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A Parent-Report Diary Study of Young Children's Prospective Memory Successes and Failures

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ABSTRACT

Although laboratory studies have examined the development of children's prospective memory (PM) and the factors that influence its performance, much less is known about children's PM performance and development in their everyday life. The current study used an online parent diary report approach to examine American 2- to 6-year-olds' PM successes and failures. In an initial session, 206 parents completed a series of questionnaires on their child's memory and cognition. For the next four days, parents reported instances of PM successes and failures and answered questions about a number of task factors (task motivation, importance to the parent and child, who assigned the PM task, task typicality, and parental assistance). We found that: (1) parents reported children as young as 2 years old had PM successes in daily life and there were no age differences in the number of reported PM successes and failures, (2) parents reported more PM successes than failures, and (3) several factors influenced the likelihood of children's success in everyday PM tasks, including child motivation and task importance to parents, whereas task typicality and parental assistance were related to PM failure. Finally, we explored the domains of PM successes and failures as well as the type of assistance that parents provided. These results are discussed in relation to past findings of children's PM in laboratory and naturalistic settings. Parent diary-report methodology is a feasible and efficient alternative to naturalistic laboratory tasks to examine young children's PM in everyday life.

Forgetting to wash their hands after using the toilet or to put a bicycle helmet on before riding a bicycle: these are everyday life examples of children's difficulty with remembering to carry out their future intentions, an ability known as prospective memory (PM). Often children forget to perform future actions and these failures can have negative consequences for academic performance, social functioning, and as in the examples above, for health and safety (Mahy et al., 2014). To date, much research has focused on the development of PM in early childhood (e.g., Kliegel & Jäger, 2007; Kvavilashvili, Messer, & Ebdon, 2001; Mahy, Moses, & Kliegel, 2014; Ślusarczyk, Niedźwieńska, & Białecka-Pikul, 2018) as well as on factors that affect its development (e.g., Kliegel et al., 2013; Mahy et al., 2014 for a review). Yet, the majority of this

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research has been conducted in laboratory settings using card sorting or computerized tasks to assess children's PM. Much less is known about children's everyday life PM, although there have been attempts to ameliorate this by employing naturalistic tasks that approximate everyday PM tasks in the laboratory (e.g., Henry et al., 2014; Mills, Garbarino, & Raskin, 2021; Ślusarczyk & Niedźwieńska, 2013; Walsh, Martin, & Courage, 2014).

Other studies attempting to capture children's real life PM have used parent-report questionnaires (e.g., Mazachowsky & Mahy, 2020; Mazachowsky, Hamilton, & Mahy, 2021) or parent-report diary methodology to examine school-aged children's PM performance across several days (Penningroth, Bartsch, & McMahan, 2012). To our knowledge, no study has used a diary report to assess very young children's PM in everyday life. This approach offers a unique window into the everyday life PM performance of young children and offers rich data collected outside of the laboratory and over the course of multiple days. The current study investigated the early emergence and development of PM by examining parent-reports of everyday PM successes and failures over a period of four days. Further, we aimed to investigate whether key factors that affect performance in laboratory settings (for an overview see Mahy et al., 2014a) also influence more naturalistic forms of young children's PM.

The emergence and development of prospective memory

Laboratory-based studies have shown that PM begins to emerge around 2 years of age. At this age, children struggle to remember the content of their intention let alone carry out those intentions (Kliegel & Jäger, 2007; Ślusarczyk, Niedźwieńska, & Białecka-Pikul, 2018). In fact, about two-thirds of 2-year-olds cannot encode, store, and recall the PM intention and of those who can, few manage to carry out the intention at the appropriate time (e.g., Kliegel & Jäger, 2007; Mahy, 2022). Although young preschoolers aged 3 and 4 years old are better at remembering what they have to do compared to 2-year-olds, they are still unreliable in carrying out their intentions. However, by the time children are 5 or 6 years of age, they become more consistent in remembering to carry out their future intentions (e.g., Kliegel & Jäger, 2007; Mahy, 2022).

Factors that affect children's prospective memory performance

Much of the literature on children's PM has focused on the factors that support or impair performance such as the effects of greater motivation, cue focality, cue salience, external reminders, and ongoing task difficulty on children's PM performance (see Mahy et al., 2014a and Zuber & Kliegel, 2020 for reviews). However, many of these factors have been examined in laboratory settings exclusively. Recently, Rummel et al., (2023) found that a substantial amount of variance in adult's real-world PM was explained by factors that also impact PM in laboratory contexts. Thus, the factors influencing children's PM in laboratory settings might also influence their everyday life PM performance. Next, we review aspects of tasks that might be especially important to children's PM performance in day-to-day life.

Task importance

Whether an intention is considered important or not has an impact on the likelihood that it will be remembered and carried out in the future (e.g., Walter & Meier, 2014). In laboratory paradigms where the PM task is emphasized relative to the ongoing task, PM performance is superior compared to when neither the PM nor the ongoing tasks are emphasized (Kliegel, Martin, McDaniel, & Einstein, 2001, 2004). Thus, PM performance can be manipulated based on which task is emphasized as most important. Rummel, Snijder, and Kvavilashvili (2023) showed that perceived task importance was a powerful predictor of fulfilling everyday life intentions. To our knowledge, task importance has not been explicitly manipulated in studies on children's PM (outside of manipulations of the motivational aspects of the PM task), although it seems likely to affect young children's PM performance.

Some studies have intentionally created more ecologically valid laboratory PM tasks; for example, one study asked children to remind a first experimenter to return the second experimenter's cell phone to them (Nigro, Brandimonte, Cicogna, & Cosenza, 2014). Most children noted the high importance of returning the cell phone to the second experimenter, with one 5-year-old stating that "To mislay a smart phone is a catastrophe!" (p. 91). Thus, children's perception of task importance might influence their performance on PM tasks similar to adults. Nevertheless, to our knowledge, no study has examined the perceived importance of a PM task to both a child and their parent. This is a critical distinction given that perceived task importance might differ between parents and their young children. For example, a parent might view brushing one's teeth before going to bed as an extremely important task, whereas a 3-year-old might view it as significantly less important. Similarly, a young child might prioritize remembering to take a toy to school to show a friend, whereas parents might view such a task as unimportant. The current study will ask parents to report PM task importance from their perspective as well as their child's perspective so that we can independently examine their influences on PM performance.

Motivation

In contrast to task importance, motivation refers to the affective response elicited by the PM task. For example, brushing your teeth or reminding an experimenter to return their colleague's cell phone are clearly important tasks, but neither likely to elicit a strong emotional response from the child. In contrast, remembering to ask for a piece of candy is highly motivating because it triggers an emotional response (i.e., excitement). Despite being highly motivating, children might still understand that asking for a piece of candy is not a particularly important task. In the current study, we distinguish between task importance and motivation to examine their independent contributions to children's PM.

Motivation has been consistently shown to increase children's PM (e.g., Causey & Bjorklund, 2014, Kliegel et al., 2010; Ślusarczyk & Niedźwieńska, 2013; Somerville, Wellman, & Cultice, 1983; although see Cejudo et al., 2019, for a marginal effect of reward in older children). In a classic naturalistic study, 2- to 4-year-old children reminded their mother to perform high-interest more often than low-interest tasks (Somerville, Wellman, & Cultice, 1983). Even the youngest children successfully reminded their mothers of high interest tasks such as buying ice cream or candy at the supermarket compared to low interest tasks such as bringing in the laundry. In

a more recent laboratory study, 2- to 4-year-old children's PM was better for remembering to ask for a sticker at the end of an experimental session compared to remembering to turn over a sign on the door (Causey & Bjorklund, 2014). Highly motivating intentions improve younger children's PM in particular; there are typically age effects in preschoolers' PM performance on low interest tasks but no age effects in PM performance on high interest tasks (e.g., Kliegel et al., 2010; Ślusarczyk & Niedźwieńska, 2013) suggesting that motivation can minimize age effects by boosting PM performance in the youngest children. The current study will examine the influence of children's motivation on their everyday PM performance.

Task typicality

Are children more successful at carrying out a future intention that is part of their regular routine versus a one-off, novel intention? While there is little research on this question in children, younger and older adults have better PM for regularly occurring tasks compared with irregular tasks (Blondelle et al., 2016; Rose, Rendell, McDaniel, Aberle, & Kliegel, 2010). Older adults performed especially poorly on irregular tasks in the virtual week, a board game that embeds PM tasks into a pretend week full of activities. The types of PM tasks that children are asked to complete in the laboratory are generally designed to be novel compared to their daily tasks; to place a card in a box, ring a bell, or say a specific phrase to a character when a certain cue appears. Thus, an open question is whether children, like adults, might show better PM for typical intentions in their daily life or whether novel tasks produce better PM due to their distinctiveness.

Who assigned the prospective intention

Is there a difference between success rates in carrying out intentions that are self-assigned compared to those that others assign? While the majority of studies on PM employ experimenter assigned intentions (i.e., the experimenter instructs the participant to complete a certain task in the future; but see Zhang, Zuber, Liu, Kliegel, & Wang, 2017 as an exception where they compared researcher and teacher-assigned intentions), a handful of studies have examined participant or self-generated intentions. For instance, Schnitzspahn, Kvavilashvili, and Altgassen (2020) found no age difference between younger and older adults in their ability to carry out future intentions that were self-assigned or assigned by the experimenter; however, there was a trend toward older adults performing better on self-assigned intentions that required an exact date and time of completion compared to younger adults (Schnitzspahn, Kvavilashvili, & Altgassen, 2020). Adults rarely reported using reminders for self-assigned intentions suggesting that they perceived these intentions as less likely to be forgotten. Similarly, adults with ADHD generated and carried out fewer self-generated intended actions compared to those without ADHD suggesting that attentional difficulties pose a challenge for generating and carrying out self-assigned intentions (Altgassen, Scheres, & Edel, 2019). To our knowledge, no studies with children have directly compared the success rate of PM tasks assigned by others to those that were self-generated. This is an important gap in the literature given that children likely begin forming their own intentions early in development.

Parental scaffolding

Children often receive support from parents and caregivers in remembering to carry out their future intentions in daily life. Most of the research has focused on the effect of visual reminders on children's PM performance. Laboratory studies have generally found that visual reminders benefit preschoolers' PM performance (e.g., Cheie et al., 2014; Kliegel & Jäger, 2007; Ryder, Kvavilashvili, & Ford, 2022; but see also Guajardo & Best, 2000). However, less research has examined the impact of verbal reminders even though parents report most often providing verbal reminders to support their child's PM performance (Mazachowsky, Hamilton, & Mahy, 2021). In a laboratory setting, Mahy, Mazachowsky, and Pagobo (2018) found that overall verbal reminders did not boost 4- to 6-year-old children's PM performance, but verbal reminder effectiveness depended on the child's age, the content of the reminder, and children's executive abilities. In naturalistic contexts, on the other hand, both visual (e.g., approaching the candy shelf in the supermarket) and verbal prompting (e.g., "weren't we supposed to buy something special at the supermarket?") improved young children's ability to remind their mother about a specific future intention (Somerville, Wellman, & Cultice, 1983). Also, a recent study showed that parents provide developmentally sensitive support for their children's PM performance; parents reported providing increasing support with age for their 3- to 6-year-olds and then decreasing support with age for their 7- to 11-year-olds' PM (Mazachowsky, Hamilton, & Mahy, 2021). In sum, parental scaffolding and external reminders from adults generally improve children's PM performance in laboratory contexts and with experimenter-assigned naturalistic tasks. Yet, it is important to further examine the role of parental assistance in young children's everyday life PM since reminders might play a significant role in successful PM especially for children who are unable to carry out their intentions independently.

Diary studies of prospective memory

The majority of PM studies using the diary method come from the aging literature (e.g., Brewer, Morris, & Lindley, 2017; Haas, Zuber, Kliegel, & Ballhausen, 2020, 2022; Schnitzspahn et al., 2016). For example, Schnitzspahn et al. (2016) found that older adults remembered planned intentions better over 30 days and considered social intentions more important than younger adults. More recently, PM was the most frequent type of everyday error for younger and older adults over a 5-day period suggesting that PM errors are common everyday occurrences across the adult lifespan (Haas, Zuber, Kliegel, & Ballhausen, 2020). In sum, adult PM diary studies suggest a critical role for task importance, that older adults do not always report more PM errors in daily life compared to younger adults, and that PM errors are a typical daily occurrence. To date, one study has used a diary methodology to examine older children's PM. Penningroth, Bartsch, and McMahan (2012) asked parents to report on their 7- to 11-year-old children's PM performance over two weeks. Parents recorded the tasks that their child had to complete, the importance of the task to their child, and finally, whether their children remembered to complete the task. Higher importance tasks were carried out more frequently. Ten and 11-year-olds remembered to complete less important tasks more often than 7- and 8-year-olds. This study successfully used a parent-report diary methodology to examine school-aged children's PM over a two week period and provides support for models that highlight the importance of motivational influences on PM (e.g., Penningroth & Scott, 2007). Yet, it remains unclear

whether parent-report diary approaches are suitable for studying very young children, who might have fewer intentions that they must perform independently, and who might receive more extensive support from parents and caregivers to accomplish many of their daily intentions.

In addition to examining the feasibility of studying very young children's everyday intentions via a parent-report diary approach, another relevant question is what kinds of intentions do young children remember and forget in their daily life? Despite many laboratory studies, little is known about what type of intentions children have to remember in their daily life, and which intentions they forget or remember to complete.

The current study

To capture children's naturally occurring PM in everyday contexts, we asked parents to complete our study online over five consecutive days. In the initial session, parents completed a number of questionnaires about their child's PM. Then, for four subsequent days, we asked parents to report tasks that their children remembered or failed to carry out in order to assess naturalistic PM performance. Our research questions were: (1) Do 2-year-old children show success in everyday PM tasks? (2) Does naturalistic PM performance develop between 2 to 6 years of age and how do PM failures and successes vary with age? (3) How do task characteristics (i.e., importance for the child and for the parent, motivation, task typicality, who assigns the task, and parental assistance) influence children's PM in naturalistic settings? and (4) What are the domains in which children succeed and fail at PM tasks and do these domains differ by age? In an exploratory analysis, we examined the type of help that parents provided children in daily PM tasks and whether the type of help differed based on children's success.

Method

Participants

A G*Power 3.1 (Faul et al., 2007) a priori power analysis revealed that for a mixed analysis of variance (ANOVA) with between-subjects and within-subjects variables, a sample of 150 parents was necessary to detect a medium to small effect size ($f^2 = 0.15$, power = .80, $\alpha = .05$). Considering the substantial attrition that is common with online and longitudinal research, we aimed to collect data from 300 parents for the initial session in order to insure a sufficient sample size for the diary sessions.

Participants were recruited from the online platform Prolific (www.prolific.co). In order to be eligible for the initial session, parents had to: (1) reside in the United States, (2) be a parent of a child between 2 and 6 years of age, (3) be a native speaker of English, and (4) have at least a 98% study approval rating on Prolific. Two hundred six parents participated in the initial session (Session 1) on Qualtrics (www.qualtrics.com). Eighteen parents were excluded from Session 1 based on our criteria (see Table S1 in the Supplemental Online Materials for more detail) resulting in a final sample of 188 parents. Parents were mostly mothers (62.2% mothers, 37.8% fathers), White (85.1%), well-educated (91.4% with at least some post-secondary education), and from middle-class backgrounds (71.8% earned above 40,000 USD annually). From this initial session, the parents ($N = 206$) who completed

Session 1 were invited each afternoon to complete the diary portion of the study for four consecutive days (Monday to Thursday). After excluding parents who did not complete any of the diary sessions or who provided an inconsistent date of birth for their child, the final sample consisted of 154 parents (90 parents of males; $M = 55.17$ months, $SD = 15.60$ months) who completed at least one diary session. Of those parents, 111 completed all four sessions; 27 completed three; 10 completed two; and 6 parents only completed one diary session.

Measures

The Children's Future Thinking Questionnaire

The Children's Future Thinking Questionnaire (i.e., CFTQ; Mazachowsky & Mahy, 2020) is a 44-item parent report measure of young children's future-oriented cognition in five key domains: PM, planning, episodic foresight, delay of gratification, and saving behavior. Parents rated 44 statements about their child's daily future thinking (e.g., "*Remembers what items need to be purchased/picked up*") on a 6-point Likert scale (ranging from "*Strongly Disagree*" to "*Strongly Agree*") with three additional non-response options ("*Don't know*," "*Does not apply*," and "*Prefer not to answer*"). The PM subscale (9 items) was used in this study. Parents' ratings were aggregated to create a subscale score. None of the parents provided missing data (i.e., blank responses). Higher CFTQ PM subscale scores indicated better PM. The subscale revealed acceptable internal consistency for each age group (αs > .76; See Table S2 in Online Supplemental Materials for more detail).

The Children's Everyday Memory Questionnaire

The Children's Everyday Memory Questionnaire (i.e., CEMQ; Mazachowsky, Hamilton, & Mahy, 2021) is a 43-item parent report measure of young children's PM. The questionnaire captures three domains of PM (i.e., long-term episodic, short-term habitual, and internally cued) and two supporting factors of PM (i.e., parental scaffolding and child strategies use). The long-term episodic, short-term habitual, and internally cued subscales were the focus of the current study as we sought to capture children's PM. The long-term episodic subscale involves 8 items and measures children's ability to remember to carry out long-term intentions (e.g., "*Forgets to return a reading book to school*"). The short-term habitual subscale involves 15 items and measures children's ability to remember to carry out routine-like short-term intentions (e.g., "*Forgets to fasten (button or zip) some part of their clothes*"). The internally cued subscale involves 10 items and measures children's ability to remember to carry out future intentions without any external cues (e.g., "*Forgets what they want to say in the middle of a sentence*"). Parents rated statements on a 5-point Likert scale (ranging from "*Never*" to "*Always*") with a non-response option ("*not applicable*"). Higher scores in the subscales indicated worse performance in the corresponding skills. Parents' ratings were aggregated to create subscale scores. Only one parent provided a single blank response on the CEMQ. The long-term episodic ($\alpha = .91$), short-term habitual ($\alpha = .90$), and internally cued subscales ($\alpha = .87$) all revealed high internal consistencies. There were large, positive correlations between the long-term episodic, short-term habitual, and internally cued PM subscales ($rs = .649$–$.740$, $ps < .001$). Thus, the subscales were combined to form an overall

CEMQ PM composite score. The CEMQ PM composite scale revealed high internal consistency for each age group (αs > .87; Table S2).

Prospective memory diary

After the initial session, parents were invited each afternoon (starting at 4 PM Eastern Standard Time and ending at 7 AM the next morning) to complete the diary portion of the study for four consecutive days. In each diary session, parents were first asked to report whether their child forgot/remembered to do something that day and then were asked to describe each instance of forgetting or remembering that occurred (up to ten examples; Table 1). As part of an exploratory analysis, these examples of remembering or forgetting were coded into eight categories (i.e., personal care, getting ready, tidying, schoolwork,

Table 1. Instructions and questions for each PM failure and success examples in the diary sessions.

Question	Instruction
PM failure	Please list an example of something your child forgot to do today (*the exact date*). This should be a task that they were expected to do independently, without help from an adult. For instance, today, your child may have forgotten to return their homework or feed the family pet. Did your child forget to do something today? *[If yes]* Please describe what your child forgot to do today.
PM success	Please list an example of something your child remembered to do today (*the exact date*). This should be a task that they were expected to do independently, without help from an adult. For instance, today, your child may have remembered to put something away without being asked or remembered to pass on a message from a family member. Did your child remember to do something today? *[If yes]* Please describe what your child remembered to do today.
Task importance for the child	How important was this task to your child? (1- not at all important to 5- extremely important)
Task importance for the parent	How important was this task to you? (1- not at all important to me to 5- extremely important to me)
Child task motivation	How interested/motivated was your child to perform the task? (1- not at all interested to 5- extremely interested)
Task typicality	How typical is this task in your child's daily life? (1- very atypical to 5- very typical)
Task assignment	Did you assign this task to your child (yes/no)? *[If no]* Please indicate who assigned this task to your child: _____
Parental assistance	How much help did you provide to your child? (1 – no help to 5 – a lot of help) What kind of help did you provide? _____

Table 2. Examples of Children's Everyday Prospective Memory Failures and successes in the diary.

	Diary Failure Examples	Diary Success Examples
2-Year-Olds	*"Forgot to bring their shoes back into the house."* *"Forgot that they have been told to get toys."*	*"Remembered to wipe her hands after eating."* *"Reminded he needed his hat to take to the zoo."*
3-Year-Olds	*"Forgot to feed our cat."* *"Forgot to pick up toys when done with them."*	*"Remembered brush her teeth."* *"Remembered that I said I would take her to the park."*
4-Year-Olds	*"Forgot to take out the trash."* *"Forgot to take his bowl to the sink"*	*"Remembered to pack toys for playtime."* *"Remembered to clean his room."*
5-Year-Olds	*"Forgot to bring something in for animal donation day."* *"Forgot to organize her closet."*	*"Remembered to feed his puppy."* *"Remembered her doctor's appointment and took a bath this morning."*
6-Year-Olds	*"Forgot to bring her tablet before the trip."* *"Forgot to start his homework."*	*"Remembered to dress on big boy clothes when we have company."* *"Remembered to take medicine."*

meals, taking care of another living thing, household rules, and other) that were formed from the data that parents provided.

Parents were then asked to provide ratings for each example based on: task importance for the child and parent, the child's motivation to perform the task, task typicality, task assignment (who assigned the child the task), and parental assistance (Table 1). In the task assignment and parental assistance questions, parents were also asked to indicate who assigned the task to the child and what kind of help they provided, respectively. As an exploratory analysis, parents' responses to the kind of help they provided were coded into 10 categories (i.e., verbal reminder, visual reminder, rewards, parent and child complete the task together, parent completes the task instead of the child, parent aids in order to complete the task, parent provides instructions, supervision, no help, and other). Parents' open-ended responses, including the PM success and failure examples, who assigned the child the task, and the type of parental assistance given, were coded by two independent research assistants. The inter-rater reliability analysis based on 20% of the data ($n = 30$) revealed substantial agreement ($\kappa = .82$ for the task examples, $\kappa = .87$ for the task assignment, and $\kappa = .82$ for the task assistance, $ps < .05$). Any disagreements were resolved through discussion.

Procedure

The procedure and analysis plan were pre-registered (https://aspredicted.org/blind.php?x=GJS_8X8). Parents' consent was obtained before each session, including the initial session on Sunday, July 10, 2022, and each of the four diary sessions (Monday, July 11 to Thursday, July 14, 2022). In the initial session, parents completed the questionnaires via Qualtrics which were presented in a random order. Data were collected as part of a larger study on children's PM which included questionnaires measuring aspects of parenting, personality, and cognitive abilities that are not reported here (see https://osf.io/p96w5/?view_only=9d0356b5f7ab4c45bdee7e8608e30132). Six of the questionnaires involved one attention check question that was randomly inserted into the questionnaire to ensure participants were paying attention throughout the study. The attention check questions used the same response scale as the questionnaire items and instructed the participants to select a particular response (e.g., "*Please select 'often' for this question*"). No parent failed more than two of the six attention check questions and thus no parents were excluded from our analyses for this reason. Parents also provided basic demographic information (e.g., annual income, education, or ethnicity). Participants were paid $9 USD for this session. After the initial session, parents were invited each afternoon to complete the diary sessions for four consecutive days (Monday to Thursday). Participants were paid $2.50 USD per diary session. All study procedures were approved by the Research Ethics Board at Brock University and the University of Victoria.

Results

Preliminary analysis

Parents frequently used the non-response optional responses (e.g., "*Don't know*") in the CFTQ and CEMQ (Table S2). The missing data in these questionnaires were replaced

using the Estimation Maximization procedure before aggregating the subscale scores. In each diary session, almost half of the parents provided at least one PM failure example (ranging from 39.5% to 48.3%) and the majority of parents provided at least one PM success example (ranging from 71.1% to 77.3%; see Table 2 for examples). For each child, *PM diary success and failure frequency ratings* were computed by dividing the total number of success/failure examples by the number of days parents participated. Next, PM successes were scored with "1" and PM failures were scored with "0" and a *naturalistic PM score* was computed for each child by averaging the sum of PM successes and failures.

Preliminary analysis indicated that child's sex ($ts < -1.51$, $ps > .05$), parental education ($rs = -.01–.12$, $ps > .05$) and annual parental income ($rs = -.07–.12$, $ps > .05$) were unrelated to children's naturalistic PM score, PM success, or PM failure frequencies, so they were excluded in subsequent analyses. Descriptive statistics of all measures are presented in Table 3.

The relations among prospective memory measures

There was a large significant correlation between the CFTQ PM and CEMQ PM composite even after controlling for age (Table 4), indicating that parents' ratings on two different measures of PM were associated. The CFTQ PM and CEMQ PM composite scores were also significantly correlated with children's PM diary failure frequency and naturalistic PM score even after controlling for age. Parents who reported higher ratings of their children's PM skills on the CFTQ and CEMQ also provided fewer PM failure examples in the diary sessions and had children with higher naturalistic PM scores. Parents who reported their child having more PM successes also reported that their child had more PM failures. There was no relation, however, between children's PM diary success frequency, the CFTQ PM and CEMQ PM composite scores (Table 4). Thus, parents' responses on the PM questionnaires correlated with parents' naturalistic observations of PM failures and overall PM performance in the diary.

The development of naturalistic prospective memory

Parents of 2-year-olds provided 100 prospective memory examples in the diary; 65 were PM successes and 35 were PM failures. When their successes ("1") and failures ("0") were scored to create a naturalistic prospective memory score, 2-year-olds were observed to have similar scores to their older peers (Table 3). Note that a pre-registered chi-square analysis was planned to examine PM successes and failures of 2-year-olds but was deemed inappropriate (see the OSF supplement for this analysis). Further, a one-sample t-test comparing performance to zero (which would indicate no PM successes) was performed to examine whether 2-year-old children showed any success in naturalistic PM tasks. Two-year-old children's mean naturalistic PM score (assessed via the diary) was significantly greater than zero, $t(18) = 15.06$, $p < 0.001$, $d = 3.46$. These findings suggested that parents of 2-year-old children reported that their child showed at least some evidence of successful PM. To explore 2-year-old children's PM in the other parent-report PM questionnaires, unregistered exploratory one-sample t-tests were conducted. Two-year-olds' parent-report PM scores assessed via the CFTQ and CEMQ were also significantly greater than one (corresponds to "*never*" in

Table 3. Descriptive statistics for all variables.

	Whole Sample			2-Year-Olds			3-Year-Olds			4-Year-Olds			5-Year-Olds			6-Year-Olds		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
Age (in months)	154	55.17	15.60	20	28.70	3.01	29	41.14	3.13	37	53.73	3.65	40	65.97	3.75	28	75.07	2.73
Naturalistic PM Score	150	.66	.23	19	.69	.20	28	.70	.21	36	.57	.25	39	.65	.25	28	.74	.21
PM Diary Success Frequency	154	.94	.53	20	.86	.52	29	.96	.44	37	.86	.54	40	.88	.46	28	1.16	.68
PM Diary Failure Frequency	154	.54	.50	20	.48	.42	29	.53	.45	37	.68	.62	40	.50	.45	28	.48	.45
CFTQ PM	154	3.98	0.92	20	3.42	1.16	29	3.54	0.85	37	3.94	0.76	40	4.40	0.77	28	4.27	0.81
CEMQ PM composite	154	1.96	0.57	20	2.08	0.72	29	1.99	0.53	37	2.05	0.56	40	1.85	0.56	28	1.86	0.52

Note. PM = Prospective Memory; CFTQ = The Children's Future Thinking Questionnaire; CEMQ = The Children's Everyday Memory Questionnaire.

Table 4. Pearson Correlations Among Child's age and Child prospective memory measures.

	2.	3.	4.	5.	6.
1. Child's Age	.13	−.02	.04	.40**	−.14
2. PM Diary Success Frequency		.39**	.25**	.13	−.01
		(.40**)	(.24**)	(.08)	(.02)
3. PM Diary Failure Frequency			−.66**	−.18*	−.34**
			(−.66**)	(−.19*)	(−.34**)
4. Naturalistic PM Score				.23**	−.30**
				(.24**)	(−.30**)
5. CFTQ PM					−.56**
					(−.56**)
6. CEMQ PM composite					

Note. PM = Prospective Memory; CFTQ = The Children's Future Thinking Questionnaire; CEMQ = The Children's Everyday Memory Questionnaire.
Age-controlled correlations are in parentheses.
Ns ranging from 150 to 154. * $p < 0.05$, ** $p < 0.01$.

the questionnaires): the CFTQ PM subscale ($t[19] = 9.33$, $p < 0.001$, $d = 2.09$) and CEMQ PM composite score ($t[19] = 6.73$, $p < 0.001$, $d = 1.51$).

Somewhat surprisingly, children's naturalistic PM score, PM diary success frequency, and PM diary failure frequency were not related to age in months (Table 4). However, there was a large, positive correlation between CFTQ PM and child's age in months, suggesting that parents reported their child's PM increased with age via a questionnaire. Also, there was a marginal small, negative correlation between CEMQ PM composite score and age, $r[153] = -.14$, $p = 0.087$.

Next, in a pre-registered analysis, children's successes and failures were compared across age groups (Figure 1). A mixed ANOVA with age group as a between-subjects variable (i.e., 2-, 3-, 4-, 5-, and 6-year-olds) and PM example type as a within-subjects variable (i.e., PM success and failure frequencies) showed a significant main effect of example type, $F(1, 149) = 79.23$, $p < 0.001$, $\eta^2 = .35$ (Figure 1). Parents reported more PM success ($M = .94$, $SD = .53$) than PM failures ($M = .54$, $SD = .50$). There was no significant main effect of age on

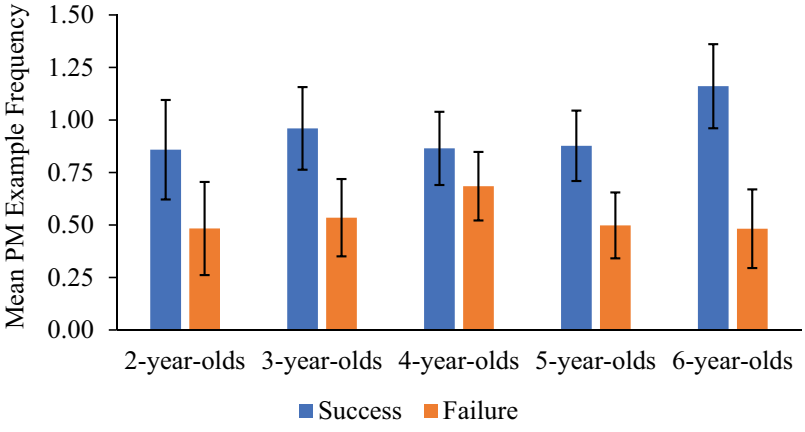

Figure 1. The average PM success and failure example across age groups. Error bars indicated 95% confidence intervals.

children's PM, $F(4, 149) = .58$, $p = 0.67$, $\eta^2 = .02$, however, there was a significant interaction between PM example type and age group on children's PM successes and failures, $F(4, 149) = 3.29$, $p = 0.01$, $\eta^2 = .08$. Bonferroni corrected post hoc analysis revealed that although there were large, statistically significant differences between PM successes and failures in 2-year-olds ($M_{diff} = .38$, $SD_{diff} = .12$, $p = 0.003$), 3-year-olds ($M_{diff} = .43$, $SD_{diff} = .10$, $p < 0.001$), 5-year-olds ($M_{diff} = .38$, $SD_{diff} = .09$, $p < 0.001$), and 6-year-olds ($M_{diff} = .68$, $SD_{diff} = .10$, $p < 0.001$), the difference between PM successes and failures in 4-year-olds was smaller (but still statistically significant; $M_{diff} = .18$, $SD_{diff} = .10$).

In a pre-registered analysis, we performed a series of one-way ANOVAs with age group as a between-subject variable (i.e., 2-, 3-, 4-, 5-, and 6-year-olds) for each parent-report questionnaire score (i.e., CFTQ PM and CEMQ PM composite scores). There was a significant main effect of age on the CFTQ PM subscale, $F(4, 149) = 7.40$, $p < 0.001$, $\eta^2 = .17$. Bonferroni corrected post hoc analysis revealed that parents of 6- ($M = 4.27$, $SD = 0.81$) and 5-year-olds ($M = 4.40$, $SD = 0.77$) reported higher scores on the CFTQ PM subscale than parents of 2- ($M = 3.42$, $SD = 1.16$) and 3-year-olds ($M = 3.54$, $SD = 0.85$), ps < .01. However, parents of 4-year-olds ($M = 3.94$, $SD = 0.76$) did not report statistically significantly different PM than parents of other-aged children on the CFTQ PM composite scale. There was no significant main effect of age on the CEMQ PM composite score, $F(4, 149) = 1.03$, $p = 0.39$.

The influence of task factors on naturalistic prospective memory

A pre-registered logistic regression was conducted to examine how task importance, motivation, regularity, assignment, and assistance are associated with children's PM performance in everyday life. Across four diary sessions, parents provided a total of 807 PM examples (292 PM failures and 515 PM successes). Failures were assigned a code of "0" and successes were assigned a code of "1". Task importance for the child, task importance for the parent, child motivation, task typicality, and parental assistance were single item Likert scale questions (ranging from 1 to 5). The task assignment question (i.e., "did you assign the task to your child"?) was a yes/no question. Parents who provided a "*no*" response were asked to indicate who assigned their child the PM task. The majority of parents reported that they assigned the task to the child (87.5%, $n = 706$). Parents also reported that the child themselves (i.e., self-initiated; 7.4%, $n = 60$), their instructor (e.g., teacher or camp counselor; 2.5% $n = 20$), other relatives (e.g., grandparents; 0.6%; $n = 5$), and undisclosed (2%; $n = 16$) assigned the PM task to the child. Parents' responses to the task assignment question were categorized into two categories of "self-initiated" (initiated by the child) and "other-assigned" (e.g., parents, teacher, or other relatives).

The PM successes and failures were included as the outcome variable in the logistic regression model. Child's age in months, task importance for the child, task importance for the parent, child motivation, task typicality, task assignment, and parental assistance were included as the predictor variables in the model. The correlations among predictor variables showed weak to moderate correlations (ranging from −.19 to .26) suggesting sufficient independence among the predictors. The logistic regression model was statistically significant, $\chi^2\ (7) = 403.62$, $p < 0.001$ (Table 5). The model explained 55.1% ($R^2_{Nagelkerke}$) of the variance in the naturalistic PM examples. The

Table 5. Predictors of Children's success in prospective memory tasks.

					95% C.I. for OR		
	B	S.E.	p	OR	Lower	Upper	W
Child's Age	−0.01	.01	.37	0.99	0.98	1.01	0.82
Child Task Importance	−0.08	.12	.50	0.93	0.74	1.16	0.45
Parent Task Importance	0.44	.12	<.001	1.55	1.22	1.96	13.26
Child Task Motivation	1.25	.13	<.001	3.50	2.69	4.56	87.10
Task Typicality	−0.39	.10	<.001	0.68	0.55	0.83	14.01
Task Assignment	−0.41	.44	.36	0.67	0.28	1.59	0.85
Parental Assistance	−1.01	.10	<.001	0.36	0.30	0.44	106.56

model correctly classified 73.5% of the PM failure examples and 88.5% of the PM success examples. Higher parental task importance and child task motivation were associated with increased likelihood of PM success whereas higher task typicality and parental assistance were associated with decreased likelihood of PM success. There were no significant predictive effects of child task importance, task assignment, or child's age.

Naturalistic prospective memory examples and types of parental scaffolding

In order to perform exploratory analyses on the domains in which children had PM success or failures, the PM examples provided by parents were coded into eight categories: (a) personal care (24.8%, $n = 199$), (b) getting ready for an event (18.2%, $n = 146$), (c) tidying (28.6%, $n = 230$), (d) schoolwork (4.1%, $n = 33$), (e) meals (2.5%, $n = 20$), (f) taking care of another living thing (3.4%, $n = 27$), (g) following household rules (13.3%, $n = 107$), and (h) other (e.g., remembered to wish someone a happy birthday, forgot to bring a picture they colored for their grandma, forgot to bring a ball home from their friend's house; 5.1%, $n = 41$). An unregistered, exploratory chi-square test showed that the category of the task was significantly associated with children's success or failure in the task, χ^2 (7, 803) = 24.36, $p < 0.001$. Bonferroni adjusted z-tests for column proportions revealed that parents reported more PM success examples than failure examples in the categories of personal care, taking care of another living thing, schoolwork, and "other," ps < .05.

For each PM example, parents were also asked to indicate whether they provided any help, and if they did, they were asked to describe the type of help they gave to their child. Parents' responses were coded into ten categories: (a) verbal reminders (22.8%, $n = 153$), (b) visual reminders (2.1%, $n = 14$), (c) rewards (0.1%, $n = 1$), (d) complete the task together with the child (1.5%, $n = 10$), (e) parent completes the task instead of the child (6.7%, $n = 45$), (f) parent provides assistance with the PM action (21.8%, $n = 146$), (g) parent directs the child to complete the task; 2.1%, $n = 14$), (h) supervision (2.4%, $n = 16$), (i) no help (40.1%, $n = 269$), and (j) other (0.3%, $n = 2$). An unregistered, exploratory chi-square test showed that the type of parental assistance was significantly associated with children's PM success or failure on the task, χ^2 (9,670) = 180.48, $p < 0.001$. Bonferroni adjusted z-tests for column proportions revealed that parents provided more verbal reminders, visual reminders, and completed the task instead of the child when their child failed the PM task, ps < .05. Parents did not provide any help or just supervised their child (without any interference) when their child succeeded, ps < .05.

Discussion

The current study used a parent diary methodology to examine the development of naturalistic PM in young children's everyday life in the United States. In an initial session, parents reported on their child's PM abilities via two questionnaires and then reported their children's PM successes and failures in an online diary over four consecutive days. According to parent-reports, children as young as 2 years of age showed success in PM tasks in their day-to-day lives. No relation was found between children's parent-reported naturalistic PM performance and their age. Across all age groups, parents reported more child PM successes than failures. However, age interacted with the PM outcome, with all parents reporting more PM successes compared to failures, except for parents of 4-year-olds who reported a smaller difference between the number of PM successes and failures. Higher parental task importance and child motivation were associated with greater likelihood of PM success. In contrast, higher task typicality and parental assistance were associated with greater likelihood of PM failure. There was no effect of child task importance, whether the task was assigned by someone else or whether it was self-assigned, or the age of the child on PM success. Parents reported that children had more PM successes than failures in the domains of personal care, schoolwork, and "other" categories. Finally, parents tended to assist with their child's PM by using verbal reminders, visual reminders, completing the task on behalf of the child, or by providing instructions to the child on how to complete the task, but parents only reported assisting their child when they failed to complete a PM task on their own. In contrast, parents provided no help and reported only supervising children when they had successful PM performance.

Prospective memory performance of two year olds

Unlike past studies that have indicated that most 2-year-olds struggle to carry out their future intentions in laboratory settings (Kliegel & Jäger, 2007; Ślusarczyk, Niedźwieńska, & Białecka-Pikul, 2018), our findings showed that according to parents, 2-year-olds had success with everyday PM tasks and remembered their future intentions more than they forgot them. Several possibilities for this finding exist. First, it is possible that 2-year-olds show superior PM in naturalistic settings with developmentally appropriate parent-assigned PM tasks compared to their PM performance on relatively difficult tasks administered in laboratory settings. This possibility is broadly supported by findings that young children's PM is better when a task is highly motivating (e.g., Causey & Bjorklund, 2014, Kliegel et al., 2010; Ślusarczyk & Niedźwieńska, 2013; Somerville, Wellman, & Cultice, 1983). Perhaps parents assign very young children easier tasks that they are likely to remember (i.e., remind me to give you a cookie when we get home vs. remind me to return a phone call from my uncle). Although our data shows that children's PM tasks were from similar domains across age groups (i.e., personal care, getting ready for an event, and tidying), parents might adjust their level of support, the complexity of the task, or the specificity of the task instructions based on their child's age. Indeed, as shown in Table 2, parents assigned simpler intentions to younger children that need to be carried out in the near future (e.g., bring their shoes into the house or wipe hands after eating) whereas they seem to expect older children to carry out more complex intentions (e.g., remembering to wear certain types of clothes when company is coming, taking medicine). Second, it is possible that parents either minimize or

are unable to detect their young children's PM failures or exaggerate their children's PM successes. Parents can only report on their children's PM successes or failures when they are aware that their child has a future intention, so parents cannot report on the success of PM intentions that have been internally generated by the child and not explicitly mentioned to their parent. Out of these two possibilities, we believe that the most likely is that parents adjust their expectations, assistance, and assignment of PM tasks based on their child's developmental level, which perhaps minimizes age effects that have been documented in laboratory settings. In support of this argument, Mazachowsky, Hamilton, and Mahy (2021) showed that parents are sensitive to their children's PM abilities and provide more support as young children age through the preschool years, and then taper off their assistance as PM ability improves over middle childhood.

The development of naturalistic prospective memory

Intriguingly, parent-reported rates of PM successes and failures in everyday life did not differ with age. Parents reported more PM successes than failures for all children, with parents of 4-year-olds reporting a smaller difference between the number of PM successes and failures than all other age groups. This lack of age effect is reminiscent of past findings from studying PM in naturalistic settings despite being inconsistent with age effects typically observed in laboratory PM tasks. For example, past studies have documented improved PM in very young children and thus smaller age effects in naturalistic settings that have employed highly motivating PM tasks (e.g., Ślusarczyk & Niedźwieńska, 2013; Somerville, Wellman, & Cultice, 1983). Our lack of age effect on PM is also similar to findings with older adults, where age effects are often much smaller or even absent in naturalistic PM tasks compared to laboratory PM measures (e.g., the age-PM paradox; Rendell & Craik, 2000; Schnitzspahn, Kvavilashvili, & Altgassen, 2020). It is possible that children have more success in the PM tasks that they are expected to accomplish in their day-to-day lives and thus do not show age effects in performance of these tasks. Perhaps like older adults, children take advantage of contextual reminders in familiar settings compared to novel laboratory settings resulting in better PM performance. Again, parents might only detect a subset of their children's PM successes and failures and be unable to detect self-generated intentions whose failures go unnoticed and thus underestimate PM failures and age effects. In line with this possibility only a small portion (7.4%) of PM intentions were child-generated. One inherent limitation of having a parent as the only informant is that parents can only report on intentions that they are aware of in the first place. However, asking young children to report on how successfully they carry out their prospective intentions would also have limitations. Another limitation to our parent-report diary methodology was that parents who reported more PM successes also reported more PM failures suggesting that parents might have a reporting bias that affected the frequencies at which they report their children's PM successes and failures.

It is reassuring from a measurement perspective that the CFTQ and CEMQ were related to children's naturalistic PM based on diary reports. This suggests that both of these parent-report PM questionnaires capture PM in children's everyday life. The two PM questionnaires, however, seem to differentially detect children's age-related changes with the CFTQ showing a strong relation with age and the CEMQ showing no relation with age. This might be because the CEMQ focuses on short-term and long-term PM tasks that even some young

children can carry out proficiently whereas the CFTQ focuses on broader statements about PM ability that may be more likely to detect age-related differences in PM.

The effect of task characteristics on prospective memory performance in daily life

In line with past research conducted in laboratory settings and findings with adults (e.g., Rummel, Snijder, & Kvavilashvili, 2023), we found that many factors that influence children's PM in the lab were also linked to the likelihood of children's PM success and failure in everyday life.

If parents rated a task as more important, this was associated with parents' reports of their child carrying the task out successfully. Because many children's PM tasks are assigned by parents, perhaps children are better at carrying out PM tasks that their parents consider important because they realize such intentions are likely to be enforced or have negative consequences for forgetting to accomplish them. Parent-rated child task importance, however, was not associated with the likelihood of PM success. Children might judge tasks as important that are not viewed as important by their parents. For instance, maybe a child would place a lot of importance on remembering to draw a picture when they arrive home from school, whereas a parent is unlikely to place much importance on such a task compared to matters of safety, hygiene, or following rules. There was a small but significant positive correlation between task importance ratings for the parent and child, $r(804) = .097$, $p = 0.006$, suggesting that parents' rating of importance was not strongly related to their assessment of importance to their child.

Consistent with past literature (e.g., Causey & Bjorklund, 2014, Kliegel et al., 2010; Ślusarczyk & Niedźwieńska, 2013; Somerville, Wellman, & Cultice, 1983), children's motivation was most strongly associated (i.e., had the largest effect size; see Table 5) with PM success in everyday life. Children's motivation to complete a future intention can be a powerful factor in their success. This has important implications for researchers who are designing laboratory PM tasks. On the one hand, PM tasks need to be interesting enough to capture children's interest and attention so there is a chance that they will be carried out. To ensure that children are interested enough in a task, researchers could consider providing children a choice of two or three tasks to complete so that they can have some confidence that children at least have some interest in the task that they select to complete. On the other hand, if laboratory tasks are too motivating, they will result in ceiling levels of performance and provide limited variance. This is the exact problem that Kvavilashvili, Kyle, and Messer (2008) described in their chapter when piloting a PM task in which young children were asked to feed a bone to a dog. This task had to be abandoned after children completed it at ceiling levels due to high levels of intrinsic interest. It is important, however, to keep in mind that children need to carry out many tasks in daily life – some exciting and some mundane – so researchers might consider varying the level of motivation of PM tasks if they have the opportunity to administer several tasks in the laboratory. Two recommendations for researchers moving forward are to: (1) consider the kinds of PM tasks that children carry out in their day-to-day lives, and (2) consult with parents when designing new laboratory PM tasks.

Children were less likely to successfully complete a PM task that occurred on a regular basis compared to tasks that were atypical (distinct and infrequent tasks). This finding was

unexpected as it is inconsistent with the adult literature (e.g., Blondelle et al., 2016; Rose, Rendell, McDaniel, Aberle, & Kliegel, 2010; Zuber & Kliegel, 2020) that documents better PM for regularly occurring tasks compared to one-off tasks. Children's PM failures were often from categories that were regularly occurring such as personal care, getting ready for an event, and tidying. Thus, the fact that children had many failures for such routine tasks likely drove this relation between task typicality and PM failure. It is also possible that children were more likely to remember distinct events compared to those mundane tasks or chores that occur on a regular basis. Ratings of children's motivation were negatively related to task typicality, $r(803) = -.113$, $p = 0.001$, with parents reporting that children were more motivated to complete tasks that were more atypical suggesting that these tasks were more interesting tasks. Another possibility is that parents were more likely to notice and report their children forgetting regularly occurring tasks compared to irregular tasks, possibly because parents monitor regular tasks such as household or school routines but might be less aware of atypical intentions that go unaccomplished.

Finally, receiving parental assistance was more predictive of PM failure, likely because parents help only when their child fails to carry out an intention. Indeed, parents did not provide any help when their child successfully carried out their own intention. Whether the task was self-assigned or assigned by another person also did not predict PM success, although this lack of effect might be due to the relatively few instances that parents reported that an intention was self-assigned by their child (7.4%). Thus, the majority of PM intentions were assigned by parents and other adults in their child's life in our sample and according to parental report.

Domains of prospective memory successes and failures

There are a number of domains in which children are expected to carry out their future intentions independently in daily life. According to parents, children had more success in carrying out their intentions in the domains of personal care, schoolwork, and the "other" category. Perhaps these domains are characterized by familiar routines, such as brushing their teeth before they go to school and remembering to complete their homework, that support children's ability to carrying out such intentions.

Types of parental scaffolding

Parents provided several types of assistance to children when they failed to carry out their future intention. Most notably, parents used verbal and visual reminders, completed the task on behalf of their child, or gave their child instructions for how to complete the task. Parents did not provide these reminders when their children were successful in carrying out the task. Thus, it seems that parents appropriately scaffold their child's PM (e.g., Mazachowsky, Hamilton, & Mahy, 2021) by helping only when necessary following a failed PM action. Although our results cannot speak to the timing of when parents assist their child in relation to their PM failure, it seems probable that once a child forgets to carry out their intention, parents step in with assistance. Future research should further investigate the temporal dynamics of this parental scaffolding.

Limitations and future directions

A main limitation of our study was the fact that parents were the only informants on their children's PM behavior. Parents might be limited in their ability to detect and report on their child's intentions, especially those that are not verbalized by their child. It is difficult for questionnaires to capture performance in very young children especially given that their PM might fluctuate and is likely difficult for parents to assess given their more limited verbal abilities. Future work should focus on ways to creatively assess PM in toddlers as it is clear that these abilities are emerging in this developmental period. However, we believe that parents are an important source of information in capturing children's naturalistic PM performance in everyday life. Further, studies suggest that parents can accurately report on their children's PM (e.g., Mazachowsky & Mahy, 2020) and parents observe their children's behavior across a number of settings and spend substantial amounts of time with their children on a daily basis (e.g., Bianchi, 2000; Sandberg & Hofferth, 2001). Another limitation is that parents might have been biased in their task ratings (e.g., task importance, motivation) by whether the task was successfully accomplished by their child or not. For instance, if a child failed to complete a task, then parents might assume that the task was not important or motivating to the child because they failed to carry it out leading the parent to provide lower ratings on task importance or motivation. Nonetheless, parents can report on various aspects of children's cognitive development quite accurately (e.g., Mazachowsky & Mahy, 2020; Ring & Fenson, 2000; Tahiroglu et al., 2014). Thus, although some biases might have been present, we are confident that parent-reports overall were reliable. A third limitation was that the diary portion of the study lasted for four days, which offers a brief snapshot of children's lives and is shorter than other diary studies that have often followed participants over longer periods (e.g., two weeks). We intentionally choose this short four-day interval, however, to capture a typical week and to minimize attrition, which is particularly important for online studies. In fact, our briefer diary period is in line with suggestions that shorter diary studies promote participation and are associated with higher quality and a greater quantity of data (e.g., Laughland & Kvavilashvili, 2018). For the purposes of this study, we combined our data to examine PM successes and failures across four days, but this strategy did not capture the structure of the data that was collected over time. We acknowledge this as a limitation of our analytical approach.

Future research should continue to use parent-report diary methodology to further explore children's PM in everyday life contexts and to examine how everyday life PM might differ from PM in laboratory contexts. For instance, it is possible that similar to the aging literature age effects are amplified in the laboratory compared to everyday life. Further, we could gain greater insight into the processes that support PM (see Mahy et al., 2014a) by asking parents to report on whether children forget to carry out their intentions due to forgetting the intention itself or whether they forget to carry out their intention at the appropriate time. There is much to be learned about the cognitive mechanisms that support PM in the lab and in everyday life; it is possible that due to the artificial and cognitive demands of laboratory PM tasks that executive function might play a more substantial role in supporting PM in laboratory settings whereas motivation might support everyday PM and lessen reliance on effortful cognitive processes.

Conclusion

This study examined American preschool children's naturalistic PM performance using a parent diary-report methodology. Studying children's everyday PM provides an important window into children's everyday memory functioning and provides information about how cognitive processes might differ in naturalistic and laboratory settings. Our findings suggest that like age differences between younger and older adults, age differences in performance in early childhood might be less pronounced in naturalistic PM tasks, particularly when these tasks are not set by researchers but are assessed as they naturally occur in children's everyday lives. Parents also seem to detect more PM successes than failures and report that children's PM success is affected by a number of factors mostly consistent with findings in laboratory settings. We hope the current research encourages others to examine children's PM in more varied and naturalistic contexts in order to obtain a more complete picture of the development of PM. Our findings also illuminate parents as an important source of information about children's memory development as it unfolds in everyday life.

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Data availability statement

The data that support the findings of this study are available on the Open Science Framework: https://osf.io/p96w5/?view_only=9d0356b5f7ab4c45bdee7e8608e30132.

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