Cognitive Development 62 (2022) 101172

Contents lists available at ScienceDirect

Cognitive Development

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

Executive and retrospective memory processes in preschoolers' prospective memory development

Taissa S.S. Fuke [*], Caitlin E.V. Mahy

Brock University, Canada

ARTICLE INFO

Keywords:
Prospective memory development
Executive function
Retrospective memory
Preschool children
Executive Framework

ABSTRACT

Prospective memory (PM), the ability to remember to carry out future intentions, is critical for children's daily functioning. The Executive Framework of PM Development predicts that executive function should drive young children's PM development once a sufficient level of retrospective memory has developed. In two studies, we investigated the predictors of PM development in 3- to 6-year-old children using behavioural and parent-report measures. Neither retrospective memory nor executive function predicted children's behavioural PM in Study 1. Retrospective memory significantly predicted parent-reported PM in Study 2. Across both studies, executive function consistently predicted parent-reported PM regardless of the method of measurement. Parent-report and behavioural measures may tap into different aspects of PM, but both retrospective memory and executive processes are important to PM development in early childhood.

1. Introduction

What enables a preschool child to remember to pass on a message to a friend or bring an item to school for show and tell? The ability to remember to carry out future intentions such as these is known as prospective memory (PM; Einstein & McDaniel, 1990). PM includes intentions for the immediate future (e.g., remembering to put a carton of milk back in the fridge after using it), the more distant future (e.g., remembering to pack a bathing suit for a trip), and is even implicated in daily routines (e.g., remembering to brush your teeth before bed; Mazachowsky, Hamilton, & Mahy, 2021). Given how frequently it is employed in daily life, PM is integral to personal autonomy and a key developmental milestone that allows for independent living (Mahy, Moses, & Kliegel, 2014a). Persistently poor PM can have negative consequences for children's academic outcomes, social relationships, and even personal safety (e.g., Dismukes, 2012; Kvavilashvili, Messer, & Ebdon, 2001; Meacham, 1982). Thus, understanding the typical emergence and development of PM and the cognitive abilities that contribute to PM in the preschool years is critical.

A common distinction in the PM literature is between event-based and time-based PM. In event-based PM tasks, the action must be performed once a particular event occurs (e.g., calling your friend when you arrive home). In time-based PM tasks, the action must be completed at a specific time of day or after a certain amount of time has passed (e.g., leaving for the airport at 10:00 A.M. or removing cookies from the oven in 20 min). In event-based PM tasks, it is often the case that a separate, ongoing task (OT) must be interrupted to perform the intended action at the appearance of the cue (e.g., interrupting an ongoing phone call to pass on a message to a friend walking by). Given young children's difficulty with telling time and knowledge of time, most studies with young children have focused

* Correspondence to: Department of Psychology, Brock University, 1812 Sir Isaac Brock Way, St Catharines, ON, Canada L2S 2A1.
E-mail address: tf20qt@brocku.ca (T.S.S. Fuke).

https://doi.org/10.1016/j.cogdev.2022.101172
Received 31 August 2021; Received in revised form 3 March 2022; Accepted 11 March 2022

on the development of event-based PM (e.g., Kliegel & Jäger, 2007; Kvavilashvili et al., 2001; Mahy & Moses, 2011).

1.1. How is children's prospective memory measured?

Event-based PM has traditionally been studied in the lab using card-sorting tasks (e.g., Kvavilashvili et al., 2001; Mahy & Moses, 2011; Mahy, Moses, & Kliegel, 2014b). In this paradigm, the child must sort a stack of cards based on a rule (the OT, e.g., by colour) and then perform a novel action when presented with the PM cue (the PM task, e.g., placing the card with an animal in a box behind them). To succeed in this paradigm, children must be able to remember both the OT instructions and PM intention across a delay period that precedes the start of the task. This delay period is intended to mimic the conditions of naturalistic PM by allowing the intention to leave the child's immediate consciousness. The child must also be able to coordinate both tasks to accurately sort cards according to the OT rules while simultaneously detecting the PM cue and carrying out their intended action.

In addition to behavioural measures, parent-report questionnaires have been used to assess children's PM ability. These parent-report measures are especially useful for understanding children's PM in real-life contexts, and typically feature items that reference home life, school, and extracurricular activities. The parent-report measures of PM in children include the Prospective and Retrospective Memory Questionnaire-Child Version (PRMQ-C; Kliegel & Jäger, 2007, adapted from Crawford, Smith, Maylor, Della Sala, & Logie, 2003) which includes both prospective and retrospective subscales, the Children's Future Thinking Questionnaire (CFTQ; Mazachowsky & Mahy, 2020) which measures five aspects of future-oriented cognition including PM, and the Children's Everyday Memory Questionnaire (CEMQ; Mazachowsky et al., 2021) which measures short-term (habitual), long-term (episodic), and internally cued PM.

1.2. The development of prospective memory during childhood

The development of PM across the lifespan follows an "inverted U" shape with PM emerging in the preschool years, peaking in early to mid-adulthood, and declining in older adulthood (e.g., Kliegel, Jäger, & Phillips, 2008; Zimmermann & Meier, 2006; Zöllig et al., 2007). Children as young as two years old have been found to be capable of carrying out some future intentions, albeit with limited success (e.g., Kliegel & Jäger, 2007; Ślusarczyk, Niedźwieńska, & Białecka-Pikul, 2018). PM ability then undergoes significant development between the ages of 3 and 6 (e.g., Guajardo & Best, 2000; Kliegel & Jäger, 2007; Wang, Kliegel, Liu, & Yang, 2008, Study 1). PM continues to develop across the middle childhood years and into adolescence (e.g., Kerns, 2000).

Parent-report measures have also revealed age-related increases in PM. Using the PRMQ-C, Kliegel and Jäger (2007) found that the PM scale was negatively correlated with age in children aged 2- to 6-years-old such that parents reported that older children experienced fewer PM errors than younger children. They also found that the PRMQ-C's PM subscale predicted children's PM performance in a behavioural card-sort task. The PM subscale of the CFTQ similarly detected age-related improvements in PM ability in children between the ages of 3- and 7-years-old. However, unlike the PRMQ-C, the PM subscale of the CFTQ was not significantly related to corresponding behavioural measures of PM, although the relation was in the expected, positive direction (Mazachowsky & Mahy, 2020). The authors argued that behavioural PM tasks may be too specific to capture the variance of everyday PM, while questionnaire measures are specifically designed to capture PM in naturalistic contexts. In fact, the CFTQ PM subscale was related to a naturalistic PM task completed in the lab when children who forgot their intention (a retrospective memory failure for the task instructions) were included in the analysis (Mazachowsky & Mahy, 2020). Finally, the CEMQ revealed age-related improvement in PM between the ages of 3- and 6-years-old, but not between the ages of 7- and 11-years-old (Mazachowsky et al., 2021). The CEMQ has not been directly compared to children's behavioural PM performance, however, the adult questionnaire that it was adapted from was related to adult performance on short-term PM tasks (Hannon, Adams, Harrington, Fries-Dias, & Gipson, 1995). Taken together, PM parent questionnaires seem to offer valuable insights into naturalistic aspects of PM that are more difficult to assess in the lab.

1.3. Theories and mechanisms of prospective memory

PM involves both retrospective and prospective processes (Graf & Uttl, 2001). Retrospective memory (RM), or memory for the past, is required to remember the content of the intention, including *what* the intended action is and *when* it must be carried out. Prospective processes work to ensure that the intended action is carried out at the appropriate time, despite ongoing distractions (Einstein & McDaniel, 1996). A prominent model of PM, the Preparatory Attentional and Memory Processes Model (PAM; Smith, 2003) proposes that the prospective component of PM relies on capacity-consuming, effortful processes. There is some debate as to whether these effortful processes are always required for PM. The Multiprocess Model (McDaniel & Einstein, 2000) argues that PM can be effortful *or* automatic depending on environmental characteristics and individual differences. While some situations may call for effortful monitoring of the environment for the PM cue, it is possible that salient or unusual features of the environment may automatically and involuntarily trigger the intended action. In the latter case, retrospective or associative processes may be sufficient to remember one's intention at the appearance of a cue. Despite these differences, both models acknowledge the importance of controlled processes for carrying out future intentions under at least some circumstances. The controlled processes involved in PM are largely believed to be in the domain of executive function (EF). EF encompasses several abilities responsible for the conscious control of thought and action, including working memory, inhibition, and shifting (Miyake et al., 2000).

1.4. The executive framework of prospective memory development

The Executive Framework of PM Development (Mahy et al., 2014a) was the first developmental model of PM. The Executive Framework argues that EF drives PM development in early childhood such that age-related improvements in PM correspond with and can be predicted by the development of specific EFs. The Executive Framework makes three predictions regarding the role of EF in children's PM development: (1) While RM is necessary for PM, it is not sufficient, (2) developmental improvements in PM should be positively associated with EF ability, (3) since different EFs are thought to be associated with different aspects of the PM paradigms (see Mahy et al., 2014a), increasing specific EF demands should impact performance on corresponding components of the task.

Support for this Executive Framework is provided by four types of research findings. First, young children struggle with PM tasks, even once they have sufficient RM to maintain the intention. For example, Kliegel and Jäger (2007) found that 3- and 4-year-old children struggled with the PM task despite their memory for the intention being intact. Second, children's EF and PM development emerges and develops on a similar developmental timetable. Children show both qualitative and quantitative improvements in EF between the ages of 3 and 5 (e.g., Carlson, 2005; Espy, 1997; Perner & Lang, 1999; Zelazo, Müller, Frye, & Marcovitch, 2003). PM has also been shown to improve substantially in preschool (e.g., Guajardo & Best, 2000; Kliegel & Jäger, 2007; Wang et al., 2008, Study 1). Third, research has also found that increasing EF demands tends to result in reduced PM performance in support of the third prediction of the framework (e.g., Kliegel et al., 2013; Mahy & Moses, 2015; Mahy et al., 2014b). For example, Kvavilashvili et al. (2001) compared 4-, 5-, and 7-year-olds' PM performance in a condition in which they had to interrupt the OT to perform the prospective intention versus a condition in which the intention was carried out after the completion of the OT without interruption. PM accuracy was better when no interruption to the ongoing task was needed. Finally, EF has been shown to predict age-related increases in PM. Studies have found that inhibition mediated age differences in PM in preschoolers (Mahy et al., 2014b) and school-aged children (Zhao, Fu, Ma, & Maes, 2019), suggesting that inhibition might be a mechanism driving age-related change across the lifespan. Zuber, Mahy, and Kliegel (2019) found that the relation between PM and specific EFs depended on features of the PM task. Working memory predicted all types of PM tasks, inhibition predicted event-based PM only, and shifting predicted PM only in non-focal (low overlap between PM task and OT), event-based PM tasks. While the exact nature of the relation between specific EFs and PM is unknown, EF seems to play a significant role in the development of PM in early childhood. What is still unclear, however, is the relative contribution of executive versus retrospective processes in PM development across the preschool years. Thus, the goal of the current studies is to determine the contribution of RM and EF to PM in early childhood.

2. The current studies

The current research aimed to test the predictions of the Executive Framework of PM Development by determining whether different abilities indeed predict children's PM performance across the preschool years. According to the Executive Framework, we expect RM to emerge as a predictor of PM early in the preschool years and that the influence of EF will increase as children age. Since both PM and EF abilities show substantial improvements in the preschool years, 3- to 6-year-old children were selected for this study to capture this period of rapid development.

3. Study 1

In Study 1, children completed a series of behavioural PM, RM, and EF tasks. Parents also completed questionnaires reporting on their children's PM and EF abilities. Regression analyses were used to determine whether behavioural composites of children's RM or EF would better predict their PM. Our exploratory research questions were: (1) will EF emerge as an independent predictor of PM when controlling for age and RM?, (2) will younger children's PM performance be predicted by their RM while older children's PM be predicted by their EF?, and (4) will behavioural and parent-report measures of PM show a similar pattern of results?

3.1. Method

3.1.1. Participants

Eighty-five children and their parents participated in the present study. Thirty-one children were excluded from the final sample for the following reasons: failing to show evidence of memory for the intention ($n = 27$), atypical development ($n = 2$), previous participation in a prior study ($n = 1$), or failure to complete a behavioural task ($n = 1$). The final sample consisted of 55 children (29 girls and 26 boys): 6 3-year-olds (4 girls; $M_{age} = 44.33$ months, $SD = 3.83$), 12 4-year-olds (five girls; $M_{age} = 51.25$ months, $SD = 7.45$), 16 5-year-olds (10 girls; $M_{age} = 67.38$ months, $SD = 3.95$), 21 6-year-olds (10 girls; $M_{age} = 77.19$ months, $SD = 3.71$). A post-hoc power analysis using G*Power version 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007) indicated that with five predictors, a sample size of 55 afforded us sufficient power ($> .9$) to detect effects of $f^2 = .34$ or greater. The children's parents (44 mothers, 10 fathers, 1 guardian) completed of the Children's Future Thinking Questionnaire (CFTQ; Mazachowsky & Mahy, 2020) and Behavioural Rating Inventory of Executive Function-Preschool (BRIEF-P; Gioia, Espy, & Isquith, 2003). The final sample of children were predominantly Caucasian (87.3% white or Caucasian, 1.8% South Asian, 1.8% Black or African American, 1.8% Hispanic, Latino, or Spanish, 1.8% Asian Indian, 3.6% biracial, 1.8% unknown) and from middle-to-upper middle-class backgrounds (1.8% less than $25,000, 3.6% between $25,000 and $40,000, 14.5% between $40,000 and $75,000, 29.1% between $75,000 and $100,000, 47.3% over $100,000%, and 3.6% chose not to answer).

3.1.2. Measures

3.1.2.1. Parent measures

3.1.2.1.1. Children's Future Thinking Questionnaire (CFTQ; Mazachowsky & Mahy, 2020). The CFTQ is a 44-item parent-report measure of five domains of children's future-oriented cognition: PM, saving, episodic foresight, planning, and delay of gratification. The questionnaire contains five subscales that correspond to these five future-oriented cognitive abilities. Parents were asked to indicate their agreement with statements pertaining to their children's future thinking on a 6-point Likert scale (1 – *strongly disagree,* 2 – *disagree,* 3 – *somewhat disagree,* 4 – *somewhat agree,* 5 – *agree,* 6 – *strongly agree*). They also had the option to select one of three additional response options (*don't know*, *does not apply*, and *prefer not to answer*). Example items include "Remembers what items need to be purchased/picked up (e.g., reminds parent to pick up cereal from grocery store)" and "Prefers to win one item with less effort rather than win two items with more effort (e.g., stickers)". Only scores from the 8-item PM scale were analysed in the current study. Scores on each subscale ranged from 1 to 6 with higher scores reflecting better performance.

3.1.2.1.2. Behaviour Rating Inventory of Executive Functioning-Preschool (BRIEF-P; Gioia et al., 2003). The BRIEF-P is a 63-item parent-report measure of preschool children's executive function. It includes five subscales that provide independent assessments of children's working memory, inhibition, cognitive flexibility, emotional control, and planning/organisation. Parents selected how often (*never*, *sometimes*, or *often*) their child's behaviour had been a problem in the past 6 months. Higher scores reflect a greater degree of executive impairment. Sample items include "is unaware of how his/her behaviour affects or bothers others", "when given two things to do, remembers only the first or the last", and "has trouble adjusting to new people (such as a babysitter, teacher, friend, or daycare worker)". Scores ranged from 0 to 2 on each subscale with lower scores reflecting better EF.

3.1.2.2. Child behavioural measures

3.1.2.2.1. Vehicle card sort task (adapted from Kvavilashvili & Ford, 2014). In this measure of PM, children were shown a series of cards featuring coloured line drawings of various vehicles (e.g., cars, trains, trucks, boats) and were instructed to verbally name the colour of the vehicle on the card. If they saw a bicycle, children were told to tell Bert the Bear "*Don't be afraid Bert*" (the prospective memory intention). After receiving the instructions, children drew pictures for a three-minute delay period before starting the task. Of the 40 total cards in the task, bicycle pictures were featured on the 7th, 23rd, and 36th positions. Children's PM score was based on the number of cues they detected and correctly acted on (out of three). At the end of the PM task children were asked a memory control question to ensure they could remember the rules of the game ("what were you supposed to do when you saw the bicycle?"). The correct answer was to tell Bert to not be scared. If children could not recall the PM intention right away, they were asked three follow-up questions (What else did you have to do in this game?", "What did you have to do when a bicycle was on one of those cards?", "What did you have to do so Bert the Bear wasn't scared?"). Children were excluded from the analysis if they could not recall the PM intention after the first question.

3.1.2.2.2. Tower of Hanoi (adapted from Carlson, Mandell, & Williams, 2004). The Tower of Hanoi measured children's planning ability and for the purposes of the current study was a measure of executive function. Children were told they would be playing the *Monkey Jumping Game* with the experimenter. In this game, there were three wooden disks each representing a member of a family of monkeys (a large "dad" monkey, a medium "brother" monkey, and a small "sister" monkey). The children were told that this family of monkeys lived in the trees (three wooden pegs) surrounded by a river. The experimenter then explained the rules of the Monkey Jumping Game, that: (1) bigger monkeys could not sit on smaller monkeys, (2) only one monkey could jump through the trees at a time, and (3) monkeys could not fall into the river (i.e., be set down on the table). Then, the memory check questions were asked (described below in memory rule check section). Children who answered the memory rule check questions incorrectly (26%) were corrected by the experimenter. Next, another set of monkeys, the copycat monkeys, were presented to the children. The experimenter explained that this set of monkeys always tried to copy the final position of the original monkeys. These original monkeys were kept on the far-right peg throughout the game and signified the end goal position of the game. The children were given one practice trial with one disk requiring one move, then began the game using two discs requiring one move and progressing until they reached the sixth and final level requiring four discs and three moves. Children were given two trials at each level. They were required to pass one of these two trials to progress to the next level. If they failed any trial, children were reminded of the relevant rule. There was no time limit within which children had to complete a trial. The game concluded when a child failed two trials of any level. The children's total score was based on the highest level they completed (range = 0–6).

3.1.2.2.3. NIH toolbox dimensional change card sort (Zelazo et al., 2013). This task is a measure of cognitive flexibility. Using an iPad, children were instructed to select the stimulus that matched the target stimulus presented to them. The criterion by which children were to match stimuli (i.e., shape or colour) appeared on the iPad screen and was verbally presented through the iPad's speakers. During initial practice trials, children practiced matching stimuli by each of the two criteria: shape (e.g., rabbit and boat) and colour (e.g., brown and white). During the test trials, children began by matching the stimuli by colour, then by shape, and finally by shape and colour in order. This assessed the children's ability to switch flexibly between the two criteria. Children completed 40 trials which lasted approximately 4 min. Children were scored from 0 to 10, with higher scores corresponding to better performance. Fifteen children were excluded for being unable to complete the practice trials ($n = 2$), technical difficulties ($n = 1$), or failure to complete the task ($n = 12$).

3.1.2.2.4. ***Memory rule check question.*** Children answered memory check questions in the Tower of Hanoi task. Children were asked about each of the task's three rules: (1) "Can larger monkeys sit on smaller monkeys?", (2) "How many monkeys can jump in the trees at a time?", and (3) "Can we put the monkeys in the water?". Children were given a score out of 3 based on how many of these memory control questions answered correctly.

3.1.3. Procedure

Parents were given 20 min to fill out the two questionnaires in the lab waiting room while the researcher interacted with the child in a warm-up phase. Once parents completed the questionnaires, their children were led to a separate testing room to complete the battery of behavioural tasks. Children participated in a total of six tasks in a fixed order to avoid order effects as a part of a larger study on children's future-oriented cognition (Study 3; Mazachowsky & Mahy, 2020). For the purpose of the current study, we were specifically interested in measures of EF, PM, as well as memory control questions from several future oriented thinking tasks. All procedures, including the secondary use of previously collected behavioural data, were approved by the Research Ethics Board at Brock University.

3.2. Results and discussion

3.2.1. Preliminary analyses

Table 1 shows descriptive statistics for all measures in Study 1. Twenty-seven participants (32%) were missing data (a blank response) from at least one item in the BRIEF-P. Of these 27 participants, 19 (22%) were missing less than 5% of data. Data were determined to be missing in a non-systematic way since a Little's (1988) Missing Completely at Random Test was insignificant, χ^2 (1204) = 1173.33, p = .731. Missing values were replaced using the estimation maximisation procedure. Because the behavioural measures of EF were positively correlated with each other (Table 2), scores were standardised and combined into an EF behavioural composite.

3.2.2. Behavioural prospective memory

A hierarchical regression was conducted to examine the influence of age, RM, and EF on behavioural PM performance. Age in months, the RM composite, and EF composite were entered into the first step of the hierarchical regression. Age interaction terms were formed by standardising variables and then multiplying them. The interaction terms with age (Age by RM and Age by EF) were entered into the second step of the hierarchical regression. The final model accounted for 16% of the variance in behavioural PM (R = .404, R^2 = .163). No significant predictors of behavioural PM emerged (see Table 3).

A second hierarchical regression was conducted to examine the influence of age and parent-reported EF on behavioural PM performance. Age in months and the BRIEF-P Global Executive Composite were entered into the first step of the hierarchical regression. Then the BRIEF-P Composite and age were standardised and multiplied to form an interaction term which was entered into the second step of the hierarchical regression. The final model accounted for 14% of the variance in behavioural PM (R = .375, R^2 = .140). In the final model, only age significantly predicted behavioural PM, B = .396, SE = .014, t = 2.87, p = .006, *95% CI* [.012,.069]. Neither RM nor EF predicted behavioural PM. The task required children to remember a specific phrase ("Don't be afraid, Bert"), placing high demands on children's verbal abilities and RM. Children's verbal memory has been found to be less robust than their memory for action sequences (Bauer & Dow, 1994) or visual memory (Cohen, Horowitz, & Wolfe, 2009; Pezdek, Whetstone, Reynolds, Askari, & Al, 1989; Shepard, 1967; Standing, 1973). Roughly a quarter of our sample could not recall the content of the prospective intentions and thus were excluded. As such, our sample may have been too small to capture enough variance in children's behavioural PM performance.

3.2.3. Parent-reported prospective memory

Table 1 shows children's mean PM scores as rated by their parents on the CFTQ. Older children were rated as having better PM than younger children on average. We ran regression analyses with the same set of predictors as above to determine whether the factors that predicted parent-reported PM differed from those that predicted children's behavioural PM.

A hierarchical regression was conducted to examine the influence of age, behavioural RM, and behavioural EF on parent-reported PM performance. Age in months, the RM composite, and EF composite were entered into the first step of the hierarchical regression. Then the two age interaction terms (Age by RM and Age by EF) were entered into the second step of the hierarchical regression. The final model accounted for 33% of the variance in behavioural PM (R = .576, R^2 = .332). Results of the final model showed that behavioural EF was a significant independent predictor of parent-reported PM, B = .416, SE = .161, t = 2.545, p = .014, *95% CI* [.086,.736]. This finding is in line with the predictions of the Executive Framework that EF drives PM development during preschool.

We also found a marginal effect of the interaction between age and RM, $B = -.261$, SE = .009, $t = -1.932$, p = .06, *95% CI* [−

Table 1
Study 1 task descriptive statistics.

	N	*Mean*	*Std. Error*	*Std. Deviation*	*Possible Range*	*Min*	*Max*	*Variance*
Behavioural PM	55	2.09	0.18	1.34	0–3	0.00	3.00	1.79
Parent-reported PM	55	4.39	0.10	0.77	1-6	2.28	5.88	0.59
Tower of Hanoi Score	55	3.45	0.31	2.28	0–6	0.00	6.00	5.22
DCCS Total Score	51	4.00	0.36	2.58	0–10	0.25	8.00	6.65
BRIEF-P Global Executive Composite	39	34.41	3.14	19.62	63–189	1.00	84.00	384.93
Tower of Hanoi RM Score	55	0.18	0.11	0.80	0–3	-3.27	0.55	0.64

Table 2
Study 1 correlations among all measures.

	1	2	3	4	5	6	7	8
1. Age								
2. Behavioural PM	.349**							
3. Parent-reported PM	.288*	.043						
4. Tower of Hanoi Score	.665**	.174	.413**					
5. DCCS Total Score	.337*	.247	.372**	.297*				
6. EF Composite Score	.608**	.222	.509**	.804**	.806**			
7. BRIEF-P Global Executive Composite	.024	.025	-.414**	-.194	-.235	-.249		
8. RM Score	.165	.230	.150	.339*	.128	.284*	.042	

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table 3
Study 1 regressions.

	Estimate	Std. Error	95% CI LL	95% CI UL	t	*p*
A. Behavioural PM						
(Constant)		1.30	-2.23	3.02	0.30	0.76
Age	0.25	0.02	-0.01	0.07	1.37	0.18
RM Composite	0.12	0.25	-0.32	0.70	0.76	0.45
EF Composite	0.04	0.30	-0.54	0.67	0.21	0.84
Age * EF	0.06	0.02	-0.04	0.06	0.43	0.67
Age * RM	-0.26	0.02	-0.06	0.01	-1.70	0.10
(Constant)		1.00	-2.68	1.33	-0.68	0.50
Age	0.40	0.01	0.01	0.07	2.87	0.01
BRIEF-P Global Executive Composite	0.06	0.01	-0.01	0.02	0.44	0.67
Age * BRIEF-P	0.13	0.00	0.00	0.00	0.96	0.34
B. Parent-reported PM						
(Constant)		0.70	2.25	5.06	5.24	< .001
Age	0.15	0.01	-0.01	0.03	0.93	0.36
RM Composite	-0.03	0.13	-0.30	0.24	-0.23	0.82
EF Composite	0.42	0.16	0.09	0.74	2.55	0.01
Age * EF	0.18	0.01	-0.01	0.04	1.37	0.18
Age * RM	-0.26	0.01	-0.04	0.00	-1.93	0.06
(Constant)		0.54	2.78	4.95	7.16	< .001
Age	0.28	0.01	0.00	0.03	2.16	0.04
BRIEF-P Composite	-0.39	0.01	-0.03	-0.01	-3.19	0.00
Age * BRIEF-P	0.03	0.00	0.00	0.00	0.22	0.82

.035,.001]. To explore this age by RM interaction, we split the sample into two groups by age-3- and 4-year-olds and 5- and 6-year-olds – and regressed RM on parent-reported PM for each age category. We intended to compare children who were one standard deviation below and one standard deviation above the mean age, however, there were too few children in each group to warrant such a comparison. RM was significantly positively related to parent-reported PM in younger children only, $B = .533$, $SE = .125$, $t = 2.52$, $p = .023$, *95% CI* [.050,.582]. This is in line with the Executive Framework's hypothesis that younger children's RM ability has a larger influence on their PM ability since their EF is still underdeveloped (Mahy et al., 2014a). However, an examination of the distribution of the parent-reported PM scores and RM scores of the low age group revealed that the RM scores were not normally distributed. Because of this, we ran a spearman's Rho correlation with bootstrapping to examine the relation between the two variables. The Spearman's rho coefficient indicated that RM and parent-reported PM were not significantly correlated, $R = .159$, $p = .530$, suggesting that the observed interaction should be interpreted with caution.

A second hierarchical regression was conducted to examine the influence of age, and parent-reported EF on parent-reported PM performance. Age in months and the BRIEF-P Global composite were entered into the first step of the hierarchical regression. Then the BRIEF-P Composite and age were standardised and multiplied to form an interaction term which was entered into the second step of the hierarchical regression. The final model accounted for 24% of the variance in behavioural PM ($R = .487$, $R^2 = .237$). In the final model, both age, $B = .280$, $SE = .008$, $t = 2.16$, $p = .036$, *95% CI* [.001,.032], and parent-reported EF, $B = -.391$, $SE = .005$, $t = -3.19$, $p = .002$, *95% CI* [$-.026$, $-.006$], significantly predicted behavioural PM. There was no significant effect of the interaction between age and parent-reported EF.

Study 1 showed that both EF and RM are important factors in PM performance during the preschool years. EF consistently predicted scores on parent-report measures of PM both when it was measured behaviourally and with parent-reports. This is in line with the prediction of the Executive Framework that EF drives PM development in preschool. RM also emerged as a marginal predictor of young children's parent-reported PM only, in line with the prediction of the Executive Framework that young children's RM play an important role in PM early in development when EF is less developed (Mahy et al., 2014a). There were no significant predictors of behavioural PM, likely due to the challenging nature of the PM task. Discrepancies between behavioural and questionnaire measures of PM have been reported in previous research and it has been suggested that lab tasks do not capture the full scope of naturalistic PM (e.g., Mazachowsky & Mahy, 2020; Talbot & Kerns, 2014; Unsworth, Brewer, & Spillers, 2012). Overall, we found support for some predictions of the Executive Framework.

A limitation of Study 1 was the small sample size of 55 children which likely limited our statistical power. Because these data had been collected for a previous study (Mazachowsky & Mahy, 2020; Study 3), a parent-report measure of RM was not included. Instead, we used a behavioural RM composite to control for RM. Ideally, a parent-report measure of RM would have been collected and used to predict parent-reported PM, something we remedy in Study 2.

4. Study 2

Based on the findings and limitations of Study 1, we conducted a second study to further investigate the predictions of the Executive Framework of PM Development. In addition to further exploring our research questions surrounding the role of RM and EF in the development of PM, we wereinterested in delving deeper into parent-report measures given the limited research on the topic and limitations to in-person behavioural testing due to the COVID-19 pandemic. Multiple reliable and valid parent-report measures of preschool PM have recently been developed (i.e., CFTQ and CEMQ) that warrant further examination. We expected these measures to be positively correlated with one another. Using questionnaires allowed us to address some of the limitations of Study 1 by collecting a larger sample size and including a parent-report measure of RM. One specific concern we had in Study 1 was that parents might have conflated their children's RM and PM ability. By using a parent-report questionnaire that measures both PM and RM, we were able to tease these two abilities apart. A Principal Components Analysis was run on all PM questionnaire items to determine whether PM errors as rated by parents reflect a single ability or multiple distinct abilities. This analysis was largely exploratory. We expected EF to predict PM controlling for age and RM. Like in Study 1, we expect a significant interaction between RM and age such that RM will predict younger children's PM. According to the Executive Framework, we would also expect an interaction between EF and Age such that EF will predict older children's PM. We also were interested to see whether the predictors of parent-reported PM would be consistent across both studies.

4.1. Method

4.1.1. Participants

Four hundred and sixty-five parents of typically developing, English-speaking children between the ages of 3- and 6-years-old participated in the current study. Participants who fit our criteria (residents of the United States, native English speaker, higher than 98% Prolific rating, and had a child between 3 and 6 years of age) were recruited to participate in the study through the online platform Prolific. A total of 167 participants were excluded for the following reasons: 42 participants responded for children who were not within the target range (e.g., younger than three, older than seven), 39 participants were excluded for providing two birth dates for their child that did not match, 20 participants were excluded because they indicated that their child was not typically developing, 63 participants were excluded for completing the survey in an unreasonably short amount of time ($<$ 19 min, lower cut-off time was shortest of two research assistants' fastest completion times), and 3 participants were excluded for failing to estimate their child's age in years and months within one year of their actual age. The final sample consisted of 298 parents (179 mothers, 116 fathers, 2 guardians, 1 chose not to disclose). A post-hoc power analysis using G-Power version 3.1 (Faul et al., 2007) indicated that with five predictors, a sample size of 298 afforded us sufficient power ($> .9$) to detect effects of $f^2 = .06$ or greater. Of these participants, 78 were parents of a 3-year-old child (36 parents of girls and 42 parents of boys; $M_{age} = 42.14$ months, $SD = 4.08$), 71 were parents of a 4-year-old child (32 parents of girls and 38 parents of boys; $M_{age} = 54.89$ months, $SD = 3.50$), 82 parents of a 5-year-old child (42 parents of girls and 40 parents of boys; $M_{age} = 64.83$ months, $SD = 4.79$), and 67 parents of a 6-year-old child (38 parents of girls and 29 parents of boys; $M_{age} = 76.43$ months, $SD = 4.83$). Parents were predominantly Caucasian (87.8% white or Caucasian, 7.1% Black or African American, 2.4% Hispanic, Latino, or Spanish, 1% Asian,.7% Asian Indian, and.3% other) and middle class (8.4% less than $25,000, 11.7% between $25,000 and $40,000, 27.9% between $40,000 and $75,000, 21.1% between $75,000 and $100,000, 30.2% over $100,000, and .7% chose not to answer).

4.1.2. Measures

4.1.2.1. Prospective memory questionnaires

4.1.2.1.1. Children's Future Thinking Questionnaire (CFTQ; Mazachowsky & Mahy, 2020). The CFTQ is a parent-report measure of children's future-oriented cognition (see Section 3). For this study we were specifically interested in the 8-item PM subscale of the CFTQ, though the questionnaire also included subscales that assess children's saving, episodic foresight, planning, and delay of gratification. Higher scores on this measure indicated better PM performance.

4.1.2.1.2. Children's Everyday Memory Questionnaire (CEMQ; Mazachowsky, et al., 2021). The CEMQ is a 43-item parent-report measure of children's PM. It is a modified version of the unpublished Prospective Memory Questionnaire – Child (Baysinger, Hannon, Seaborne, & Hoover, 2005) which itself was adapted from the Prospective Memory Questionnaire (PMQ; Hannon et al., 1995), a self-report measure of PM in adults. The questionnaire features four subscales intended to measure different aspects of everyday PM. The long-term episodic subscale is concerned with sporadic intentions meant to be carried out hours or days in the future (e.g., "forgets to return a reading book to school", "forgets to give you a message"). The short-term habitual subscale captures regular, routine intentions (e.g., "forgets to fasten (button or zip) some part of their clothes", "forgets to brush their teeth"). The internally-cued subscale measures children's ability to remember intentions that do not have a clear external cue (e.g., "get part way through a job and forget to finish it", "forget to ask you for something they need i.e., for school/nursery"). The questionnaire also features a fourth subscale which measures children's strategy use, but that was not of interest in the current study. Parents were asked to indicate the frequency with which their child forgets to carry out certain intentions on a 5-point Likert scale (1 – *never*, 2 – *sometimes*, 3 – *often*, 4 – very often, 5 – *always*). A "non-applicable" option was also available. Higher scores indicated worse PM (i.e., the child being prone to forgetting), but items were reverse-scored such that higher scores reflected better PM.

4.1.2.1.3. Prospective and Retrospective Memory Questionnaire – Children (PRMQ-C; Kliegel & Jäger, 2007). The PRMQ-C is a 16-item parent-report measure of both prospective and retrospective memory in children. It was adapted from the original PRMQ, an adult self-report measure of the frequency of everyday PM and RM errors (Smith, Della Sala, Logie, & Maylor, 2000). In the PRMQ-C, parents are instructed to indicate how often their child makes various errors of PM and RM on a 5-point Likert scale (1 – *never*, 2 – *sometimes*, 3 – *often*, 4 – *very often*, 5 – *always*). The questionnaire features an equal number of PM and RM items which are evenly divided into self-cued and environmentally-cued scenarios. Items include "Does your child decide to do something in a few minutes' time and then forget to do it?" and "Does your child look at something without realising he/she has seen it moments before?". Higher scores on the PRMQ-C indicate worse PM and RM, but the PM subscale was reverse-scored so that higher scores reflected better PM.

4.1.2.2. Retrospective memory questionnaire

4.1.2.2.1. Children's Memory Questionnaire – Revised (CMQ-R; Hedges, Drysdale, & Levick, 2015). The CMQ-R is a 36-item questionnaire designed to assess parental perceptions of their children's RM. It was based on the Everyday Memory Questionnaire (EMQ; Sunderland, Harris, & Baddeley, 1983), a self-report measure of adult retrospective memory. The questionnaire features three subscales intended to tap distinct aspects of RM: (1) Episodic memory, (2) Visual Memory, and (3) Working Memory and Attention. Parents were asked to indicate how often their children experience particular memory problems on a 5-point Likert scale (1 – *Never or almost never happens*, 2 – *Happens less than once a week*, 3 – *Happens once or twice in a week*, 4 – *Happens about once a day*, 5 – *Happens more than once a day*). Example items include "Forgets what she/he was told a few minutes ago" and "Loses things".

4.1.2.3. Executive function questionnaire

4.1.2.3.1. Behaviour Rating Inventory of Executive Functioning - Preschool (BRIEF-P; Gioia et al., 2003). The BRIEF-P is a 63-item parent-report measure of executive function in preschool (see Section 3). It assesses five aspects of EF: working memory, inhibition, cognitive flexibility, emotional control, and planning/organisation. Higher scores reflected a greater degree of executive impairment.

4.1.2.4. Demographics questionnaire. Participants completed a demographics questionnaire that asked parents to report on their own education, occupation, and annual family income, and their child's age, sex, health, and ethnicity.

4.1.3. Procedure

Participants completed all questionnaire measures in this study using the online survey platform Qualtrics and were recruited through Prolific. After providing consent, the questionnaires were presented to participants in random order except for the parent and child demographics questionnaires which were always presented at the end of the study. The items in each questionnaire were ordered according to their original administration and were not randomised. One attention check question was randomly inserted into each questionnaire except for the demographics questionnaire (five in total). Participants who failed more than one attention check were excluded from the final sample. The average time to complete the study was 37.59 min. All procedures for this study were approved by the Research Ethics Board at Brock University.

Table 4
Study 2 descriptive statistics.

	N	*M*	*SD*	*Possible Range*	*Minimum*	*Maximum*	*Std. Error*	*Variance*
CFTQ Total Score	298	3.82	0.63	0-6	1.71	5.89	0.04	0.39
CFTQ PM Score	298	4.09	0.88	0–6	1.57	6.00	0.05	0.78
CEMQ Total PM Score	298	4.15	0.53	1–5	1.62	5.00	0.03	0.28
CEMQ Total Score	298	3.56	0.42	1–5	1.54	4.46	0.02	0.18
CEMQ Long-term Episodic Subscale	298	4.19	0.68	1–5	1.13	5.00	0.04	0.46
CEMQ Short-term Habitual Subscale	298	4.04	0.55	1–5	1.89	5.00	0.03	0.31
CEMQ Internally-Cued Subscale	298	4.27	0.59	1–5	1.31	5.00	0.03	0.35
PRMQ Total Score	298	33.49	9.54	16–80	16.00	65.00	0.55	90.96
PRMQ PM Subscale (Reverse-Scored)	298	31.09	5.29	8–40	11.00	40.00	0.31	28.06
PRMQ RM Subscale	298	15.99	4.34	8–40	8.00	29.00	0.25	18.83
CMQ Total Score	298	63.87	18.04	34–170	36.00	138.00	1.05	325.46
CMQ Episodic Subscale	298	29.60	9.14	14–70	14.00	64.00	0.53	83.58
CMQ Visual Subscale	298	14.70	4.33	11–55	11.00	34.00	0.25	18.75
CMQ Working Memory & Attention Subscale	298	19.57	6.61	11–55	11.00	48.00	0.38	43.65
BRIEF-P Global Executive Composite Score	298	101.81	20.98	63–189	65.00	164.00	1.22	440.16

Table 5
Study 2 correlations between measures.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. CFTQ Total Score																	
2. CFTQ PM Score	.809**																
3. CEMQ Total PM Score	.582**	.530**															
4. CEMQ Total Score	.638**	.582**	.959**														
5. CEMQ Long-term Episodic Subscore	.465**	.490**	.846**	.827**													
6. CEMQ Short-term Habitual Subscore	.579**	.502**	.916**	.897**	.648**												
7. CEMQ Internally-Cued Subscore	.468**	.402**	.874**	.797**	.654**	.689**											
8. PRMQ Total Score	-.013	-.058	-.072	-.054	-.051	-.084	-.046										
9. PRMQ PM Subscale (Reverse-Scored)	.484**	.475**	.671**	.647**	.537**	.616**	.611**	-.113									
10. PRMQ RM Subscale	-.443**	-.404**	-.585**	-.529**	-.428**	-.521**	-.593**	.096	-.751**								
11. CMQ Total Score	-.518**	-.454**	-.711**	-.661**	-.515**	-.659**	-.692**	.048	-.680**	.704**							
12. CMQ Episodic Subscale	-.517**	-.484**	-.689**	-.661**	-.513**	-.657**	-.630**	.036	-.693**	.662**	.941**						
13. CMQ Visual Subscale	-.338**	-.272**	-.525**	-.436**	-.397**	-.419**	-.589**	.083	-.422**	.583**	.761**	.570**					
14. CMQ Working Memory & Attention Subscale	-.478**	-.393**	-.646**	-.603**	-.435**	-.616**	-.632**	.026	-.620**	.624**	.930**	.812**	.634**				
15. BRIEF-P Global Executive Composite Score	-.520**	-.397**	-.611**	-.589**	-.379**	-.627**	-.564**	.001	-.587**	.586**	.728**	.711**	.448**	.710**			
16. PM Composite Score	.707**	.810**	.643**	.670**	.592**	.606**	.495**	-.006	.135*	-.183**	-.376**	-.372**	-.275**	-.330**	-.336**		
17. RM Composite Score	-.526**	-.486**	-.697**	-.651**	-.515**	-.644**	-.670**	.073	-.793**	.916**	.899**	.906**	.633**	.785**	.710**	-.302**	
18. BRIEF-P Composite Score	-.509**	-.385**	-.600**	-.577**	-.368**	-.620**	-.555**	-.004	-.577**	.583**	.720**	.702**	.446**	.702**	.998**	-.326**	.703**

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

4.2. Results and discussion

4.2.1. Preliminary analyses

Table 4 shows descriptive statistics for all measures in Study 2. One hundred and eighty-five participants (62.1%) were missing data (blank, *not applicable*, *prefer not to answer*, or *does not apply*) from at least one item of one of the questionnaires. Most missing data were non-response options (i.e., *not applicable* or *prefer not to answer*). Blank responses made up less than 1% of missing data. Missing values were replaced in SPSS using the estimation maximization procedure.

4.2.2. Correlational analyses

Table 5 shows the correlations between all questionnaires and subscales. As predicted, all three PM questionnaires (CEMQ, PRMQ-C PM scale, and CFTQ PM subscale) were significantly positively correlated (see Table 5). This was the first time that these three PM questionnaires have been examined and suggests that all questionnaires are tapping into a similar PM construct. Scores on each PM scale were standardised and combined into a single PM composite.

The CMQ-R Episodic subscale and PRMQ-C RM subscale were also positively correlated (Table 5) and combined into a single RM composite. The BRIEF-P Global Executive Composite (the sum of scores on all subscales) was our composite EF measure.

4.2.3. The role of retrospective memory and executive function in children's prospective memory

A regression analysis was conducted to determine the extent to which age, parent-reported RM, and parent-reported EF predicted parent-reported PM (see Table 6). Age-in-months, the RM composite, and the EF composite were entered in the first step of a hierarchical regression analysis. Then, RM, EF, and age were standardised and multiplied to form two interaction terms: Age by RM and Age by EF. These interaction terms were entered into the second step of the regression analysis.

The final model accounted for 14% of the variance in parent-reported PM ($R = .375$, $R^2 = .140$). In the final model, both the EF composite, $B = -.193$, $SE = .042$, $t = -2.48$, $p = .013$, *95% CI* [− .187, − .022], and the RM composite, $B = -.167$, $SE = .039$, $t = -2.16$, $p = .031$, *95% CI* [− .163, − .008], significantly predicted parent-reported PM. The finding that EF independently predicted PM lends support to the Executive Framework of PM development and adds to the growing literature that suggests that EF is responsible for PM development in preschool-aged children (Mahy et al., 2014b; Zhao et al., 2019). However, RM also independently predicted PM, indicating that the involvement of RM in PM is not limited to younger preschool children. This finding suggests that both RM and EF contribute to the ongoing development of PM.

There was also a significant effect of the interaction between age and EF, $B = .162$, $SE = .003$, $t = 2.14$, $p = .033$, *95% CI* [.001,.013]. To explore the interaction effect, we split the sample into three groups corresponding to young, middle, and older age (following our approach in Study 1). EF was significantly positively related to PM in young children, $B = -.423$, $SE = .056$, $t = -4.62$, $p < .001$, *95% CI* [− .368, − .147], and middle-age children, $B = -.350$, $SE = .051$, $t = -.350$, $p < .001$, *95% CI* [− .288, − .086], but not in the older-age group, $p > .05$. This finding is contrary to the prediction of the Executive Framework that suggests younger children's PM should reflect their RM while older children's PM is driven by their EF.

Children younger than 24 months show evidence of executive ability (Müller & Kerns, 2015), however, young children are assumed not to have sufficient executive ability to carry out their intentions. Past behavioural research has found that young children fail PM tasks despite memory for the intention being intact (e.g., Guajardo & Best, 2000; Kliegel & Jäger, 2007). The present results using parent-reports contradict previous behavioural research, indicating that there may be particular EF demands in lab tasks that young children struggle with that are not present in naturalistic PM. Toplak, West, and Stanovich (2013) have argued that EF measures in the lab only reflect efficiency of processing while questionnaire measures capture a holistic account of children's tendency to self-initiate and complete complex tasks. Thus, young children's EF may not be efficient enough to succeed in laboratory PM tasks, however that does not mean they do not draw on their executive abilities to initiate and complete tasks independently in their day-to-day lives.

4.2.4. Do children's prospective memory errors fit into distinct categories?

Finally, we examined the factor structure of the PM items used in this study to determine whether they reflect a single ability or multiple distinct abilities. A principal components analysis (PCA) with varimax rotation was performed on the items from the CEMQ, CFTQ PM subscale, and PRMQ-C PM subscale. The Kaiser–Meyer–Olkin (KMO) was .94, exceeding the recommended value of .6 (Kaiser & Rice, 1974) and Bartlett's Test of Sphericity was significant ($\chi^2 = 9753.51$, $df = 1128$, $p < .001$) indicating that the data were appropriate for a PCA.

Table 6
Study 2 regression.

	Standardised coefficients		95% CI			
	Beta	Std. Error	LL	UL	*t*	*p*
(Constant)		0.106	-0.388	0.029	-1.697	0.091
Age	0.094	0.002	0	0.006	1.712	0.088
RM Composite	-0.167	0.039	-0.163	-0.008	-2.162	0.031
BRIEF-P Composite	-0.193	0.042	-0.187	-0.022	-2.489	0.013
Age * RM	-0.072	0.003	-0.009	0.003	-0.947	0.344
Age * BRIEF	0.162	0.003	0.001	0.013	2.137	0.033

Eight components had eigenvalues greater than one and explained 64.94% of the variance when combined. However, the scree plot did not support the retention of eight components, nor did a parallel analysis which indicated that the eigenvalues of only five of the components could not have occurred by chance. Based on these metrics, a 5-component solution was selected. In total, these five components explained 57.54% of the variance. After rotation, component one explained 14.32% of the variance, component two explained 12.24%, component three explained 9.43%, component four explained 7.81% and component five explained 6.83%.

See Appendix A for full rotated component matrix. Items that loaded onto the first component were all concerned with passing on messages (e.g., Forgets to give you a message) or returning or handing in items (e.g., Forgets to return something they borrowed from a friend or relative). Children would likely be instructed to carry out these tasks by someone else (e.g., parents or teachers), and thus would not be highly motivating to the child. Failure to complete these tasks could reflect a failure of memory, or failure to keep the intention at the forefront of consciousness due to lack of interest or motivation. Items that loaded onto the second component involved the child beginning an activity but failing to see it through to completion (e.g., get partway through a job and forget to finish it). Failure to follow through with commenced activities or tasks could be due to a failure to inhibit other distractions to stay on task. Component three included items which detailed the child reminding caregivers to perform scheduled tasks (e.g., reminding parents to pick up Halloween treats) or remembering their own schedule (e.g., remembering what time to be at a friend's house). All scheduled activities would be motivating to a child, perhaps explaining their propensity to anticipate and plan for them. Items that loaded on component four seemed to involve failures of short-term memory such as forgetting to carry out very recently set intentions, even when a visual cue was present (e.g., forgetting to take something with them when they leave the room despite it being right in front of them). The inability to bring a recent intention to mind at the appearance of a cue could indicate a lack of monitoring of the external environment. Finally, items that loaded onto component five consisted of daily tasks, routines, and scripts that a child might be instructed to perform in their daily life such as combing their hair writing their name on their schoolwork (e.g., "Forgets to comb/brush their hair in the morning"). Failure to complete these tasks could indicate a failure to effectively form habits, perhaps because they have not sufficiently encoded each routine/script.

Because we found that PM items loaded onto five components, we ran some exploratory analyses to determine whether the components were related to the five subscales of the BRIEF-P. Table 7 shows the correlations between the components and the BRIEF-P subscales. All components were significantly related to multiple EFs as measured by the BRIEF-P and therefore did not tell a clear story regarding the relation between these abilities. To further explore the relations between the PM components and individual EFs as measured by the BRIEF-P, we conducted a series of regression analyses. The five BRIEF-P subscales as well as RM were regressed onto each component (See Table 8). Component one was independently predicted by RM, lending support to the idea that component one corresponds to a failure to recall the content of the intention. Component two was predicted by RM and working memory, indicating that children who only get partway through a task do so because they fail to keep their intentions in mind. Component three was predicted by RM, which may contribute to children's memory for their scheduled activities, and emotional control, which may relate to the salient and motivating nature of the items. Component four was predicted by planning and RM. These may reflect a child's inability to encode short-term intentions and to construct multi-step plans to carry them out effectively. Component five was marginally predicted by WM, which we speculated would be related to children's inability to carry out recently-set intentions.

Study 2 provided mixed support for the Executive Framework. EF was revealed to be a significant predictor of parent-reported PM in preschool when controlling for age and RM. These results support the prediction that EF is a substantial driver of PM development during preschool (Mahy et al., 2014a). However, RM also emerged as an independent predictor of children's PM and EF emerged as a predictor of younger, but not older children's PM in particular. These findings are not in line with the predictions of the Executive Framework. It seems that while EF is clearly involved in PM development, its influence may appear earlier than predicted. It seems that RM is also involved beyond what was expected by the Executive Framework.

The three parent-report measures of PM were all significantly positively correlated, indicating that they are indeed measuring the same underlying construct of PM. The items from our PM questionnaires loaded onto five components. Although these components did not clearly reflect errors due to RM and EF, examining the items revealed that each component seemed to correspond to varying levels of self-initiation and motivation that may be relevant to automatic versus controlled processes involved in PM. This suggests that PM is

Table 7
Correlations between PM components and BRIEF-P subscales.

	1. BRIEF-P Inhibit Subscale	2. BRIEF-P Shift Subscale	3. BRIEF-P Emotional Control Subscale	4. BRIEF-P Working Memory Subscale	5. BRIEF-P Planning Subscale
1. Component 1	-.105	-.001	-.009	-.169**	-.123*
2. Component 2	-0.255**	-.287**	-.191**	-.428**	-.305**
3. Component 3	-.180**	-.067	-.047	-.238**	-.203**
4. Component 4	-.250**	-.223**	-.213**	-.335**	-.262**
5. Component 5	-.115*	-.161**	-.060	-.200**	-.156**

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table 8
Predictors of PM components.

	Estimate	Std. Error	95.0% CI		*t*	*p*
			LL	UL		
A. Component 1						
(Constant)		0.42	-1.05	0.61	-0.51	0.61
Inhibit Subscale	0.00	0.02	-0.03	0.03	0.05	0.96
Shift Subscale	0.10	0.02	-0.01	0.06	1.37	0.17
Emotional Control Subscale	0.11	0.02	-0.01	0.07	1.34	0.18
Working Memory Subscale	-0.16	0.02	-0.07	0.01	-1.34	0.18
Planning Subscale	0.03	0.03	-0.04	0.06	0.30	0.77
RM	-0.19	0.11	-0.44	-0.03	-2.22	0.03
B. Component 2						
(Constant)		0.38	0.31	1.81	2.78	0.01
Inhibit Subscale	0.09	0.01	-0.01	0.04	1.07	0.29
Shift Subscale	-0.12	0.02	-0.06	0.00	-1.87	0.06
Emotional Control Subscale	0.12	0.02	-0.01	0.06	1.54	0.13
Working Memory Subscale	-0.46	0.02	-0.11	-0.04	-4.17	< .001
Planning Subscale	0.13	0.02	-0.01	0.08	1.37	0.17
RM	-0.20	0.10	-0.43	-0.05	-2.50	0.01
C. Component 3						
(Constant)		0.42	-0.47	1.17	0.85	0.40
Inhibit Subscale	0.00	0.02	-0.04	0.02	-0.67	0.50
Shift Subscale	0.00	0.02	-0.03	0.05	0.58	0.56
Emotional Control Subscale	-0.03	0.02	0.00	0.08	2.04	0.04
Working Memory Subscale	0.07	0.02	-0.07	0.01	-1.42	0.16
Planning Subscale	0.18	0.03	-0.06	0.04	-0.36	0.72
RM	-0.72	0.10	-0.38	0.03	-1.73	0.09
D. Component 4						
(Constant)		0.36	-1.69	-0.29	-2.78	0.01
Inhibit Subscale	0.00	0.01	-0.03	0.03	0.01	0.99
Shift Subscale	0.00	0.02	-0.03	0.03	0.06	0.95
Emotional Control Subscale	-0.03	0.02	-0.04	0.03	-0.46	0.64
Working Memory Subscale	0.07	0.02	-0.02	0.05	0.70	0.49
Planning Subscale	0.18	0.02	0.00	0.08	1.99	0.05
RM	-0.72	0.09	-1.03	-0.68	-9.67	< .001
E. Component 5						
(Constant)		0.42	-0.03	1.69	2.03	0.04
Inhibit Subscale	0.04	0.02	-0.03	0.04	0.37	0.71
Shift Subscale	-0.13	0.02	-0.07	0.00	-1.73	0.09
Emotional Control Subscale	0.14	0.02	-0.01	0.07	1.66	0.10
Working Memory Subscale	-0.24	0.02	-0.08	0.00	-1.95	0.05
Planning Subscale	-0.01	0.03	-0.05	0.05	-0.09	0.93
RM	0.00	0.11	-0.21	0.21	-0.003	0.10

not a unitary ability and performance may change depending on who initiates the intention and its salience and important to the child (e.g., Kliegel & Jäger, 2007; Robson, 2016; Somerville, Wellman, & Cultice, 1983).

5. General discussion

The goal of the current study was to test the predictions of Mahy et al. (2014a) Executive Framework of PM Development. Specifically, we were interested to see whether children's PM would be predicted by their RM or EF ability and whether these predictors changed with age. Using both behavioural and parent-report measures of PM allowed us to determine whether predictors differed between these two methods.

In Study 1, children completed a series of behavioural tasks assessing their PM, RM, and multiple aspects of their EF. Parents also filled out questionnaires pertaining to their children's PM and EF abilities. In Study 2, only parent-report measures were used; three measures of PM and independent measures of RM and EF. Overall, we found some support for the Executive Framework's prediction that EF should predict preschool PM. However, this was only observed for parent-reported and not behavioural PM. Further, RM also emerged as a predictor of parent-reported PM in Study 2.

5.1. *Support for the executive framework*

In accordance with the Executive Framework of PM Development, EF consistently predicted parent-reported PM in both studies, independently of age and RM. This suggests that executive improvements indeed drive PM development in preschool, particularly when measured by parents in a naturalistic context. This is consistent with other work reporting that preschool improvements in PM were predicted by prospective rather than retrospective processes (Mahy et al., 2014b; Walsh, Martin, & Courage, 2014) and with prevailing theories of PM that focus on controlled processes such as the Multiprocess Framework (McDaniel & Einstein, 2000) and the PAM model (Smith, 2003). Further, both behavioural and parent-rated EF predicted parent-reported PM in Study 1, adding robustness to this finding. We also observed a marginal interaction between age and RM in Study 1 such that parent-reported PM was predicted by the RM composite in younger children only. This finding lends support to the prediction of the Executive Framework that younger children with less-developed EFs must rely on their RM ability to succeed on PM tasks (Guajardo & Best, 2000; Kliegel & Jäger, 2007; Mahy et al., 2014a).

5.2. Results inconsistent with the executive framework

The results of Study 2 somewhat diverge from the predictions of the Executive Framework. While EF remained a significant predictor of parent-reported PM controlling for age, RM also emerged as a significant predictor of PM in the same model. This indicates that the Executive Framework may underestimate the enduring role of RM in PM development. Indeed, Smith, Bayen, and Martin (2010) found RM predicted PM in children from age 7 to 10, indicating that retrospective abilities remain important to successful PM long after the preschool years. The Multiprocess Framework (McDaniel & Einstein, 2000) argues that associative processes may support PM depending on task features and individual differences. Perhaps older children who are more proficient in both the retrospective and prospective components of PM require less executive help to carry out their intentions and can instead rely on the strength of their associative abilities.

The interaction between age and EF in Study 2 also contradicts the predictions of the Executive Framework. Better EF as rated by parents was related to better parent-reported PM in younger children but not older children. According to the Executive Framework, we expect executive abilities to predict older children's PM performance and RM to predict younger children's PM performance. One explanation for this unexpected finding is that young children with better overall self-control are more independent in setting and carrying out their own intentions without caregiver help relative to their peers, resulting in higher PM scores as rated by parents. Parents likely have higher expectations of older children, resulting in lower scores for similar behaviour.

5.3. Predictors of behavioural PM

Neither EF nor RM predicted behavioural PM in Study 1. Only age emerged as a significant predictor when included in a model with parent-reported EF. Focal (high level of overlap between PM task and OT) and specific (specific event signals the occasion to carry out the intention) PM tasks such as the one used in the present study have been shown to tax RM processes more than tasks with categorical PM cues (Cottini, Basso, & Palladino, 2018; Marsh, Hicks, & Cook, 2005). Indeed, children in our sample struggled with the RM component of the task, as roughly a quarter of children failed to recall the PM intention. After excluding children who failed the RM control question, we were left with only 55 children. This sample size may have been too small to capture sufficient variance in children's behavioural PM.

5.4. Predictors of behavioural vs parent-reported prospective memory

Despite the small sample size in Study 1, both behavioural and parent-reported EF were found to predict scores on our parent-report measure of PM. It is not unexpected that we found different predictors of behavioural and parent-reported PM in the same sample. Unsworth et al. (2012) showed that adult self-reports of PM failures were unrelated to performance in a laboratory PM task. The validation of the CFTQ similarly showed that the PM scale was the only subscale not significantly correlated with its corresponding behavioural measure, although the relation was in the expected positive direction (Mazachowsky & Mahy, 2020). It has been speculated that lab tasks might be too narrow in scope to capture PM processes as they occur in everyday life, instead capturing peripheral processes such as RM or verbal ability (Einstein & McDaniel, 1996). Our results are consistent with this notion and support the utility of both types of measures in capturing the full scope of PM. Future research should consider developing new laboratory measures that better reflect everyday PM.

5.5. Executive function and parent-reported prospective memory

Parent-reported PM was predicted by EF in Study 1, and again in Study 2. The repeated implication of EF in parent-reported, but not behavioural PM seems to indicate that the questionnaire measures in the present study may be uniquely suited to capturing the prospective component of PM. Talbot and Kerns (2014) found that children (8- to 13-year-olds) who were rated highly on measures of inattention and hyperactivity were also reported as experiencing more PM errors on the PRMQ-C. Ratings of inattention and hyperactivity, however, showed no relationship to event-based PM performance. This suggests that parent ratings of EF are uniquely related to parent-rated, but not to behavioural, PM performance. Of course, the fact that EF did not predict behavioural PM may suggest that the relation between parent-reported PM and EF could have been due to the common method biases. Since one parent completed all the measures in Study 2, this may have artificially inflated the covariance between our parent-report measures (see Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). For example, parents might have wanted to appear consistent when answering each questionnaire resulting in positive relations that may not have appeared in performance-based measures. Many of our questionnaires featured similar scale formats (Likert scales) which may have similarly inflated the positive relations between our measures. However, both behavioural and parent-reported EF were significant predictors in Study 1, indicating that this may not have been the case in the present study.

It has been argued that performance-based and questionnaire measures capture different constructs. In their review, Toplak et al. (2013) speculated that the optimal performance conditions of most lab tasks leave little room for interpretation or self-initiation, and as such, are only equipped to capture efficiency of processing. By contrast, they argue that questionnaire measures capture a more holistic reflection of children's typical performance under normal conditions. As such, they are better equipped to capture children's ability to self-regulate and accomplish goals. Each type of measure provides insight into different aspects of PM and both should be used in tandem to understand the full scope of children's PM.

5.6. Principal components analysis

A Principal Components Analysis indicated that the items from the PM questionnaires loaded onto five distinct components. After an examination of the items, we speculated that each component reflected a different cognitive ability associated with PM, namely: (1) working memory, (2) inhibition, (3) planning, (4) monitoring, and (5) RM. Our exploratory correlation analyses found some support for this idea. Hannon and colleagues (1995) categorised PM into three distinct categories, each reflecting different types of intentions applicable to distinct contexts. The components identified in the present study along with the finding that PM is predicted differently in naturalistic and lab settings (Mazachowsky & Mahy, 2020; Talbot & Kerns, 2014; Unsworth et al., 2012) supports the notion that PM may not refer to a singular behaviour, but rather represents a group of behaviours that involve the setting and completion of different types of future intentions in varying contexts. Future research should consider teasing the different PM contexts apart to study them individually.

5.7. Relations among prospective memory questionnaires

A novel contribution of the present study was to establish positive correlations among three parent-report measures of PM in childhood. The CFTQ and CEMQ are relatively new measures of children's PM, having been developed or adapted within the last two years, and their relations to the more established PRMQ-C and each other have yet to be explored. All three scales showed strong positive correlations indicating that they are indeed tapping into the same construct. This finding is encouraging for future research on preschool PM as there are now three reliable and valid parent-report measures of PM that are available to researchers. These questionnaire measures will be especially valuable for providing insights into naturalistic aspects of preschool children's PM that cannot be obtained in laboratory settings and for capturing the relationship between EF and PM. Future research should consider combining parent-reports with other respondents such as teacher-reports or secondary-caregiver reports to capture the full scope of children's PM.

5.8. Limitations

Despite the findings of the current study, relying on parent-reports of PM has some limitations. Since naturalistic PM often involves internal processes (i.e., setting one's own intention and then fulfilling it at the appropriate time), parents may not be able to accurately report on the frequency of their children's PM errors. This may have disproportionately affected older children who might have more self-initiated intentions that are unknown to parents. Additionally, parents may be hesitant to report on their children's PM, RM, and EF errors, despite these being natural features of development, resulting in reporting bias. Though behavioural measures were included in our Study 1, the COVID-19 pandemic prevented the collection of behavioural data for Study 2. We found that the same predictors of parent-reported PM persisted across both studies but could not verify the consistency of behavioural predictors in our second study.

6. Conclusion

In sum, the present study investigated the predictors of preschool children's PM to better understand the mechanisms of age-related improvements during this period. EF consistently predicted parent-reported PM regardless of the method of EF measurement lending support to the Executive Framework's prediction that executive abilities drive PM development in preschool. RM was also a significant predictor of parent-reported PM in Study 2 and there was a significant effect of the interaction between EF and age such that EF predicted younger, but not older children's PM. We found evidence that parent-report PM questionnaires are tapping into a similar construct but may capture different aspects of PM than behavioural measures. PM errors fell into five distinct categories reflecting various levels of self-initiation and motivation. Future research should further investigate the role of RM and EF as predictors of PM using behavioural measures and incorporate parent-report questionnaires into research whenever possible. Longitudinal studies are necessary to provide a more in-depth understanding of cognitive abilities that drive PM development in early childhood.

Acknowledgments

Preparation of this manuscript was partially supported by an NSERC RGPIN-2015-03774, Discovery Grant and an Early Research Award - ER 17-13-118 from the Ontario Ministry of Research, Innovation, and Science to CEVM. TSSF was supported by an Ontario Graduate Scholarship and a Social Sciences and Humanities Research Council of Canada Joseph Armand Bombardier Canada Graduate Scholarship-Master's Scholarship.

Appendix A. Rotated component matrix

	Component				
	1	2	3	4	5
7. Forgets to give a message or note to their teacher	0.809				
5. Forgets to give you a message	0.809				
1. Forgets to return a reading book to school	0.795				
3. Forgets to give you a party invitation from a friend	0.784	0.334			
2. Forgets to give you letters or forms from school	0.778				
6. Forgets to pass on a message to one of their friends	0.764				
8. Forgets to return something they borrowed from a friend or relative	0.736				
4. Forgets it's going to be another family member's birthday	0.623				
25. Comes into a room and forgets what they came in for		0.773			
28. Forget to finish telling someone a story about their day		0.755			
30. Start writing or drawing something and forget what they were trying to write/draw		0.699			
24. Forgets what they want to say in the middle of a sentence		0.656			
33. Forget to finish an activity (e.g. puzzle, jigsaw, drawing)		0.640			
32. Forget to tell you something important that happened	0.318	0.623			
27. Get part way through a job and forget to finish it	0.302	0.557			
22. Forgets to take something to school/nursery/relative's house that they wanted to show		0.529			0.368
26. Forgets to bring something they need with them when they leave the house	0.314	0.516			
29. Forget to ask you for something they need i.e. for school/nursery	0.451	0.508			
31. Forget to tell you that they've used the last of something (e.g. chips, drinks, toilet roll)			0.763		
11. Gives reminders to parent or others of something he/she forgot (e.g., reminds his/her parent to pick up Halloween treats for the class).			0.745		
9. Forgets to fasten (button or zip) some part of their clothes			0.732		
19. Forgets to say please and thank you			0.704		
27. Remembers to pass on messages to family/friends (e.g., tell mom/dad to pick up pizza for dinner when mom/dad picks you up from school).			0.672		
5. Remembers what time he/she is supposed to be places (e.g., at 3 p.m. he/she is due at a friend's house).			0.669		
34. Forgets what is scheduled for the week (e.g., music lessons after school).			0.612		
43. Forgets to bring appropriate clothing for changes in weather (e.g., forgets rain jacket or umbrella when it is going to rain).			0.526		
16. Does your child forget to say something he/she had meant to mention a few minutes prior?		0.333		0.665	
5. Does your child forget to get parent notices signed, or go to extracurricular activities if he/she is not prompted by someone else or by a reminder such as an agenda or planner?	0.371			0.621	0.304
12. Does your child fail to mention or give you something that he/she was asked to pass on?	0.404			0.617	
10. Does your child intend to take something with him/her before leaving a room or going out, but minutes later leaves it behind, even though it's there in front of him/her?				0.615	
7. Does your child forget to either bring or turn in his/her homework that is completed?				0.596	0.395
1. Does your child decide to do something in a few minutes' time and then forget to do it?		0.340		0.572	
3. Does your child fail to do something he/she was supposed to do a few minutes later even though it's there in front of him/her, like turning off the TV or video game console or picking up his/her backpack before heading to school?				0.551	
14. If your child tried to contact a friend or relative but they were out, would he/she forget to try again later?				0.480	
14. Forgets to bring/hand in their lunch money	0.363	0.381			0.635
16. Forgets to do their homework	0.303				0.588
21. Forgets to take their homework to school	0.375	0.434			0.570
23. Forgets what they are supposed to do for homework					0.564
13. Forgets to write their name on a piece of schoolwork or a drawing					0.542
9. Forgets to fasten (button or zip) some part of their clothes		0.334			0.491
10. Forgets to comb/brush their hair in the morning					0.484

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

Appendix B. Are predictors of PM in line with the executive framework?

	Outcome	All predictors	Significant predictors	In line with the executive framework?
Study 1	Behavioural PM	Step 1: Age, EF, RM Step 2: Age by EF, Age by RM	N/A	No
		Step 1: Age, BRIEF Global Composite Step 2: Age by BRIEF Global Composite	Age	No
	Parent-Report PM	Step 1: Age, EF, RM Step 2: Age by EF, Age by RM	EF	Yes
		Step 1: Age, BRIEF Global Composite Step 2: Age by BRIEF Global Composite	Age EF	Yes
Study 2	Parent-Report PM			Mixed support

(*continued on next page*)

(*continued*)

Outcome	All predictors	Significant predictors	In line with the executive framework?
	Step 1: Age, EF, RM Step 2: Age by EF, Age by RM	RM EF Age by EF	

References

Bauer, P. J., & Dow, G. A. (1994). Episodic memory in 16- and 20-month-old children: Specifics are generalized but not forgotten. *Developmental Psychology, 30*(3), 403–417. https://doi.org/10.1037/0012-1649.30.3.403

Baysinger, K., Hannon, R., Seaborne, L., & Hoover, M. (2005). *Developing a prospective memory questionnaire for 10–12 year olds* [Poster presented]. Meeting of the Western Psychological Association, Portland.

Carlson, S. M. (2005). Developmentally sensitive measures of executive function in preschool children. *Developmental Neuropsychology, 28*, 595–616. https://doi.org/10.1207/s15326942dn2802_3

Carlson, S. M., Mandell, D. J., & Williams, L. (2004). Executive function and theory of mind: Stability and prediction from ages 2 to 3. *Developmental Psychology, 40*(6), 1105–1122. https://doi.org/10.1037/0012-1649.40.6.1105

Cohen, M. A., Horowitz, T. S., & Wolfe, J. M. (2009). Auditory recognition memory is inferior to visual recognition memory. *Proceedings of the National Academy of Sciences, 106*(14), 6008–6010. https://doi.org/10.1073/pnas.0811884106

Cottini, M., Basso, D., & Palladino, P. (2018). The role of declarative and procedural metamemory in event-based prospective memory in school-aged children. *Journal of Experimental Child Psychology, 166*, 17–33. https://doi.org/10.1016/j.jecp.2018.10.008

Crawford, J. R., Smith, G., Maylor, E. A., Della Sala, S., & Logie, R. H. (2003). The Prospective and retrospective memory questionnaire (PRMQ): Normative data and latent structure in a large non-clinical sample. *Memory, 11*(3), 261–275. https://doi.org/10.1080/09658210244000027

Dismukes, R. K. (2012). Prospective memory in workplace and everyday situations. *Current Directions in Psychological Science, 21*(4), 215–220. https://doi.org/10.1177/0963721412447621

Einstein, G. O., & McDaniel, M. A. (1990). Normal aging and prospective memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*, 717–726. https://doi.org/10.1037/0278-7393.16.4.717

Einstein, G. O., & McDaniel, M. A. (1996). Retrieval processes in prospective memory: Theoretical approaches and some new empirical findings. In M. Brandimonte, G. O. Einstein, & M. A. McDaniel (Eds.), *Prospective memory: Theory and applications* (pp. 115–141). Lawrence Erlbaum Associates Publishers.

Espy, K. A. (1997). The shape school: Assessing executive function in preschool children. *Developmental Neuropsychology, 13*, 495–499. https://doi.org/10.1080/87565649709540690

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175–191. https://doi.org/10.3758/BF03193146

Gioia, G. A., Espy, K. A., & Isquith, P. K. (2003). *BRIEF-P: Behavior rating inventory of executive function–preschool version*. Odessa, FL: Psychological Assessment Resources.

Graf, P., & Uttl, B. (2001). Prospective memory: A new focus for research. *Consciousness and Cognition: An International Journal, 10*(4), 437–450. https://doi.org/10.1006/ccog.2001.0504

Guajardo, N. R., & Best, D. L. (2000). Do preschoolers remember what to do? Incentive and external cues in prospective memory. *Cognitive Development, 15*(1), 75–97. https://doi.org/10.1016/S0885-2014(00)00016-2

Hannon, R., Adams, P., Harrington, S., Fries-Dias, C., & Gipson, M. T. (1995). Effects of brain injury and age on prospective memory self-rating and performance. *Rehabilitation Psychology, 40*, 289–298. https://doi.org/10.1037/0090-5550.40.4.289

Hedges, R., Drysdale, K., & Levick, W. R. (2015). The children's memory questionnaire-revised. *Applied Neuropsychology: Child, 4*(4), 285–296. https://doi.org/10.1080/21622965.2014.925806

Kaiser, H. F., & Rice, J. (1974). Little Jiffy, Mark IV. *Educational and Psychological Measurement, 34*(1), 111–117. https://doi.org/10.1177/001316447403400115

Kerns, K. A. (2000). The CyberCruiser: An investigation of development of prospective memory in children. *Journal of the International Neuro psychological Society, 6*, 62–70. https://doi.org/10.1017/S1355617700611074

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. https://doi.org/10.1016/j.cogdev.2006.08.003

Kliegel, M., Jäger, T., & Phillips, L. H. (2008). Adult age differences in event-based prospective memory: A meta-analysis on the role of focal versus nonfocal cues. *Psychology and Aging, 23*, 203–208. https://doi.org/10.3389/fnhum.2014.01021

Kliegel, M., Mahy, C. E. V., Voigt, B., Henry, J. D., Rendell, P. G., & Aberle, I. (2013). The development of prospective memory in young school children: The impact of ongoing task absorption, cue salience, and cue centrality. *Journal of Experimental Child Psychology, 116*, 792–810. https://doi.org/10.1016/j.jecp.2013.07.012

Kvavilashvili, L., & Ford, R. M. (2014). Metamemory prediction accuracy for simple prospective and retrospective memory tasks in 5-year-old children. *Journal of Experimental Child Psychology, 127*, 65–81. https://doi.org/10.1016/j.jecp.2014.01.014

Kvavilashvili, L., Messer, D. J., & Ebdon, P. (2001). Prospective memory in children: The effects of age and task interruption. *Developmental Psychology, 37*, 418–430. https://doi.org/10.1016/j.jecp.2014.01.014

Little, R. J. A. (2001). A test of missing completely at random for multivariate data with missing values. *Journal of the American Statistical Association, 83*, 1198–1202. https://doi.org/10.1080/01621459.1988.10478722

Mahy, C. E., Moses, L. J., & Kliegel, M. (2014a). The development of prospective memory in children: An executive framework. *Developmental Review, 34*, 305–326. https://doi.org/10.1016/j.dr.2014.08.001

Mahy, C. E., Moses, L. J., & Kliegel, M. (2014b). 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. https://doi.org/10.1016/j.jecp.2014.01.006

Mahy, C. E. V., & Moses, L. J. (2011). Executive functioning and prospective memory in young children. *Cognitive Development, 26*(3), 269–281. https://doi.org/10.1016/j.cogdev.2011.06.002

Mahy, C. E. V., & Moses, L. J. (2015). The effect of retention interval task difficulty on children's prospective memory: Testing the intention monitoring hypothesis. *Journal of Cognition and Development, 16*, 742–758. https://doi.org/10.1080/15248372.2014.930742

Marsh, R. L., Hicks, J. L., & Cook, G. I. (2005). On the relationship between effort toward an ongoing task and cue detection in event-based prospective memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31*(1), 68–75. https://doi.org/10.1037/0278-7393.31.1.68

Mazachowsky, T., & Mahy, C. (2020). Constructing the children's future thinking questionnaire: A reliable and valid measure of children's future-oriented cognition. *Developmental Psychology, 56*, 756–772. https://doi.org/10.1037/dev0000885

Mazachowsky, T. R., Hamilton, C., & Mahy, C. E. (2021). What supports the development of children's prospective memory? Examining the relation between children's prospective memory, memory strategy use, and parent scaffolding. *Journal of Cognition and Development, 22*(5), 721–743. https://doi.org/10.1080/15248372.2021.1939352

McDaniel, M. A., & Einstein, G. O. (2000). Strategic and automatic processes in prospective memory retrieval: A multiprocess framework. *Applied Cognitive Psychology, 14*, 127–144. https://doi.org/10.1002/acp.775

Meacham, J. (1982). A note on remembering to execute planned actions. *Journal of Applied Developmental Psychology, 3*, 121–133. https://doi.org/10.1016/0193-3973(82)90023-5

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*, 49–100. https://doi.org/10.1006/cogp.1999.0734

Müller, U., & Kerns, K. (2015). The development of executive function. In L. S. Liben, U. Müller, & R. M. Lerner (Eds.), *Handbook of child psychology and developmental science: Cognitive processes* (pp. 571–623). John Wiley & Sons, Inc. https://doi.org/10.1002/9781118963418.childpsy214.

Perner, J., & Lang, B. (1999). Development of theory of mind and executive control. *Trends in Cognitive Sciences, 3*, 337–344. https://doi.org/10.1016/s1364-6613(99)01362-5

Pezdek, K., Whetstone, T., Reynolds, K., Askari, N., & Al, E. (1989). Memory for real-world scenes: The role of consistency with schema expectation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15*(4), 587–595. https://doi.org/10.1037/0278-7393.15.4.587

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Robson, S. (2016). Self-regulation, metacognition and child- and adult-initiated activity: Does it matter who initiates the task? *Early Child Development and Care, 186*(5), 764–784. https://doi.org/10.1080/03004430.2015.1057581

Shepard, R. N. (1967). Recognition memory for words, sentences, and pictures. *Journal of Verbal Learning and Verbal Behavior, 6*(1), 156–163. https://doi.org/10.1016/s0022-5371(67)80067-7

Ślusarczyk, E., Niedźwieńska, A., & Białecka-Pikul, M. (2018). The first signs of prospective memory. *Memory, 26*(10), 1385–1395. https://doi.org/10.1080/09658211.2018.1483516

Smith, G. V., Della Sala, S., Logie, R. H., & Maylor, E. A. M. (2000). Prospective and retrospective memory in normal aging and dementia: A questionnaire study. *Memory, 8*, 311–321. https://doi.org/10.1080/09658210050117735

Smith, R. E. (2003). The cost of remembering to remember in event-based prospective memory: Investigating the capacity demands of delayed intention performance. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29*, 347–361. https://doi.org/10.1037/0278-7393.29.3.347

Smith, R. E., Bayen, U. J., & Martin, C. (2010). The cognitive processes underlying event-based prospective memory in school-age children and young adults: A formal model-based study. *Developmental Psychology, 46*(1), 230–244. https://doi.org/10.1037/a0017100

Somerville, S. C., Wellman, H. M., & Cultice, J. C. (1983). Young children's deliberate reminding. *The Journal of Genetic Psychology, 143*(1), 87–96. https://doi.org/10.1080/00221325.1983.10533537

Standing, L. (1973). Learning 10000 pictures. *Quarterly Journal of Experimental Psychology, 25*(2), 207–222. https://doi.org/10.1080/14640747308400340

Sunderland, A., Harris, J. E., & Baddeley, A. D. (1983). Do laboratory tests predict everyday memory? A neuropsychological study. *Journal of Verbal Learning & Verbal Behavior, 22*(3), 341–357. https://doi.org/10.1016/S0022-5371(83)90229-3

Talbot, K. D., & Kerns, K. A. (2014). Event- and time-triggered remembering: The impact of attention deficit hyperactivity disorder on prospective memory performance in children. *Journal of Experimental Child Psychology, 127*, 126–143. https://doi.org/10.1016/j.jecp.2014.02.011

Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Practitioner review: Do performance-based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry, 54*(2), 131–143. https://doi.org/10.1111/jcpp.12001

Unsworth, N., Brewer, G. A., & Spillers, G. J. (2012). Variation in cognitive failures: An individual differences investigation of everyday attention and memory failures. *Journal of Memory and Language, 67*, 1–16. https://doi.org/10.1016/j.jml.2011.12.005

Walsh, S., J., Martin, G., M., & Courage, M., L. (2014). The development of prospective memory in preschool children using naturalistic tasks. *Journal of Experimental Child Psychology, 27*, 8–23. https://doi.org/10.1016/j.jecp.2013.10.003

Wang, L., Kliegel, M., Liu, W., & Yang, Z. (2008). Prospective memory performance in preschoolers: Inhibitory control matters. *European Journal of Developmental Psychology, 5*, 289–302. https://doi.org/10.1080/17405620600778161

Zelazo, P. D., Anderson, J. E., Richler, J., Wallner-Allen, K., Beaumont, J. L., & Weintraub, S. (2013). II. NIH toolbox cognition battery (CB): Measuring executive function and attention. *Monographs of the Society for Research in Child Development, 78*, 16–33. https://doi.org/10.1111/mono.12032

Zelazo, P. D., Müller, U., Frye, D., & Marcovitch, S. (2003). The development of executive function in early childhood: VI. The development of executive function: Cognitive complexity and control–revised. *Monographs of the Society for Research in Child Development, 68*(3), 93–119. https://doi.org/10.1111/j.0037-976X.2003.00266.x

Zhao, X., Fu, J., Ma, X., & Maes, J. H. (2019). Age differences in prospective memory: A further evaluation of the executive framework. *Journal of Cognition and Development, 20*(5), 680–701. https://doi.org/10.1080/15248372.2019.1648268

Zimmermann, T. D., & Meier, B. (2006). The rise and decline of prospective memory performance across the lifespan. *The Quarterly Journal of Experimental Psychology, 59*, 2040–2046. https://doi.org/10.1080/17470210600917835

Zöllig, J., West, R., Martin, M., Altgassen, M., Lemke, U., & Kliegel, M. (2007). Neural correlates of prospective memory across the lifespan. *Neuropsychologia, 45*(14), 3299–3314. https://doi.org/10.1016/j.neuropsychologia.2007.06.010

Zuber, S., Mahy, C. E., & Kliegel, M. (2019). How executive functions are associated with event-based and time-based prospective memory during childhood. *Cognitive Development, 50*, 66–79. https://doi.org/10.1016/j.cogdev.2019.03.001