw pictures for Morris. After this delay period, children were randomly assigned to one of three experimental conditions: no reminder, a retrospective reminder ("Remember whenever you see an animal in this game, you should put it in the box behind you"), or an executive reminder ("Remember you need to pay attention to every picture and keep watching them all the time"; see Table 1 for full reminder instructions). Note that this reminder came three minutes after the initial instructions and immediately prior to the start of the ongoing task.

Immediately following the reminder/no reminder, children began the ongoing task. Children sorted two stacks of 30 cards; three animal pictures (PM cues) were embedded in each stack. In the first stack, the 9th, 18th, and 25th cards were animals (dog, cat, horse) and in the second stack the 5th, 12th, and 28th cards were animals (lion, sheep, elephant). In between sorting the two stacks of cards, children were given a 1-minute drawing break. Once children had completed the ongoing task, they were asked the retrospective memory control question, "What were you supposed to do when you saw a picture of an animal?" This question was asked to ensure that children's memory for the intention was intact and that PM failures were not driven by a retrospective memory failure or inability to understand task instructions. Five 4-year olds and one 5-year-old failed this control question but were included in our analyses given our goal of examining the effects of reminders on children's forgetting under various reminder conditions. Children were given an ongoing task score out of 54 (based on their accuracy of naming the location of the dot on 54 cards) and a PM score out of 6 (based on how many animal cards they placed in the box behind them).

3.2. Episodic memory recall task

In this measure of retrospective memory (adapted from Naito, 2003), children were asked to name 12 l in. drawings of familiar items (e.g., trumpet, tree, candle, etc.) as the experimenter laid them on a table in front of the child. Once all the pictures were placed on the table, the experimenter instructed the child to look at the cards carefully for 20 s because they would be asked to remember the items later. After the 20 s, children were given a 1-minute drawing break and then the experimenter asked children to recall as many of the 12 items as they could. Children were given a score ranging from 0 to 12 depending on how many items they recalled correctly.

3.3. Track-it task

In this computerized task designed to measure attention and monitoring (Fisher, Thiessen, Godwin, Kloos, & Dickerson, 2013),

Table 1
Prospective memory task with reminder conditions and scripts.

Reminder Condition Type	Script
No reminder	"Alright, now it's time to play the card game with Morris. Are you ready?"
Retrospective reminder	"Alright, now it's time to play the card game with Morris. **Remember whenever you see an animal in this game, you should put it in the box behind you.** Are you ready?"
Executive reminder	"Alright, now it's time to play the card game with Morris. **Remember you need to pay attention to every picture and keep watching them all the time.** Are you ready?"

children were first introduced to Pete who was a pirate looking for his buried treasure. Children were asked to help Pete find his treasure by watching a treasure shape until it disappeared in the sand in one of nine boxes on a 3 by 3 grid on the computer screen. In addition to the treasure shape, there were two additional distractor shapes moving around on the screen. Each trial was 10 s in length or less. Children were given one practice trial where the experimenter used her index finger to follow the treasure shape as it moved around the grid. Once the shapes disappeared, children were asked to point to the spot in the grid where it has disappeared (tracking accuracy question). Then, children were asked to point to the shape they were tracking out of a choice of four shapes (the memory control question). The experimenter selected the shape that the child pointed with the mouse for both questions. Each time the experimenter clicked on a box or shape, a smiley face appeared immediately in the center of the screen to keep children engaged. The experimenter corrected children's performance during the practice trial. Then, children began six test trials. Children were given 1 point for correct responses to where the shape disappeared and 1 point for correct responses to which shape they were following. Children's tracking accuracy score was calculated only for trials in which they answered the memory control question correctly. Track-It task performance was a percentage out of 100.

3.4. Grass/snow task

In this measure of inhibitory control (Carlson & Moses, 2001), children were asked to play a silly game where they had to touch a green-colored square when the experimenter said "snow" and a white-colored square when the experimenter said "grass." Children were given two practice trials, which they had to pass in order to move on to the test trials. After the practice trials, they were given 14 additional grass/snow trials. Their score ranged from 0 to 32 points depending on their hand movements during each trial (2 points for a correct response, 1 point for a self-corrected response, and 0 points for an incorrect response). Two independent research assistants scored 25% of children's responses resulting in substantial agreement (Cohen's Kappa = .83).

4. Results

Preliminary analysis revealed that child's sex did not have an effect on ongoing task performance or PM performance (*ps* > .86), so it was not included in further analyses. Descriptive statistics for PM task performance by condition and age is shown in Table 2 and performance on all other tasks by age is shown in Table 3.

4.1. Ongoing task performance by age group and reminder

In order to first examine the effect of age group and reminder condition on children's ongoing task performance, a 3 (Age Group: 4-year-olds vs. 5-year-olds vs. 6-year-olds) by 3 (Reminder condition: retrospective reminder vs. executive reminder vs. no reminder) ANOVA on ongoing task performance was carried out. Results revealed a main effect of age group, F (2, 104) = 15.51, p = .002, η_p^2 = .112. Follow-up tests revealed that 4-year-olds (M = 52.48, SD = 2.17) and 5-year-olds (M = 53.02, SD = 1.32) had significantly worse ongoing task performance compared to 6-year-olds (M = 53.75, SD = .55), *ts* (71) > 3.03, *ps* < .003, but there was no difference between 4-year-olds and 5-year-olds' ongoing task performance, t (75) = 1.33, p = .19. There was no main effect of reminder condition, F (2, 104) = 1.59, p = .208, η_p^2 = .03, nor an interaction between age group and reminder condition, F (4, 104) = .42, p = .796, η_p^2 = .02. Given that age had a significant effect on ongoing task performance, we included ongoing task performance as a covariate in our analyses moving forward.

4.2. Prospective memory performance by age group and reminder condition

Fig. 1 shows PM performance by age group and condition. A 3 (Age Group: 4-year-olds vs. 5-year-olds vs. 6-year-olds) by 3 (Reminder condition: retrospective reminder vs. executive reminder vs. no reminder) ANCOVA on prospective memory performance with ongoing task performance as a covariate revealed a main effect of age group, F (2, 103) = 12.52, p < .001, η_p^2 = .20. Follow-up tests revealed that 4-year-olds (M = 2.86, SE = .33) had significantly worse PM than 5-year-olds (M = 4.92, SE = .33) and 6-year-olds (M = 4.91, SE = .35), *ts* (74) > 4.66, *ps* < .001, but 5- and 6-year-olds' PM performance did not differ significantly, t (70) = .42, p = .68. There was no main effect of reminder condition, F (2, 103) = 1.10, p = .34, η_p^2 = .021. However, there was a significant interaction between age group and reminder condition, F (4, 103) = 2.49, p = .048, η_p^2 = .088. Simple effects revealed that 6-year-olds (M = 4.73, SE = .59) outperformed 4-year-olds (M = 3.06, SE = .56) in the no reminder condition ($M_{Difference}$ = 1.67, p = .04),

Table 2
Estimated Marginal Means and standard errors on the Prospective Memory task by condition and age group controlling for ongoing task performance.

Condition	Age Group 4	5	6
No reminder	3.06 (.56)	4.26 (.58)	4.73 (.59)
Retrospective Reminder	3.87 (.59)	5.48 (.56)	4.52 (.59)
Executive Reminder	1.64 (.52)	5.02 (.58)	5.47 (.58)

Note. Standard errors are in parentheses. Range of scores: 0–6.

Table 3
Means and Standard deviations on all other measures by Age Group.

Measures	Age Group 4	5	6
Ongoing task (0-54)	52.48 (2.17)	53.03 (1.32)	53.75 (.55)
Episodic Recall (0-12)	3.82 (2.30)	4.38 (1.55)	5.69 (1.79)
Track-it Task Accuracy (0-1)	.55 (.36)	.80 (.29)	.87 (.18)
Grass/Snow (0-32)	23.64 (7.31)	27.97 (7.23)	30.17 (2.69)

Note. Standard deviations are in parentheses.

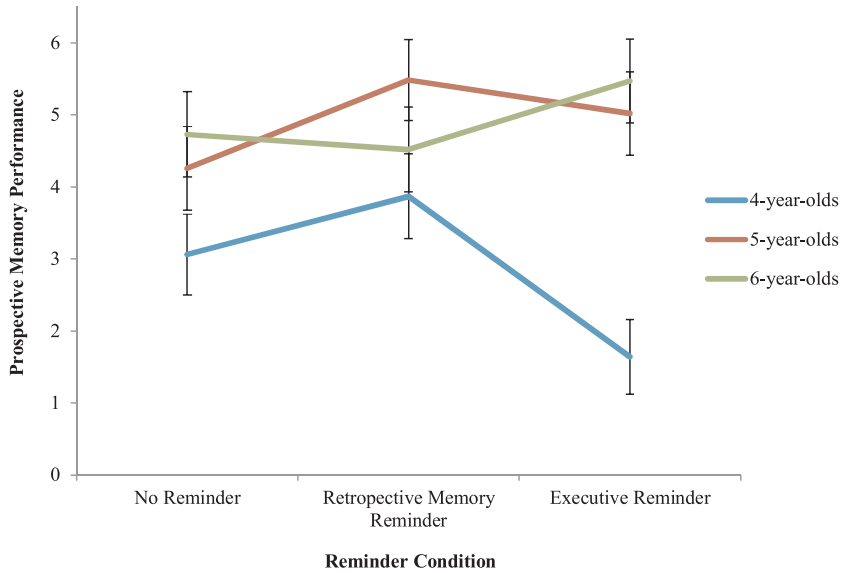

Fig. 1. Prospective Memory performance by age group and reminder condition. Error bars indicate +/− 1 standard error.

5-year-olds (M = 4.48, SE = .56) outperformed 4-year-olds (M = 3.87, SE = .59) in the retrospective memory reminder condition ($M_{Difference}$ = 1.62, p = .05), and that both 5- (M = 5.02, SE = .58) and 6-year-olds (M = 5.47, SE = .58) outperformed 4-year-olds (M = 1.64, SE = .52) in the executive reminder condition ($M_{Differences}$ > 3.38, ps < .001).

In order to control for the possibility that the effect of the verbal reminders wore off over the course of the PM task, we conducted the same 3 (Age Group: 4-year-olds vs. 5-year-olds vs. 6-year-olds) by 3 (Reminder condition: retrospective reminder vs. executive reminder vs. no reminder) ANCOVA on PM performance with ongoing task performance as a covariate for the first PM cue only (that appeared just a few seconds after the reminder). Results revealed a significant effect of age, F (2, 99) = 11.42, p < .001, η_p^2 = .18, but no effect of reminder condition (p = .39, η_p^2 = .02) nor an interaction between age group and reminder condition (p = .42, η_p^2 = .04) on PM performance.

4.3. Correlations among tasks

Table 4 shows correlations among all measures and child's age in months. We found that age in months was positively correlated with performance on all measures. We also found that PM was positively correlated with ongoing task performance, Episodic Recall, Track-It task accuracy, and Grass/Snow. After controlling for children's age in months, only the correlations between PM and ongoing task performance and between Track-It task accuracy and Grass/Snow performance (our two measures of executive function)

Table 4
Correlations among all tasks.

	2.	3.	4.	5.	6.
1. Child Age (months)	.51**	.35**	.39**	.48**	.41**
2. PM Task		.39** (.24*)	.21* (.02)	.37** (.17^t)	.35** (.19^t)
3. Ongoing Task			.20* (.08)	.25** (.11)	.27** (.16^t)
4. Episodic Recall				.24* (.06)	.23* (.08)
5. Track-It Accuracy					.39** (.24*)
6. Grass/Snow					

Note. ^{t} p < .10, * p < .05. ** p < .01. Age-controlled correlations are in parentheses. PM = prospective memory.

Table 5
Correlations with prospective memory by reminder condition.

Measures	Conditions		
	No reminder	Retrospective reminder	Executive reminder
Episodic Recall	.03 (-.18)	.39* (.30[t])	.29[t] (.01)
Track-It	.27 (.08)	.32[t] (.23)	.60** (.26)
Grass/Snow	.44** (.29[t])	.31[t] (.22)	.38* (.16)

Note. [t] $p < .10$, * $p < .05$, ** $p < .001$. Age-controlled correlations are in parentheses.

remained significant. In order to further examine these correlations with sufficient power, we divided our sample using a mean-age split and examined correlations among measures in younger and older children separately. For children younger than 5.5 years old, PM was positively related to ongoing task performance only, r (51) = .28, p = .04. This relation disappeared once age in months was controlled for. For children older than 5.5-years old, PM performance was positively related to Episodic Recall and Track-It task Accuracy, rs (53) > .26, ps < .05. After controlling for age in months, these relations persisted, rs (52) > .26, ps < .05.

4.4. Individual differences by reminder condition

Table 5 shows correlations between PM performance and all other measures by experimental condition. In the executive monitoring reminder condition, Track-It task and Grass/Snow performance were highly positively correlated with PM, rs (37) > .38, ps < .02, but Episodic Recall was not, r (37) = .29, p = .08. These correlations did not remain after controlling for children's age in months. Interestingly, in the retrospective reminder condition PM was positively correlated with Episodic Recall performance, r (36) = .39, p = .02, but not significantly related to Track-It task and Grass/Snow performance (rs (36) < .32, ps > .05).

In order to examine the specificity of this relation, we conducted a fisher's z-test to compare correlations between PM and individual difference measures between the executive reminder and no reminder condition. The relation between PM and Track-It task accuracy differed significantly between the no reminder condition (r = .27) compared to the executive reminder condition (r = .60, z = 1.73, p = .04). There was only a marginal difference between the relation between PM and Episodic Recall in the no reminder condition (r = .03) and the retrospective memory reminder condition (r = .39, z = 1.57, p = .06).

5. Discussion

The goal of the current study was to explore the effect of verbal reminders on young children's PM performance from the perspective of the Executive Framework of PM Development (Mahy et al., 2014b). In line with our predictions, PM performance improved between 4- and 6-years with noticeable increases in performance between 4 and 5 years specifically. Neither the retrospective memory nor the executive reminder had an effect on PM performance, which was in line with our prediction for the retrospective memory reminder but in contrast with our prediction of a positive effect of an executive reminder on PM. Interestingly, however, age group and reminder condition significantly interacted but not in the manner we predicted (that an executive reminder might be more beneficial for older children's PM performance compared to younger children). Instead, we found that: 6-year-olds had better PM than 4-year-olds after no reminder, 5-year-olds had better PM than 4-year-olds after a retrospective memory reminder, and 4-year-olds had *worse* PM performance after an executive reminder compared to older children. After controlling for age, there was no relation between PM and executive function across the entire sample, but there were significant relations between PM, retrospective memory, and one measure of executive function (Track-It task) in the children over 5.5 years old. In line with our prediction, children with better executive functioning (as measured by the Track-It task) had better PM after receiving an executive reminder compared to no reminder. These results suggest that both age group and individual differences have important implications for whether a certain type of verbal reminder will be effective in boosting children's PM performance.

5.1. Age-related effects in prospective memory

Consistent with past literature, children's PM increased between 4- and 6-years (Ford et al., 2012; Kliegel & Jäger, 2007; Kvavilashvili et al., 2001; Mahy & Moses, 2011; Mahy, Moses, & Kliegel, 2014a). Interestingly, most of the PM development seemed to occur between 4- and 5-years old as the older children outperformed 4-year-olds in the current study. Cognitive advances in working memory and inhibitory control that occur between 4 and 5 years likely contribute to these improvements in PM (Ford et al., 2012; Hongwanishkul, Happaney, Lee, & Zelazo, 2005; Jacques, Zelazo, Kirkham, & Semcesen, 1999; Mahy & Moses, 2011; Mahy et al., 2014a) but other general advances in verbal ability might also contribute to such age-related increases (see Mahy, Mohun, Müller, & Moses, 2016).

5.2. Impact of reminders on prospective memory performance

Past research has focused on the effects of explicit visual reminders on young children's PM (Guajardo & Best, 2000; Kliegel & Jäger, 2007) with only one study examining implicit reminder stories (Kvavilashvili & Ford, 2012) but no study had examined the

effect of explicit verbal reminders on young children's PM. This is important as parents, teachers, and caregivers often give children a single reminder in a verbal form (e.g., "don't forget to take your lunch") and expect this to improve children's PM performance. The current study attempted to fill this gap by examining two types of explicit verbal reminders: one that explicitly reminded children of what they had to do (retrospective reminder) and one that reminded children to keep monitoring their environment (executive reminder) and compared them to a condition in which children received no reminder.

The lack of main effect of reminder type on the one hand supported our prediction that retrospective memory reminders would not boost PM performance compared to no reminder. This result is not surprising given that the majority of 4- to 6-year-olds in past research have been able to retain the content of their intention over the course of a PM task (Ford et al., 2012; Kliegel & Jäger, 2007; Mahy & Moses, 2011). On the other hand, the lack of main effect of reminder type was in contrast with our prediction that the executive reminder would have a beneficial effect on PM performance given that executive functioning is positively related to PM performance in young children (Ford et al., 2012; Mahy & Moses, 2011).

Importantly, a significant age group by reminder condition emerged qualifying both the main effect of age and lack of effect of reminder condition. The interaction revealed that 5-year-olds had better PM performance than 4-year-olds in the retrospective memory reminder condition. Thus, it seems that 5-year-olds' PM still benefited from a reminder about the content of the intention compared to 4-year-olds possibly because 5-year-olds had better metacognitive awareness (see Kvavilashvili & Ford, 2014) and could take advantage of this reminder about the content of their intention. Perhaps by 6 years of age, a retrospective memory reminder is no longer helpful because the vast majority of children encode and store the PM intention without any difficulty.

Further, the executive reminder had a negative effect on the PM performance of 4-year-olds compared to 5- and 6-year-olds. Although we expected this executive reminder condition to especially benefit older children's PM rather than specifically harm the youngest children's PM performance, this finding lends support to the Executive Framework in that younger children might be less able to take advantage of reminders targeting executive functioning skills that are still undergoing rapid development. The executive reminder condition might have resulted in worse PM performance in 4-year-olds for several reasons. First, the executive reminder itself might have distracted or confused 4-year-olds who perhaps might not have realized the relevance of continuing to pay attention throughout the task in order to detect and act on the PM cue. It is possible that children's metacognitive awareness is lacking at 4-years of age and that until children are aware that paying attention can boost performance such an instruction is unlikely to benefit task performance. Second, perhaps 4-year-olds lacked the executive control to take advantage of the executive reminder to keep looking and paying attention (despite understanding that paying attention might be important to PM performance). Finally, 4-year-olds might have interpreted the executive reminder as an instruction to pay attention to the ongoing task rather than the PM task (which was critical for cue detection). Interestingly, this interaction between age group and reminder condition was not significant when examining performance on the first PM trial only, suggesting that the interactive effects of the reminder condition with age was cumulative over the course of the PM task.

More generally, there are several possible explanations for why an explicit verbal reminder focusing on attention and monitoring had no beneficial effect on 5- and 6-year-old children's PM performance. First, one possibility is that the reminder was given at the start of the ongoing task and thus children were not provided with the reminder immediately before the appearance of a PM cue. It is possible that reminders only work if they are very close temporally to when the PM cue appears (see Guynn et al., 1998). However, our findings showed that the reminders did not even boost PM performance on the very first cue which was presented a few seconds after the reminder. This suggests that the executive reminder was ineffective and not simply that it wore off over time. Second, children might have ignored the verbal reminder to pay attention as they are used to being given this type of instruction in their daily lives. Finally, perhaps a verbal reminder to pay attention was not salient enough compared to other types of visual reminders that have been shown to boost PM performance. Findings documenting the efficacy of visual reminders on young children's PM (Cheie et al., 2013; Kliegel & Jäger, 2007) lend support for this possibility. Repeated verbal reminders across the ongoing task might have been more effective in improving children's PM than a single verbal reminder before the ongoing task begun. An important future direction is to further examine reminders focusing on retrospective memory and executive function, as it is possible that our retrospective reminder also may have increased children's monitoring by highlighting the importance of paying attention to the pictures in order to detect the animal cues.

5.3. Correlations among measures

PM performance was correlated with retrospective memory as well as the two executive functioning measures consistent with past research (e.g., Kerns, 2000; Mahy & Moses, 2011; Mahy et al., 2014a). Interestingly, once age in months was controlled for, these relations disappeared in contrast with previous research. In order to further examine these relations with sufficient power, we divided the sample into a younger and older age group. Interestingly, older children's (above 5.5 years) PM performance was correlated with retrospective memory and one measure of executive function (Track-It task) even after controlling for age whereas this was not the case in the younger age group (under 5.5 years old). Thus, it seems that older children's executive and retrospective memory performance is more related to their PM performance than younger children's. The positive relation between PM and executive function performance supports the predictions of the Executive Framework of PM Development by showing that children's executive function is related to their PM performance once their retrospective memory reaches a sufficient level. In addition to executive function, it seems that retrospective memory may also play a role in supporting older (but not younger) children's PM performance. Perhaps superior retrospective memory allowed these children to more quickly retrieve their intention due to greater accessibility in memory. Thus, it seems that beyond aged 4, individual differences in retrospective memory may still contribute to PM performance.

5.4. Individual differences in executive monitoring

Individual differences revealed that children who have better executive functioning were better able to take advantage of a single verbal reminder to pay attention and continue looking at all cards. Thus, children with better executive function (as measured by a monitoring task specifically) had better PM after an executive reminder. Importantly, the magnitude of this correlation in the reminder condition was significantly different than the correlations in the no reminder condition providing evidence for specificity. Notably, this was not the case with the relation between retrospective memory and PM in the retrospective memory reminder condition, as this relation was only marginally different from the no reminder condition. Perhaps children with better executive functioning are better able to engage these abilities when they are reminded to do so. In fact, findings from the metacognitive awareness literature suggest that 8-year-olds with higher meta-memory knowledge perform better on a PM task (Cottini, Basso, & Palladino, 2018) suggesting that greater awareness of memory and memory strategies is related to superior PM performance. Similarly, Kvavilashvili and Ford (2014) found that 5-year-olds had high accuracy in predicting their PM performance suggesting that meta-memory for PM is in place early in development. Thus, children with better executive control might also understand the importance of paying attention and continuing to search for PM cues in the context of a PM task. Our findings suggest that executive-type reminders are most helpful to the PM of children with higher executive ability, who seem better equipped to take advantage of a reminder to engage executive control.

6. Conclusions

The current study was the first to examine the effect of explicit verbal reminders, targeting retrospective and executive aspects, on young children's PM to test the predictions of the Executive Framework of PM Development (Mahy et al., 2014b). Findings revealed that PM improved from 4- to 6-years and age group and reminder condition interacted such that 4-year-olds PM performance in particular suffered after an executive reminder compared to older children. Further, older children but not younger children's PM was positively related to their retrospective memory and executive control performance after controlling for age. Correlational analyses revealed individual differences in that children with better executive function were able to take advantage of an executive reminder to the benefit of their PM. These results suggest that a child's age and individual differences are critical factors in considering whether PM will benefit from specific verbal reminders. Importantly, given the positive relation between age and executive function performance, future work should explore the overlap between age-related differences and individual differences in executive function on PM in order to tease apart their influences. Much work is still needed in this burgeoning area of research. Practically speaking, surprisingly little is known about the effects of different types of reminders on young children's PM despite how often adults verbally remind children about their future intentions. From a theoretical perspective, many predictions of the Executive Framework of PM development still need to be tested. Thus, we believe that children's PM research is ripe for future work given that it is a critical aspect of children's development at the intersection of memory and executive control.

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References

Cheie, L., Miclea, M., & Visu-Petra, L. (2013). What was I supposed to do? Effects of individual differences in age and anxiety on preschoolers' prospective memory. *International Journal of Behavioral Development, 38*, 52–61.

Cottini, M., Basso, D., & Palladino, P. (2018). The role of declarative and procedural metamemory in event-based prospective memory in school-age children. *Journal of Experimental Child Psychology, 166*, 17–33.

Einstein, G. O., & McDaniel, M. A. (1990). Normal aging and prospective memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*, 717–726.

Fisher, A., Thiessen, E., Godwin, K., Kloos, H., & Dickerson, J. (2013). Assessing selective sustained attention in 3- to 5-year-old children. *Journal of Experimental Child Psychology, 114*, 275–294.

Ford, R. M., Driscoll, T., Shum, D., & Macaulay, C. E. (2012). Executive and theory-of-mind contributions to event-based prospective memory in children: Exploring the self-projection hypothesis. *Journal of Experimental Child Psychology, 111*, 468–489.

Guajardo, N. R., & Best, D. L. (2000). Do Preschoolers remember what to do? Incentive and external cues in prospective memory. *Cognitive Development, 15*, 75–97.

Guynn, M. J., McDaniel, M. A., & Einstein, G. O. (1998). Prospective memory: When reminders fail. *Memory & Cognition, 26*, 287–298.

Henry, J. D., Rendell, P. G., Phillips, L. H., Dunlop, L., & Kliegel, M. (2012). Prospective memory reminders: A laboratory investigation of initiation source and age effects. *The Quarterly Journal of Experimental Psychology, 65*, 1274–1287.

Hongwanishkul, D., Happaney, K. R., Lee, W. S., & Zelazo, P. D. (2005). Assessment of hot and cool executive function in young children: Age-related changes and individual differences. *Developmental Neuropsychology, 28*, 617–644.

Jacques, S., Zelazo, P. D., Kirkham, N. Z., & Semcesen, T. K. (1999). Rule selection versus rule execution in preschoolers: An error-detection approach. *Developmental Psychology, 35*, 770–780.

Kerns, K. (2000). The CyberCruiser: An investigation of development of prospective memory in children. *Journal of the International Neuropsychological Society, 6*, 62–70.

Kliegel, M., & Jäger, T. (2007). The effects of age and cue-action reminders on event-based prospective memory performance in preschoolers. *Cognitive Development, 22*, 33–46.

Kvavilashvili, L., & Ford, R. M. (2014). Metamemory prediction accuracy for simple prospective memory tasks in 5-year-old children. *Journal of Experimental Child Psychology, 127*, 65–81.

Kvavilashvili, L., Messer, D. J., & Ebdon, P. (2001). Prospective memory in children: The effects of age and task interruption. *Developmental Psychology, 37*, 418–430.

Mahy, C. E. V., & Moses, L. J. (2011). Executive functioning and prospective memory in young children. *Cognitive Development, 26*, 269–281.
Mahy, C. E. V., & Moses, L. J. (2015). The effect of retention interval task difficulty on young children's prospective memory: Testing the intention monitoring hypothesis. *Journal of Cognition and Development, 16*, 742–758.
Mahy, C. E. V., Mohun, H., Müller, U., & Moses, L. J. (2016). The role of subvocal rehearsal in preschool children's prospective memory. *Cognitive Development, 39*, 189–196.
Mahy, C. E. V., Moses, L. J., & Kliegel, M. (2014a). The impact of age, ongoing task difficulty, and cue salience on preschoolers' prospective memory performance: The role of executive function. *Journal of Experimental Child Psychology, 127*, 52–64.
Mahy, C. E., Moses, L. J., & Kliegel, M. (2014b). The development of prospective memory in children: An executive framework. *Developmental Review, 34*, 305–326.
Meacham, J. A., & Colombo, J. A. (1980). External retrieval cues facilitate prospective remembering in children. *The Journal of Educational Research,* 299–301.
Naito, M. (2003). The relationship between theory of mind and episodic memory: Evidence for the development of autonoetic consciousness. *Journal of Experimental Child Psychology, 85*, 312–336.
Somerville, S. C., Wellman, H. M., & Cultice, J. C. (1983). Young children's deliberate reminding. *Journal of Genetic Psychology, 143*, 87–96.