Development and Psychopathology, **10** (1998), 655–679
Copyright © 1998 Cambridge University Press
Printed in the United States of America

If memory serves, will language? Later verbal accessibility of early memories

PATRICIA J. BAUER, MARIA G. KROUPINA, JENNIFER A. SCHWADE, PATRICIA L. DROPIK, AND SANDI SAEGER WEWERKA
Institute of Child Development, University of Minnesota

Abstract
Of major interest to those concerned with early mnemonic process and function is the question of whether early memories likely encoded without the benefit of language later are accessible to verbal report. In the context of a controlled laboratory study, we examined this question in children who were 16 and 20 months at the time of exposure to specific target events and who subsequently were tested for their memories of the events after a delay of either 6 or 12 months (at 22–32 months) and then again at 3 years. At the first delayed-recall test, children evidenced memory both nonverbally and verbally. Nonverbal mnemonic expression was related to age at the time of test; verbal mnemonic expression was related to verbal fluency at the time of test. At the second delayed-recall test, children evidenced continued accessibility of their early memories. Verbal mnemonic expression was related to previous mnemonic expression, both nonverbal and verbal, each of which contributed unique variance. The relevance of these findings on memory for controlled laboratory events for issues of memory for traumatic experiences is discussed.

In 1995 was published a Grand Rounds case presentation of 4-year-old Audrey who, at the age of 12-1/2 months, was witness to the violent death of her mother caused by explosion of a letter bomb (Gaensbauer, Chatoor, Drell, Siegel, & Zeanah, 1995). As described by Gaensbauer et al., in the years after the traumatic loss, Audrey experienced a number of symptoms that culminated in her referral for psychological evaluation. Virtually immediately after the incident, Audrey began experiencing disturbed sleep, including frequent night wakings and recurrent nightmares. She had intense screaming episodes that, over time, decreased in frequency yet recurred at times of stress. She was quite fearful of loud noises, such as car backfiring, as well as other stimuli thought to remind her of the trauma (e.g., Santa Claus, presumably because of the red clothing). Audrey also experienced eating disturbances and exhibited angry, disruptive, and resistant behavior. Her symptoms, preceded as they had been by an apparently normal course of development prior to the event of her mother's death, seem relatively clearly to be related to the violent episode and traumatic loss. Moreover, although she did not verbalize it, in the course of her evaluation at the age of 4 years, Audrey nonverbally ex-

This research was supported by a McKnight–Land Grant professorship, grants from the Graduate School of the University of Minnesota, and the National Institute of Child Health and Human Development (HD-28425). Preparation of the manuscript was supported in part by a Bush Sabbatical Supplement award. We also thank Maribelle de la Torre, Angie Farley, Lynn Johnson, Caren Lowe, Ian Walker, and many other members of the Cognition in the Transition laboratory group for their help in data collection, coding, and transcription; Melissa Burch for her comments on an earlier version of this manuscript; and Dante Cicchetti and Sheree Toth for their invitation to contribute to this Special Issue and for their comments on an earlier draft. We extend a special message of gratitude to the children and parents whose dedication to the effort made this work possible.

Address correspondence and requests for reprints to: Patricia J. Bauer, Institute of Child Development, 51 East River Road, University of Minnesota, Minneapolis, MN 55455–0345; E-mail: pbauer@maroon.tc.umn.edu.

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

pressed memory for the event: she engaged in what both the evaluator and her adopted mother interpreted as a behavioral reenactment of the violent episode that she had witnessed at the age of 12 months.

The relevance of Audrey's case for the topics of a Special Issue on risk, trauma, and memory processes is obvious. Less clear is the form in which Audrey retained the experience and thus, the mechanism by which it affected her posttraumatic behavior. Looming large is the question of whether Audrey remembered the experience of her mother's death in the traditional sense of the term (i.e., entailing conscious access), or whether the experience left its indelible mark only on her unconscious mind. The nature of the representation of Audrey's experience is nontrivial as, among other things, it could be expected to figure in decisions as to the most beneficial course of treatment for the young girl. Conceptually related to questions of the nature or form of memory representations are questions about the later verbal accessibility of early memories: Audrey behaviorally reenacted, yet did not verbally report on, her previous experience. The question of whether experiences likely encoded without the benefit of language later are accessible to verbal report is our primary focus in the present research. Fortunately for our participants, the experiences, memory for which we tracked over a 2 year period, were not traumatic for them. In fact, the controlled laboratory events that served as the mnemonic targets of this investigation were relatively pedestrian. Nevertheless, we expect that information about long-term retention and subsequent expression of memory garnered from this research will have implications for cases in which an experience is less mundane.

Little more than a decade ago the suggestion that memory for an event experienced by a 12-month-old might be retained in a format accessible to verbal report would by the "basic" research community have been met with considerable skepticism. Both our general theories of cognitive development and our theories of early memory assumed a qualitative change in representational or mnemonic process somewhere between 2 and 3 years of age. It was widely believed that after the change, children were capable of forming memories of specific events that they later were able to recall. In contrast, it was thought that before the qualitative change, they either could not form accessible memories (e.g., Piaget, 1952) or early memories became inaccessible over the course of development (e.g., Neisser, 1962, 1988). Although not described in the same terms, the mnemonic abilities presumed available before versus after the qualitative change were roughly those attributed to nondeclarative or unconscious processes on the one hand and declarative or conscious processes on the other. Until the qualitative change, children were assumed capable of nondeclarative, but not declarative, memory. That very young children did not yet have available to them declarative memory capacity resolved the issue of the apparent lack of verbal accessibility of early memories: Only conscious, declarative memories can be expressed through language; since they lacked declarative memories, they had no content to express. Consistent with this perspective, Gaensbauer et al. (1995) interpreted Audrey's behavioral reenactment as evidence of nondeclarative, but not of declarative, memory for the traumatic event of her mother's death.

Today, the assumption that children younger than 2 or even 3 years of age are not able to form memories of events that they subsequently can recall no longer is tenable. Using elicited imitation of action sequences, a nonverbal analogue to verbal recall (see Bauer, 1995; Mandler, 1990; and Meltzoff, 1995, for discussion), a number of laboratories have demonstrated accurate immediate and long-term recall by children late in the first and throughout the second year of life (see Bauer, 1997, for a review). In elicited imitation, props are used to produce an action or sequence of actions that a child is given the opportunity to imitate. Children's reproduction of the event serves as the measure of recall. Although the props used to produce the events are available during the recall periods, for multistep sequences, the order in which the actions unfolded disappears once the model has produced the event. To remember the order of the event, children must encode

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

it during presentation and later retrieve it from a memory representation, in the absence of ongoing perceptual support. In this requirement, the circumstances of testing for nonverbal production of temporally ordered sequences closely mimic those of verbal recall paradigms (Mandler, 1990). Consistent with the argument that elicited imitation engages the same cognitive processes as those involved in verbal recall is the finding that adults with amnesia, in whom recall processes are disrupted, are unable to perform an age-appropriate version of the task (McDonough, Mandler, McKee, & Squire, 1995; see Bauer, 1995, for further discussion).

Research employing elicited imitation makes clear that from a young age, children are able to remember specific past events. Over relatively short delays (e.g., 1 week), children evidence excellent retention (e.g., Bauer, Hertsgaard, Dropik, & Daly, 1998); over longer delays, forgetting becomes apparent. Thus far, the longest retention interval over which young children have been tested for recall of specific novel multistep events is 8 months. In Bauer, Hertsgaard, and Dow (1994), we tested children 21, 24, and 29 months of age for recall of events that they experienced 8 months previously, as 13-, 16-, and 21-month-olds. To evaluate memory after the long delay, performance of the experienced children was compared to that of age- and gender-matched control children who never before had seen the test events. Although the naive children spontaneously produced some of the target actions and sequences, in all three age groups, performance by the experienced children was significantly greater than that by the naive controls. Thus, even the youngest children remembered the novel events over the long delay.

Whereas Bauer et al. (1994) represents the longest interval over which recall of multistep sequences has been tested, our findings do not stand alone in suggesting very long-term recall by children in the 1- to 2-year-old age range. Meltzoff (1995) observed recall by 18- and 20-month-olds of single, novel object-specific actions that they had experienced 4 months previously. Hudson and Sheffield (1995) observed recall after 6 months of events that children originally had experienced at 18 months of age. McDonough and Mandler (1994) reported that 63% of 23-month-olds reproduced one of four single object-specific actions (i.e., "feeding" a schematic bottle to a stuffed bear) that they had experienced 12 months previously, when only 11 months of age. Together these data indicate that by late in the first year of life, children have the capacity to recall specific events after long periods of time. What is more, there are essential similarities in the apparent mnemonic processes of very young as compared to older children and even adults. As do older mnemonists (see van den Broek, 1997, for a review), young children evidence causal, temporal and goal-based organization of their memories (e.g., Bauer, 1992; Travis, 1997), and their recall is influenced by familiarity with and the temporal structure of events (e.g., Bauer & Dow, 1994) as well as by reminders of them (Bauer, Hertsgaard, & Wewerka, 1995). In short, within the 1- to 2-year period, event memory is qualitatively similar to that of older children and even adults (see Howe & Courage, 1997, for a similar argument).

Although evidence of continuity in basic mnemonic processes now abounds, there remains a striking discontinuity in the form of mnemonic *expression*: Young children rely exclusively on nonverbal expression, whereas older children and adults use language to convey the contents of their memories. This difference may sound trivial. Of course older children are able to provide verbal reports of their past experiences: they have command of the verbal medium. However, the difference in mode of expression of early as compared to later memories persists, even once children have become well integrated into the language community (see Fivush, Pipe, Murachver, & Reese, in press, for a review). Audrey's is an illustrative case in point. Whereas she had experienced some speech delay, at the time of evaluation at the age of 4 years, her language usage was appropriate for her age (Gaensbauer et al., 1995). Nevertheless, even though questioned relatively directly, she failed to use language to express her memory for the traumatic event.

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

At least for nontraumatic events, the difference in mode of expression of early and later memories is not absolute; children can provide verbal reports of events experienced in the distant past (e.g., Fivush, Gray, & Fromhoff, 1987). However, interviewers must work hard to elicit them. For children younger than 24 months, the adult must provide both the structure of the report and its content: The adults tells "what happened" in the event and the child confirms, denies, or repeats the information (e.g., Eisenberg, 1985; Fivush, 1991; Hudson, 1990; Peterson & McCabe, 1992). Between 2 and 2-1/2, interviewers can substitute yes/no questions with memory questions, thus requiring that children provide at least some mnemonic content. Nevertheless, the structure of the report is provided by the adult who both cues memory and directs the memory search (Hudson, 1990). It is not until 3 years or older that children begin to provide coherent narratives about the past (e.g., Fivush et al., 1987). Even at this age these conversations are rare (Sachs, 1983) and the majority of information provided in them is elicited by prompts and direct questions. In Hamond and Fivush (1991), for example, 78% of the information provided by 3- to 5-year-olds in a structured interview was elicited by prompts and directed questions from the interviewer. Tellingly, the patterns observed when children engage in conversation about the past are in contrast to those when they talk about the present; in the latter case, children are active participants from the dawn of language acquisition.

That children have difficulty verbally expressing memories that at least potentially are represented in a declarative format is not as incomprehensible as it might at first appear to be. We already have seen that the mode of expression of a memory is not confounded with its representational format: Early declarative memories can be expressed nonverbally (Bauer, 1995). Likewise, because a memory is declarative does not mean that it is symbolic or propositional. Herein may lie a source of difficulty with subsequent verbal access to early memories. Before language, mental life (including recall) must take place without linguistic symbols: It must rely on a nonverbal representational format. With the onset of language, linguistic tokens must then be mapped onto preverbal meanings, thereby making nonverbal representational products accessible for linguistic expression. It is relatively easy to imagine (although, not to instantiate) how mapping of symbol to referent could be accomplished for objects in the environment—the linguistic token and its referent simultaneously are perceptually available. This is not the case for events that happened in the past; unless the event occurs again, the referent is not available for labeling or description. By this analysis, mapping newly acquired language onto representations of past events may present a substantial challenge. Difficulties associated with this requirement may partially explain why so few early memories appear to be verbally accessible.

Perhaps because it is only recently that researchers have recognized that very young children form and maintain declarative memories, there have been few investigations of the subsequent verbal accessibility of memories likely encoded without the benefit of language. There are the occasional reports in the literature of children making reference to experiences that they had as preverbal infants. For example, Nelson and Ross (1980) reported instances in which 21- to 27-month-old children verbalized about events or objects they had experienced well before they were able to label them. Similarly, Todd and Perlmutter (1980) provided examples of later verbal accessibility of memories unlikely to have been encoded verbally. Finally, Myers, Clifton, and Clarkson (1987) included a report of a 32-month-old who correctly verbally identified as a "whale" the subject of a hidden picture last seen at the age of 40 weeks.

More comprehensive analyses of the question of subsequent verbal accessibility of early memories have been provided by Peterson and Rideout (1998) and Bauer and Wewerka (1995, 1997). Peterson and Rideout interviewed children about their memories for emergency room procedures necessitated by accidents. The accidents occurred when the children were between 13 and 35 months of age; the interviews were conducted very shortly after the children's visits to the emer-

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

gency room and then again 6 months, 12 months, and 18 or 24 months later. Children who were 18 months of age or younger at the time of their injuries were unable to provide verbal accounts of their experiences, even though, at the later interviews, they had the language ability to do so. In contrast, although they had not been able to talk about their experiences at the time, children who were injured at between 20 to 25 months were able to provide verbal reports at the 6 month interview. Some of the children maintained verbal accessibility of their memories over the subsequent delays between interviews. Children who were 26 months of age or older at the time of the experience were able to provide verbal reports at all of the delays.

Peterson and Rideout's (1998) results suggest that children 18 months of age or younger at the time of a traumatic event have difficulty using language to describe it at a later point in time. However, with respect to address of the question of subsequent verbal accessibility of memories likely encoded without language, this intriguing study has certain limitations. First, for obvious reasons, no control over the to-be-remembered events was exercised: Children suffered different injuries in different ways; their experiences in the emergency room all varied from one another. Second, no task-independent assessments of the language abilities of the children at the time of their experiences were available. In light of the large ranges in each age group (i.e., 13–18 months, 20–25 months, 26–35 months), children within a group could be expected to vary from one another rather dramatically in terms of their language abilities. Third, the only measure of memory for the target event was a verbal one. As a result, it is impossible to determine whether the youngest children were not able to talk about their memories, or whether they had no memories about which to talk. Finally, whereas our ultimate goal is to inform the relation between trauma and memory, their point of intersection may not be the best place to begin to address the question of verbal accessibility of early memories: Absent data on the long-term accessibility of nontraumatic experiences, it is difficult to know how to interpret data on memory for traumatic ones (although see Fivush, 1998, and Howe & Courage, 1997, for arguments that memories for traumatic and nontraumatic events are qualitatively similar).

Work by Bauer and Wewerka (1995, 1997) serves as a complement to that of Peterson and Rideout (1998). We initiated study of the question of long-term verbal accessibility of early memories in the context of a large-scale investigation of normative memory development. Children were enrolled in the study at the age of 13, 16, or 20 months. At that time they were exposed to six novel events, their memories for which subsequently were tested after intervals of either 1, 3, 6, 9, or 12 months: Children were between 14 (13-month-olds with a 1-month delay) and 32 (20-month-olds with a 12-month delay) months at the time of their recall tests. Also at the time of enrollment, children's parents completed the MacArthur Communicative Development Inventory, as an index of their children's language ability. After the appointed delay, children were tested on the six target events, as well as on three new events, as a within-subjects control. Although we did not elicit them, under the contextually supported circumstances of testing (see Conclusions and Implications for discussion of the importance of this aspect of the design), children often produced verbalizations about the events. In Bauer and Wewerka (1995) we characterized the verbalizations of 60 of the children (20 of each age; 5 from each of the 1 and 3 combined, 6, 9 and 12 month delays) rather coarsely, as either indicative of memory or not indicative of memory.

The results of Bauer and Wewerka (1995) were clear: The 14- to 32-month-old children were able to show that they remembered, nonverbally; they also were able to verbalize their memories. They produced a larger number of mnemonic verbalizations on events to which they previously had been exposed, relative to events that were new to them. Moreover, reported productive vocabulary at the time of exposure to the events (ranging from 0 to 481 words across the 13 to 20 month age range, based on the MacArthur Communicative Development Inventory) was related to spontaneous verbal expression of memory; it pre-

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

dicted 26% of the variance in mnemonic verbalizations. In contrast, it bore only a modest relation to nonverbal expression of memory and to nonmnemonic verbalizations. Thus, memory was related to verbal ability at the time of encoding but it was not dependent upon it; children with limited vocabulary demonstrated memory for the events, nonverbally. Moreover, language at the time of encoding apparently was not necessary for later verbal expression. Rather, under the contextually supportive conditions of testing, it seemed that children were able to "translate" preverbal memories into verbal format.

In Bauer and Wewerka (1997), we reported the results from 12 of the 60 children who were invited to return to the laboratory at the age of 36 to 40 months. All of the children had been 20 months at the time of exposure to the events. At their 3-year follow-up visit, rather than relying on spontaneous verbalizations, we elicited from the children verbal reports about the events. For each event in turn, the experimenter placed the props beyond the child's reach and said "What was this called? What did we do with this? Tell me about it." Each utterance that the children produced was classified as mnemonic or nonmnemonic; within an utterance, each unit of information provided was classified as belonging to the narrative category of *who*, *what*, *where*, *when*, *why*, or *how*. Performance by the 12 experienced children was compared to that of age and gender-matched naive control children tested with the same protocol. Although the children did not differ in verbal fluency, the experienced children produced a larger number of mnemonic units than did the naive ones. Thus, although 6 to 14 months had passed since their last exposure to the events, the children still were able to verbally report on them. Critically, the number of mnemonic units of information produced at the first delayed-recall test predicted verbal expression of memory at the second delayed-recall test. This result suggests that the opportunity to verbally describe the events at the first delayed-recall test may have served to "recode" them from nonverbal to verbal format.

In the present research we extended Bauer and Wewerka (1997) in a number of ways. First, we enlarged the sample to include 40 children. Our preliminary investigation of the long-term accessibility of early memories was based on a sample of only 12. A larger sample is desirable to assess the generalizability of the findings, as well as to stabilize the data base on which claims are grounded. Second, we extended the investigation to include children who were 16 months of age at the time of exposure to the events. Comparison of patterns of performance in children younger and older than 18 months at the time of experience is important in evaluation of claims of changes in mnemonic function, mnemonic expression, or both, at or around 18 months (compare, for example, Meltzoff, 1995, and Peterson & Rideout, 1998). Third, to enable a more controlled investigation of the effects of the delay interval between exposure and test, we drew the samples from among the children who had experienced an initial delay of either 6 or 12 months. In contrast, in Bauer and Wewerka (1997), children were drawn from a variety of delay intervals; small cell frequencies prevented an authoritative address of the influence of delay on subsequent memory. Additional improvements on the methods employed in our preliminary investigation include a more fine-grained coding scheme, to enable examination of the different ways in which children might express their memories, as well as coding at the level of the proposition, rather than the "unit" of information. The change to a larger unit of analysis was necessitated by the larger sample. In addition, we were concerned that coding at the level of the unit implied greater precision in transcription than might be warranted. Finally, for a subset of the children ($n = 25$ of 40) performance at delayed-recall Test 2 was evaluated within, rather than between, participants.

Method

Participants

The data for this analysis were derived from a subset of children who participated in a larger study of long-term memory development. The subset consisted of 40 children, selected by virtue of the fact that they were tested by the

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

Table 1. *Mean ages at each phase of testing and mean number of days between delayed-recall tests*

Age/Delay Condition	Phase of Testing			
	First Exposure	Delayed Recall		Days Between Tests 1 and 2
		Test 1	Test 2	
16-month-olds				
6-month delay	16; 00	22; 15	37; 26	464
12-month delay	15; 29	28; 14	39; 04	316
20-month-olds				
6-month delay	20; 00	26; 15	38; 07	352
12-month delay	20; 08	32; 22	39; 18	204

same experimenter at each of five sessions. A summary of the mean ages and ranges of age at each phase of the study is provided in Table 1. At the time of exposure to the specific test events 20 of the children were 16 months of age and 20 were 20 months of age. Within each age group, children were randomly assigned and subsequently tested for delayed recall of events after either 6 (10 children per age group) or 12 (10 children per age group) months. Thus, at the time of their first delayed-recall test, children were aged 22 (16-month-olds in the 6-month delay condition) to 32 (20-month-olds in the 12-month delay condition) months. All of the children were seen for a second delayed-recall test at between 34 and 41 months of age ($M = 38.7$ months). There were 8 girls and 12 boys in each age group.

All of the children were seen in the laboratory for five 45- to 60-min sessions. The first three sessions (exposure sessions) each were separated by 1 week (*M* number of days between sessions was 6.95 for the 16-month-olds and 6.85 for the 20-month-olds). The fourth session (delayed-recall Test 1) took place after a preassigned delay of either 6 or 12 months (*M* number of days between the final exposure and delayed-recall Test 1 session was 183 and 365 for the 6-month and 12-month delay conditions, respectively). The fifth session (delayed-recall Test 2) took place a minimum of 6 months after delayed-recall Test 1. The mean number of days between delayed-recall Tests 1 and 2 are reflected in Table 1 for each group.

Participants were recruited from an existing pool of volunteer parents who had indicated interest in participating in research at the time of their children's births. One of the children was African American, 38 were Caucasian and 1 was Hispanic. Although no data on socioeconomic status were collected, the participant pool primarily includes families of middle- and upper-middle class status. All children were given a gift for their participation. At the end of each delayed-recall session, parents were provided a copy of their children's videotape.

Materials

Test events. Children were exposed to multistep event sequences. For purposes unrelated to the present research questions, the events were either three or four steps in length: All of the 20-month-olds were exposed to four-step test events; 16-month-olds were exposed to either four-step ($n = 10$) or three-step ($n = 10$) test events. The test sequences represented a range of event types, from those that were completely temporally constrained to events that lacked any temporal constraints and thus, were arbitrarily ordered (see Bauer, 1996, for a review of the effects of event type on recall). Because differences in performance as a function of event type are not the subject of the present research, this factor was not considered further. Two examples of events follow; a complete listing and description of the test events is available from the first author.

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

Make a gong. Materials included a base with a post on each end, a bar hinged to one post, a metal plate with edge curved so as to hang on the bar, and a small mallet. For the three-step version of the event, the experimenter modeled *put on the bar* (placing the bar across the base to form a cross piece), *hang up the bell* (hanging the metal plate from the cross piece), *ring the bell* (hitting the metal plate with the mallet). For the four-step version of the event, the bar first had to be extended to its full length, before it could be made to span the posts.

Make a windmill. Materials included a base structure consisting of a hollow rectangle 1-in. in height attached to a clear plastic square tube 4-in. tall, a spinner with a rectangular base, and a small ball. For the three-step version of the event, the experimenter modeled *put in the block* (placing the spinner base into the hollow rectangle), *put in the ball* (placing the ball in the tube), *spin it* (hitting the spinner to make it spin). For the four-step version, the tube was decorated with a sticker prior to hitting the spinner.

Vocabulary checklist. At the time of enrollment in the study, children's parents completed the MacArthur Communicative Development Inventory for infants (16-month-olds) or for toddlers (20-month-olds). Parents were asked to indicate which words their children produced. The instrument has been externally validated through comparison with observational measures and has considerable stability with respect to its assessment of general linguistic sophistication (Fenson, Dale, Reznick, Bates, Thal, & Pethick, 1994).

Procedure

The same female experimenter (SSW) conducted all of the sessions with all of the children. Children were seen individually in a laboratory playroom. After a brief warm-up period, they were seated across an adult-size table from the experimenter. One of the children's parents remained in the room throughout each session. Parents were asked not to label any objects, to suggest behaviors to their children, or to otherwise assist them. Parents complied with this request.

Exposure sessions. In previous research we have found that for children in the target age range, memory over a long delay is enhanced by repeated exposure to events (Bauer et al., 1995). Therefore, children were exposed to the events at each of three sessions. Previous research also has revealed differences in ordered recall as a function of whether or not children are allowed to imitate events prior to imposition of a delay (Bauer et al., 1995). To assess the influence of mode of participation in the event on long-term recall and subsequent verbal accessibility, children watched, but did not imitate, three test events. For another three events to be tested at delayed-recall Test 1, children were allowed to imitate prior to imposition of the delay. However, to avoid satiation, they imitated the events only once, at the third exposure session.

At the first exposure session, for each event in turn, the experimenter first familiarized the children with the props by allowing them to manipulate them for a child-controlled period. After familiarization, she modeled the event, with narration, two times in succession. She then put the props away and presented the child with the props for the next event. The session ended after presentation of all six test events. At the second exposure session, the children again experienced two models of each event; they had no opportunity to interact with the props. The second exposure session ended after presentation of all six test events. For the first three events (watch condition), the third session was identical to the second. For the last three events, after modeling, the children were encouraged to imitate the sequences with statements such as "Now you make the windmill, just like I did" (imitate condition). In sum, by the end of Session 3, the children had been exposed to six test events a total of three times; they had imitated half of them one time.

Delayed-recall Test 1. For each of the six events in turn, the experimenter presented the props for the event, and allowed the child to interact with them. Upon initial presentation

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

she encouraged the child by saying, "Show me what you can do with this stuff." After a brief period of manipulation the experimenter prompted the child by providing the label given for the event at each exposure session: "You can make/do X with that stuff. Show me how to make/do X." The child's production of the target actions and sequences constituted the measure of nonverbal memory for the test events. At the end of the delayed-recall period, the experimenter once again modeled the sequence of action as she had at each of the exposure sessions. After modeling, the children were invited to imitate. Performance after modeling was not considered in the present analyses.

In addition to the six events to which they previously has been exposed, the children were tested on three new events. The procedure for the new events was identical to that for the old, previously experienced ones. Because administration of the old and new events was procedurally identical, higher levels of production of the target actions and sequences on the old, compared with the new, events can be attributed to memory for them.

Delayed-recall Test 2. The procedure for the second delayed-recall test essentially was the same as that for the first. A major exception was that, before allowing the children to manipulate the props and thus produce the target events, the experimenter elicited from them verbal reports about the events. Specifically, for each event in turn, the experimenter placed the props in front of her, beyond the child's reach, and asked the child to "Look at this. What was this one called? What did we do with this?" Children were prompted to continue their reports with general statements such as "What else did we do?" and "And then what did we do?" This method of eliciting verbal reports is recognized as effective in encouraging narration, without imposing structure (Peterson & McCabe, 1983, 1992). Once the children either had completed a description of the actions necessary to produce the event or appeared to have exhausted the effort, the props were given to them. As she turned over the props the experimenter also provided a specific verbal reminder of the target event: "We made an X with these. Show me how we made an X." Children also were encouraged to continue to talk about the events as they manipulated the props.

In addition to the nine events to which they previously had been exposed (i.e., six events presented at Sessions 1–4 and three presented for the first time at Session 4), 25 children (15 who were 16 months at the time of enrollment and 10 who were 20 months at enrollment) also were tested on three new events. The procedure for the new events was identical to that for those previously experienced. Data on events new at Session 5 are not available on the first 15 children who completed the protocol due to an oversight on the part of the principal investigator (PJB).

Scoring

All sessions were videotaped for later analysis. From the videotapes we derived nonverbal and verbal measures of performance at each test session. Coders were not explicitly aware of the children's ages either at the time of exposure to the events or at the time of the delayed-recall tests. Moreover, they were unaware of (a) the delay interval, (b) whether a given event was old or new, and (c) the specific research hypotheses.

Nonverbal measures. Because the data for this analysis were obtained from a larger sample, production of target behaviors in baseline (Session 1) and at immediate- (Session 3, for events imitated only) and delayed- (Sessions 4 and 5) recall testing was assessed by a number of different individuals. All coders had been trained to achieve a criterion of reliability of 90% or greater against a coding template. Continued high reliability was ensured through frequent cross-checks among coders. In the sample as a whole, reliability was maintained at 90% or greater.

For each sequence, we calculated the total number of different target actions produced (maximum = 3.0 for three-step sequences and 4.0 for four-step sequences) and the number of actions produced in the target order (maximum = 2.0 and 3.0 for three- and four-step sequences, respectively). For the number of ac-

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

tions produced in the target order, following the data reduction procedures described in, for example, Bauer et al. (1998), only the first occurrence of each target action was considered, thereby reducing the likelihood that children would receive credit for pairs of actions that were correctly ordered by chance or by trial and error (for additional illustrations of the nonverbal scoring procedure, see, for example, Bauer & Dow, 1994, Bauer et al., 1995). To enable direct comparison across sequence lengths, we converted the raw scores to mean proportions of component actions and pairs of actions produced.

Verbal measures. An estimation of productive vocabulary at the time of exposure to the events was obtained by counting the total number of words on the MacArthur Communicative Development Inventory that parents indicated their children produced.

The first step in assessing verbal performance at the time of the delayed-recall sessions was to transcribe the audio portion of the sessions. A number of individuals were involved in the transcription process. For each session, one individual transcribed all verbalizations made while the child was seated at the testing table. Only verbalizations produced during the delayed-recall periods (i.e., prior to modeling by the experimenter) were considered. A second individual then reviewed the transcript against the videotape, marking instances of disagreement. One of the authors (JAS), who has graduate training in speech and language sciences, then viewed each of the sessions again and arbitrated all disagreements. Utterances on which a decision could not with confidence be reached were classified as "unclear."

We next assigned each propositional unit to one of eight mutually exclusive and exhaustive categories. The following examples illustrate the categories with reference to *make a gong*.

1. *Mnemonic* utterances were propositional units judged to be indicative of memory for a test event. Instances included verbal behaviors wherein the child (a) named or described an event (e.g., "it makes a loud noise"), (b) asked questions about or made statements regarding target actions of an event while not simultaneously performing the target action (see "narrative"; e.g., "put that [indicating the metal plate] on there [indicating the cross piece]") or (c) requested or commented on an as yet unseen prop or event (e.g., "can I see the bell?").
2. *Narrative* utterances were propositional units produced in conjunction with performance of a target action (e.g., saying "hang up the bell" while placing the metal plate on the cross piece).
3. *Label-object* utterances or propositions included conventional labels for prototypical exemplars of their category (e.g., "hammer" or "it's a hammer" for the plastic mallet).
4. *Label-action* utterances or propositions included conventional labels for canonical actions performed on prototypical exemplars of their category (e.g., regarding the mallet, "you pound it").
5. *Nonmnemonic* utterances were propositional units judged to be relevant to the props or laboratory sessions (in contrast to those classified as "off task," see below), yet indicated neither memory for the previous experience nor a specific relation to a target action or prop. They included general questions asked about the props or events (e.g., "what is this?"), comments or statements about nontarget activities (e.g., "we can make a fire station"), repetitions of the experimenter's or child's own verbalizations, and general requests or comments (e.g., "I want some more toys"). Also coded as nonmnemonic were children's "yes" or "no" responses to the experimenter's questions (e.g., "Shall we get some more toys?"—"Yes.").
6. *Generic* utterances were propositional units that made reference to a target action or prop yet, neither from their linguistic content nor their nonlinguistic context, could with confidence be classified either as "mnemonic" or as "nonmnemonic" (e.g., "put it," without accompanying nonverbal specification of the directive).

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

7. *Off task* utterances were not relevant to the props or events (e.g., "we have a kitty at home").

8. *Unclear* utterances were judged to be unintelligible or could not confidently be arbitrated.

Three coders (including two of the authors: MGK and PLD) established reliability on the coding scheme. Working from the videotapes and arbitrated transcripts, each individual then coded approximately one-third of the delayed-recall sessions. Propositions that potentially could have been classified into more than one category were discussed among the coders and classified after consensus was reached. Independent re-coding of the transcriptions of 10 children (25% of the sample) yielded overall reliability of 92.5% (range = 86.7%–97.2%).

Results and Discussion

Data bearing on the issue of long-term accessibility of early memories are presented in two parts: (a) analysis of children's nonverbal and verbal memory performance at delayed-recall Test 1, and (b) analysis of children's nonverbal and verbal performance at delayed-recall Test 2.

Delayed-recall Test 1

Nonverbal indices of memory. The children provided nonverbal evidence of memory for the events that they had experienced, regardless of their age at the time of exposure to the events, and of the delay interval imposed.

To compare children's performance on events to which they previously had been exposed and events that were new to them, we conducted 2 (age: 16-month-olds, 20-month-olds) × 2 (delay: 6 month, 12 month) × 3 (condition: imitate, watch, new) mixed analyses of variance on both the proportion of individual target actions produced and the proportion of pairs of actions produced in the target order, with repeated measures on condition. Descriptive statistics are provided in Table 2. On both dependent measures there were main effects of condition, Fs(2, 72) > 8.70, ps < .001. Children produced a larger and equivalent proportion of individual target actions on events imitated and watched (Ms = .53) than on new events (M = .39); they also produced a larger and equivalent proportion of ordered pairs of actions on events imitated and watched (Ms = .23 and .24, respectively) than on new events (M = .13) (Tukey, p < .05). Effects of delay also were in evidence, Fs(1, 36) > 5.40, ps < .05. Children in the 12-month delay condition exhibited superior levels of performance (Ms = .53 and .24, for individual actions and pairs of actions, respectively), relative to children in the 6-month delay condition (Ms = .43 and .17, for actions and pairs, respectively). Findings of better performance over a longer delay are less paradoxical when one considers that, at the time of testing, children in the 12-month delay condition were 6 months older than their counterparts in the 6-month delay condition. With increased age, children are better able to "figure out" how to produce target events (Bauer, Schwade, Wewerka, & Delaney, 1997). Although 20-month-

Table 2. *Means* (*and standard deviations*) *for proportion of individual target actions and proportion of pairs of actions produced in target order at delayed-recall Test 1*

Age/Delay Condition	Condition: Events Imitated	Condition: Events Watched	Condition: New Events
Proportion of Individual Actions Produced			
16-month-olds			
6-month delay	.45 (.12)	.52 (.15)	.28 (.18)
12-month delay	.49 (.20)	.51 (.19)	.45 (.20)
20-month-olds			
6-month delay	.53 (.22)	.48 (.27)	.31 (.15)
12-month delay	.65 (.14)	.59 (.17)	.52 (.18)
Proportion of Pairs of Actions Produced in Target Order			
16-month-olds			
6-month delay	.16 (.10)	.18 (.16)	.08 (.12)
12-month delay	.22 (.14)	.21 (.11)	.15 (.10)
20-month-olds			
6-month delay	.24 (.18)	.24 (.19)	.09 (.09)
12-month delay	.31 (.11)	.31 (.17)	.22 (.14)

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

olds ($M = .23$) produced a larger proportion of pairs of actions than 16-month-olds ($M = .17$), $F(1, 36) = 5.05$, $p < .05$, higher levels of performance on events previously experienced relative to new events were apparent in both age groups.

Evidence that the children remembered the events also was apparent in comparison of performance after the delay to that in baseline (i.e., prior to modeling at Session 1). We conducted 2 (age) × 2 (delay) × 2 (testing phase: baseline, delay) × 2 (condition: imitate, watch) mixed analyses of variance on both dependent measures, with repeated measures on testing phase and condition. Children produced a greater proportion of individual target actions at delayed testing ($M = .53$) than at baseline ($M = .20$); they also produced a greater proportion of pairs of actions in the target order at delayed testing ($M = .23$) than at baseline ($M = .04$): Fs(1, 36) > 82.20, ps < .001. Although 20-month-olds ($M = .40$) produced a larger proportion of individual target actions than 16-month-olds ($M = .33$), $F(1, 36) = 4.32$, $p < .05$, evidence of event memory was evident in both age groups. Moreover, children's performance was not affected by the length of the delay between sessions: Neither of the main effects of delay reached significance, Fs(1, 36) < 1.45, and delay did not enter into any significant interactions.

Although the children provided nonverbal evidence of memory for the events, they nevertheless exhibited some forgetting, as indicated by comparison of levels of immediate and delayed recall on the three events imitated once at Session 3. We conducted 2 (age) × 2 (delay) × 3 (testing phase: baseline, immediate, delay) mixed analyses of variance on both dependent measures, with repeated measures on testing phase. Main effects of recall, Fs(2, 72) > 205.80, ps < .001, indicated higher levels of immediate (Ms = .95 and .65, for individual actions and action pairs, respectively) relative to delayed (Ms = .53 and .23, for individual actions and action pairs, respectively) recall. Although this evidences forgetting, delayed recall performance was nevertheless greater than baseline (Ms = .19 and .03, for individual actions and pairs of actions, respectively). The patterns were the same for the 16- and 20-month-olds.

Verbal indices of memory. The children provided verbal evidence of memory for the events that they previously had imitated but not for the events that they had only watched.

We conducted 2 (age) × 2 (delay) × 3 (condition: imitate, watch, new) mixed analyses of variance for each verbal category, with repeated measures on condition. Because with the few exceptions noted below, the children's performance was unaffected by the length of the delay, descriptive statistics for their verbal performance are provided in Table 3, collapsed across delay. Analysis of the propositions classified as mnemonic revealed only a main effect for condition, $F(2, 72) = 3.73$, $p < .05$. Children produced a larger number of mnemonic propositions on events that they had imitated ($M = 1.11$) relative to events that were new to them ($M = .46$); their production of mnemonic propositions on events that they had only watched ($M = .79$) was intermediate and did not differ either from the number produced on events imitated or on new events (Tukey, $p < .05$). Although the Age × Condition interaction was not significant, $F(2, 72) = 1.11$, $p = .34$, it is clear from Table 3 that 20-month-olds' production of mnemonic propositions on events only watched was closer to that on events that they had imitated, whereas for 16-month-olds, performance on events only watched and on new events was more similar to one another.

The categories of narrative, labels for objects and labels for actions had the potential to provide additional evidence of memory for the previous events. Propositions classified into these categories were directly relevant to the target actions and props; greater production of such utterances on events previously experienced as compared to new events would have been consistent with interpretation of propositions in these categories as indicative of memory. In spite of this possibility, in none of these categories was there an effect for condition, Fs(2, 72) < 1.30. Likewise, although the intended referents of utterances classified as generic could not clearly be iden-

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

Table 3. *Means* (*and standard deviations*) *for number of propositional units produced in each cateogry at delayed-recall Test 1*

	Condition		
Age/Category	Events Imitated	Events Watched	New Events
16-month-olds			
Mnemonic	0.93 (1.44)	0.48 (0.72)	0.50 (0.89)
Narrative	0.98 (1.01)	1.13 (1.26)	1.10 (1.29)
Object labels	0.53 (0.55)	0.80 (0.88)	0.53 (0.72)
Action labels	0.05 (0.22)	0.05 (0.22)	0.00 (—)
Nonmnemonic	20.55 (10.43)	22.65 (12.09)	15.30 (8.71)
Generic	1.75 (2.27)	1.10 (1.62)	0.75 (1.02)
Off-task	0.75 (2.15)	0.45 (1.05)	0.20 (0.62)
Unclear	2.20 (1.79)	2.05 (2.32)	2.25 (2.53)
20-month-olds			
Mnemonic	1.30 (1.69)	1.10 (1.89)	0.43 (0.78)
Narrative	1.70 (2.03)	1.63 (1.94)	1.53 (1.67)
Object labels	0.80 (0.95)	0.55 (0.89)	0.50 (0.61)
Action labels	0.00 (—)	0.15 (0.37)	0.10 (0.31)
Nonmnemonic	24.75 (14.34)	24.98 (13.74)	21.98 (12.31)
Generic	1.00 (1.59)	1.15 (2.28)	0.95 (1.19)
Off-task	1.05 (3.09)	0.10 (0.31)	0.35 (0.93)
Unclear	3.80 (3.16)	2.15 (1.81)	2.10 (1.83)

tified, there was the potential that children would produce such utterances differentially, as a function of prior exposure to the props and events. However, the only effect in the generic category was for delay, $F(1, 36) = 6.29$, $p < .05$. Across age groups, children with a 12-month delay ($M = 1.62$) produced a larger number of generic utterances than children with a 6-month delay ($M = .62$). In these categories, there were no other significant effects.

There was an effect of condition in the nonmnemonic category, $F(2, 72) = 8.23$, $p < .001$. Children produced a larger and equivalent number of nonmnemonic utterances on events that they had imitated and watched (*M*s = 22.65 and 23.81, respectively) than on events new to them ($M = 18.64$) (Tukey, $p < .05$). They also evidenced a trend toward greater production of off-task propositions on events that they had imitated ($M = .90$) relative to events that they had only watched or that were new (*M*s = .28 for both watch and new), $F(2, 72) = 2.72$, $p < .08$. Moreover, analysis of the Age × Condition interaction on unclear utterances, $F(2, 72) = 3.28$, $p < .05$, revealed that 16-month-olds produced an equivalent number of unclear utterances across conditions, whereas 20-month-olds produced a smaller and equivalent number of unclear utterances on events that they had watched and that were new, relative to on events that they had imitated (Tukey, $p < .05$). Together, these results indicate that, at the first delayed-recall test, children had more to say about events that they previously had experienced, relative to events that were new to them; they were particularly talkative about events that they previously had imitated.

Predicting nonverbal and verbal expressions of memory. We first examined whether age at the time of encoding, the delay interval between the last exposure session and the test session, or age at the time of delayed recall were related either to nonverbal or verbal expression of memory. Although age at the time of encoding was correlated with nonverbal immediate recall performance, *r*s(38) = .37 and .33, *p*s < .05, for proportions of target ac-

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

tions and pairs of actions, respectively, neither it nor the length of the delay interval was related to nonverbal or verbal delayed-recall performance. The children's age at the time of delayed recall was correlated with the proportion of pairs of actions that they produced: $r(38) = .36$, $p < .05$; for the proportion of individual target actions, the correlation fell below the level of statistical significance: $r(38) = .30$, $p < .07$. Age at the time of delayed recall was not correlated with verbal expression of memory.

As expected, children's reported productive vocabulary at the time of exposure to the events was related to their age at encoding, $r(35) = .44$, $p < .01$. Sixteen-month-olds had a mean reported productive vocabulary of 40 words (range 6–242 words), and 20-month-olds had a mean reported productive vocabulary of 128 words (range 10–444 words). Productive vocabulary was related to the proportion of pairs of actions produced in the target order at immediate recall: $r(35) = .37$, $p < .05$; it was not related to any other indices of memory. Thus, unlike in Bauer and Wewerka (1995), in which vocabulary at the time of encoding was predictive of verbal mnemonic expression at the equivalent of delayed-recall Test 1, in this research, we did not find this relation.

Neither were the various indices of memory related among themselves. At each time point, children's production of individual target actions was related to their production of ordered pairs, rs$(38) = .64$ and $.87$, $p < .01$, for immediate and delayed recall, respectively. With this exception, none of the concurrent or cross-lag correlations between nonverbal and verbal expression of memory reached or approached significance (rs ranging from .06 to .26). Thus, whether children expressed their memories nonverbally was unrelated to their verbal expression of memory.

Whether children expressed their memories nonverbally also was relatively unrelated to their overall verbal production at Test 1. We examined the relation between children's production in each of the seven non-memory categories of verbal expression (i.e., narrative, label for object, label for action, nonmnemonic, generic, off-task, unclear) and their nonverbal expression of memory. We also calculated a "total verbal" measure, which included all clear utterances not classified as mnemonic, and examined its relation with the nonverbal indices of memory. None of the measures was correlated with the proportion of individual target actions produced. The only notable correlation between verbal production and production of ordered pairs of actions was with the category of narrative: $r(38) = .32$, $p < .06$. Thus, as measured in this research, children's verbal mnemonic and nonmemory production was not related to nonverbal indices of memory.

Although nonverbal expression of memory was not related to overall verbal production, overall verbal production was related to verbal expression. Production of propositions classified as narrative, $r(38) = .42$, $p < .01$, and as nonmnemonic, $r(38) = .37$, $p < .05$, was correlated with mnemonic verbalizations. In addition, the total number of propositions produced was correlated with verbal expression of memory: $r(38) = .44$, $p < .01$; it accounted for 19% of the variance in mnemonic expression: $F(1, 38) = 9.16$, $p < .01$. Consideration of propositions classified as narrative added little to the predictive utility of the total number of propositions, bringing the proportion of variance accounted for to only 22%: $F(2, 37) = 5.21$, $p < .01$. In contrast, consideration of propositions classified a nonmnemonic increased to 35% of variance the predictive utility of total number of propositions alone: $F(2, 37) = 10.07$, $p < .001$. In sum, verbal and nonverbal expressions of memory were not correlated with one another. Nonverbal expression of memory was not correlated with categories of verbal production. Verbal expression of memory was correlated with what might be regarded as measures of concurrent verbal fluency, as captured by the categories of nonmnemonic and total propositions; it was not correlated with the measure of verbal fluency at the time of encoding, namely, reported productive vocabulary.

Delayed-recall Test 2

Nonverbal indices of memory. When tested an average of 11 months later (range 6–17

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

Table 4. *Means (and standard deviations) for proportion of individual target actions and proportion of pairs of actions produced in target order at delayed-recall Test 2*

Age/Delay Condition	Condition			
			Events New	
	Events Imitated ($N = 40$)	Events Watched ($N = 40$)	at Test 1 ($N = 40$)	at Test 2 ($N = 25$)
Proportion of Individual Actions Produced				
16-month-olds				
6-month delay	.66 (.15)	.74 (.20)	.69 (.18)	.68 (.21)
12-month delay	.75 (.15)	.79 (.12)	.77 (.16)	.95 (.09)
20-month-olds				
6-month delay	.70 (.18)	.78 (.12)	.60 (.21)	.53 (.22)
12-month delay	.90 (.12)	.83 (.12)	.74 (.10)	.60 (.23)
Proportion of Pairs of Actions Produced in Target Order				
16-month-olds				
6-month delay	.40 (.20)	.44 (.24)	.42 (.23)	.39 (.27)
12-month delay	.45 (.18)	.52 (.22)	.51 (.19)	.64 (.20)
20-month-olds				
6-month delay	.43 (.20)	.46 (.22)	.33 (.18)	.24 (.19)
12-month delay	.57 (.23)	.56 (.17)	.44 (.16)	.28 (.21)

months), the children provided little nonverbal evidence of recall. This is not to say that they performed poorly on the events. On the contrary, as suggested by the values in Table 4, even on events to which they had been exposed only once at delayed-recall Test 1, their levels of production of target actions and pairs of actions were relatively high. Critically, for the 25 children on whom data on events new at delayed-recall Test 2 are available ($n = 15$ children 16 months of age at the time of exposure; $n = 10$ children 20 months of age at the time of exposure), performance on the new events was virtually as high. For the sample of 25, we analyzed the proportion of target actions and ordered pairs of actions in 2 (age) $\times$ 2 (delay) $\times$ 4 (condition: imitate, watch, new at Test 1, new at Test 2) mixed analyses of variance, with repeated measures on condition. In neither case was the main effect of condition reliable: Fs(3, 63) < 1.50. Thus, the children performed equivalently on events to which they previously had been exposed and events that were new to them. The high levels of performance are to be expected: Whereas the three- and four-step events were designed to be challenging for 16- and 20-month-olds, they were not engineered with the more advanced problem solving skills of children aged 34–41 months in mind (Bauer et al., 1997). Because children's nonverbal mnemonic and nonmnemonic performance could not be distinguished, we gave no further consideration to nonverbal indices at delayed-recall Test 2.

Verbal indices of memory. Children who had been 20 months at the time of exposure to the events provided verbal evidence of memory at the age of 3 years; children who had been only 16 months did not. The first suggestion of this interaction is apparent in inspection of Table 5, in which are presented descriptive statistics for each age group and verbal category. The means presented are collapsed across delay interval because, as at Test 1, there were few effects of delay.

For the 25 children on whom we had data on responses to events new at Test 2, we conducted 2 (age) $\times$ 2 (delay) $\times$ 4 (condition) $\times$ 2 (props: before, after) mixed analyses of variance for each verbal category, with repeated measures on condition and props. The factor

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

Table 5. *Means (and standard deviations) for number of propositional units produced in each cateogry at delayed-recall Test 2*

	Condition			
			Events New	
Age/Category	Events Imitated ($N = 40$)	Events Watched ($N = 40$)	at Test 1 ($N = 40$)	at Test 2 ($N = 25$)
16-month-olds				
Mnemonic	6.48 (3.44)	5.45 (2.04)	5.25 (3.25)	5.80 (4.06)
Narrative	1.58 (1.84)	2.00 (2.03)	1.62 (1.98)	2.20 (1.90)
Object labels	1.75 (1.45)	1.95 (1.32)	1.78 (1.32)	1.00 (0.85)
Action labels	0.10 (0.31)	0.45 (0.60)	0.28 (0.50)	0.20 (0.41)
Nonmnemonic	21.80 (10.17)	24.80 (8.86)	24.45 (8.46)	18.93 (10.02)
Generic	2.38 (2.53)	2.30 (1.63)	2.50 (1.90)	2.40 (3.44)
Off-task	0.40 (0.99)	0.75 (2.02)	1.05 (2.72)	0.33 (0.90)
Unclear	1.40 (2.35)	2.20 (3.14)	1.50 (2.54)	1.27 (1.62)
20-month-olds				
Mnemonic	7.80 (3.30)	6.80 (3.82)	5.95 (3.05)	3.70 (2.58)
Narrative	3.30 (2.45)	2.68 (2.27)	2.43 (2.10)	1.70 (1.64)
Object labels	1.60 (1.31)	1.80 (1.58)	1.88 (1.41)	2.30 (1.34)
Action labels	0.40 (0.60)	0.40 (0.60)	0.20 (0.41)	0.40 (0.70)
Nonmnemonic	17.65 (7.87)	19.68 (7.68)	19.98 (8.60)	26.10 (10.56)
Generic	2.20 (1.79)	1.93 (1.91)	3.28 (2.57)	2.00 (1.49)
Off-task	0.00 (—)	0.10 (0.45)	0.20 (0.70)	0.00 (—)
Unclear	1.15 (2.03)	0.83 (1.12)	1.35 (2.50)	0.90 (1.10)

Note: Narration was classified after props; all other categories reflect performance before props.

"props" refers to whether the observation was made before or after the props had been given to the children. (For the category "narrative," the analysis did not include this factor because the category was not coded before the props were given to the children.) Analysis of the propositions classified as mnemonic revealed a main effect for delay, $F(1, 21) = 4.34$, $p < .05$. Children who had been tested on the events after a 12-month delay ($M = 3.93$) produced a larger number of mnemonic propositions than children tested after a 6-month delay ($M = 3.06$). In addition, the interaction of Age × Condition × Props was statistically reliable, $F(3, 63) = 3.95$, $p < .05$. Once children received the props, there were no reliable effects. In contrast, in analysis of children's performance before the props were delivered to them, the interaction of Age × Condition was significant, $F(3, 69) = 4.71$, $p < .01$. Children who had been 16 months of age at the time of exposure to the events provided no verbal evidence of memory for them at the age of 3 years, $F(3, 42) = .71$. Their production of verbalizations classified as mnemonic was equivalent across conditions (Ms = 6.77, 5.73, 5.27, and 5.80, on events imitated, events watched, events new at Test 1, and events new at Test 2, respectively). Children who had been 20 months of age at the time of exposure to the events provided an equivalent number of propositions on events that they had imitated ($M = 9.00$), events that they had watched ($M = 9.40$), and events new at Test 1 ($M = 6.80$); their production of mnemonic propositions on events new at Test 2 ($M = 3.70$) was reliably lower than on events to which they previously had been exposed, $F(3, 27) = 10.37$, $p < .001$ (Tukey, $p < .05$).

As had been the case at delayed-recall Test 1, although the categories of narrative, labels for objects and labels for actions had the potential to provide additional verbal evidence of memory for the events, they did not. In none of these categories was there an effect for condition, Fs(3, 63) < 2.20, ns. For the two label categories, the only substantive effects were for props, Fs(1, 21) > 18.70, ps < .001. Children provided more labels for ob-

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

jects ($M = 1.86$) and actions ($M = .29$) before being given the props than after (Ms = .33 and .05, for object and action labels, respectively). Utterances classified as generic also had the potential to provide additional verbal evidence of memory. Again, as had been the case at delayed-recall Test 1, they did not.

With one exception, the categories of nonmnemonic, off task, and unclear also yielded no effects of condition. In the nonmnemonic category, analysis of the interaction of Age × Condition, $F(3, 63) = 3.92$, $p < .05$, revealed no effect of condition among children first exposed to the events at 20 months of age. For children 16 months of age at the time of first exposure, the effect was reliable, $F(3, 42) = 4.04$, $p < .05$. Children produced a larger number of nonmnemonic propositions on events that they had watched ($M = 25.77$) than on events new to them at Session 5 ($M = 19.30$) (Tukey, $p < .05$). There were no other reliable differences among conditions. This effect is reminiscent of one observed at delayed-recall Test 1, wherein children had somewhat more to say about events that they previously had experienced, relative to events that were new.

Predicting verbal expressions of memory at delayed-recall Test 2. We first examined whether age or delay interval was related to verbal mnemonic expression. Children's age at the time of exposure to the events was not related to verbal expression of memory at age 3 years, $r(38) = .23$, $p > .10$; age at the time of delayed-recall Test 1 bore a modest relation, $r(38) = .28$, $p < .10$; age at the time of delayed-recall Test 2 was significantly positively correlated with concurrent verbal expression of memory, $r(38) = .44$, $p < .01$. Neither the length of the delay interval between the last exposure session and the first delayed-recall test nor the length of the interval between the first and second delayed-recall test was correlated with verbal mnemonic expression.

The cross-lag correlations between mnemonic performance at Tests 1 and 2 were robust. The proportion of individual target actions, $r(38) = .38$, $p < .05$, the proportion of pairs of actions in the target order, $r(38) = .33$, $p < .05$, and the number of mnemonic propositions produced, $r(38) = .43$, $p < .01$, at delayed-recall Test 1 all were positively correlated with the number of propositions classified as indicative of memory at Test 2. Thus, children's memory performance at delayed-recall Test 1, whether expressed nonverbally or verbally, was related to their memory performance at delayed-recall Test 2. Nonverbal and verbal indices of memory also contributed unique variance in predicting verbal expression of memory at delayed-recall Test 2. The proportions of individual target actions and pairs of actions in the target order produced at Test 1 predicted 15% and 11% of the variance in Test 2 production of propositions classified as mnemonic, respectively. With the addition of verbal memory performance from Test 1, the proportions of variance accounted for increased to 26% and 24%, respectively, Fs(2, 37) > 5.80, ps < .01. Verbal expression of memory at Test 1 also predicted additional variance beyond that contributed by age at delayed-recall Test 2: Age alone predicted 20% of the variance; the addition of Test 1 verbal expression of memory increased the proportion of variance accounted for to 31%, $F(2, 37) = 8.45$, $p < .001$.

The cross-lag relations between verbal performance at Tests 1 and 2 were unique to memory: Children's non-memory verbalizations at delayed-recall Test 1 were not predictive of verbal expression of memory at Test 2. Unlike at Test 1, where overall concurrent verbal fluency was related to verbal mnemonic expression, at Test 2, none of the correlations between verbal memory performance and production of propositions classified in the seven categories of verbal non-memory performance even approached significance. Thus, the only delayed-recall Test 1 verbalizations related to verbal expression of memory at delayed-recall Test 2 were mnemonic verbalizations; concurrent verbal memory and nonmemory performance were unrelated.

Summary and Conclusions

Of major concern in the present research was the question of later accessibility, particularly

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

verbal, of early memories. We found that children exposed to specific events at the ages of 16 and 20 months subsequently demonstrated recall of them after delays of 6 and 12 months. Nonverbally, they evidenced memory for events that they had imitated, as well as for events that they had only watched. Their success at nonverbal expression of memory was related only to their age at the time of test. Through their spontaneous verbal productions, the children evidenced memory for events that they had imitated one time, before imposition of the 6- or 12-month delay; they did not provide verbal evidence of memory for events that they had only watched. Rather than with their age at the time of test, verbal expression of memory was related to what we might regard as measures of overall concurrent verbal fluency (e.g., total number of propositions). Nonverbal and verbal expressions of memory were not correlated with one another. That children evidenced any kind of memory for the events after the 12 month delay is itself remarkable. That children of 22 to 32 months spontaneously used language to "comment" on their previous experiences also is noteworthy; children in this age range typically respond to memory questions by providing mnemonic content, but they are not known for initiating talk about the past.

When tested for memory for the target events an average of 11 months later (range 6 to 17 months), at the age of 3 years, the children no longer provided nonverbal evidence of recall. Although their performance on events that they previously had experienced was high, it was not greater than on events that the children had not previously experienced. On the new events, the children apparently were able to use the verbal information provided by the experimenter (information intended to serve as a reminder of previously experienced events) to figure out how to produce the events, even though they had no prior experience with them. This result was not totally unexpected: The sequences were designed to be age appropriate when the children were 16 and 20 months of age; they were not engineered with the more advanced problem solving skills of 3-year-olds in mind.

That children's undifferentiated nonverbal performance on "old" and "new" events at Test 2 should not be attributed to their having forgotten them is evidenced by their verbal memory performance: Children who had been 20 months at the time of exposure to the events provided verbal evidence of memory for them at the age of 3 years; children who had been 16 months at the time of exposure did not provide verbal evidence of memory. Critically, it is unlikely that the differential age effect actually should be attributed to age at the time of encoding: Age at encoding was not related to nonverbal or verbal expression of memory at Test 1 or to verbal mnemonic expression at Test 2. More likely, it is an effect of the children's age at the time of the first delayed-recall test. As is easily derived from Table 1, at delayed-recall Test 1, the average age of children 16 months at the time of initial exposure was roughly 25 months; the average age of children 20 months at the time of initial exposure was roughly 29 months. Thus, at delayed-recall Test 1, the children enrolled at 20 months were older than those enrolled at 16 months. Age at the time of Test 1 was modestly, though not significantly, correlated with verbal mnemonic expression at Test 2. It also is the case that the average delay between tests was longer for children enrolled at 16 than for children enrolled at 20 months (roughly 12 and 9 months, respectively). Although the lack of correlation between the length of the second delay interval and verbal expression of memory would suggest otherwise, $r(38) = -.13$, differential delay may have contributed to the effect.

In contrast to delayed-recall Test 1, when verbal expression of memory was related to measures of overall concurrent verbal fluency, at delayed-recall Test 2, none of the correlations between concurrent measures of the number of propositions produced in the nonmemory verbal categories and the number in the verbal mnemonic category was significant. What is more, none of the cross-lag correlations reached significance either. This difference may be attributable to the different conditions of testing: At Test 1, verbalizations were spontaneous, whereas at Test 2, they were explicitly encouraged. Rather than by overall verbal fluency, that which predicted

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

verbal expression of memory at delayed-recall Test 2 was children's age at the time of the test and their previous nonverbal and verbal expressions of memory. The correlations with previous mnemonic expression suggest that a solid representational foundation, as indexed by higher levels of recall at Test 1, is important to maintenance of memory for an event over a longer period of time. That verbal expression of memory at Test 1 predicted unique variance, above that contributed by the other measures alone, suggests that an additional ingredient in the maintenance of verbal accessibility is previous verbal mnemonic expression.

Implications

Although our results were obtained within the confines of a laboratory task in which children were exposed to relatively mundane events, we believe that they have implications for issues of the long-term retention and expression of memory for traumatic events. One direct implication is that they demonstrate that children who were quite young at the time of exposure to events can remember them over long periods. After as much as 1 year, children who were only 16 and 20 months of age at the time of exposure to events evidenced memory for them. The present is not the first report of long-term retention by children in the 1- to 2-year range (Bauer et al., 1994; Hudson & Sheffield, 1995; McDonough & Mandler, 1994; Meltzoff, 1995). It is, however, the first evidence of retention of multi-step sequences over a delay interval of up to a year, in a study originally designed to test retention over such a long term. Maintenance of information over as many as 12 months makes clear that, although storage failures may be more prevalent in younger than in older children (see Howe & Courage, 1997, for discussion), they are not inevitable.

It also is notable that in this research the children remembered a number of unique events and that the test materials varied in length and in the type of temporal relation that connected the individual elements to one another. Thus, in addition to demonstration of recall over longer retention intervals than previously tested, the research substantially increases the generalizability of findings of long-term memory for specific past events. Moreover, that the target events were multi-step sequences is significant in evaluation of the mnemonic processes underlying the children's nonverbal behavior. Adults suffering from amnesia, in whom recall processes are disrupted, are unable to reliably reproduce age-appropriate, multi-step sequences (McDonough et al., 1995). This lends support to the argument that recall, rather than some nondeclarative process, is responsible for performance on the elicited-imitation task. All of these factors increase our confidence in the conclusion that children in the 1- to 2-year range are able to construct memories of specific events that endure and are accessible over time. The present findings thus lend considerable credibility to claims that young children are, in principle, capable of remembering the experiences of their lives.

A second implication of the present results is that memories likely encoded without language can, nevertheless, later be accessible to verbal report. Bauer and Wewerka (1995) provided evidence of this apparent possibility: We found that productive vocabulary at the time of experience of an event predicted 26% of the variance in later spontaneous verbal expression of memory. In the present research, we found a weaker relation between language ability at the time of experience and subsequent verbal expression: Productive vocabulary at the time of encoding was not correlated with verbal mnemonic expression at Test 1. Thus, children with little to no command over the verbal medium, as measured by parental report of productive vocabulary, nevertheless were able to verbally comment on their experiences. The reason for the different patterns of results in the two investigations is not clear, but compression in the range of productive vocabulary sampled is a likely explanation. The 13-month-olds who represented the negative end of the distribution in Bauer and Wewerka (average vocabulary of 13 words) were not included in the present sample. Conversely, whereas in Bauer and Wewerka, the 20-month-olds who represented the positive

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

end of the distribution had an average vocabulary of 178 words, in the present sample, the mean was 128 words. Regardless of the reason for the differential estimate of the proportion of variance in subsequent verbal expression of memory accounted for by verbal ability at the time of experience, the message is the same: Children who likely encoded events without the benefit of language are capable of subsequent verbal mnemonic expression of them.

Even as we proclaim their relevance to conceptualizations of memory for traumatic events by pre- and early-verbal children, we note cautions in extension of our results. After considering two potential limitations of the generalizability of our findings, we identify three factors that distinguish traumatic from nontraumatic events and then discuss their potential influences on memory. One important consideration in extension of the current findings is whether the events remembered by our young participants were autobiographical. Almost by definition, traumatic experiences are highly personally relevant. Consequently, memories for them are autobiographical; whether of an event observed (e.g., a child witnessing violence) or an event directly experienced (e.g., a child subjected to violence), they are memories that involve the self as experiencing agent (Brewer, 1986). In contrast, it is not clear that the memories that our young children had of, for example, how to make a gong, had a self component. They are episodic memories, but not necessary autobiographical ones. Consistent with this classification, we note that the children's verbal reports lacked some of the features typically associated with autobiographical memories. For example, the children typically did not overtly proclaim their familiarity with the context or the events. With a few exceptions, they did not use evaluative statements to convey the personal meaning that the events had for them. In short, the children did not use their language to "tell the story" of an autobiographical experience (e.g., Fivush, Haden, & Adam, 1995). That the children's reports lacked elements characteristic of autobiographical accounts can, of course, be attributed at least in part to the nature of the events themselves—a good explanation of how to *make a gong* does not have much room for autobiographical embellishment. The children's accounts also were produced without the aid of a partner who, as many parents do for early autobiographical reports (e.g., Fivush et al., 1995), participated in the co-construction of a narrative about the events. Nevertheless, it remains the case that their verbal reports lacked certain of the qualities typically present in those of more personally meaningful experiences.

Whether children who were only 16 and 20 months of age at the time of an experience even possess the capacity to construct personally relevant memories is not at all clear. Howe and Courage (1993, 1997), for example, have suggested that memories, be they of potentially self-relevant experiences or not, cannot take on personal significance in the absence of a cognitive self or concept of "me" as an object of knowledge. In other words, in the absence of a self for whom experiences are relevant, there can be no "auto" in the "biography." Eighteen to 24 months of age, a time by which the majority of infants recognize themselves in the mirror, has been suggested as the youngest age at which experiences might be encoded as being personally relevant and therefore, potentially autobiographical (Howe & Courage, 1993, 1997). By this metric, many of our 16- and 20-months-olds would not have been capable of forming autobiographical memories because they would not have had a sufficiently well developed cognitive self.

The issue of the role of a cognitive self in the construction of personal or autobiographical memories is more than academic; it concerns children such as Audrey who experienced trauma early in life (i.e., at 12 months; Gaensbauer et al., 1995). The logical extension of the argument is that, even though the event that she experienced had great personal relevance for her, Audrey would not have a "personalized" memory for it because she would have lacked the necessary cognitive frame of reference. However, based on the results of the present research, we might speculate that once she had achieved the requisite understanding of self, Audrey would have had

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

the potential to recode her early experience with reference to the new concept. That is, just as preverbal memories can be recoded or translated into verbal form once language is available, so might early episodic memories be recognized for their relevance to self once the requisite concept is available. As in the case of language, recognition of personal relevance might be dependent upon reinstatement of memory for the early experience. Given that environmental stimuli such as loud noises were described as eliciting trauma-related responses in Audrey, reinstatement of the memory, or at least fragments thereof, may have occurred.

The extent to which reinstatement of early memories and their subsequent translation into verbal format is dependent upon contextual support is the second important consideration in application of the results of the present research to questions of the accessibility of memories of early traumatic experiences. Rarely is the precise context reexperienced; we do not know the amount of contextual overlap necessary for reinstatement. This issue is nontrivial because unless the memory is reinstated, there will not be a time at which the memory and the language to describe it are available simultaneously. For older children and adults, verbal reminders often serve as the impetus for memory trace reinstatement. However, because preverbal memories were encoded without language, alone, verbal prompts and reminders (e.g., "Tell me about the time . . .") may not be useful in retrieving them. Retrieval cues may be effective only to the extent that they overlap with information in memory (Tulving & Thomson, 1973). Reexperience of the context in which an event occurred may be one of the few means by which children are afforded the opportunity to verbally redescribe preverbal memories.

That in the one case children reexperienced the context in which the to-be-recalled events occurred whereas in the other they did not may account at least in part for the differential findings in Peterson and Rideout (1998) as compared to the present research. Based on interviews with children who had undergone emergency room treatment for traumatic injuries at 13 to 35 months, Peterson and Rideout concluded that, for experiences prior to 18 months, subsequent verbal accessibility was unlikely. That is, even after they had gained the verbal fluency necessary to talk about their experiences, when subsequently interviewed about them in their homes, children 18 months of age and younger at the time of their experiences were unable to verbally describe them. In contrast, we found that at 22 to 32 months, concurrent verbal fluency, rather than age at the time of experience, determined whether an event would be verbally described. Moreover, maintenance of verbal accessibility over a subsequent period of several months was related to previous expression of memory, either nonverbal or verbal; nonverbal and verbal indices of memory contributed unique variance. We speculate that the apparent attachment of linguistic tokens to preverbal memories that we observed in this research occurred because the contextual support provided by the same room, the same experimenter, and the familiar props effectively reinstated the children's memories for the events, an experience that language alone is unlikely to accomplish.

We readily acknowledge that differential conditions of testing were not all that separated the circumstances of Peterson and Rideout (1998) from those of the present research. Whether understood in cognitive terms or not (i.e., whether referenced to a cognitive self), the traumatic injuries studied in Peterson and Rideout had immediate personal relevance for the children who experienced them; the events experienced by our children likely did not. In addition, traumatic and nontraumatic experiences are likely to differ in the levels of stress associated with them and in their distinctiveness. We discuss each of these potential influences on memory in turn.

First, it is clear that events in which young children are involved are better remembered by them, relative to events that they only witness. For example, active involvement has been shown to result in greater resistance to suggestion (Rudy & Goodman, 1991) and in more exhaustive recall (Baker–Ward, Hess, & Flannagan, 1990); effects of involvement are particularly pronounced in young children (Rudy & Goodman, 1991). A good illustra-

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

tion was provided in the present research. Although at the first delayed-recall test, children verbally reported on events that they had imitated, they did not provide verbal reports on events that they had only watched. The difference in verbal accessibility of events imitated and watched was particularly apparent for the 16-month-olds. In previous research, we interpreted differences in levels of recall of events imitated versus watched in terms of the more elaborative encoding afforded by active participation (e.g., Bauer et al., 1995). However, it seems reasonable to suggest that superior memory associated with participation also might be the result of a more general tendency to differentially attend to and recall material that is relevant to one's self. Thus, we might expect that anytime "self" is engaged or involved in an event, whether as an active participant or, as in the case of Audrey, as a witness to a violent episode involving a primary attachment figure, greater attention to and elaborative encoding of the event might result. By virtue of their self relevance then (again, whether referenced to a cognitive self or not), we might expect traumatic experiences to be well remembered.

Expectation of superior memory for self-relevant material could perhaps be translated into a methodology for investigating the possible occurrence of trauma or abuse. As illustrated in the domain of gender, the imitation task used in the present research is sensitive to differences in recall of self-consistent and self-inconsistent events. At the age of 25 months, boys differentially imitate event sequences depicting masculine activities such as *shaving* and *building a garage* relative to feminine activities such as *diapering* and *making breakfast* (Bauer, 1993). Although girls show equivalent memory for different event types, under conditions of explicit gender labeling of the activities as "for girls" and "for boys," they too appear to exhibit the pattern (Sen & Bauer, work in progress). In older children, asymmetrical memory effects are more apparent in children for whom gender is a highly salient construct (e.g., Carter & Levy, 1988). In addition, children demonstrate better memory for familiar than for unfamiliar events (see Bauer, 1995, 1996, for reviews). Together, these findings suggest a methodology involving examination of relative levels of imitation of schematic representations of potentially self-relevant abusive or traumatic versus neutral events. That "play" with props designed to suggest particular scenarios could be used diagnostically (as well as therapeutically) is of course not a novel suggestion. Potential advantages of the methodology just outlined are that it provides an opportunity to more objectively quantify the behavior as well as to elicit it more or less "on demand." Thus, differential imitation presents itself as a potentially useful tool for investigating the possible occurrence of abuse or trauma.

One of the things that makes an experience traumatic is the stress, be it physical or psychological, that it places on the organism. By definition, nontraumatic events are considerably less stressful. Differential levels of stress associated with traumatic and nontraumatic events thus are a second potential source of variance in memory for them. The source is particularly viable because one of the neural structures involved in memory, namely, the hippocampus, is one of the targets of the physiological stress response (see Howe, 1998 and Nelson & Carver, 1998, for discussions). Consistent with the expectation of a relation between stress and memory, as reviewed in Fivush (1998), in general, there seems to be a facilitating effect of stress on recall of particular events (e.g., Bahrick, Parker, Merritt, & Fivush, in press; Goodman, Hirschman, Hepps, & Rudy, 1991; Ornstein, Gordon, & Laurus, 1992). Thus, there is reason to expect that memory for a single stressful or traumatic event, such as experienced by Audrey, would be as good or better than memory for a more mundane event. In contrast, there is increasing speculation and mounting evidence that chronic or prolonged stress may result in damage to hippocampal neurons and thus, have a negative impact on memory. As discussed in Nelson and Carver (1998), neural images of adult survivors of childhood abuse have revealed reduced left hippocampal volume (Bremner et al., 1997) and deficits in verbal short-term memory (Bremner et al., 1995). Thus, although the stress associated with a

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

single traumatic experience may have an enhancing effect on memory for it, repeated or chronic stress, such as would be expected to occur in situations of repeated trauma or chronic abuse, may lead to generalized deficits in memory performance.

Consideration of the frequency and duration of exposure to stress leads to the third potential influence on memory, namely, the distinctiveness of the event, or the extent to which it shares features with other events. Traumatic and nontraumatic experiences differ in their degree of distinctiveness. Whether we are talking about a unique trauma, such as experienced by Audrey, or repeated trauma, such as would be experienced by a child subjected to chronic abuse, the event stands out from the routines of everyday life. Their distinctive nature would be expected to render traumatic or abusive experiences particularly memorable (see also Howe, 1998). Consistent with this expectation, in the preschool years, even a single experience of a unique event such as a trip to Disneyworld is sufficient for accurate and enduring memory of it (e.g., Hamond & Fivush, 1991).

Particularly for very young children, the sword of distinctiveness may have another edge, however. To the extent that an event is distinctive, there may be little in the arsenal of experience from which to generalize in order to construct a coherent representation of it. Generally speaking, accuracy in event memory is dependent upon a well-organized event representation (see Bauer, 1996, for a review). For older children, construction of a well organized representation of a distinctive event, such as a trip to Disney World, may be facilitated by familiarity with components of the experience: Long before they actually visit the theme park, children in Western culture are exposed to Mickey Mouse and Donald Duck; they likely also have had at least passing experience with such features as rides and food concessions. Moreover, the talk in which children and parents engage prior to, during, and/or after an event works to organize, integrate, and, thereby, facilitate children's memory for it; effects of event comprehension on memory are apparent for nontraumatic (e.g., a trip to a museum: Tessler & Nelson, 1994) as well as traumatic (e.g., a painful medical procedure: Goodman, Quas, Batterman–Faunce, Riddlesberger, & Kuhn, 1994) experiences. Thus, although in general, one experience may be sufficient for accurate recall, we may speculate that single experiences of events that are highly distinctive and for which children have no frames of reference may be poorly organized in memory and as a result, not readily or accurately recalled. This may be particularly likely in the case of young children in whom encoding processes may be slower and storage failures more prevalent. Indeed, the decision in the present research to provide three exposure sessions was based on the results of Bauer et al. (1995) in which we found that, after a 1-month delay, for events experienced only once, children 15 months of age exhibited significant forgetting. In contrast, the children exhibited robust retention of events experienced three times.

In conclusion, although our results were obtained in the context of research on pre- and early verbal children's memory for controlled laboratory events, we believe that they can inform expectations regarding children's memory for traumatic experiences. They suggest that material initially encoded without the benefit of a particular tool such as language, may, once the tool becomes available, be recoded using it. We speculate that in like manner, memories originally encoded without regard to a particular construct such as the cognitive self may subsequently be referenced to it. Processes of recoding and "retro-referencing" likely are facilitated by reinstatement of memory such as might occur were the event context to be re-experienced. By virtue of their self relevance, traumatic experiences would be expected to be well remembered. Documented differential memory for self-schema consistent versus inconsistent material has been observed in children as young as 25 months of age and presents itself as a viable candidate methodology for examining possibly traumatic or abusive experiences in pre- and early verbal children. Based on the results of a growing literature with preschool-age and older children, we suggest that the stress associated with a traumatic experience would have a neutral or enhancing effect on memory for

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

it. In contrast, repeated or chronic stress may lead to generalized deficits in memory performance. Finally, whereas in general, a single experience of an event may be sufficient to support accurate recall of it, it is likely that memory for highly distinctive events for which children have no frame of reference would be less readily or accurately recalled. This may be particularly true for young children in whom encoding processes may be slower and storage failures more prevalent.

References

Bahrick, L., Parker, J., Merritt, K., & Fivush, R. (in press). Children's memory for Hurricane Andrew. *Journal of Experimental Psychology: Applied.*

Baker–Ward, L., Hess, T. M., & Flannagan, D. A. (1990). The effects of involvement on children's memory for events. *Cognitive Development, 5*, 55–70.

Bauer, P. J. (1992). Holding it all together: How enabling relations facilitate young children's event recall. *Cognitive Development, 7*, 1–28.

Bauer, P. J. (1993). Memory for gender-consistent and gender-inconsistent event sequences by twenty-five-month-old children. *Child Development, 64*, 285–297.

Bauer, P. J. (1995). Recalling past events: From infancy to early childhood. *Annals of Child Development, 11*, 25–71.

Bauer, P. J. (1996). What do infants recall of their lives? Memory for specific events by 1- to 2-year-olds. *American Psychologist, 51*, 29–41.

Bauer, P. J. (1997). Development of memory in early childhood. In N. Cowan (Ed.), *The development of memory in childhood* (pp. 83–111). Sussex, United Kingdom: Psychology Press.

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

Bauer, P. J., Hertsgaard, L. A., & Dow, G. A. (1994). After 8 months have passed: Long-term recall of events by 1- to 2-year-old children. *Memory, 2*, 353–382.

Bauer, P. J., Hertsgaard, L. A., Dropik, P., & Daly, B. P. (1998). When even arbitrary order becomes important: Developments in reliable temporal sequencing of arbitrarily ordered events. *Memory, 6*, 165–198.

Bauer, P. J., Hertsgaard, L. A., & Wewerka, S. S. (1995). Effects of experience and reminding on long-term recall in infancy: Remembering not to forget. *Journal of Experimental Child Psychology, 59*, 260–298.

Bauer, P. J., Schwade, J. A., Wewerka, S. S., & Delaney, K. (1997). *Planning ahead: Goal-directed problem solving by two-year-olds*. Manuscript submitted for publication.

Bauer, P. J., & Wewerka, S. S. (1995). One- to two-year-olds' recall of events: The more expressed, the more impressed. *Journal of Experimental Child Psychology, 59*, 475–496.

Bauer, P. J., & Wewerka, S. S. (1997). Saying is revealing: Verbal expression of event memory in the transition from infancy to early childhood. In P. van den Broek, P.J. Bauer, & T. Bourg (Eds.), *Developmental spans in event comprehension and representation: Bridging fictional and actual events* (pp. 139–168). Mahwah, NJ: Erlbaum.

Bremner, J. D., Randall, P., Scott, T. M., Capelli, S., Delaney, R., McCarthy, G., & Charney, D. S. (1995). Deficits in short-term memory in adult survivors of childhood abuse. *Psychiatry Research, 59*, 97–107.

Bremner, J. D., Randall, P., Vermetter, E., Staib, L., Bronen, R. A., Mazure, C., Capelli, S., McCarthy, G., Innis, R. B., & Charney, D. S. (1997). Magnetic resonance imaging-based measurement of hippocampal volume in posttraumatic stress disorder related to childhood physical and sexual abuse—A preliminary report. *Biological Psychiatry, 41*, 23–32.

Brewer, W. F. (1986). What is autobiographical memory? In D. C. Rubin (Ed.), *Autobiographical memory* (pp. 25–49). New York: Cambridge University Press.

Carter, D. B., & Levy, G. D. (1988). Cognitive aspects of early sex-role development: The influence of gender schemas on preschoolers' memories and preferences for sex-typed toys and activities. *Child Development, 59*, 782–792.

Eisenberg, A. R. (1985). Learning to describe past experiences in conversation. *Discourse Processes, 8*, 177–204.

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. J., & Pethick, S. J. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development, 59*(5).

Fivush, R. (1991). The social construction of personal narratives. *Merrill–Palmer Quarterly, 37*, 59–81.

Fivush, R. (1998). Children's recollections of traumatic and nontraumatic events. *Development and Psychopathology, 10*, 699–726.

Fivush, R., Gray, J. T., & Fromhoff, F. A. (1987). Two-year-olds talk about the past. *Cognitive Development, 2*, 393–410.

Fivush, R., Haden, C. A., & Adam, S. (1995). Preschoolers' developing narrative structure: Implications for childhood amnesia. *Journal of Experimental Child Psychology, 60*, 32–56.

Fivush, R., Pipe, M-E., Murachver, T., & Reese, E. (in press). Events spoken and unspoken: Implications of language and memory development for the recovered memory debate. In M. Conway (Ed.), *False and recovered memories*. London: Oxford.

Gaensbauer, T., Chatoor, I., Drell, M., Siegel, D., & Zeanah, C. H. (1995). Traumatic loss in a one-year-old girl. *Journal of American Academy of Child and Adolescent Psychiatry, 34*, 520–528.

Goodman, G. S., Hirschman, J. E., Hepps, D., & Rudy, L. (1991). Children's memory for stressful events. *Merrill-Palmer Quarterly, 37*, 109–158.

Goodman, G. S., Quas, J. A., Batterman–Faunce, J. M., Riddlesberger, M. M., & Kuhn, J. (1994). Predictors of accurate and inaccurate memories of traumatic events experienced in childhood. *Consciousness and Cognition, 3*, 269–295.

Hamond, N. R., & Fivush, R. (1991). Memories of

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press

Mickey Mouse: Young children recount their trip to Disneyworld. *Cognitive Development*, *6*, 433–448.
Howe, M. L. (1998). Individual differences in factors that modulate storage and retrieval of traumatic memories. *Development and Psychopathology*, *10*, 681–698.
Howe, M. L., & Courage, M. L. (1993). On resolving the enigma of infantile amnesia. *Psychological Bulletin*, *113*, 305–326.
Howe, M. L., & Courage, M. L. (1997). The emergence and early development of autobiographical memory. *Psychological Review*, *104*, 499–523.
Hudson, J. A. (1990). The emergence of autobiographical memory in mother–child conversation. In R. Fivush & J. A. Hudson (Eds.), *Knowing and remembering in young children* (pp. 166–196). Cambridge: Cambridge University Press.
Hudson, J. A., & Sheffield, E. (1995, July). *Extending young children's event memory: Effects of reminders on 16- to 24-month-olds' long-term recall*. Paper presented at the American Psychological Society, New York, NY.
Mandler, J. M. (1990). Recall of events by preverbal children. In A. Diamond (Ed.), *The development and neural bases of higher cognitive functions* (pp. 485–516). New York: New York Academy of Science.
McDonough, L., & Mandler, J. M. (1994). Very long-term recall in infants: Infantile amnesia reconsidered. *Memory*, *2*, 339–352.
McDonough, L., Mandler, J. M., McKee, R. D., & Squire, L. R. (1995). The deferred imitation task as a nonverbal measure of declarative memory. *Proceedings of the National Academy of Sciences*, *92*, 7580–7584.
Meltzoff, A. N. (1995). What infant memory tells us about infantile amnesia: Long-term recall and deferred imitation. *Journal of Experimental Child Psychology*, *59*, 497–515.
Myers, N. A., Clifton, R. K., & Clarkson, M. G. (1987). When they were very young: Almost-threes remember two years ago. *Infant Behavior and Development*, *10*, 123–132.
Neisser, U. (1962). Cultural and cognitive discontinuity. In T. E. Gladwin & W. Sturtevant (Eds.), *Anthropology and human behavior* (pp. 54–71). Washington, DC: Anthropological Society of Washington.
Neisser, U. (1988). Five kinds of self-knowledge. *Philosophical Psychology*, *1*, 35–59.
Nelson, C. A., & Carver, L. J. (1998). The effects of stress on brain and memory: A view from developmental cognitive neuroscience. *Development and Psychopathology*, *10*, 793–809.
Nelson, K., & Ross, G. (1980). The generalities and specifics of long-term memory in infants and young children. In M. Perlmutter (Ed.), *New directions for child development—Children's memory* (pp. 87–101). San Francisco: Jossey–Bass.
Ornstein, P. A., Gordon, B., & Laurus, D. (1992). Children's memory for a personally experienced event: Implications for testimony. *Applied Cognitive Psychology*, *6*, 49–60.
Peterson, C., & McCabe, A. (1983). *Developmental psycholinguistics: Three ways of looking at a child's narrative*. New York: Plenum.
Peterson, C., & McCabe, A. (1992). Parental styles of narrative elicitation: Effect on children's narrative structure and content. *First Language*, *12*, 299–321.
Peterson, C., & Rideout, R. (1998). Memory for medical emergencies experienced by 1- and 2-year-olds. *Developmental Psychology*, *34*, 1059–1072.
Piaget, J. (1952). *The origins of intelligence in children.* New York: International Universities Press.
Rudy, L., & Goodman, G. S. (1991). Effects of participation on children's reports: Implications for children's testimony. *Developmental Psychology*, *27*, 527–538.
Sachs, J. (1983). Talking about the there and then: The emergence of displaced reference in parent-child discourse. In K. E. Nelson (Ed.), *Children's language* (Vol. 4, pp. 1–27). New York: Gardner Press.
Tessler, M., & Nelson, K. (1994). Making memories: The influence of joint encoding on later recall by young children. *Consciousness and Cognition*, *3*, 307–326.
Todd, C. M., & Perlmutter, M. (1980). Reality recalled by preschool children. In M. Perlmutter (Ed.), *New directions for child development—Children's memory* (pp. 69–85). San Francisco: Jossey–Bass.
Travis, L. L. (1997). Goal-based organization of event memory in toddlers. In P. van den Broek, P.J. Bauer, & T. Bourg (Eds.), *Developmental spans in event comprehension and representation: Bridging fictional and actual events* (pp. 111–138). Mahwah, NJ: Erlbaum.
Tulving, E., & Thomson, D. M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review*, *80*, 352–373.
van den Broek, P. W. (1997). Discovering the cement of the universe: The development of event comprehension from childhood to adulthood. In P. van den Broek, P. J. Bauer, & T. Bourg (Eds.), *Developmental spans in event comprehension and representation: Bridging fictional and actual events* (pp. 321–342). Mahwah, NJ: Erlbaum.

https://doi.org/10.1017/S0954579498001801 Published online by Cambridge University Press