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Infantile Amnesia Across the Years: A 2-Year Follow-up of Children's Earliest Memories

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Although infantile amnesia has been investigated for many years in adults, only recently has it been investigated in children. This study was a 2-year follow-up and extension of an earlier study. Children (4–13 years old) were asked initially and 2 years later for their earliest 3 memories. At follow-up, their age at the time of these memories shifted to several months later, with younger children unlikely to provide the same memories. Moreover, when given cues about memories recalled 2 years previously, many were still not recalled. In contrast, older children were more likely to recall the same memories, and cues to former memories were successful. Thus, older children were becoming consistent in terms of recalling very early memories.

Infantile amnesia, also called childhood amnesia, is the absence or scarcity of memories about very early life events (Hayne, 2004; Nelson & Fivush, 2004; Peterson, 2002). This phenomenon has been investigated for more than a century (e.g., see Henri & Henri, 1898) and by now, a large body of research conducted with adults concurs that there is very little recall for events from before the age of 3–4 years (Bruce, Dolan, & Phillips-Grant, 2000; Conway & Holmes, 2004; MacDonald, Uesiliana, & Hayne, 2000; Mullen, 1994; Rubin, 2000). This boundary is not absolute, however. First, all of the above studies have found individual differences with some people able to recall memories from an earlier age than others. Second, there also seem to be differences related to the methodology used (Jack & Hayne, 2007; Peterson, Noel, Kippenhuck, Harmundal, & Vincent, 2009). Lastly, the person's culture influences the age of earliest memory, with the Maori of New Zealand typically able to recall memories from earlier in their lives (MacDonald et al., 2000) while Korean and Chinese adults' earliest memories are from more than half a year later (MacDonald et al., 2000; Mullen, 1994; Wang, 2001; Wang, Conway, & Hou, 2004; see review in Wang, 2003).

Overall, among those of European descent (including European Americans) the average age of earliest memory in adults has been identified as around 3½ years, although Bruce et al. (2000) and Multhaup, Johnson, and Tetirick (2005) argue that the offset of childhood amnesia is closer to 4½ or 5 years. But, as pointed out by Peterson, Grant, and Boland (2005) and Cleveland and Reese (2008), either of these ages raises a paradox. Considerable research has shown that 2- and 3-year-olds have a well-functioning memory system and can readily talk about past events, including ones that occurred when they were months or even more than a year younger (Bahrick, Parker, Fivush, & Levitt, 1998; Cleveland & Reese, 2008; Fivush & Schwarzmueller, 1998; Harley & Reese, 1999; Peterson, 1999; Peterson & McCabe, 2004; Peterson & Rideout, 1998; Van Abbema & Bauer, 2005). This is all the more remarkable when one considers that children can also recall many events from several years in the past. For example, Peterson and her colleagues (Peterson & Parsons, 2005; Peterson & Whalen,

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2001) found that 7- and 8-year-olds had detailed and mostly accurate memory for injuries they had sustained 5 years previously when they had been only 2 or 3 years old, and likewise Fivush and her colleagues found that former 3- and 4-year-olds recalled a destructive hurricane very well after the passage of 6 years (Fivush, Sales, Goldberg, Bahrick, & Parker, 2004; Sales, Fivush, Parker, & Bahrick, 2005; for reviews of long-term memory in children, see Bauer, 2006, 2007; Peterson, 2002).

Thus, young *children* demonstrate that they have verbally accessible memory for many events that occurred when they were 2 or 3 years of age and yet *adults* seem to have no recall of any of those events, and the years in their early lives when those events took place become shrouded by childhood amnesia. In order to understand what happens to these memories as well as develop our understanding of the phenomenon of infantile amnesia, Peterson et al. (2005) argued that it is necessary to explore two issues: First, since the vast majority of research on infantile amnesia explored this phenomenon in adults, it was necessary to study it in children to see if they, too, experience infantile amnesia. Second, there needed to be longitudinal research that traced the maintenance and/or disappearance of early memories through childhood.

Infantile Amnesia in Children

In terms of research on childhood amnesia in children, until recently there was almost no investigation of this issue. One exception is Sheingold and Tenney (1982) who interviewed 4-, 8-, and 12-year-olds about the birth of a sibling; these authors found that children recalled very little if they had been younger than 4 at the time of the birth. However, this may be because a sibling's birth is not as salient to young children as to older children and adults (Fivush, Gray, & Fromhoff, 1987). Another exception is Fitzgerald (1991) who used a picture-cue method to interview 6- and 9- to 10-year-old children about their early memories, but unfortunately this technique did not work well since younger children were unable to successfully do the task. Recently, there has been considerably more interest in assessing childhood amnesia in children. In the first systematic study of this phenomenon in children across a wide age range, Peterson et al. (2005) asked European Canadian children between 6 and 19 years of age to describe their earliest memory. Other recent investigations of infantile amnesia in children include that by Bauer, Burch, Scholin, and Güler (2007) who used cue words to investigate the distribution of early memories in 7- to 10-year-olds, Peterson, Noel, et al. (2009) who elicited not only the earliest memory of 7- to 14-year-olds but also their memory fluency (how many memories they could retrieve in 4 min) from before they started school, and both Wang (2004) and Peterson, Wang, and Hou (2009) who did cross-cultural comparisons of European-descent and Chinese children, with the latter also using a memory fluency procedure. Although there are differences in methodology between these studies, in all that have a wide age range the age of earliest memory for the older participants was later than for younger children. That is, the boundary of infantile amnesia changed across age. It should also be noted that in most of these studies, parents were asked to verify whether the events recalled by children actually occurred and how accurate the children's age estimates were, and parent verification showed that children were remarkably accurate. The parallel findings of these studies support two conclusions: (a) Infantile amnesia is a robust phenomenon in children too, not just adults, and (b) the boundary of childhood amnesia seems to increase as children get older.

Longitudinal Investigations of Children's Early Memories

In terms of longitudinal research that traces what happens to early memories through childhood, a number of investigators have elicited children's memory for various events when they were younger than the traditional boundary for childhood amnesia (i.e., 3½ years) and then reinterviewed them about those same events after the passage of several years. As stated above, 2- and 3-year-old children who experienced highly stressful events such as injuries requiring hospital emergency room treatment or destructive hurricanes can recall these same events in considerable detail several years later (Fivush et al., 2004; Peterson & Parsons, 2005; Peterson & Whalen, 2001; Sales et al., 2005). However, recall of such traumatic events may distort estimations about the boundary of infantile amnesia. Some investigators have argued that particular types of events are more likely to be recalled from this early period of life, and traumatic events (including injuries or hospitalizations) are among the specific content likely to be retained long term (Usher & Neisser, 1993; Wang, 2003). But most of the earliest memories provided by both adults and children are not of traumatic events (Kihlstrom &

Harackiewicz, 1982; Mullen, 1994; Peterson et al., 2005). Thus, what happens to memories of more mundane events over time?

The long-term maintenance or disappearance of nonstressful but novel events has been investigated in several studies. For example, Fivush and Schwarzmueller (1998) asked 8-year-olds to recall distinctive events that they had previously discussed with either a researcher or a parent when they had been 40, 46, 58, or 70 months of age. When children were first interviewed at 40 months of age, they were recalling events from when they had been only 34 months of age, on average. The 8-year-olds still recalled 78% of the events that they had discussed when they had been 40 months of age, although in comparison they could recall 95% of the events previously discussed when they had been 70 months old. In another study, Van Abbema and Bauer (2005) interviewed 7-, 8-, and 9-year-olds about four events that they had previously been asked about when they had been 3 years old. They found that 7-year-olds recalled 60% of those events while 8- and 9-year-olds recalled only 36% and 34% of the events, respectively. And finally, Cleveland and Reese (2008) interviewed 5½-year-olds about novel, one-time events that they had previously talked about with their mothers or a researcher at 19, 25, 32, or 40 months of age. Accuracy of the information children provided was assessed by mothers after the 5½-year interview. Few events were asked about from the 19-month conversations, and of those, children provided at least one unit of accurate information about only one third of them, and of all the information they did provide, half was inaccurate. This supports other research suggesting that little from this young age is recalled years later (Bauer, 2006, 2007; Peterson, 2002; Peterson & Parsons, 2005). Considering children's ability to recall events that had been discussed when they were 2 or 3 years of age, they provided at least one piece of accurate information about 52%, 72%, and 78% of the events that they had talked about when they were 25, 32, or 40 months old, respectively. Although almost half of the information provided about events previously recalled at 25 months of age was inaccurate, at least three-fourths of the information provided about events recalled at older ages was accurate.

The results of these studies paint a consistent picture: After the passage of several years, children can recall at least some events from before the traditional boundary of childhood amnesia that has emerged from studies of adults (i.e., 3½ to 4½ years of age). As well, as children get older, they are less likely to recall these events from younger time points in their lives. That is, they are forgetting some of those early-occurring events as they age.

However, all of the events the children were asked to recall in the above studies shared properties that may not be shared with many of the memories that children identify as their earliest. For example, all of these events were ones that were nominated by their parents and so may not have had as much importance to the children themselves as to their parents. If so, extant data may overestimate forgetting by children. However, these events were also salient family events and there had been considerable discussion of them in the days that followed as well as photographic or video records for most, which may lead to forgetting being underestimated. Similarly, the injury events and hurricane experiences that children recall so well are also ''big news'' family events (Fivush et al., 2004; Peterson & Parsons, 2005; Peterson & Whalen, 2001; Sales et al., 2005).

In contrast, when children are asked to talk about their earliest memories, many of the events they recall are not the stuff of family discussion, and in fact, some of the events are ones that parents have no specific knowledge of although they judge them as reasonable and thus say they probably occurred (Peterson et al., 2005; Peterson, Wang, et al., 2009). As an example, the 18-year-old son of one of the authors recalled swallowing a small piece of Lego in preschool. He recalled subsequently sitting in his car seat in the back of the family car with his mother driving across campus to pick up his father, and being terrified that he was going to die because of that Lego. However, he said nothing because he was afraid to tell his parents. The context within which the memory was embedded and the detail of recall convinced us that this was a memory of a real event, but the parent obviously could not specifically confirm it. Another child recalls waiting for a bus with her mother and noticing a flower growing up through a crack in the pavement. She recalled various details about the pavement crack and the flower, but again, the parent could not specifically confirm it (although thought it reasonable that it had occurred). Thus, it is important to extend the longitudinal study of children's memories to those that are not parent nominated nor embedded in family meaning making. Most importantly, we need to longitudinally study the consistency of the memories that children identify as their earliest. After all, these are the ones that have been used to define the boundary of childhood amnesia.

The Current Study

We know of no extant research that has looked at the consistency over time of the memories that children identify as their earliest, and doing this is one focus of the current study. This research is a 2-year follow-up and extension of the children studied by Peterson et al. (2005); the same children were reinterviewed about their earliest memories 2 years later. In the initial study, children were not only asked for their earliest memory but also for their next two earliest memories. Thus, children's three earliest memories were elicited, although only the memory identified as the earliest was analyzed in that report. Also, the prior report included 136 children and adolescents, divided into four age groups; 6- to 9-year-olds, 10- to 13-year-olds, 14- to 16-year-olds, and 17- to 19-year-olds. The average age of earliest memory for children in these age groups was 36.1, 43.7, 47.4, and 42.8 months, respectively, with the youngest age group having the earliest age of first memory and the older three age groups not differing statistically. However, the authors called for future research to have sufficient numbers of participants at younger ages so that the crucial 6- to 9-year-old group could be subdivided—something that we did here through recruitment of additional participants.

The first question addressed in this study is (a) whether the pattern of results found when studying children's single earliest memory is replicated when three memories are elicited. If so, this suggests that there is not something particularly special about the memory identified as the very earliest, in comparison to other early memories. In terms of the consistency of the memories, (b) do children recall the same memory 2 years later when asked for their earliest memory? (c) Of the three earliest memories that they provide 2 years later, how many are the same as recalled previously? (d) If the memories are different ones, are they from a later age?

Although consistency of which early memories are recalled over time is an important issue, another is whether the memories that children provided in their initial interview but did not provide 2 years later are actually forgotten or are they merely less accessible and could be readily retrieved with appropriate cuing. However, if one provides cues, it is possible that children will claim to recall an event even if they do not. In fact, they have been shown to ''remember'' even totally false or fabricated events (Ceci, Powell, & Principe, 2002; Jones & Powell, 2005; Pezdek & Hodge, 1999). Because of this, it is important to provide children with cues to not only their own former memories but also to additional (and plausible; Pezdek & Hodge, 1999) events that did not happen to them. Thus, additional questions asked in the current research are the following: (e) If provided with cues, do children recall the events that they had provided 2 years previously? (f) If provided with both cues to their prior memories and cues to false events, can children accurately discriminate these false ''memories'' from their true former memories? (g) And how does the age of the child interact with these issues?

Finally, it is also possible to explore the ways in which children's earliest memories change over time, and this is the last issue we will explore. (h) Even if the memories are about the same events, does the content of what children recall about those events change over time? Specifically, do children provide the same details about that event 2 years later? Is their later memory of the same event more elaborated or more abbreviated? How much of what they later recall about the event contradicts what they recalled earlier? Longitudinal research allows us to investigate these questions.

Hypotheses

Prior research has suggested that the age of earliest memory seems to be later in older children than in younger children; that is, the age of earliest memory changes across childhood (Peterson et al., 2005; Peterson, Wang, et al., 2009), and this was particularly the case for children younger versus older than age 10. Thus, we predict the following: This increase in age at the time of earliest memories will be found longitudinally. That is, as children get older, their age at the time of their early memories will shift forward in time. Thus, the cross-sectional differences found in prior research will be reflected by longitudinal changes as well. Moreover, the pattern of increasing age at the time of remembered events with increasing current age of the child will be true regardless of whether one assesses children's single earliest memory or their three earliest. In terms of consistency of memories across time, we predict that older children will show considerable consistency across time but that younger children will be less likely to and that this will be true for both their single earliest memory as well as for all three of their earliest memories. As well, when memories recalled in the first interview are not recalled in the follow-up interview after cuing, these memories are more likely to

derive from when children were younger whereas memories derived from older ages are more likely to be successfully cued. In terms of children's ability to discriminate cues to their own former earliest memories versus false early ''memories,'' this study is mostly exploratory since there is little extant research to guide hypotheses. However, it is likely that age is an important variable when considering this issue too. That is, older children are more likely to be able to successfully discriminate their own true memories from false ones than are younger children. In terms of explorations of how the content of children's memories changes over time, this investigation is strictly exploratory.

Method

Participants

A total of 140 children were interviewed twice about their earliest memories. They were divided into five age groups, and the ages provided here and throughout this article are their ages at the time of initial interviews, even though they were 2 years older at the time of follow-up. There were twenty-seven 4- to 5-year-olds (9 girls, mean age = 4.84 years, *SD* = 0.55 years), twenty-three 6- to 7-year-olds (8 girls, mean age = 6.94 years, *SD* = 0.64 years), twenty-nine 8- to 9-year-olds (16 girls, mean age = 9.08 years, *SD* = 0.56 years), thirty-five 10- to 11-year-olds (19 girls, mean age = 10.95 years, *SD* = 0.58 years), and twenty-six 12- to 13-year-olds (13 girls, mean age = 12.77 years, *SD* = 0.60 years).

Procedure

The participants were recruited from the emergency room of the only children's hospital in St. John's, Newfoundland, Canada as part of another study investigating children's memories for injuries (Peterson & Whalen, 2001). Families were contacted a few days later and subsequently visited at their homes for their initial interview. Children were asked to think of their three earliest memories 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?'' Children were then asked how old they were when it happened, followed by questions to try to narrow down their age estimate into a particular month or small range of months: ''How old were you when this happened?'' ''Do you remember what time of year it was?'' ''Was it summertime? In the winter?'' ''Was it near your birthday/Christmas/Halloween etc?'' Their parents were then asked to verify these memories.

In the current study the same parents were contacted again for consent to participate in the 2-year follow-up. Once consent was obtained, another home interview took place, conducted by one of four female research assistants. Parents had also been asked to not discuss any memories with their child. At the homes, written consent was obtained from parents and either written or oral consent (depending upon the child's age) from children. As well, parents were taken aside and shown three potential false memories that had been randomly selected from a pool of 10 false memories and asked if their children had ever had an experience similar to any of them. If so, that memory was discarded and replaced by another randomly selected memory until there were three that parents identified as unlike anything their children (or their siblings or friends) had experienced. Parents were also offered the opportunity to discard any that they did not want asked to their children, but none were discarded for this reason. Examples of false memories include ''Do you remember when you were little you were playing with your friend and you cut all his/her hair off?'' (See the Appendix for a complete list of the false memories.) The researcher had a brief synopsis of each of the memories that the child had recalled during the previous visit written on a card in a parallel format to the false memories.

Children were interviewed identically to their prior interview 2 years previously. Thus, their three earliest memories were elicited. A sampling of the memories recalled by children is presented in online supporting information Appendix S1. Children were then told they were going to be asked about some other memories, some of which were ones that they had talked about the last time they were interviewed and others were memories from other children and did not happen to them. The false and actual memories were all written on separate identical cue cards that were randomly mixed prior to being read aloud. A synopsis of any memory produced among the three elicited at the beginning of the interview was not read to the child, since the memory was clearly recalled. Thus, if none of the child's three earliest memories were the same as those recalled previously, the researcher read three real memory summaries plus three false memories to the child in random order. If one of

the child's memories was the same as those previously recalled, only two real memories but three false memories were read, and so on. Therefore, it was possible for a child to be read a maximum of six memories, half true and half false, in the event that none of the memories provided in the current visit overlapped with prior memories. At the other extreme, in the case where all three of the child's memories were the same as previously, a child was read only three memories, all false. After each memory was read, children were asked whether this memory ever happened to them. If children said that they recognized the memory, they were probed for their recall of that memory using the same questions as before. Parents were also asked to confirm whether any new memories children provided had actually happened, and to provide the child's age at the time. All aspects of the project were approved by the University's Interdisciplinary Committee on Ethics in Human Research.

Data Coding

Age at earliest memory. Both the child's and the parent's estimates of the child's age at the time of the recollected memory were collected. For some memories, age could be calculated with precision (e.g., first day of kindergarten). For others the age was taken as the midpoint of the range determined through detailed questioning (e.g., for ''the summer when he was three,'' the age was taken at the midpoint of that range). Consistent with Peterson et al. (2005) and Peterson, Wang, et al. (2009), the age provided by the parent was used if available.

Mean age of all earliest memories. The mean age (in months) of all the memories provided by the child in any specific interview was calculated.

Consistency of memories. Memories in the 2-year follow-up were scored for consistency by comparing (a) whether the memory identified as the earliest was consistent across both interviews, and (b) what proportion of the three earliest memories provided in the follow-up interview were the same as the ones provided initially, ranging from 0 (*no overlap*) to 1.0 (*all memories were the same*). A memory was scored as consistent if it was about the same topic and included the same or highly similar unique detail, even if the children's age estimates varied by as much as a year.

Recognition of former memories. Recall that children could potentially have been read between zero and three synopses of former memories. Here, we scored the proportion of previous memories the child had been read that he recognized as being his own memory. For this analysis, children who were read no former memories (because they provided the same memories in both interviews) were excluded.

Incorporation of false memories. Interviews were scored for the number of false memories that the child identified as ''remembering,'' ranging from 0 to 3.

Similarity of content in memories recalled in both interviews. Memories for events that had been recalled in both interviews were selected for analyses of content. Each memory was scored for information about event actions, locations, objects, time, or descriptions. Subsequently, each item of content recalled in the second interview was compared with content provided in the initial interview and classified into one of the following categories: the same information, new information, or information that contradicted prior information.

Reliability. Fifteen percent of the transcripts were coded by two independent scorers, and interrater reliability (Cohen's Kappa) averaged 0.92.

Results

Children's Earliest Memories

Number of memories provided. Interviewers attempted to elicit three earliest memories but not all children provided three. The number of memories in the initial interview provided by children grouped into five ages, namely, 4- to 5- through 12- to 13-year-olds, was 2.3, 2.6, 2.8, 2.8, and 2.7 memories, respectively. For the follow-up interview, the number of memories provided by children in the five age groups was 2.5, 2.9, 2.9, 3.0, and 3.0, respectively. The number of memories was analyzed in a repeated measures analysis of covariance (ANCOVA), with age in months (treated as a continuous variable) the covariate and time the repeated measure. Preliminary analyses showed that gender was never a significant variable in any analysis, and it is ignored hereafter. The covariate of age was significant, $F(1, 138) = 23.06$, $p < .001$, $\eta^2 = 0.143$, with children providing more memories with increasing age. However, the effect of time was nonsignificant, both alone and in interaction with age. Thus, children were providing as many memories 2 years later as initially.

Age of earliest memory. The children's ages at the time of their single earliest memory is shown in the first panel of Figure 1 for the initial interview and in the second panel for the follow-up interview. Their mean age at the time of their earliest memory

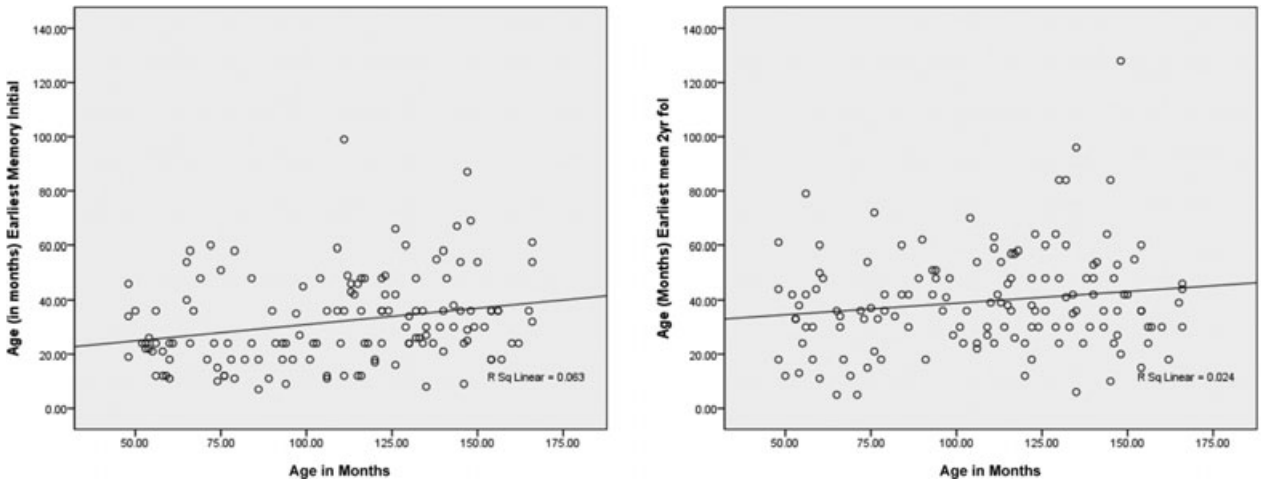

Figure 1. Scatter plot and linear best fit line for children's age at the time of their earliest memory, plotted against their age at the time of their initial interview.
Note. The panel on the left shows children's earliest memories at their initial interview and the panel on the right at their 2-year follow-up interview.

was 32.0 months in the initial interview and more than 7 months later (39.6 months) in the follow-up interview, and these data were analyzed in a repeated measures ANCOVA with age in months (treated as a continuous variable) the covariate and time the repeated measure. The covariate of age was significant, $F(1, 138) = 8.93$, $p = .003$, $\eta^2 = 0.061$, and the effect of time approached significance, $F(1, 138) = 3.75$, $p = .055$, $\eta^2 = 0.026$. There was no interaction between time and age. Thus, there was a tendency for a shift in time between interviews for the age of earliest memory, and it was equivalent across all ages.

Mean age of all three early memories. We calculated the mean for each child's age at the time of all the memories she or he provided. If a child produced fewer than three memories, the average was calculated on the remaining memories. The mean age for all three memories was of course later than that for the very earliest memories, with children's age at the time of all their memories averaging more than 14 months later than their age at the time of their very earliest memory. These data were analyzed in a repeated measures ANCOVA with age in months (treated as a continuous variable) the covariate and time the repeated measure. The covariate of age was significant, $F(1, 138) = 20.08$, $p < .001$, $\eta^2 = 0.127$, as was the effect of time, $F(1, 138) = 10.52$, $p = .001$, $\eta^2 = 0.071$. The mean age of all the children's memories was later in the follow-up ($M = 56.5$ months) than in the initial interview ($M = 44.4$ months). There was no interaction between time and age; thus, the shift to a later age for the mean of all memories was equivalent across ages.

Consistency of memories. Because investigators in much of the extant research elicited only a single earliest memory from research participants, we first present an analysis of the consistency of this single earliest memory. However, because we had asked children to provide multiple early memories, that is, their earliest three, we also could look at the consistency of their group of memories. Analyses on the consistency of this group of memories are presented second.

In terms of how consistent children were when providing their single earliest memory, the number of children in each age group who identified the same memory as their earliest was compared to the number of children who provided a different earliest memory (see Table 1). Because so few children in the youngest two age groups provided the same memory, these groups were combined in a 2 (same vs. different) × 4 (age group) chi-square. The age groups differed in terms of the number of children providing a consistent earliest memory, $\chi^2(3, N = 140) = 10.68$, $p = .014$. Follow-up comparisons of two age groups at a time showed that the 4- to 7-year-olds differed from the 10- to 11- and 12- to 13-year-olds, but the 8- to 9-year-olds differed from no other age group. Thus, children between 4 and 7 years of age were less likely than 10- to 13-year-olds to provide the same single earliest memory 2 years later.

Next, we looked at the consistency of the set of early memories provided by the children. Table 1

Table 1
Number (and Percentage) of Children Who Had the Same Earliest Memory and Who Had No Overlap Between Interviews in Their Memories, as Well as the Mean Proportion of Memories That Overlapped Between Interviews for Children Grouped by Age

Age group (in years)	Same earliest memory	No overlap in interviews	Proportion of overlap
4–5	2 (7.4%)	23 (85.2%)	.062
6–7	3 (13.0%)	18 (78.3%)	.079
8–9	6 (20.7%)	13 (44.8%)	.223
10–11	12 (34.3%)	13 (37.1%)	.271
12–13	10 (38.5%)	12 (46.2%)	.295
Total	33 (23.6%)	79 (56.4%)	.193

also shows the proportion of memories in the second interview that overlapped with those provided initially. A proportion was used because children had different numbers of memories in their initial interview, and a proportion compensates for this difference. As seen in Table 1, approximately 80% of the 4- to 7-year-olds were providing all new memories in their follow-up interview whereas more than half of the children in the oldest three age groups provided some memories that were the same as in their earlier interview. A hierarchical regression with age entered in the first step and age^2 entered in the second step showed a linear effect of age, $F(1, 138) = 23.17$, $p < .001$, $R^2 = .144$, standardized $\beta = .379$. Thus, the overlap between memories generated in the two interviews increased as children got older.

As a follow-up to provide more clarity on the consistency of the group of memories provided by children, we also tabulated how many children had any overlap at all (vs. no overlap) between the memories they provided in their two interviews (see Table 1). A 2 (overlap or not) × 5 (age) chi-square was tabulated that compared children who had all new memories versus one or more repeated memories in each of the five age groups, and children in the various age groups differed significantly, $\chi^2(4, N = 140) = 21.54$, $p < .001$. Follow-up comparisons of two age groups at a time showed that the youngest two age groups, while not differing from each other, differed from all three older age groups, which in turn did not differ from each other. Thus, children under 8 years of age at the time of their initial interview mostly had no overlap at all between the memories they provided at the two time points; this was not the case for the majority of children who were at least 8 years of age.

Recognition of Former Memories

The degree to which children recognized the synopses we provided of their memories from their initial interview is shown in Table 2, with children grouped into age categories for ease of comparison. Recall that if children provided the same memory as 2 years previously when asked for their earliest three memories, a synopsis of that memory was not read since they had already demonstrated recollection of it. Thus, the proportion for a child who was read two former memories and recognized only one of them would be .50. In contrast, a child who was read three former memories and recognized only one of them would have a proportion score of .33 while another child who was only read one former memory and recognized it would have a proportion score of 1.00. Also, data from children who provided all the same memories in both interviews were excluded. A hierarchical regression was calculated on the proportion of memories that children recalled after being cued, with age entered in

Table 2
Mean Frequency and Proportion of Prior Memories Recalled After Cuing Versus Not Recalled After Cuing, as Well as the Number of Memories and Mean Age of Memories Recalled Versus Not Recalled by Children

	Recalled after cuing					Not recalled after cuing				
				Age at memory					Age at memory	
Age (in years)	Mean freq.	Mean propor.	No.	*M*	*SD*	Mean freq.	Mean propor.	No.	*M*	*SD*
4–5	1.27	.61	21	37.6	12.4	0.77	.39	17	33.4	14.0
6–7	1.83	.76	21	39.3	15.1	0.48	.24	9	31.0	24.7
8–9	1.78	.85	26	47.4	21.7	0.30	.15	7	31.7	15.8
10–11	1.88	.91	33	49.4	20.0	0.21	.09	7	50.7	32.1
12–13	2.00	.97	24	52.2	23.7	0.08	.03	1	69.0	0.0

Step 1 and age^2 in Step 2. There was a linear effect of age, $F(1, 131) = 31.00$, $p < .001$, $R^2 = .191$, standardized $\beta = .437$. Children were increasingly likely to recognize former memories with age. The youngest children did not recognize over one third of the synopses about their former memories whereas almost all of the memories of the oldest children were recognized.

False memories. Almost all of the false memories read to children were correctly rejected by them. Only three 4- to 5-year-olds and one 12- to 13-year-old claimed a false memory as true that their parents maintained never happened. There were another six memories that children claimed were true but their parents were unable to confirm as happening or not, generally saying that it may well have happened but at a friend's house. Thus, overall, children were accurately identifying false memory cues as false.

Comparing Recalled and Nonrecalled Memories

We calculated the mean age of children at the time of cued memories that were recalled and their mean age at the time of cued memories that were not recalled. Separate scores were not derived for each child; rather, the children's age at the time of each memory was derived and then a mean was calculated for this age-at-memory for those children who fell within a particular age group. These data are also in Table 2. For the 4- to 5- and 10- to 11-year-old age groups, inspection of the table suggests that there is little difference between the child's age for memories that were recalled versus not recalled. However, for both the 6- to 7- and 8- to 9-year-olds, the mean age for memories that were recalled after cuing was at least a year older than for nonrecalled memories. (Since there was only one nonrecalled memory among 12- to 13-year-olds, little can be inferred.) It is apparent from the table that if recalled versus nonrecalled memories differ in terms of the child's age, those memories that occurred when children were younger were more likely to be unrecognized.

Similarity of Content in Memories Recalled in Both Interviews

For each child, the mean number of items of content information provided in memories recalled in each interview was calculated. If there was more than one memory that overlapped between the two interviews, data on the number of items of information was the mean for all of these twice-recalled memories in each interview for each child. Thus, data for a child who had two memories that overlapped in the initial and follow-up interview was the mean for the two memories in each interview. Table 3 shows the mean amount of information provided for memories recalled in the first interview and then recalled again in the second interview. These data were analyzed in a repeated measures ANCOVA with age in months (treated as a continuous variable) the covariate and time the repeated measure. The covariate of age was significant, $F(1, 129) = 18.81$, $p < .001$, $\eta^2 = 0.127$. Children provided more content information with age. However, the effect of time was nonsignificant, both alone and in interaction with age. Thus, children were providing as much content information 2 years later as initially.

The mean amounts as well as percentages of information provided in the follow-up interview that was the same, new, or contradictory in comparison with that provided in the initial interview are also found in Table 3. For both the amount of

Table 3
Comparison of Information Provided at Time 2 Versus Time 1: Total Mean Amount of Information and Mean Amount (and Percentage) of Information That Is the Same in Both Interviews, New at Time 2, or Contradictory

Age (in years)	Number of children	Total information		Comparison of Time 2 with Time 1					
				Same		New at time 2		Contradictory	
		Time 1	Time 2	*M (SD)*	*%*	*M (SD)*	*%*	*M (SD)*	*%*
4–5	20	4.9 (1.8)	5.5 (3.2)	1.9 (0.8)	34.5	3.0 (1.8)	54.5	0.6 (0.5)	10.9
6–7	21	5.6 (2.8)	7.0 (3.1)	2.6 (1.7)	37.1	3.9 (2.2)	55.7	0.5 (0.6)	7.1
8–9	30	7.9 (3.2)	7.6 (2.4)	4.0 (1.6)	52.6	3.0 (2.1)	39.5	0.6 (1.0)	7.9
10–11	34	8.7 (2.9)	9.1 (3.0)	4.7 (1.9)	51.6	3.7 (2.1)	40.7	0.7 (0.8)	7.7
12–13	26	7.6 (2.7)	7.5 (2.6)	4.2 (1.7)	56.0	2.5 (1.6)	33.3	0.7 (0.7)	9.3

information that was the same or was new, percentages were analyzed rather than frequencies because this controls for differences in the total amount of information provided by different children. For the percentage of information in the second interview that was the same as was provided in the initial interview, a hierarchical regression was calculated that treated age as a continuous variable. The children's age in months (at first interview) was entered in the first step, and age^2 was entered in the second step to see if the data fit a curvilinear pattern. Only the factor of age was significant, $F(1, 129) = 14.47$, $p < .001$, standardized $\beta = .318$. Older children were more likely to have the same content in both interviews than were younger children. The percentage of information that was new in the second interview was also analyzed in a hierarchical regression. The children's age in months (at first interview) was entered in the first step, and age^2 was entered in the second step, and again, only the factor of age was significant, $F(1, 129) = 18.52$, $p < .001$, standardized $\beta = -.354$. Older children were less likely to have new information in the second interview than were younger children. The percentage of information that was contradictory was too low to analyze.

Discussion

To our knowledge, this is the first longitudinal investigation of infantile amnesia in children, specifically of the memories identified by children as their earliest. The few cross-sectional studies that have been done on this phenomenon in children found that older children had later ages of first memory than did younger ones (Peterson et al., 2005; Peterson, Noel, et al. 2009; Peterson, Wang, et al., 2009; Wang, 2004), and we found the same pattern longitudinally. That is, the age of children's single earliest memory shifted to a later age by an average of 7.6 months. These results were even more robust when we investigated children's three earliest memories. The mean age for all of the provided memories was later in older than younger children, and it shifted an average of 12.2 months in their follow-up interview 2 years later. This shift was found across ages. Overall, children's earliest memory at the time of the initial interview was dated from when they were 32 months of age, and 2 years later it was dated from when they were almost 40 months old. Likewise, the mean age for all memories shifted from approximately 45 months to 57 months old. Thus, the early memories of children when they were interviewed 2 years later dated from a later period of their lives.

A novel aspect of the current research is that we could assess the consistency of children's early memories, both the single earliest one and a group of early ones. There was almost no consistency in the earliest memories of children in the youngest two age groups, but as children got older, the consistency of their earliest memory increased. Only two former 4- to 5-year-olds and three 5- to 6-year-olds had the same earliest memory 2 years later whereas 22 of the children in the two oldest age groups did. Likewise, when considering all three early memories, there was almost no overlap between memories for the youngest two age groups of children whereas more than half of the children in the three oldest age groups had overlap between the memories they recalled initially and 2 years later. In fact, in the oldest age group almost one out of four children recalled at least two of the three memories that they had recalled 2 years previously. Thus, there is increasing stability over time in the memories that children identify as their earliest ones. The relatively high consistency of the older children is in keeping with research on adults who have been found to be consistent in their recall of early events when reinterviewed a year later (Crawley & Eacott, 1999).

Not only are older children more likely to generate the same early memories, they are also more likely to recognize those memories that they had provided 2 years earlier but did not provide in the follow-up interview, when these memories were cued. Almost 90% were recognized by former 8- to 11-year-olds and only one memory was not recognized by a former 12- to 13-year-old. In contrast, more than one third of the memories provided in the initial interview by former 4- to 5-year-olds were not recognized 2 years later. Rather, the children deny that these previously recalled events ever happened. These findings should be interpreted within the context of how accurate children are in identifying false memory cues. Thus, younger children seem to have forgotten a substantial number of the memories that they could recall before, and our cues did not effectively remind them. It may well be that more extensive cuing, especially by members of their family, could eventually remind them of the forgotten events. But a danger of such extensive cuing is the creation of a false memory for the event rather than successfully retrieving it (Ceci et al., 2002; Jones & Powell, 2005; Pezdek & Hodge, 1999).

Overall, children are forgetting some of the memories that they provided 2 years earlier, and it is the younger children (those who were between 4 and 7 years old in the initial interview) who are most likely to forget. The older children, in contrast, not only are more likely to generate the same memories 2 years later, they are also very likely to recognize any others that they had provided earlier, if given cues. Thus, the early memories retrieved by children under 8 years of age in the initial interview, especially those initially under 6 years of age, seem to be unstable over time whereas considerably more stability in early memories is found in older children—those who were at least 8 years old at the initial interview. Furthermore, the memories of the younger children that are not retrieved after cuing were for events that date from an earlier period of their lives. That is, their mean age at the time of the memories that were successfully recalled after cuing was older than their mean age at the time of the memories for which cuing was unsuccessful.

When considering the content of memories that were recalled in both interviews, findings parallel those described above. Although older children are providing more information than are younger children, all of the children are providing approximately the same amount of information in both interviews. And importantly, children are becoming more consistent with age in what details they provide. That is, older children are providing proportionately more content information that is the same and less that is new 2 years later than are younger children. Little of the content children provided was contradictory between the two interviews. Rather, younger children are simply more likely to provide different details 2 years later about the same events whereas the content of older children's accounts is more likely to remain the same. Thus, again, the memories of older children are becoming more consistent, and this consistency is reflected not only in which events are recalled but also in what content details are described.

There are a number of theoretical explanations that have been put forward to account for infantile amnesia as well as variation in this phenomenon between individuals (for reviews, see Bauer, 2007; Hayne, 2004; Nelson & Fivush, 2004; Wang, 2003). One of them highlights children's language development; that is, children must have the appropriate language skills to encode events verbally at the time they occur in order for the memories to be verbally accessible at a later point in time (Fivush, 1994; Hayne, 2007; Nelson, 1996; Peterson & Rideout, 1998; Richardson & Hayne, 2007; Simcock & Hayne, 2002). Another theoretical account suggests that the advent of a child's self-concept plays a role in overcoming childhood amnesia (Howe & Courage, 1993, 1997; Welch-Ross, 1995, 2000). Yet another theoretical explanation is based on social interaction, particularly early parent–child memory sharing (Harley & Reese, 1999; Nelson & Fivush, 2004; Reese, 2002; Wang, 2003). This theoretical approach sees the decrease of childhood amnesia as related to children's increasing narrative skills that develop through parent–child reminiscing. Although these theories (or more likely, an integration of them; see Bauer, 2007; Nelson & Fivush, 2004; Reese, 2002; Wang, 2003) might account for the occurrence of the phenomenon as well as individual variation in children's or adults' access to early memories, they are less successful in accounting for the longitudinal shift in age at the time of children's early memories that we found here as well as the changes in consistency of early memories as children get older. Consider, for example, that the mean age for the earliest memories provided by the youngest children dated from when the children were barely 2 years of age; thus, a significant number of these memories were from before the children's second birthday. If these young children are recalling personal memories from several years in their past, they clearly already had considerable competence in terms of the memory skills, the language ability, and the requisite concept of self that are proposed by the above theories. Thus, we need to understand not only why long-term early memories begin to appear but also why they can be subsequently forgotten.

However, these data are consistent with recent theorizing by Bauer et al. (2007; see also Bauer, 2006, 2007). Bauer et al. used a cue-word technique to examine the distribution of memories generated by 7- to 10-year-old children and found that the distribution of their memories best fit an exponential function rather than the power function that most successfully accounts for forgetting of memories in adults. A power function suggests that forgetting slows over time, due to consolidation of memories. However, an exponential function suggests that memories from early childhood still remain fragile and vulnerable to both interference and forgetting, even as the children get older. Thus, these fragile memories are less likely to consolidate and more likely to become unavailable as children get older (see discussion of this issue in Bauer, 2006). This seemed to be what was happening to the very early memories generated by the youngest participants in the present study.

Children begin to make extended references to the past, including the distant past, when they are between 20 and 24 months of age, although these references are infrequent and fragmentary (see review in Nelson & Fivush, 2004). At the same time, they have also acquired a primitive sense of self. Thus, primitive tools are present from this age for remembering personally relevant episodes of their lives. But as children get older, they not only acquire more complex language skills and a more differentiated and psychological sense of self, they also acquire narrative skills. Nelson and Fivush (2004) argue that narrative structuring ''adds layers of comprehensibility to events above and beyond what is available from direct experience by linking events together through causal, conditional, and temporal markers'' (p. 494). Furthermore, events get embedded within personal meaning making, which makes them more memorable. Thus, children's memories from their earliest years may be more fragile because they do not have this embedding and this relevance to personal goals, motivations, and emotion. Memories from later ages are also likely to have been influenced by more complex skills in language, narrative, temporal concepts, and self-representation, which in turn may also increase the likelihood of them being remembered long term.

To summarize, this study replicated prior research showing that younger children seem to have access to earlier first memories than do older children, and it also extended that body of research by studying the same children prospectively. Over a 2-year delay, children's average age at the time of their earliest memories shifted to a later age. Furthermore, the early memories provided by younger children were more likely to be different 2 years later than initially, and it seems that many of the memories provided previously were forgotten since cues were not successful in reminding the children. Thus, it appears that the very early memories of young children are fragile and vulnerable to forgetting. Even when the same events were recalled 2 years later, the specific details of content were likely to be different. However, older children seem to have a more consolidated set of early memories since many of the same memories were provided in the interview 2 years later, and even the specific content of those memories that were recalled again was more likely to be the same 2 years later. As well, those memories that were not provided when older children were asked for their earliest three memories were mostly recalled once the child was given cues.

Future research should replicate and extend these findings by increasing the delay between interviews, assessing more memories, and doing more fine-grained comparisons between distant and more recent memories. In conclusion, prospectively exploring changes in infantile amnesia and early memory as children age seems to be a fruitful new direction for research.

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Appendix

False Memory Cues

1. Do you remember when you were little you found some makeup and painted your whole face?
2. Do you remember when you were little your mom locked the keys in the house and you had to go to your neighbors?
3. Do you remember when you were little you laid your bike down behind a car and someone ran over it?
4. Do you remember when you were little you saw a fly on the window and you tried to squish it and broke the window?
5. Do you remember when you were little you poked your head through the railings and got it stuck?
6. Do you remember when you were little you were riding in the car and you lost one of your favorite toys out the window?
7. Do you remember when you were little you were playing with your friend and you cut all of his/her hair off?
8. Do you remember when you were little, someone gave you a coin and you swallowed it?
9. Do you remember when you were little you were pretending to drive in your parents' car and it started moving?
10. Do you remember when you were little you were feeding the ducks and one chased after you and bit you?

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Examples of early memories by children of different ages. Prompts by the interviewer to 'tell me more' are omitted.

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