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Predicting Which Childhood Memories Persist: Contributions of Memory Characteristics

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This investigation identified memory-level predictors of the survivability of 4- to 13-year-old children's earliest recollections over a 2-year period. Data previously reported by Peterson, Warren, and Short (2011) were coded for inclusion of emotion terms and thematic, chronological, and contextual narrative coherence. In addition, the uniqueness and content of the reported events were classified, and the presence or absence of event reminders was recorded. The use of logistic multilevel modeling indicated that emotion and each dimension of coherence added to the prediction of a memory's survivability over and above age-related variance. In contrast, event uniqueness, content category, reminders, and word count were not associated with retention. The findings help explain why particular early memories endure over time.

Keywords: childhood amnesia, infantile amnesia, narrative coherence, emotion, memory

Childhood amnesia was originally construed as a barrier that prohibited access to all memories of experiences that transpired before three or 4 years of age (e.g., Freud, 1905/1953a, 1905/1953b; Pillemer & White, 1989), but recently it is described as the relative paucity of memories for the events of early childhood rather than their absence (Bauer, 2007; Nelson & Fivush, 2004). In cross-sectional research, childhood amnesia becomes apparent during middle childhood (Bauer, Burch, Scholin, & Güler, 2007; Peterson, Grant, & Boland, 2005; Tustin & Hayne, 2010). For most typical individuals, however, some memories of preschool experiences persist into late childhood and adulthood (Rubin, 2000). Much research has explored general age-related changes (e.g., increases in domain-specific knowledge) and environmental factors (e.g., reminiscing style) that affect the mechanisms and timing of childhood amnesia at the level of the person, whereas fewer studies have empirically examined characteristics of the small number of earliest memories that do survive to adulthood. Moreover, the majority of investigations exploring the properties of individual memories are cross-sectional, and hence cannot compare memories that survive to those that were forgotten earlier in life (e.g., Howes, Siegel, & Brown, 1993; Usher & Neisser, 1993; cf. Morris, Baker-Ward, & Bauer, 2010). The present longitudinal study uses characteristics of individual memories to predict which earliest memories escape the erasing effects of childhood amnesia to endure over time.

This investigation recoded and reanalyzed data originally collected by Peterson, Warren, and Short (2011) to examine a very different issue. Specifically, we examined influences on the survival of children's earliest memories. In the original study, 4- to 13-year-old children were asked for their earliest three memories in an initial interview and again 2 years later. To control for the possible failure to report existing memories, children were given brief cues to memories they provided initially but omitted during their follow-up interview, and these cues were randomly mixed with similar cues to false events. Children virtually always rejected the false events, giving more credibility to their assertions of "I don't remember that" or "That never happened to me" when they responded to cues of previously mentioned memories.

The findings of that study were threefold: Overall, children's age at the time of their first memory increased as their current age increased, and their age at the time of their first memory shifted upward by several months between their initial and follow-up interview. Second, younger children were most likely to provide all new memories in their follow-up interviews, whereas older children were more likely to provide the same memories in both interviews. Third, cues for previously reported memories did not

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typically lead to recall in the younger children but often elicited confirmation of the event and the addition of considerable detail among the older children. Thus, younger children forgot some of their early memories over a 2-year delay, while older children were becoming consistent in their recall of very early memories.

Peterson et al. (2011) was the first study to prospectively assess children's earliest memories, and although it documented some forgetting over 2 years, it provided no clues about why certain memories were retained, whereas others were lost. This is the focus of the present study: Can we identify specific characteristics of individual memories that make them more likely to be retained?

Several memory-level possibilities have been considered by prior cross-sectional research. But none of them have been able to explore the ability of these characteristics to predict which memories survive and which fade away. The unique contribution of the present study is that for the first time we can now empirically evaluate the predictive value of these proposed characteristics on the survivability of earliest memories because we are using a prospective data set. One of these proposed possibilities is the uniqueness of the remembered experience (Bauer, 2007; Howe, 1997; Nelson & Fivush, 2004). One-time experiences embody a distinctiveness assumed to set the event apart in memory, contributing to the likelihood of its retention, although repeated events are also regularly identified as earliest memories (Peterson et al., 2005; Peterson, Wang, & Hou, 2009). Another assumption is that an individual's surviving memories of early childhood experiences are more likely to be infused with emotion, either positive or negative, than are the memories that are lost across time. Several cross-sectional investigations (Howes et al., 1993; Mullen, 1994; Saunders & Norcross, 1988) found that adults' early memories represent emotional events (but see Kihlstrom & Harackiewicz, 1982). In contrast, cross-sectional research with children indicated that reports of earliest memories tended to refer to everyday experience that did not include affective terms (Peterson et al., 2005; Peterson et al., 2009).

Reinstatement, the reactivation of a memory for a prior experience when an aspect of the event is reencountered, is another potential predictor of the survivability of specific earliest memories that has been suggested by cross-sectional research, although never evaluated using longitudinal data. Whereas it seems reasonable to expect that reinstatement of early childhood experiences through reminders such as photographs or family discussions might contribute to the persistence of early childhood experiences in memory, there is surprisingly little evidence to support this assumption. Although Usher and Neisser (1993) found that opportunities for rehearsal or review were positively associated with college students' memories for events occurring when they were ages 4 to 5, such reminders were negatively linked with memories for events occurring when they were 2 to 3 years old. Further, potentially reinstating experiences, such as parent-reported discussion or continued exposure to the setting for the event, have not always enhanced children's memories for their experiences (e.g., Baker-Ward, Gordon, Ornstein, Larus, & Clubb, 1993; Principe, Ornstein, Baker-Ward, & Gordon, 2000).

A number of limitations characterize the extant evidence for influences on the persistence of first memories. Most notably, the investigations that examine the influences of the distinctiveness, emotion, and content of the memory and the presence or absence of reminders are cross-sectional in design. Hence, only characteristics of surviving memories can be examined; importantly, predictors of the long-term maintenance or loss of specific memories cannot be discerned. In the present research, we can now do so because of the prospective design. In addition, the few studies that do include prospective studies of children's memory differ from the current study in critical ways. Specifically, they do not investigate the children's earliest memories. Rather, they focus on memories from later points in their lives. Second, they do not include memories that the children themselves nominate as constituting their earliest memories. Parents chose the recently occurring, moderately pleasant everyday events (e.g., apple picking) about which children are subsequently interviewed (Cleveland & Reese, 2008; Fivush & Schwarzmueller, 1998; Van Abbema & Bauer, 2005). Thus, the limited range of experiences nominated by parents precluded the investigation of some potentially important predictors of memory survivability, especially the emotion associated with the event. In addition, many investigations of children's early memories rely on parental ratings of the emotionality of an event (e.g., Fivush, Hazzard, Sales, Sarfati, & Brown, 2003); however, parental perspectives might differ markedly from the child's own. In the present investigation, affect is operationalized on the basis of the emotion expressed by the children themselves in their initial descriptions of their self-selected earliest memories.

Recent research provides initial evidence for the importance of additional factors in the persistence of early autobiographical memories, namely, two dimensions of narrative coherence. Coherence, defined as how well a particular memory is structured, organized, and elaborated (e.g., Fivush, 2007; Peterson & McCabe, 1983), increases the likelihood that a memory is retained over time (Reese et al., 2011; Baker-Ward, Ornstein, & Principe, 1997). Morris et al. (2010) coded the narrative coherence of 4-, 6-, and 8-year-old children's reports of recently occurring, unique events selected by their parents (such as a birthday party or field trip) and examined the influence of coherence and memory breadth on the survival of memories over an interval of a year. The authors applied an established coding scheme for narrative coherence (Reese et al., 2011), which enabled them to score two dimensions of the construct, specifically, chronological and thematic coherence. Two important findings emerged: The thematic coherence of the memory, defined as the extent to which there was a clear focus to the narrative, contributed to the prediction of whether a specific memory would survive for 1 year, over and above age, as well as the breath of the initial report, defined as the inclusion of who, what, when, where, and why. In contrast, chronological coherence did not affect the likelihood that a particular memory would be retained.

The design of the present study allows for the examination of the effects of the influence of coherence on the survivability of children's self-selected earliest memories (as opposed to parent-nominated recent events), which is directly applicable to the understanding of childhood amnesia. Further, the current work investigates the third and final dimension of narrative coherence, context, which has yet to be studied. Memories that include time and place may be reactivated through everyday references to these components, which could serve as cues for incidental retrieval (Baker-Ward et al., 1997). In addition, the retention interval in the present study is twice as long as in the Morris et al. (2010) work.

As stated previously, the present study used data from Peterson et al.'s (2011) prospective study of childhood amnesia to examine influences that may affect the survival of children's earliest memories. Augmenting the existing literature, we explored the extent to which the distinctiveness, emotionality, and content of children's

reports of their earliest memories predicted the survival of these memories 2 years later. Because the parent-selected memories examined by Morris et al. (2010) were overwhelmingly reports of pleasant, everyday experiences, these influences on the retention of memories could not be examined in the previous work. Further, we examined the influence of parents' reported discussion and/or provision of reminders about specific memories on their continued existence over time. Following Morris et al. (2010), we used multilevel modeling to examine separately influences at the level of the child and the memory. This study thus provides an empirical test of memory-level factors that have been proposed to differentiate memories that are lost to childhood amnesia from those that contribute to the autobiographical self.

Method

Participants

There were 140 participants, divided into five age groups. Their ages at the time of their initial interviews are as follows: 27 4- to 5-year-olds (nine girls, mean age = 4.84 years, *SD* = 0.55 years), 23 6- to 7-year-olds (eight girls, mean age = 6.94 years, *SD* = 0.64 years), 29 8- to 9-year-olds (16 girls, mean age = 9.08 years, *SD* = 0.56 years), 35 10- to 11-year-olds (19 girls, mean age = 10.95 years, *SD* = 0.58 years), and 26 12- to 13-year-olds (13 girls, mean age = 12.77 years, *SD* = 0.60 years). All references to children's ages throughout this article are to their age at the time of the initial interview, even though they were 2 years older in their second interview. Participants were mostly of European-descent and had been recruited from the emergency room of the only children's hospital in their community as part of another study (Peterson et al., 2011).

Procedure

When visited in their homes during their initial interview, children were given the prompt, "I want you to think way back and tell me the first thing you ever remember, something that happened when you were really little," and then probed to give as much information as possible by asking "What else do you remember about that?" They were then asked for additional details: "Where did this happen?" "How did it make you feel?" and "How many times did this happen to you?" These prompts were repeated twice more, asking for their next earliest memories. Children were asked to date these memories, and they were verified by parents. Two years later the children were revisited and asked once more to describe their three earliest memories. Because memories that were retained by children may not have been mentioned in their descriptions of their earliest three, children were given prompts about any memories provided in the initial interview that had not been spontaneously described in the follow-up interview. If children said that they could recall a memory after being prompted, they were asked to tell as much as they could remember about it. Children were also given foils—prompts about "memories" that had never happened to them, and they virtually always denied that these false events had occurred. (See Peterson et al., 2011, for details about the prompts.) Memories were classified as remembered if the children described them among their earliest three or else added more information after identifying a prompted memory as being recalled. If children failed to mention a memory, said they did not remember to the memory prompt, or could not provide any information beyond a prompt, the memory was coded as forgotten.

Data Coding

The following additional measures were obtained through new coding of the existing transcripts of the participants' initial reports of their earliest memories (Peterson et al., 2011).

Characteristics of recalled versus nonrecalled memories. Memories were classified in three ways. First, they were classified as referring to a unique event or a repeated event; a memory was classified as unique if children in each interview stated that it only happened once. Next, they were categorized as to whether they contained at least one explicit reference to an emotion or affective state (e.g., "mad, happy, excited, cried"). If they did include an emotional term, the memory as a whole was further classified as being positive, negative, or containing both (mixed emotions). Last, the presence or absence of reminders was assessed by whether parents said that there was at least one of the following about the remembered event: photos, videos, or family stories. In addition, the length of the memories was measured by counting the number of words.

Content of recalled versus nonrecalled memories. Each of the memories was classified into one of the following mutually exclusive content categories, based on Peterson et al. (2005): (a) a trip, (b) play event, (c) family outing, (d) injury or trauma, (e) transition event, (f) toy, (g) birthday, (h) birth of sibling, (i) family move, or (j) miscellaneous other content.

Narrative coherence. Coherence was coded using the Narrative Coherence Coding Scheme (NaCCs; Reese et al., 2011), as recently applied by Morris et al. (2010). Ratings from 0 to 3 were made for each narrative on the following dimensions of narrative coherence: context, chronology and theme. The *context* dimension assessed inclusion of information that orients the memory in both time and place. Reports coded as 0 contained none of this information, whereas reports coded as 3 provided specific information about both time and location (e.g., "It happened in my Nana's backyard when I was three.") The *chronology* dimension measured whether the events that comprise the narrative could be placed on a timeline by a listener, ranging from 0 (*no temporal ordering*) to 3 (*75% or more of the actions were sequenced*). This differs from the context dimension above because chronology captures the sequential temporal relationship between specific elements in the child's entire account of the event (e.g., "First we . . ., then we . . . and before we went home, we . . ."). Last, the *theme* dimension indicated the extent to which there was a clearly developed focus to the narrative. Narratives with low theme scores had minimally developed topics, whereas narratives with high theme scores substantially developed a topic by including elaborations, interpretations or causal links and possibly information linking the event to other aspects of autobiographical memory or self-concept.

Approximately 15% (n = 55) of the transcripts were randomly selected for calculating reliability, with approximately proportionate representation of each age group. For memory characteristics, interrater reliability (Cohen's kappa) averaged .92. For memory content, kappa = .85. For coding coherence, two coders independently rated each dimension of coherence on these narratives, and resolved disagreements through discussion. The intraclass correlations were 0.86 for the context dimension, 0.83 for the chronol-

ogy dimension, and 0.73 for the theme dimension. Intercorrelations were used to determine that the three coherence dimensions were related but distinct dimensions. Theme was weakly associated with context ($r = .26$, $p < .05$) and moderately association with chronology ($r = .33$, $p < .05$); however, context and chronology were not related to each other.

Results

Although all 140 children were asked to provide their three earliest memories in their initial interview, not all children did so, with younger children less likely to report three memories (see Peterson et al., 2011). Recording malfunction or interviewer error made 11 other memories unavailable. Thus, the final sample included 362 memories provided by children in their initial interview that could be assessed as remembered versus forgotten 2 years later. Overall, children remembered 86.5% of their initially reported earliest memories 2 years later (Peterson et al., 2011), with older children remembering a greater proportion of their memories than younger children, $\chi^2(4, N = 362) = 33.5$, $p < .01$; 4- to 5-year-olds remembered 65.5%; 6- to 7-year-olds, 81.4%; 8- to 9-year-olds, 88.5%; 10- to 11-year-olds, 92.7%; 12- to 13-year-olds, 97.2%.

Content and Characteristics of Memories

Table 1 summarizes the coded content of memories. As is apparent, early memories varied widely in content, and it is not the case that only particular types of content were likely to comprise children's earliest memories. It is also apparent that particular types of content were not uniformly recalled 2 years later, whereas other types of content were uniformly forgotten.

The length (in words) of the children's memories as well as the proportion of memories that were about unique events; referred to an affective state; and had photographs, videos, or family stories associated with them are presented in Table 2. Although the length of narratives differed by age, $F(4, 357) = 13.53$, $p < .05$, $\eta^2 = .13$, post hoc analyses revealed that 4- to 5-year-olds' memories did not significantly differ in length from 6- to 7-year-olds', but both of these age groups' narratives were shorter than those of the older three age groups, which did not differ from each other. In addition, the older three age groups were more likely to include emotional information in their memory narratives than the younger two groups, $\chi^2(4, N = 362) = 61.5$, $p < .01$. The youngest group of children were more likely to discuss repeated events than all older age groups, $\chi^2(4, N = 362) = 15.08$, $p < .01$. Older children were more frequently exposed to photos, stories, or videos about their memories than younger children, $\chi^2(4, N = 340) = 29.6$, $p < .01$; 4- to 5-year-olds had reminders about 8.9% of their memories; 6- to 7-year-olds, 16.9%; 8- to 9-year-olds, 26.0%; 10- to 11-year-olds, 41.1%; 12- to 13-year-olds, 45.2%.

A series of separate logistic multilevel models (Raudenbush & Bryk, 2002) were conducted to examine whether the within-person variations in these four memory characteristics (length, uniqueness, inclusion of emotion, and reported presence of reminders) could predict the likelihood of an earliest memory's survival over 2 years above and beyond the influence of between-person differences in age. It is important to note that the person-level differences captured by age likely include typical developmental differences, such as verbal IQ and increases in domain-specific knowledge. Logistic multilevel modeling was most appropriate for the present nested data set because each child contributed up to three different mem-

Table 1
Number (and Proportion) of Memories by Content Type at the Initial Interview, for Memories Recalled Versus Not Recalled 2 Years Later by Children Grouped by Age

	Age group				
Content of memories	4–5 years	6–7 years	8–9 years	10–11 years	12–13 years
	Memories that were recalled 2 years later				
Trip	5 (.13)	6 (.13)	9 (.13)	6 (.07)	4 (.06)
Play event	11 (.29)	9 (.19)	9 (.13)	19 (.21)	22 (.32)
Outing	5 (.13)	2 (.04)	7 (.10)	2 (.02)	3 (.04)
Injury	6 (.16)	7 (.15)	18 (.27)	18 (.20)	8 (.12)
Transition event	2 (.05)	10 (.21)	12 (.17)	15 (.17)	13 (.19)
Toy	2 (.05)	7 (.15)	3 (.04)	6 (.07)	2 (.03)
Birthday	0	2 (.04)	3 (.04)	5 (.06)	6 (.09)
Birth of sibling	2 (.05)	1 (.02)	1 (.01)	3 (.03)	0
Family move	1 (.03)	0	1 (.01)	0	0
Other	4 (.11)	4 (.08)	6 (.09)	15 (.17)	11 (.16)
	Memories that were not recalled 2 years later				
Trip	2 (.10)	0	0	0	0
Play event	8 (.40)	2 (.18)	2 (.22)	1 (.14)	1 (.50)
Outing	1 (.05)	1 (.09)	0	0	0
Injury	2 (.10)	1 (.09)	0	2 (.29)	0
Transition event	1 (.05)	0	2 (.22)	1 (.14)	0
Toy	2 (.10)	2 (.18)	1 (.11)	0	0
Birthday	0	2 (.18)	1 (.11)	0	0
Birth of sibling	0	0	0	0	0
Family move	0	0	0	0	0
Other	4 (.20)	3 (.27)	3 (.33)	3 (.43)	1 (.50)

Table 2
Characteristics at the Initial Interview of the Memories Recalled Versus Not Recalled 2 Years Later by Children Grouped by Age

Characteristics of memories	Age group				
	4–5 years	6–7 years	8–9 years	10–11 years	12–13 years
	Memories that were recalled 2 years later				
No. of memories	38	48	69	89	69
Mean no. words (*SD*)	37.8 (22.4)	54.9 (40.9)	100.1 (69.3)	102.3 (64.4)	92.2 (102.6)
Proportion about unique events	.58	.71	.86	.78	.74
Proportion with affect reference	.40	.38	.74	.76	.76
Proportion with photos/stories	.10	.15	.26	.40	.39
	Memories that were not recalled 2 years later				
No. of memories	20	11	9	7	2
Mean no. words (*SD*)	35.7 (22.0)	31.5 (12.5)	75.5 (55.4)	103.7 (67.3)	139.5 (133.6)
Proportion about unique events	.55	.73	.78	1.00	.50
Proportion with affect reference	.15	.18	.56	1.00	.50
Proportion with photos/stories	.05	.27	.11	.14	.50

ories, resulting in observations that are not independent. Since the majority of children reported three earliest memories, only two Level 1 variables were included in each model to insure adequate degrees of freedom (Raudenbush & Bryk, 2002). The specific equations used can be found in the Appendix. A preliminary analysis indicated that 90% of the variability in remembering was between children ($\tau_{00} = 3.60$) and 10% was within children ($\sigma^2 = 0.38$).

Although the word count of the initial memory, the uniqueness of the event, and the parent-reported existence of reminders of the event did not contribute to the prediction of which memories survived, the inclusion of affective terms did. Events that were described with either positive, negative or mixed emotions were two and a half times more likely to be remembered over a 2-year delay than events with no affective terms (see Table 3). A follow-up logistic multilevel model revealed a small but significant Age Group × Presence of Affect interaction (see Table 4), suggesting that the effects of emotion on remembering may differ by age. Although the data did not allow a full examination of the effects of the type of emotion on subsequent memory retention, we report in Table 5 the proportion of memories that were retained in each emotional category over the 2-year interval. These descriptive data suggest that for all age groups except the 10- to 11-year-olds, the presence of emotion, regardless of valence, appeared to notably increase the likelihood of a memory being retained. For example, only 58% of the memories initially generated by the 4- to 5-year-olds that had no emotional terms were recalled 2 years later. In contrast, 83% of the initially generated memories that contained either positive or negative emotion were remembered 2 years later.

Coherence

In the present data, three child memory narratives could not be coded for any coherence dimension due to tape malfunction, and an additional 56 could not be coded for chronology because they did not include more than one action in an uninterrupted statement. Thus, analyses including coherence are based on 303 memory narratives. Not surprisingly, younger children's memories were more likely to be excluded based on this criteria than older children's, $\chi^2(4, N = 362) = 21.8, p < .01$; 32.8% of memories from 4- to 5-year-olds contained only one action, 20.3% from 6- to 7-year-olds, 14.1% from 8- to 9-year-olds, 5.2% from 10- to 11-year-olds, 18.3% from 12- to 13-year-olds. The 303 included memories did not differ from the 56 excluded memories in terms of emotionality, $\chi^2(1, N = 362) = 1.45, p > .05$; reported reminders, $\chi^2(1, N = 362) = 1.48, p > .05$; or the probability of being recalled 2 years later, $\chi^2(1, N = 362) = 0.18, p > .05$; however, they were more likely to describe unique rather than repeated events, $\chi^2(1, N = 362) = 4.97, p < .05$, and tended to be longer. Mean number of words of included memories = 90, excluded = 33; $F(1.362) = 34.89, p < .01$. Consistent with expectations, additional cross-sectional analyses revealed age-

Table 3
Logistic Multilevel Model Results for Remembering an Earliest Memory Over 2 Years Using Age and Affect

Variable	Odds ratio	LCI	UCI
Probability of remembering earliest memory, β_0			
Intercept, γ_{00}	0.87	0.38	2.02
Age group, γ_{01}	1.90**	1.42	2.54
Inclusion of affect slope, β_2			
Intercept, γ_{20}	2.60**	1.35	5.01

Note. LCI = lower boundary of the 95% confidence interval; UCI = upper boundary of the 95% confidence interval. $n = 362$ memories.
** $p < .01$.

Table 4
Logistic Multilevel Model Results for Remembering an Earliest Memory Over 2 Years Using Age × Affect Interaction

Variable	Odds ratio	LCI	UCI
Probability of remembering earliest memory, β_0			
Intercept, γ_{00}	0.40	0.14	1.14
Age group, γ_{01}	2.85**	1.83	4.42
Inclusion of affect slope, β_2			
Intercept, γ_{20}	17.53**	3.85	79.82
Age × Inclusion of affect slope, β_3			
Intercept, γ_{30}	0.48**	0.28	0.82

Note. LCI = lower boundary of the 95% confidence interval; UCI = upper boundary of the 95% confidence interval. $n = 362$ memories.
** $p < .01$.

related increases in all coherence dimensions; Theme, $F(4, 298) = 12.78$, $p < .01$; Context, $F(4, 298) = 2.66$, $p < .05$; Chronology, $F(4, 298) = 4.22$, $p < .01$ (see Table 6).

Multilevel modeling (Raudenbush & Bryk, 2002) was again used to examine whether within-person variations in narrative coherence could predict the likelihood of an earliest memory's survival over 2 years above and beyond the influence of between-person differences in age. Two separate models were used to analyze the influence of the three Level 1 variables describing coherence. Theme was included in both models because previous research has indicated that it adds to the prediction of whether children's early memories survive over time (Morris et al., 2010). The first model included theme and chronology and the second model included theme and context.

The results of Model 1 indicated that both Level 1 predictors, theme and chronology, were significant. Each one unit increase in theme in the initially reported memory corresponded to an almost fivefold increase in the likelihood that that memory would be recalled 2 years later. Each one unit increase in chronology in the initially reported memory corresponded to an almost 60% increase in the likeliness that memory would be recalled 2 years later. As expected, significant effects were also found at Level 2. Each 2-year increase in age corresponds to a doubling of the likelihood that an early memory would be remembered 2 years later (Table 7).

In addition, the results of Model 2 showed that context was also a significant predictor of remembering. Again, each one unit increase in theme in the initially reported memory corresponded to about a threefold increase in the likelihood that memory would be recalled 2 years later. However, each one unit increase in context in the initially reported memory corresponded to an almost 145% increase in the likelihood that memory would be recalled 2 years later. Age was again significant; each 2-year increase in age corresponded to an almost doubling of the likelihood that an early memory would be remembered (see Table 8).

In sum, all three dimensions of narrative coherence of an early memory narrative added to the prediction of whether the memory would survive over 2 years, over and above age. Theme is the strongest predictor, although both chronology and context contributed to the survivability of children's earliest memories. A follow-up logistic multilevel model showed that there was no significant age group by theme interaction, suggesting that the effects of theme on remembering were not different for each age group.

A final logistic multilevel model combining the two strongest predictors of remembering (the presence of affect and theme) revealed that while age, inclusion of emotion, and theme all add to the likelihood that a memory will survive, theme was the strongest contributor (Table 9).

Discussion

Childhood amnesia veils but does not obliterate all our early memories. Not only do some memories persist beyond childhood, but the current study is the first to show that we have some ability to predict which early memories will do so by comparing those memories that were kept over a 2-year period with those that were forgotten by children. This prospective investigation considered more than just age-related differences (cf. Peterson et al., 2011) to focus on memory-level factors that predict which memories will survive over time. It identified the inclusion of emotional terms and all three dimensions of narrative coherence as predictive of the continuing existence of specific memories over a 2-year delay. In

Table 5
Proportion of Memories Recalled After a 2-Year Delay by Age Group and Emotional Content

Emotion of memories	Age group				
	4–5 years	6–7 years	8–9 years	10–11 years	12–13 years
Neutral (no emotion)	.58	.77	.82	1.00	.94
Positive emotion	.83	.82	.93	.97	.97
Negative emotion	.83	1.00	.89	.87	1.00
Mixed emotions			1.00	.75	1.00

Note. $n = 362$ memories.

Table 6
Coherence of the Memories at the Initial Interview That Were Recalled Versus Not Recalled 2 Years Later by Children Grouped by Age

Coherence of memories	Age group				
	4–5 years	6–7 years	8–9 years	10–11 years	12–13 years
	Memories that were recalled 2 years later				
Mean theme (*SD*)	1.08 (0.40)	1.13 (0.53)	1.48 (0.57)	1.70 (0.67)	1.50 (0.57)
Mean context (*SD*)	0.96 (0.84)	1.34 (0.91)	1.57 (0.98)	1.57 (0.95)	1.36 (0.90)
Mean chronology (*SD*)	0.92 (1.19)	0.95 (1.04)	1.57 (1.11)	1.49 (1.04)	1.32 (1.08)
	Memories that were not recalled 2 years later				
Mean theme (*SD*)	1.00 (0.00)	1.00 (0.00)	1.25 (0.46)	1.29 (0.76)	1.50 (0.71)
Mean context (*SD*)	1.14 (0.77)	1.00 (0.50)	0.88 (0.99)	1.43 (0.98)	2.00 (1.41)
Mean chronology (*SD*)	1.21 (1.05)	0.67 (0.71)	1.75 (1.17)	1.29 (0.76)	0.00 (0.00)

Note. $n = 303$ memories.

contrast, memory content, uniqueness and the presence of parent-reported reminders did not contribute to the likelihood of a memory's persistence over this delay, despite the importance assigned to these factors in the interpretations of results from previous cross-sectional data sets. The current study demonstrates the necessity of prospective research for understanding the factors related to memory survivability.

Events that were described with emotion were two and a half times more likely to be remembered 2 years later than events described without emotional terms, over and above the contributions of age. The importance of emotion in predicting memory survivability may at first seem in contrast to Peterson et al. (2005), which classified the majority of children's earliest memories as conveying no emotion. However, we note that the present finding refers to the likelihood of a memory enduring and does not describe the characteristics of the entire corpus of childhood memories. An intriguing possibility is that emotionally neutral early memories are the ones most likely to be vulnerable to the descending veil of childhood amnesia, whereas emotional memories are the ones most likely to endure beyond childhood. If so, it could be the case that the characterization of children's earliest memories as affectively neutral (Peterson et al., 2005) is not contradictory to the depiction of adults' early memories as emotionally significant (Howes et al., 1993; Mullen, 1994; Saunders & Norcross, 1998; but see Kihlstrom & Harackiewicz, 1982). Consistent with this view, Peterson et al. (2005) found that older children's memory reports were more likely to contain emotion than were younger children's reports. Continuing longitudinal work is necessary to examine this possibility.

In addition to emotion, the persistence of early memories was predicted by the coherence of the initial narrative report of the event, including theme, context, and chronology. As was the case in previous research (Morris et al., 2010), theme emerged as the most predictive dimension of coherence, with each one unit increase in theme making an event five times more likely to be retained over 2 years. We emphasize that theme conveys information about the organization of a memory report rather than merely the amount of information conveyed in this account. As described above, word count was not a significant predictor of memory survivability. Further, the expected age-related increase in theme does not account for this finding. Why might greater thematic coherence foster memory maintenance? Higher levels of theme indicate a more cohesive memory with more interconnections between discrete aspects of an entire experience.

Contextual coherence also increased the likelihood of memory survivability. Consistent with Reese et al. (2011), levels of contextual coherence were relatively low in the present sample. Taken as a whole, the sample tended to include only a general reference to either time or location in each memory report. This level of responding reflects the fact that inclusion of information about

Table 7
Model 1: Logistic Multilevel Model of Results for Remembering an Earliest Memory Over 2 Years Using Theme and Chronology

Variable	Odds ratio	LCI	UCI
Probability of remembering earliest memory, β_0			
Intercept, γ_{00}	0.38	0.10	1.44
Age group, γ_{01}	2.03**	1.38	2.99
Theme slope, β_1			
Intercept, γ_{10}	5.16**	2.47	10.79
Chronology slope, β_2			
Intercept, γ_{20}	0.61**	0.44	0.86

Note. LCI = lower boundary of the 95% confidence interval; UCI = upper boundary of the 95% confidence interval. $n = 303$ memories.
** $p < .01$.

Table 8
Model 2: Logistic Multilevel Model of Results for Remembering an Earliest Memory Over 2 Years Using Theme and Context

Variable	Odds ratio	LCI	UCI
Probability of remembering earliest memory, β_0			
Intercept, γ_{00}	0.26*	0.07	0.95
Age group, γ_{01}	1.91**	1.32	2.75
Theme slope, β_1			
Intercept, γ_{10}	2.94**	1.49	5.77
Context slope, β_2			
Intercept, γ_{20}	1.59*	1.11	2.30

Note. LCI = lower boundary of the 95% confidence interval; UCI = upper boundary of the 95% confidence interval. $n = 303$ memories.
* $p < .05$. ** $p < .01$.

time and place in personal experience narratives is emergent in this age group (Peterson, 1990; Peterson & McCabe, 1994, 2004). It is reasonable to assume that children are not yet contextually embedding all of their experiences, but when they do apply this developing skill, it makes a memory more likely to endure.

In terms of chronological coherence, memories that were conveyed with greater temporal ordering were about half again as likely to survive over time. Although a more modest contribution than theme and context, this dimension added to the prediction of which memories would survive beyond the effect of age. This finding stands in contradiction to Morris et al. (2010), in which chronology did not add to the prediction of memory survivability, but we note several distinctions between the studies. The participants in Morris et al. were discussing parent-nominated events as opposed to self-nominated events, and the former are more likely to have been embedded in parent–child conversations in which chronology was scaffolded. In contrast, many of the events children discussed in the present study were likely not the subject of parent–child conversations; indeed, parents often expressed surprise at what was remembered. Thus, it is possible that these memories were less likely to be scaffolded. Nevertheless, these were the memories for which chronology was predictive for survivability over 2 years. So we can speculate that direct parental scaffolding may not be necessary for children to provide appropriate chronological organization to a particular memory report, at least beyond early childhood. Rather, such scaffolding could help children develop the broadly applicable skills to do so (Fivush, Reese, & Haden, 2006; Peterson & McCabe, 2004). However, further study is necessary to evaluate these possibilities.

Results of the present study provide powerful evidence for the importance of narrative coherence to memory survivability in a paradigm directly applicable to childhood amnesia. However, the question remains, why are some events remembered more coherently than others? Data from the present investigation offer some suggestion that some event types may be more coherently organized than others. Although not related to the coherence dimensions of theme or context, event type was linked with the chronological sequencing of events in a narrative. Specifically, trips and play events appeared to have lower levels of chronology, whereas trauma events seemed to have higher levels of chronological coherence. Unfortunately, the limited number of memories per event type prohibited more than descriptive analysis in this investigation. Thus, more work is needed to explain why some event memories are more coherent than others.

In contrast to widespread expectations stressing the importance of memory content, uniqueness, and presence of reminders, these factors were unrelated to memory maintenance in the current study. Upon reflection, it is not surprising that memory content does not predict which memories survive. Classification of early memory content only captures broad dimensions of experience, not particulars about individual experiences including the structure of the event (Peterson & McCabe, 1983) and the significance to the child (Bauer & Fivush, 2010). As well, our characterization of the event as unique or repeated may not have encompassed impor-

Table 9
Logistic Multilevel Model of Results for Remembering an Earliest Memory Over 2 Years Using Theme and Affect

Variable	Odds ratio	LCI	UCI
Probability of remembering earliest memory, β_0			
Intercept, γ_{00}	0.34*	0.12	0.98
Age group, γ_{01}	1.71**	1.25	2.35
Inclusion of affect slope, β_1			
Intercept, γ_{10}	2.50**	1.27	4.93
Theme slope, β_2			
Intercept, γ_{20}	2.91**	1.52	5.56

Note. LCI = lower boundary of the 95% confidence interval; UCI = upper boundary of the 95% confidence interval. $n = 359$ memories.
* $p < .05$. ** $p < .01$.

tant aspects of distinctiveness as applied in the literature. The data, however, do indicate that repeated as well as unique events are retained during childhood as well as adulthood. It was also the case that the existence of photos, videos, or family stories did not affect the prediction of continued accessibility of a particular memory over time. A significant limitation of our operationalization of reminders was our reliance on the coding of presence or absence of these materials. No data existed measuring the frequency and recency of exposure to these potentially reinstating materials.

Further investigations should extend this work in other regards. Building on the importance of this documentation of the importance of emotion on the survivability of memories, more finely grained analyses of emotional valence and saturation would be merited. An extended longitudinal investigation is needed in light of the limited forgetting that occurs after the passage of only 2 years by the oldest children in the present research.

The overall findings of this study suggest potential answers to parents' frequently asked question, "Is there anything I can do to help my child remember her early childhood?" Our data suggest that the answer to this question may be yes. Our findings point to potential practices that should be examined in future research as possible methods to increase the likelihood that specific memories can be maintained. Due to the importance of emotional language in memory maintenance, it might be that encouraging children to articulate their emotional responses to experienced events will result in more durable memories. Additionally, in light of the evidence indicating the importance of narrative coherence, practices that increase the coherence of children's reports of their own experiences would seem likely to foster enduring memories (Baker-Ward et al., 1997). Elaborative parent–child reminiscing may be one means of increasing coherence (Fivush et al., 2006). Consistent with this possibility, preschool children who engaged in more elaborative discussions with their mothers about recent experiences were more likely to remember these reports as adolescents (Jack et al., 2009).

Ultimately, this study suggests that our recollections of earliest childhood are not merely random flashes of previous life that penetrate the veil of childhood amnesia for unknown reasons. Rather, we can predict with surprising power which memories are retained based on their characteristics as assessed at an earlier point in time. Hence, the onset of autobiographical remembering appears to be a more lawful and knowable process than was previously assumed.

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Appendix

Statistical Procedures

All logistic multilevel model analyses were conducted with the macro %GLIMMIX in SAS software (Version 9.1) of the SAS System for Windows in accordance with standards in the extant literature (Guo & Zho, 2000). The equations for the logistic multilevel models are

$$\textbf{Level 1}: \textbf{logit}\ (REMEMBER)_{ij} = \beta_{0ij} + \beta_1(MEMORY\ CHARACTERISTICS)_{ij} + r_{ij}$$

$$\textbf{Level 2}: \beta_{01} = \gamma_{00} + \gamma_{01}(AGE\ GROUP) + u_{0i}$$

$$\beta = \gamma_{10}$$

where the indices *i* and *j* are used to denote individual children and earliest memories, respectively. In Level 1, the intercept, β_{0ij} is defined as the expected probability of remembering for memory j of child *i*, and the slope coefficient β_1 represents the associated change in log odds of remembering. The error term, r_{ij}, represents a unique effect associated with child *i* (i.e., how much an individual fluctuates in remembering over multiple events). The individual intercept (β_{0i}) and slope ($\beta_{1,}$) become the outcome variables in the Level 2, where γ_{00} represents the overall mean probability of remembering for the entire sample. Further, γ_{01} corresponds to the effects of age group on the log odds of remembering, above and beyond the memory characteristic. The extent to which children vary from the sample average probability of remembering is represented by u_{0i}. γ_{10} represents the average change in log odds of remembering given a one-unit change in the particular memory characteristic. The slope was constrained to be equal across all children.

The memory characteristics used varied from model to model and included length, uniqueness, inclusion of emotion, and presence of parent-reported reminders, theme, chronology, and context. Further, if multiple memory characteristics were included, the appropriate slopes were added.

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