Research Article

BREAKING THE BARRIER? Children Fail to Translate Their Preverbal Memories Into Language

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Abstract—*We examined children's ability to translate their preverbal memories into language following a period of substantial language development. Children participated in a unique event, and their memory was assessed 6 months or 1 year later. At the time of the event and at the time of the test, their language skills were also assessed. Children of all ages exhibited evidence of verbal and nonverbal memory. Their language skills also improved over the delay. By the time of the test, children of all ages had acquired most of the vocabulary necessary to describe the target event. Despite this, they did not translate preverbal aspects of their memory into language during the test. In no instance did a child verbally report information about the event that was not part of his or her productive vocabulary at the time of encoding. We conclude that language development plays a pivotal role in childhood amnesia.*

Childhood amnesia refers to the inability of adults to recall events that occurred during their infancy and early childhood. Freud (1905/1953) originally identified the phenomenon by asking his patients to describe their earliest personal memories. On the basis of these reports, he argued that the period of childhood amnesia extends into the 6th or 8th year of life. Subsequent normative studies of adults' earliest memories have shown that Freud may have overestimated the period of childhood amnesia. There is now a general consensus that adults' earliest autobiographical memories are for events that occurred when they were approximately 3 to 4 years of age (Bruce, Dolan, & Phillips-Grant, 2000; Dudycha & Dudycha, 1933; Mullen, 1994; Sheingold & Tenney, 1982; Waldfogel, 1948) or even slightly younger (MacDonald, Uesiliana, & Hayne, 2000; Usher & Neisser, 1993; Wetzler & Sweeney, 1986).

Freud's most often-cited explanation of childhood amnesia was highly influenced by his patient population. Freud argued that adults' early childhood memories remain intact, but are actively repressed because of their emotionally charged content. Subsequent studies of childhood amnesia conducted with normal adults have failed to provide any evidence in support of Freud's repression model (for review, see Pillemer & White, 1989). Although some studies have suggested that adults are more likely to recall emotionally laden events than neutral events from their childhood (Dudycha & Dudycha, 1933, 1941; Waldfogel, 1948), others have shown that many of adults' earliest memories are emotionally neutral (MacDonald et al., 2000). Taken together, these studies do not reveal any obvious pattern in the emotional content of adults' earliest memories.

Spear (1979) was one of the first memory experts to argue that the key to childhood amnesia might emerge through systematic studies of memory development. Consistent with this view, more recent attempts to understand the mechanism responsible for childhood amnesia have focused on age-related changes in memory processing during infancy and early childhood. These studies have shown that children's ability to verbally describe their past experiences improves dramatically during the preschool period (Fivush, Kuebli, & Clubb, 1992; Howe, Courage, & Peterson, 1994; Peterson & Rideout, 1998; Pillemer, 1998; Pillemer, Picariello, & Pruett, 1994). Although these data provide prospective support for the 2- to 4-year-old boundary for childhood amnesia, they have yet to provide a definitive account for why it might occur.

To date, developmental explanations for childhood amnesia have hinged on general advances in cognitive skill (Neisser, 1962; Schachtel, 1947), the development of a new (socially accessible) memory system (Fivush, 1991; K. Nelson, 1993; Pillemer & White, 1989), neurological maturation (Bachevalier, 1990; Campbell & Spear, 1972; C.A. Nelson, 1995), and the emergence of a self-concept (Howe & Courage, 1993, 1997). One potentially important contribution to childhood amnesia may involve the acquisition of language. It may be no coincidence, for example, that the offset of childhood amnesia corresponds to a period of rapid language development (Fenson et al., 1994).

Psychologists' interest in the relation between language development and childhood amnesia has waxed and waned for more than 50 years. Some early theorists believed that language development plays a key role in the decline of childhood amnesia (Allport, 1937; Schachtel, 1947). More recently, K. Nelson (1993) and Hudson (1990) have argued that language acquisition makes two important contributions to children's emerging memory skills. First, conversations about the past, particularly those that occur between mothers and children, have been shown to facilitate children's ability to encode and express their early autobiographical memories (see Fivush, 1991, 1995; Hudson, 1990; K. Nelson, 1993; Pillemer & White, 1989). Second, children's ability to use another person's language to cue retrieval of their own memory increases the probability that memory retrieval will occur, prolonging subsequent retention of that particular memory (Hudson, 1990; K. Nelson, 1993; Tessler & Nelson, 1994).

There is a distinct possibility that in addition to facilitating the development of memory during early childhood, language development may preclude the retrieval of memories that were acquired without the benefit of language. Drawing on Tulving's encoding-specificity hypothesis (Tulving, 1983; Tulving & Thomson, 1973), Hayne and Rovee-Collier (1995) argued that "although the fate of memories originally encoded without language is unknown, it seems likely that a retrieval failure would occur when linguistically competent subjects attempt to access memories that are composed primarily of perceptually-based attributes" (p. 904; see also Howe & Courage, 1993; Peterson & Rideout, 1998).

Some investigators take the contrasting view that children do eventually gain verbal access to their preverbal memories. Unfortunately, however, the bulk of this claim rests on anecdotal (Todd & Perlmutter, 1980) or retrospective (Myers, Clifton, & Clarkson, 1987; Myers, Perris, & Speaker, 1994; Perris, Myers, & Clifton, 1990) reports of children's memory. In the handful of studies that were specifically designed to assess the relation between language acquisition and memory development, the objects that were part of the original event were present during the test, making it impossible to differentiate between children's verbal recall of

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a preverbal memory and their on-line descriptions of objects or actions at the time of the test (Bauer, Kroupina, Schwade, Dropik, & Wewerka, 1998; Bauer & Wewerka, 1995, 1997). Furthermore, children's preverbal status is often inferred on the basis of their age alone or on the basis of general language measures that may or may not include the vocabulary relevant to the memory task at hand. Thus, whether or not children can actually translate their preverbal experiences into language is not known (for a similar argument, see K. Nelson, 1994).

The primary goal of the present experiment was to determine whether or not children could translate preverbal aspects of their memory into language once they had acquired the vocabulary necessary to do so. Young children participated in a unique event and were tested only once after a 6-month or a 1-year delay. Both verbal and nonverbal memory were assessed. In addition, the children's productive and receptive language skills were measured at the time of the original event and again at the time of the test. In this way, we could evaluate the possible verbal expression of preverbal memories, and we could also evaluate possible transitions in memory performance across the age range that is typically used to define the boundary for childhood amnesia.

METHOD

Participants

Groups of 27-, 33-, and 39-month-old children were recruited from publicly available birth records. The mean age (in months) of the participants and their gender distribution are shown in Table 1.

Procedure

Each child participated in the same unique event during two identical sessions that were separated by 24 hr. During each session, two experimenters visited the child individually in his or her own home and invited him or her to play a game with the Magic Shrinking Machine (see Fig. 1). At the beginning of the event, the child was shown how to turn on the machine by pulling down a lever to activate an array of lights on the front panel (Target Action 1). One of the experimenters then took a toy from a large case (Target Action 2) and placed it inside the Magic Shrinking Machine (Target Action 3), where it disappeared from view. The experimenter then turned a handle on the side of the machine to produce a series of unique sounds (Target Action 4). The sounds lasted for approximately 4 s with each turn of the handle. When the sounds stopped, the child was shown how to retrieve a smaller, yet identical toy from a door on the front of the machine (Target Action 5). This sequence was repeated for a total of seven trials; a different toy was made smaller on each trial. Children of all ages mastered the actions necessary to make the machine work by the end of the first session and were able to operate the machine independently during the second session. The same toys from the first session were made smaller in the second session.

Independent groups of children at each age were tested 6 months or 1 year later. For the test, the same experimenters returned to each child's home to assess his or her verbal and nonverbal memory for the event. To ensure that the children's verbal accounts of the event were based exclusively on their memory for it, the Magic Shrinking Machine was left outside during the verbal-recall and photograph-recognition phases of the memory interview.

To assess each child's verbal recall for the event, one of the experimenters asked him or her general, open-ended questions about the event (e.g., "Last time I visited you, we played a really exciting game! Tell me everything that you can remember about the game."). Once the child failed to report additional information, the experimenter then asked a series of direct questions (e.g., "What were the names of the toys?" and "How did we make the magic machine work?"). During the final stage of the verbal interview, the child was shown a photograph of the Magic Shrinking Machine and was asked if he or she could report any more information about the event.

When the child could report no more information, his or her nonverbal memory for the event was evaluated. First, the experimenter produced a photograph album and asked the child to identify a photograph of each target item when it was presented among three distractor items from the same category (photograph recognition). For example, children were asked to identify the teddy bear that had been placed inside the Magic Shrinking Machine from among a group of four teddy bears. Second, the Magic Shrinking Machine was brought into the child's house, and the experimenter asked the child to show her how to make it work (behavioral reenactment). Prior research with this task has shown that children in this age range score over 80% on both the photograph-recognition and the behavioral-reenactment tasks when they are tested after a 24-hr delay (Simcock & Hayne, 2000).

Language Skill

Each child's general language skill was assessed both at the time of the event and at the time of the test, 6 months or 1 year later. At each time point, the child's receptive vocabulary was assessed with the

Table 1. *Mean age (in months) and gender distribution of participants at the time of the event (i.e., encoding), as a function of age group and retention interval*

Age group (months)	Retention interval: 6 months, Mean age	6 months, Gender	1 year, Mean age	1 year, Gender
27	26.90 (0.21)	7 girls, 7 boys	27.04 (0.40)	9 girls, 4 boys
33	33.04 (0.23)	8 girls, 7 boys	32.92 (0.35)	6 girls, 5 boys
39	38.87 (0.36)	6 girls, 7 boys	38.96 (0.22)	5 girls, 9 boys

Note. Standard deviations are shown in parentheses.

Fig. 1. The Magic Shrinking Machine.

third edition of the Peabody Picture Vocabulary Test (PPVT-III; version A at encoding, version B at retrieval; Dunn & Dunn, 1997), and his or her productive vocabulary was assessed with the Expressive Vocabulary Test (EVT; Williams, 1997). In addition, the child's ability to produce the words required to describe the target event was assessed separately using a parent checklist. This checklist contained 23 target words that were specific to the Magic Shrinking Machine event, such as *ball* and *turn*. Parents were required to indicate whether these target words were part of their child's productive vocabulary at the time of the event and again at the time of the test.

Coding

All aspects of the test were video-recorded and were coded by two independent observers. During the verbal-recall portion of the test, a child was assigned 1 point for each new item of information that he or she reported about the event (e.g., "There was a ball" or "We made things smaller"). Interobserver agreement for verbal recall was extremely high (reliability = 93%, $\kappa = .86$).

During the nonverbal portion of the test, each child was assigned 1 point for each of the 10 target photographs that he or she correctly identified, and 1 point for each of the five target actions that he or she reenacted. Interobserver agreement for behavioral reenactment was also extremely high (reliability = 94%, $\kappa = .93$).

RESULTS

Before we could evaluate the children's ability to translate preverbal aspects of their memory into language, two things had to occur. First, the children had to remember the target event over the delay. Second, they had to acquire new language skills over the delay.

Memory Performance

To compare performance on the verbal and nonverbal measures, we converted the children's scores on each measure into a proportion of the total score possible for that measure. For verbal recall, for example, there was a total of 23 items that the children could report about the event. For photograph recognition, there was a total of 10 photos they could identify (the 7 toys plus 3 additional objects that played a significant role in the event—the shrinking machine, the large case from which the toys were originally drawn, and a brightly colored cloth bag in which the smaller versions of the toys were placed after each trial); for behavioral reenactment, there were 5 actions that they could reproduce during the test. Preliminary analyses of variance (ANOVAs) indicated there was no effect of gender on any measure, and gender did not enter into any significant interactions. For this reason, the data were collapsed across gender for all subsequent analyses.

The proportion of information that the children remembered during the test is shown in Figure 2 as a function of age, retention interval, and memory measure. These data were submitted to a 3 (age) × 2 (retention interval) × 3 (memory measure) ANOVA with repeated measures over memory measure. Memory performance increased as a function of age, $F(2, 73) = 18.23$, $p < .0001$. Post hoc Student-Newman-Keuls tests ($p < .05$) indicated that, overall, the 27-month-olds remembered less information than the 33- and 39-month-olds; the memory performance of the 33- and 39-month-olds did not differ. The children's memory performance also varied as a function of the retention interval, $F(1, 73) = 25.08$, $p < .0001$. Children who were tested after a 6-month delay remembered more than children who were tested after a 1-year delay. There was no Age × Retention Interval interaction.

The children's memory performance also varied as a function of memory measure, $F(2, 146) = 141.09$, $p < .0001$. Post hoc Student-Newman-Keuls tests ($p < .05$) indicated that, overall, the children's performance on each memory measure differed from their performance on the others. They remembered the greatest proportion of information on the behavioral-reenactment test ($M = .64$, $SE = .04$) and the smallest proportion of information on the verbal-recall test ($M = .21$, $SE = .02$). Their performance on the photograph-recognition test was intermediate between these two extremes ($M = .54$, $SE = .02$).

Finally, there was a significant Age × Memory Measure interaction, $F(4, 146) = 3.08$, $p < .05$. To evaluate this interaction, we conducted a series of one-way ANOVAs across age for each memory measure. These analyses indicated that although there was a significant effect of age on verbal recall and behavioral reenactment (both ps $< .0001$), there was no effect of age on photograph recognition (see Fig. 2).

Taken together, the data shown in Figure 2 clearly illustrate that, despite age-related and delay-related changes in memory performance, children of all ages remembered at least something about the target event irrespective of whether they were tested after a 6-month or a 1-year delay.

Language Development

Our next step was to assess changes in the children's language skill between the time of the event and the time of the memory test, 6 months or 1 year later. The children's receptive (PPVT-III) and productive (EVT) vocabulary scores at the time of the event (i.e., encod-

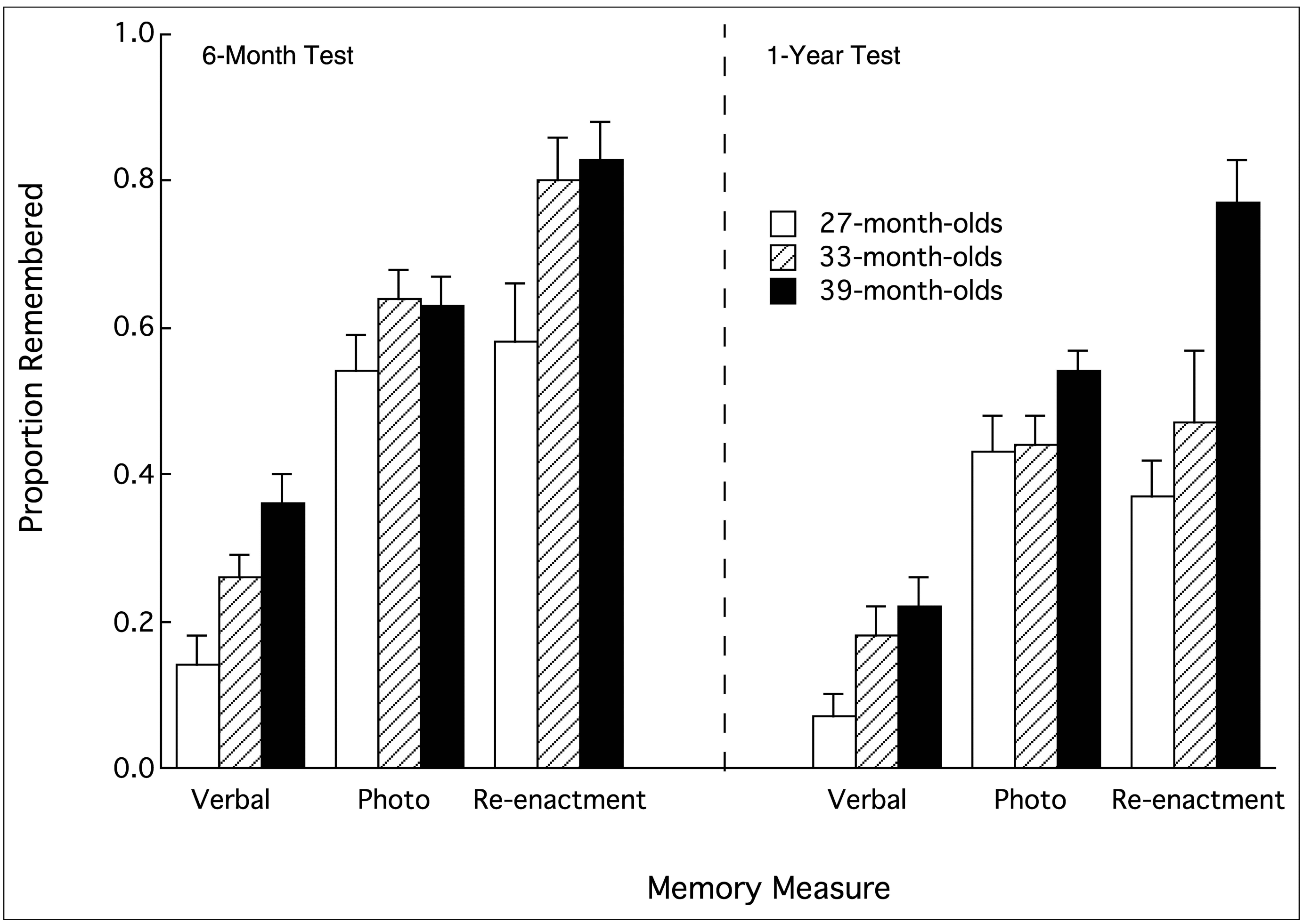

Fig. 2. Proportion of information that children recalled (+ 1 *SE*) during the retention test as a function of age, memory measure (verbal recall, photograph recognition, or behavioral reenactment), and retention interval (6-month or 1-year delay).

Table 2. *Mean vocabulary scores at the time of original encoding and at the time of the test 6 months or 1 year later*

Age group at encoding (months)	Encoding		6-month test		1-year test	
	PPVT (A)	EVT	PPVT (B)	EVT	PPVT (B)	EVT
27	—	24.61 (1.71)	31.00 (2.11)	33.92 (1.17)	44.73 (2.98)	38.18 (2.19)
33	30.20 (1.88)	31.64 (1.48)	44.93 (2.34)	43.46 (2.46)	55.50 (2.70)	45.54 (1.32)
39	37.96 (2.09)	35.04 (1.28)	52.00 (2.41)	42.50 (1.77)	57.86 (2.50)	46.14 (1.91)

Note. Standard errors are shown in parentheses. The table shows raw scores on the Expressive Vocabulary Test (EVT; Williams, 1997) and versions A and B of the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997). Because the PPVT is designed to assess the receptive language skill of children 30 months old and older, the 27-month-old children in the present study were unable to reach the basal score necessary to be assessed with this measure.

ing) and at the time of the test are shown in Table 2. These data were subjected to separate 3 (age) × 2 (retention interval) × 2 (time point) ANOVAs with repeated measures over time point (i.e., encoding and test). Not surprisingly, children's receptive vocabulary, $F(1, 46) = 7.72$, $p < .01$, and productive vocabulary, $F(2, 63) = 12.15$, $p < .0001$, increased as a function of age. More important, both receptive vocabulary, $F(1, 46) = 172.94$, $p < .0001$, and productive vocabulary, $F(1, 63) = 193.22$, $p < .0001$, increased over the retention interval, indicating that the children's general language skills increased between the time of the original event and the time of the subsequent retention test.

Recall that at each time point, parents were asked to indicate whether or not their child could say the 23 target words specifically associated with the event. A 3 (age) × 2 (retention interval) × 2 (time point) ANOVA with repeated measures over time point indicated that although there was an age-related difference in children's production of the target words at the time of original encoding, $F(2, 52) = 3.72$, $p < .05$, their production of the target words increased over the delay between the event and the retention test, $F(1, 47) = 42.33$, $p < .0001$. By the time of the test, children of all ages had acquired most of the vocabulary necessary to describe the target event (see Fig. 3).

Verbal Recall of Preverbal Information

The data described thus far indicated that we were in a position to evaluate children's verbal recall of preverbal aspects of their memory. That is, the children remembered the event (see Fig. 2) and developed new language skills over the retention interval (see Fig. 3 and Table 2). To determine whether the children translated preverbal attributes of their memory of the event into language, we looked for instances in which during the retention test a child described the event using a word or words that were not part of his or her productive vocabulary at the time of the event. To do this, we compared the information that each child reported during the memory interview word for word with the target checklist completed by that child's parent at the time of the event. As shown in Table 3, there was not a single instance in which a child used a word or words to describe the event that had not been part of his or her productive vocabulary at the time of encoding. Thus, although the children could remember information that had been encoded without the benefit of language, they could not translate that information into words even though they had acquired the vocabulary to do so. A similar analysis of the children's nonverbal memory performance, by contrast, indicated that they did recognize photographs and perform actions corresponding to words that had not been part of their productive vocabulary at the time of the test (see Table 3).

DISCUSSION

The results of the present experiment yielded no evidence whatsoever that children could translate preverbal (i.e., nonverbal) attributes of their memory representations into language. In no instance during the test did a child use a word or words to describe the event that had not been part of his or her productive vocabulary at the time of the event. In short, children's verbal reports of the event were frozen in time, reflecting their verbal skill at the time of encoding, rather than at the time of the test. This finding is clearly limited to the verbal recall of preverbal items. That is, at the time of the test, the children recognized photographs and performed actions for which they did not have the relevant vocabulary at the time of original encoding.

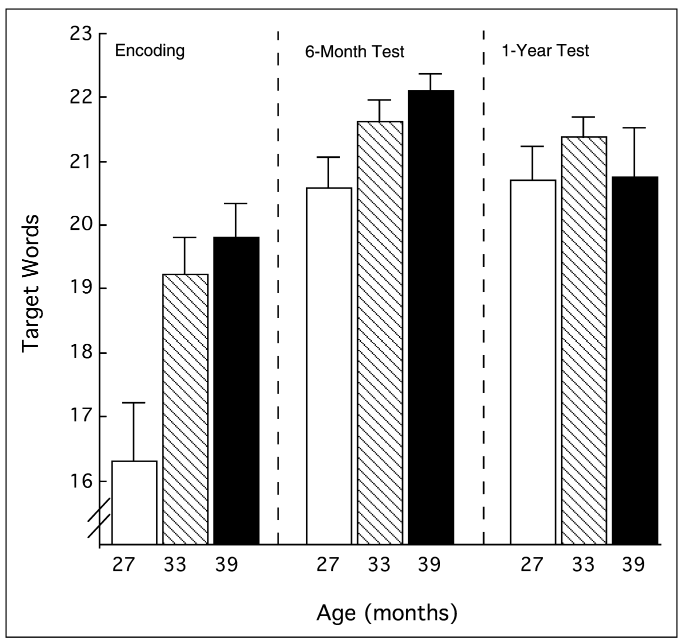

Fig. 3. Mean number of target words (+ 1 *SE*) in children's productive vocabulary at the time of encoding and at the time of the test 6 months or 1 year later as a function of age group.

Table 3. *Total number of items that children remembered during the test that were not part of their productive vocabulary at the time of original encoding, as a function of age group, retention interval, and memory measure*

Age group at encoding (months)	Retention interval					
	6 months			1 year		
	Verbal	Photo	Reenactment	Verbal	Photo	Reenactment
27	0	9	9	0	9	5
33	0	7	3	0	4	1
39	0	4	2	0	3	0

The present findings have a number of implications for current understanding of the mechanisms responsible for childhood amnesia. First, although there were age-related changes in both verbal and nonverbal memory performance, without exception, these changes were gradual and continuous. This pattern of development is consistent with the findings of recent studies of nonverbal memory during the infancy period (Barr & Hayne, 2000; Hartshorn et al., 1998; Herbert & Hayne, 2000) and suggests that both nonverbal and verbal recall also develop in a smooth and continuous manner throughout early childhood. These findings challenge explanations of childhood amnesia that rely on dramatic, discontinuous changes in memory processing (see also Bruce et al., 2000).

Second, despite their emerging language skill, the children in the present experiment continued to rely primarily on their nonverbal skills during the memory interview. Across the entire age range tested, children's verbal memory performance lagged substantially behind their nonverbal memory performance. Given that behavioral reenactment is thought to provide a nonverbal measure of recall (McDonough, Mandler, McKee, & Squire, 1995), the children's poor performance on the verbal-recall test cannot be attributed exclusively to the difficulty inherent in tests of recall relative to tests of recognition. Instead, the difficulty must be attributed to verbal information per se.

Furthermore, the children's verbal recall lagged behind their language skill as well. According to parental report, children of all ages used most of the target words in daily conversation; however, they often failed to use them to describe aspects of the event that they clearly remembered, as indicated by their performance on the photograph-recognition and behavioral-reenactment tests. We propose that this lag in verbal recall reflects the representational nature of young children's memories. Prior to the acquisition of language, by definition, children must encode information in a nonverbal way. Even as their language skills improve, however, young children apparently rely more heavily on nonverbal representations than on their somewhat limited language skill.

Contrary to the prediction originally outlined by Hayne and Rovee-Collier (1995), the results of the present experiment indicate that language development does not preclude the retrieval of memories that are composed primarily of perceptually based attributes. That is, children remembered behaviors and visual images of objects even when they did not have the relevant vocabulary for those behaviors or images at the time of original encoding. However, language development did not render these perceptually based memories accessible to verbal recall. That is, in no instance did children verbally report an aspect of the event that had not been part of their productive vocabulary at the time of original encoding, despite having the productive vocabulary necessary to do so at the time of the test. Building on the position of K. Nelson (1993) and of Hudson (1990), we hypothesize that the inability to translate early, preverbal experiences into language prevents these experiences from becoming a part of autobiographical memory. In this way, language development may be the rate-limiting step in the offset of childhood amnesia.

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