Memory for traumatic experiences in early childhood

Ingrid M. Cordón, a Margaret-Ellen Pipe, b Liat Sayfan, a Annika Melinder, c and Gail S. Goodman a,c,*

a University of California, Davis, CA, USA
b National Institute of Child Health and Human Development, USA
c University of Oslo, Norway

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Abstract

Traumatic experiences in early childhood raise important questions about memory development in general and about the durability and accessibility of memories for traumatic events in particular. We discuss memory for early childhood traumatic events, from a developmental perspective, focusing on those factors that may equally influence memories for both traumatic and non-traumatic events and those factors that may uniquely affect memories of traumatic events and possibly memory development generally. To obtain a more complete understanding of trauma-related memory, we draw on both the scientific and clinical literatures. These literatures indicate commonalities across memories for traumatic and non-traumatic events as well as potentially unique influences on trauma memory.

Keywords: Memory; Development; Trauma; Children; Infancy; Infantile amnesia

A 39-month-old child wakes up from a nap to find a stranger holding a gun on his mother. The child is then kidnapped and held for ransom (Terr, 1988). Traumatic events, such as the experience of this young child, raise important questions about memory development in general, and the durability and accessibility of memories for traumatic events in particular. Will this young child, for example, be able to recall this traumatic event in the years to come? Are traumatic events more
memorable than non-traumatic events? What factors affect memory for traumatic events, particularly when these occur in early childhood? What are some of the long-term consequences for later memory development? These questions have been intensely debated for decades. In the following pages, we examine memory for traumatic events, specifically from a developmental perspective, focusing on the question of how early memory for trauma differs from memory more generally.

Our approach is, first, to lay some groundwork by discussing such basic issues as the development of memory systems (i.e., explicit versus implicit memory), the definition of trauma, and research based on distress and memory, keeping in mind that the relation between trauma and memory may differ from that between “mere” distress and memory. We next consider the extant research on trauma and memory in infancy and early childhood, and in turn, explore the question of whether early traumatic memories are special. Specifically, are there factors specific to traumatic events that cannot be accounted for by the same mechanisms involved in memory for non-traumatic events? To examine this issue, we will consider both perspectives, that is, research indicating that the variables known to influence memory for non-traumatic events also influence memory for traumatic events, as well research suggesting that memory for trauma does indeed differ from memory for non-traumatic events. Finally, we consider the mental health and neurobiological correlates of early trauma and how such correlates may underlie the relation between trauma and memory in young children.

Memory systems and trauma: Definitions

Explicit versus implicit memory systems

Before discussing early memory for traumatic events, we must consider what we mean by “memory.” Several researchers have proposed that memory is not a unitary process, but rather, consists of multiple interacting systems, which differentially contribute to our ability to store and recall information (e.g., Moscovitch, 1994; Pillemer & White, 1989; Schacter, 1987, 1993; Tulving, 1985; Tulving & Markowitsch, 1998; see Roediger III, Buckner, & McDermott, 1999, for review). To the extent that this is an accurate characterization of memory, early trauma might differentially affect each memory system.

There is considerable debate, however, about whether different memory systems exist, and if so, the course of their development. Of particular relevance to the present discussion, the different systems underlying explicit and implicit memory are also often assumed to have different developmental trajectories (e.g., Moscovitch, 1985; Nelson, 1995; Perner, 2000). The infant is presumed to start out with a “primitive” implicit (or non-declarative) memory system, serving a kind of memory that occurs in the absence of specific directions or attempts to remember, usually without conscious awareness (e.g., Nelson, 1995). This “early” memory system, which is functional at or soon after birth, is distinguished from a “late” memory system, which develops over the first few years of life as a function of neurological (Nelson,
cognitive (Howe & Courage, 1993, 1997; Perner & Ruffman, 1995), and/or sociolinguistic developments (see Nelson, 1993; Pillemmer & White, 1989; Reese & Fivush, 1993; Reese, Haden, & Fivush, 1993). The late memory system is often assumed to develop into a more adult-like explicit or conscious form of memory associated with deliberate remembering.

An alternative perspective is that memory is a unitary process, that explicit and implicit forms of memory are both functional early in infancy (Adler, Gerhardstein, & Rovee-Collier, 1998; Howe, 2000; Rovee-Collier, 1997; Rovee-Collier, Hayne, & Colombo, 2001). Indeed, the basic processes for learning and memory are in place and functioning at or even before birth (DeCasper, Lecanuet, Busnel, Granier-Deferre, & Maugeais, 1994; DeCasper & Spence, 1986; Howe & Courage, 1993, 1997). Further, Rovee-Collier (1997) has recently argued that the kinds of memory dissociations observed in normal adults and amnesics, for tasks that tap implicit and explicit memory, can also be observed in preverbal infants’ performance in the mobile conjugate reinforcement paradigm. Rovee-Collier and colleagues conclude that if there are indeed two systems that mediate memory, both are present from a very early age (see Rovee-Collier & Hayne, 2000; Rovee-Collier et al., 2001; see also Perner, 2000).

A major point at issue in the infancy literature concerns the interpretation of early non-verbal demonstrations of memory as evidence of explicit memory and, in turn, episodic memories located in time and space. Although verbal recall provides the least ambiguous evidence of explicit memory (Parkin, 1993), few would argue that it is the only evidence (e.g., Bauer, 1995; Bauer, Hertsgaard, & Dow, 1994; Meltzoff, 1995). Nor is explicit memory, whether it is assessed verbally or non-verbally, the only form of memory with which we should be concerned in our discussion of memory and trauma in early childhood. Although what we know about memory in everyday contexts has been focused almost exclusively on explicit memory (Anooshian, 1998), to quote Graf and Masson (1993), “…explicit memory is only a small part—the conscious tip of the iceberg—of how memory for recent events and experiences influences us in our daily lives. The submerged and much larger part of the iceberg is the domain of implicit memory” (p. 8). We have little idea of the extent of the “submerged” part of the iceberg, with respect to memory for trauma specifically, although good reason to think that it is likely to be far from negligible (e.g., Brewin, Dalgleish, & Joseph, 1996; Gaensbauer, 1995, 2002). Evidence for non-verbal indicators of trauma memory, however, must be considered cautiously, given the difficulty of establishing that they are, indeed, the direct result of trauma, and the lack of appropriate control conditions in studies to date. Nonetheless, we believe it is important to remain open to the possibility that non-verbal indicators of memory for trauma may be evident even in the absence of verbal recall.

We, therefore, include in our review laboratory, field, and clinical studies that pertain to both verbal and non-verbal (e.g., physiological or behavioral responses and preferences) indicators of trauma memory, which may arise without conscious recall of the events giving rise to these reactions. This distinction does not correspond perfectly to the explicit–implicit, declarative–non-declarative distinctions made in the literature, although there is considerable overlap. Nonetheless, given the dearth of
research on non-verbal, perhaps implicit, memory for real-world events, traumatic or otherwise, it is useful to begin with this broader distinction.

**What constitutes a traumatic experience?**

One of the difficulties in studying trauma and memory not only relates to how one characterizes memory, but also to how one characterizes trauma. At present, there is a lack of a clear, generally accepted definition of what constitutes a traumatic experience. Trauma has been variously described as an experience that: (1) threatens the health and well-being of an individual (Brewin et al., 1996); (2) creates an overwhelming fear that oneself or a loved one is about to suffer severe injury or death (American Psychiatric Association, 1994); (3) overloads an individual’s coping mechanisms (van der Kolk & Fisler, 1995); (4) significantly disrupts the functioning of the individual (Cicchetti & Toth, 1997); (5) indicates that the world is an uncontrollable and unpredictable place (Foa, Zinbarg, & Rothbaum, 1992); and involves a stress that is particularly severe and exceeds normal or at least the specific individual’s resources for coping (Hubbard, Realmuto, Northwood, & Masten, 1995).

In their definition of trauma, Cicchetti and Toth (1997) emphasize the importance of interpretation. How, though, does an infant or young child interpret and understand a traumatic event? This is a particularly important question when considering the ways in which memories for traumatic experiences are encoded and later accessed. Encoding events in memory is dependent on experience and prior knowledge (e.g., Cordón, 2002; Ornstein, Shapiro, Clubb, Follmer, & Baker-Ward, 1997b), which, in turn, may lead to some memories being more elaborate, detailed, and durable than others (Schneider & Bjorklund, 1992). Although clearly limited, infants in the first year of life have expectations, can appraise events, and infer consequences based on acquired knowledge (Haith, Hazan, & Goodman, 1988; Stein & Liwag, 1997). Even limited prior knowledge may nonetheless affect the understanding and interpretation of traumatic events. On the one hand, potentially traumatic events may not be interpreted as such because of lack of knowledge (Pollak, Cicchetti, & Klorman, 1998; Saarni, 1999). On the other hand, lack of knowledge may make the child susceptible to misinterpretation, leading to increased distress (Steward, O’Connor, Acredolo, & Steward, 1996). Thus, the extent to which any particular event is perceived and experienced as traumatic may depend on the child’s level of acquired knowledge and experience at the time of the event.

**Stressful versus traumatic events**

Many recent studies have attempted to address questions concerning the relation between trauma and memory by examining young children’s memories of stressful, painful medical procedures (Goodman, Quas, Batterman-Faunce, Riddlesburger, & Kuhn, 1994, 1997; Ornstein, 1995; Quas et al., 1999), treatments for cancer (Steward, 1993; Steward et al., 1996), injuries (e.g., Howe, Courage, & Peterson, 1994; Peterson & Bell, 1996), or natural disasters (Fivush, McDermott Sales, Goldberg, Bahrick, & Parker, in press; Parker, Bahrick, Lundy, Fivush, & Levitt, 1998). An important
question arises concerning these studies: Are these experiences traumatic? Undoubtedly some of the children in these studies experienced trauma according to some of the definitions we have outlined. For other children, the experiences may be distressing or painful, but not traumatic.

We take the view that it is only by examining children’s memory in relation to a wide range of experiences that we can begin to understand the way in which cognitive, social, and individual-difference variables interact to determine children’s memories on a continuum of at one end neutral or mundane, and at the other traumatic. No single study can capture the complexity of the possible outcomes of trauma. Children experience trauma in relation to very different kinds of events; some traumatic experiences can be anticipated, as in cases of repeated abuse or ongoing medical treatments (e.g., Steward et al., 1996), whereas others (e.g., accidents, violence) cannot be anticipated. Anticipation and the opportunity to “prepare” for the trauma, however inadequate, are likely to contribute to the way in which the event is subsequently represented and maintained in memory (e.g., Goodman et al., 1994, 1997; Steward et al., 1996). Further, whereas some incidents leading to trauma may be experienced while the child is alone (e.g., sexual abuse), other traumas may be shared (e.g., natural disasters). If there is no such continuum but rather a disjunction for traumatic events, it is best seen in the context of a wide range of studies, including laboratory, field, and clinical studies. Thus, we draw heavily on these literatures in discussing young children’s memory for traumatic events. As we shall see, there are some remarkable consistencies in the findings based on research studies and clinical observations, and where there are differences, they are informative.

Memory and trauma: Infancy

Young infants have a remarkable ability to encode, store, and retain information for relatively long periods of time (e.g., Bauer et al., 1994; Hartshorn et al., 1998; McDonough & Mandler, 1994; Myers, Perris, & Speaker, 1994; Rovee-Collier, 1997; Rovee-Collier & Hayne, 2000). However, although we can see evidence of memory in one form or another from the first days of life (DeCasper & Fifer, 1980), significant developmental changes in memory also take place in the first year. A variety of procedures, such as the novelty preference and conditioning paradigms with younger infants, and imitation tasks with older infants, all show that the time frame of forgetting a novel experience changes significantly during infancy (see Rovee-Collier & Hayne, 2000, for review). Nonetheless, under some circumstances even very young infants are capable of long-term remembering (e.g., Hildreth, Sweeny, & Rovee-Collier, 2003; Rovee-Collier, Hartshorn, & DiRubbo, 1999; see also Hartshorn et al., 1998). Thus, while verbal recall of memories in narrative form awaits the emergence of language skills, socialization, and further cognitive development, infants can accumulate memories of their past, including memories of trauma.

In so far as remembering traumatic experiences is likely to have survival value, it would not be surprising if traumatic experiences were retained particularly well over
long delays (Christianson, 1992; Christianson & Lindholm, 1998). Further, in so far as traumatic experiences are likely to be highly distinctive, they may be particularly accessible to explicit memory under appropriate conditions (Bernstein, 2002; Howe, 1997). A critical question, therefore, is whether early traumatic memories are any more likely to traverse the infantile amnesia barrier than other memories.

Infantile amnesia for traumatic experiences

As far back as Freud (1966), psychologists have observed the intriguing phenomenon whereby our earliest experiences are not available for conscious verbal recall later in life. When adults are asked to recall their earliest memories, for example, their earliest memories are, on average, from about 3½ years of age, ranging from approximately 2–8 years of age (Dudycha & Dudycha, 1941; Sheingold & Tenney, 1982; Usher & Neisser, 1993; Waldfogel, 1948), a finding that has been observed cross-culturally (MacDonald, Uesiliana, & Hayne, 2000; Mullen, 1994). Infantile amnesia (or childhood amnesia) refers to this lack of conscious (explicit) memory for events in early childhood. Accounts of infantile amnesia have been proposed in terms of cognitive, neurological, linguistic, and social factors (Bauer & Wewerka, 1995; Drummey & Newcombe, 1995; Fivush, Haden, & Adam, 1995; Newcombe, Drummey, Fox, Lie, & Ottingo-Alberts, 2000; Reese et al., 1993; see X this volume). Although several of these factors may contribute to the inaccessibility of early memories, precisely how they do so is currently a matter of considerable debate (see Fivush, 1998a, 1998b, 2002; Harley & Reese, 1999; Howe & Courage, 1993, 1997; Nelson & Fivush, 2000; Reese & Fivush, 1993).

The difficulty in accessing early memories is not restricted to adulthood. Even in childhood we see evidence of amnesia for our earliest experiences, at least when memory is assessed verbally; children, like adults, have difficulty providing verbal narratives of experiences that occurred before the end of the second year of life. Simcock and Hayne (2002) provide compelling evidence for the accessibility of verbal, but not preverbal memories in very young children (see also Bauer & Wewerka, 1997). Even when children can remember early childhood events across short delays, after long delays these memories may no longer be consciously accessible. Pillemer and colleagues, for example, found that although both 3- and 4-year-old children provided some evidence that they remembered a fire alarm and associated activities after a 2-week delay, none of the children in the younger group were able to remember the incident 7 years later and only a subset of the children who were 4 years at the time of the original event remembered it (Pillemer, 1993; Pillemer, Picariello, & Pruett, 1994; see also Drummey & Newcombe, 1995).

There is little evidence that traumatic experiences are any more likely than nontraumatic experiences to traverse the infantile amnesia barrier. Research studies and clinical observations converge on the conclusion that stressful and traumatic events occurring prior to age 2 or 3 years are unlikely to be available for later conscious recall. For example, Howe et al. (1994) assessed children’s memories for emergency room experiences, following injuries such as lacerations, severe burns, and fractures. Children ranging in age from 18 months to 5 years were interviewed
within a few days of their experience and again 6 months later. Children younger than 30 months at the time of the injury recalled little at either interview, whereas children 30 months and older were able to report their experiences both immediately and 6 months after the injury. Similarly, Peterson and Rideout (1997) focused on a larger sample of children who had experienced injuries and emergency room treatment when they were between 12 and 33 months old. Children older than 27 months displayed impressive recall immediately after the injury as well as 2 years later. Children younger than 18 months at the time of injury, however, were unable to report their experiences either immediately or at delayed recall. Interestingly, Peterson and Rideout report that some children between 20 and 25 months, who were not able to provide a verbal report at the time of the experience, were able to recall their experiences 2 years later (cf. Simcock & Hayne, 2002). Quas and colleagues (1999) similarly examined children’s long-term memory for the invasive VCUG test, which occurred in early childhood. Children who experienced the VCUG test prior to 4 years of age were less likely to remember it than were children who were older than age 4 years at the time of the test. The responses of the younger children who did remember the procedure suggested that they mainly retained vague memories. In contrast, children 5 years and older generally showed clear memories of the procedure.

The clinical literature provides similar findings. Terr (1988), for example, examined verbal and behavioral indices of memory for 20 children with documented traumatic experiences (e.g., sexual abuse, evisceration, kidnapping, and dog bites) that occurred during or before their preschool years. When children were interviewed between 5 months and 12 years after their traumatic experiences, Terr found either no verbal memories or only fragmentary memories when the trauma occurred prior to 36 months of age. The youngest age of occurrence of trauma subsequently verbally recalled was 28 months, and the average age of occurrence of trauma that led to full verbal recall was 43 months. Thus, even highly traumatic events did not appear to be available for later explicit recall if the event occurred early in life.

Non-verbal (implicit) memory

From an adaptive perspective, memories of traumatic experiences would not necessarily need to be available for conscious verbal recall, but rather might be manifest as non-verbal, implicit memories. As Anooshian (1998) puts it “With implicit retrieval, memory for episodes can contribute to the earliest phases of the perception and interpretation of events, thereby allowing for rapid adaptation to local circumstances” (p. 35; see also Drummey & Newcombe, 1995). Anooshian (1999) also raises the possibility that implicit memories are more durable than explicit memories, arguing that there is evidence that performance on explicit memory tasks declines much more quickly across delays than performance on implicit memory tasks (Drummey & Newcombe, 1995; Mitchell & Brown, 1988; Naito, 1990; Sloman, Hayman, Ohta, Law, & Tulving, 1988). It is therefore possible that there are non-verbal indicators, reflecting implicit memory for experiences that occurred within the first 2
years of life. Both experimental and clinical studies suggest that, indeed, this may be the case.

Myers et al. (1994), for example, followed children over several years to assess their memory for a single experience that occurred at 10 or 14 months of age. Although there was virtually no evidence of explicit verbal recall, there was some evidence of behavioral memory of the event, in that children who had experienced the original event showed more interest in the objects used than did children who had not experienced the event.

Descriptions from the clinical literature also provide some evidence of implicit memories of early childhood trauma (see Paley & Alpert, 2003, for review). For example, Terr (1988) noted that all children, even those children who demonstrated no explicit memory or only fragmentary memory, demonstrated aspects of their trauma behaviorally (e.g., repetitive play, fears, and personality changes). Thus, although typical infantile amnesia effects were evident for memory of traumatic experiences assessed using verbal recall, non-verbal indicators were consistent with implicit memories of the trauma. Gaensbauer (1995) similarly reports that during play therapy, in which the children were provided with all the appropriate props and encouraged and guided by the therapist who knew what had occurred, most children could re-enact their trauma. However, the evidence for non-verbal memories appears to be dependent on context, and young children may be reliant on re-encountering events, places, and people for reactivating and accessing these memories (Fivush, Pipe, Murachver, & Reese, 1997; see Howe et al., 1994, for a case study example).

Summary

In summary, although infants and young children are capable of acquiring and retaining memories of past experiences, there is little evidence that even following the acquisition of language, children can provide narrative accounts of experiences, traumatic or otherwise, that occur in the first 2 years of life. Young children may show evidence of verbal recall of bits and pieces of past experiences that occurred between 18 and 30 months of age, but still have great difficulty providing a coherent narrative of their experiences. Events experienced before the age of 2 years are rarely accessible in verbal form (but see Gaensbauer, 1995), although some behavioral indices consistent with implicit memories may be evident (see also Eisen & Goodman, 1998; Fivush, 1998a, 1998b). It should be no surprise, therefore, that these earliest memories of trauma seldom become part of our adult autobiographical memories (e.g., Williams, 1994) given that, even in childhood, these experiences are not available for later explicit recall.

Trauma and memory: Early childhood

By age 2–3 years of age, children are able to provide coherent, albeit brief, verbal reports of distinctive (e.g., Fivush, Gray, & Fromhoff, 1987; Fivush & Schwarzmueller, 1998; Hamond & Fivush, 1991), stressful (e.g., Howe et al., 1994; Peterson &
Rideout, 1997), and traumatic events (e.g., Pynoos & Nader, 1989; Terr, 1988). Do the variables that influence children's memories of neutral or positive experiences similarly influence memory of traumatic experiences, or are traumatic memories in some ways special? In this section, we examine how age, delay, distinctiveness, and reminders (variables known to influence memory for non-traumatic events), also influence memory for trauma in early childhood.

**Age**

Even beyond the influence of infantile amnesia, age is a reliable predictor of memory for mundane experiences, particularly when children are asked for open-ended or narrative accounts of their experiences (see Ornstein et al., 1997b; Schneider & Pressley, 1997, for review). Age at the time memory is assessed is also an important influence on children's verbal recall of traumatic experiences. For instance, when children are interviewed within a few weeks of having the VCUG test (Goodman et al., 1994; Merritt, Ornstein, & Spicker, 1994; Ornstein, 1995), they generally remember the procedure well, indeed, better than they remember a more routine medical examination (e.g., Merritt et al., 1994). Even so, there are marked age differences in the amount of information children recall, and sometimes also in the accuracy of their accounts (e.g., Goodman et al., 1994; Merritt et al., 1994; Salmon, Price, & Pereira, 2002). Goodman et al. (1994), for example, interviewed 46 children within 3 weeks of the VCUG test and found differences in free recall accounts and in accuracy, across the 3- to 4-year-old, 5- to 6-year-old, and 7- to 10-year-old age groupings, consistent with characterizations of children's recall of other (non-traumatic) events (e.g., Baker-Ward, Ornstein, & Principe, 1997).

Whereas the VCUG is an anticipated and socially sanctioned event, accidental injuries are neither, and therefore provide another "snapshot" of children's memory for potentially traumatic experiences. In a series of reports, Howe, Peterson, and colleagues describe the changes in children's accounts of traumatic injuries requiring treatment at an emergency facility (e.g., Howe et al., 1994, 1995; Peterson, 1999; Peterson & Bell, 1996; Peterson & Whalen, 2001; see also Peterson, Moores, & White, 2001). As in the VCUG studies, older children reported significantly more information than did younger children; at all delays, the proportion of details that children reported increased across age groupings, with the youngest (2-year-old) group typically reporting fewer than 50% of details available, and the oldest typically reporting 80–90% (Peterson & Bell, 1996; Peterson & Whalen, 2001).

Finally, age differences have also been found in field studies of forensic interviews conducted with children suspected of having been sexually abused (Lamb, Sternberg, & Esplin, 2000; Sternberg, Lamb, Orbach, Esplin, & Mitchell, 2001). Lamb et al., for example, examined 145 interviews conducted by forensic interviewers with children between the ages of 4 and 12 years. Measures of completeness of recall showed that younger children generally responded less informatively than did older children. Interviews conducted using the NICHD interview protocol similarly showed age differences in the amount of information that children were able to provide, particularly in response to open-ended prompts (Sternberg et al., 2001).
**Age and implicit memory**

How might factors such as age influence young children’s implicit memory for trauma? This is a difficult question to answer because systematic studies of implicit memory in childhood have focused almost exclusively on laboratory-based tasks, such as fragment completion (Naito, 1990), color priming (Mecklenbraeuker, Hupbach, & Wipich, 2001), picture clarification (Anooshian, 1997), perceptual facilitation (Drummey & Newcombe, 1995), and conceptual processing (Perez, Peynircioğlu, & Blaxton, 1998). These studies indicate that implicit memories are more “developmentally robust” than are explicit memories (Newcombe, Drummey, & Lie, 1995), with few developmental differences between the ages of 4 or 5 years, and 10 years. Several studies suggest that implicit memories are also more durable than explicit memories (e.g., Drummey & Newcombe, 1995). However, to the extent that age-associated cognitive variables relate to encoding, we might expect some changes during childhood also. Indeed, both Parkin (1993) and Cycowicz, Friedman, Snodgrass, and Rothstein (2000) reported findings consistent with developmental improvement in implicit memory under carefully constructed and analyzed conditions (but see Drummey & Newcombe, 1995). It is possible that developmental differences are particularly evident when conceptual implicit memory rather than perceptual implicit memory is tested (Alexander, 2002). It would be of interest for future researchers to examine possible developmental differences in conceptual versus perceptual implicit memory for trauma stimuli.

**Delay**

Once in memory, how durable are memories of traumatic experiences? This question is relevant to whether trauma memories are “special.” When children recall neutral or positive events over long time periods, there is typically evidence of forgetting, and sometimes this is quite marked (e.g., Jones & Pipe, 2002; Ornstein, Baker-Ward, Gordon, & Merrit, 1997a; Salmon & Pipe, 2000); in some instances, forgetting appears to have become almost complete, at least in terms of explicit memory (e.g., Goodman, Batterman-Faunce, Schaaf, & Kenney, 2002), or children have required substantial cuing and provision of props to recall the event at all (Hudson & Fivush, 1991; but cf. Fivush & Schwarzmüller, 1998).

Traumatic experiences, especially their core features, generally appear to be remembered better over longer delays than is typically the case for other experiences (Bernstein, 2002). This is so whether delays are relatively short, over several weeks, or much longer, such as over several years. Merritt et al. (1994), for example, examined the effects of a 6-week delay on children’s recall of the VCUG. Although, in general, children did recall somewhat less when interviewed 6 weeks versus shortly after the test, the change was not statistically significant. Merritt et al. concluded that “Despite the limitations presented, the findings of excellent recall, minimal forgetting, and accurate responses to misleading questions suggest that, under some conditions, children are capable of providing accurate accounts of stressful events they have experienced” (p. 22).

The studies reported by Peterson (Peterson & Bell, 1996; Peterson & Whalen, 2001) offer a relatively unique opportunity to examine the effects of long delays in
the context of repeated interviewing, on children’s memory of both injury and hospital events. When children were interviewed 6 months after the injury they reported significantly less information than when they were interviewed soon after the injury (Peterson & Bell, 1996). At the initial and 6-month-delay interviews, injury and hospital events were recalled similarly with respect to the extent of detail reported. With respect to accuracy, younger children made more commission errors than did older children, although at the 6-month delay all groups under age 5 showed evidence of high error rates, especially for the hospital visit. Peterson and Bell concluded: “Overall, children’s patterns of recall were consistent with the large bodies of data that describe memory for more mundane experiences; older children remembered more than younger, and these experiences were subject to forgetting over time” (1996, p. 3067).

All children were interviewed 2 years and 5 years after the injury, with some children also having an “intervening interview” at a 1-year delay. At longer delays, a somewhat different pattern emerged than that observed at 6 months (Peterson, 1999; Peterson & Whalen, 2001). Whereas children recalled less about the hospital event at both the 2- and 5-year-delay interviews compared to the proportion of details recalled in the initial interview, for the injury event itself there was now no difference between the initial interview and the interviews at the longer delays. That is, in contrast to the findings at the 6-month delay, over even longer delays there was little evidence of forgetting. The accuracy of children’s accounts of both injury and hospital events was lower at both the 2-year delay and the 5-year delay compared to the initial interview. Peterson and Whalen (2001) concluded “The most striking finding is how well children recalled some aspects of the target event so many years later.” (p. S19).

Burgwyn-Bailes, Baker-Ward, Gordon, and Ornstein (2001) examined children’s recall of facial lacerations that required suturing, following injuries such as animal bites or sporting injuries. Children between the ages of 3 and 7 years were interviewed about the suturing, within a few days of surgery, 6–8 weeks later, and again 1 year after the accident. Children’s recall of the features did not change significantly over time, although false alarms increased in response to suggestive questions but not absent features questions. Burgwyn-Bailes et al. commented that “In this investigation, young children’s memory for emergency medical treatment remained relatively stable over a year’s time” (p. S42). In contrast, Peterson and Whalen (2001) reported remarkable stability for the injury, rather than the hospital treatment. Hospital experiences certainly vary in their memorability, and hence durability, as is undoubtedly true for most other events.

Finally, in a field study, Lamb et al. (2000) found that children interviewed soon after the alleged abuse (within a month) were more likely to provide some information in response to the interviewer’s prompts and questions, than children interviewed following long (5–14 months) delays, although children provided no more detail when they did respond. The strongest effects of delay were observed for responses to open-ended prompts, rather than suggestive or closed questions, and forgetting was most rapid over the shorter delays. Overall, therefore, childhood traumatic events are subject to forgetting, as are non-traumatic events. The durability and accessibility of traumatic events, however, may exceed that of many
non-traumatic events. Furthermore, as discussed in the next section, there may be times when memory reports of early traumatic events actually become more detailed as children develop.

**Improvements in memory for traumatic experiences over time?**

Fivush et al.’s (in press) findings, based on the follow-up of children’s recall of Hurricane Andrew, are intriguing in that they raise the possibility that children’s memory reports (albeit perhaps not their memory per se) sometimes become more detailed over long delays. Forty-two children, now between the ages of 9 and 10 years, were re-interviewed 6 years after the hurricane. Children in the high stress group no longer reported less information than children in the moderate stress group at the 6-month interview. Of interest, all children provided more, rather than less, information about the storm in the follow-up interview. Indeed, the effects were quite dramatic, with children reporting almost twice as much information when they were interviewed 6 years after the event than when interviewed shortly after the event (Parker et al., 1998).

Closer examination of the data reported by Peterson and Whalen (2001) similarly suggests an increase in the amount reported over time, at least for the youngest children. For children age 5 years or older at the time of the injury, there was a decrease in the proportion of details reported over the 5-year delay, for both events, and for both central and peripheral information (Peterson & Whalen, 2001, Table 1). Younger children, in contrast, evinced an increase in the amount of information reported in relation to the injury, and no change in amount reported about the hospital event, over the 5-year delay.

It is not clear whether these improvements in memory reports reflect actual increases in recollection or whether the observed growth arises as a byproduct of other factors, such as rehearsal, increases in general and/or script knowledge, or suggestion (Howe, 1998; Howe & O’Sullivan, 1997). All of these factors (as well as other factors) may play a role. Peterson and Whalen (2001) offer several explanations for the observed increases in recollection, such as possible improvements in narrative skill, rehearsal (as a result of repeated interviews), and discussions within the family, leading to more detailed, albeit second hand, information. In addition, consistent with eyewitness studies with adults indicating that repeated recall attempts may lead to hypermnesia, improved recall over time might also reflect greater memory accessibility (e.g., Bluck, Levine, & Laulhere, 1999; Bornstien, Liebel, & Scarberry, 1998; Dunning & Stern, 1992; Scrivner & Safer, 1988).

**Delay and implicit memories**

We might expect traumatic experiences to be manifest in behavioral responses, preferences, and emotional reactions over longer delays than for explicit memories (Terr, 1988). In only a few studies of early traumatic experiences have non-verbal measures of memory been collected. In Goodman et al.’s (1997) study, for example, children were first asked to recall their VCUG experience and then re-enact it with dolls and props (e.g., an anatomical doll, catheter tube); in this case, reporting of the main event was greatly facilitated for all age groups. Generally, however, there
is a dearth of relevant studies, and non-verbal manifestations of early traumatic experiences have remained largely in the domain of the clinical literature where age and delay comparisons are typically not possible. The inclusion of non-verbal measures in studies examining children’s memory for stressful as well as non-stressful events would further our understanding of the role of implicit memory for traumatic experiences.

**Distinctiveness**

Events, traumatic or otherwise, differ from one another on many dimensions likely to influence memory, such as in distinctiveness, personal significance, and duration; whether or not they are anticipated, discussed, or involve other people; and whether they occur once or many times to name but a few possible dimensions. All of these variables may influence whether or not or how well a memory of a particular experience is retained and accessed over time.

Distinctiveness is clearly an important determinant of the memorability of events (Howe, 1997; Thompson, Skowronski, Larsen, & Betz, 1996), and indeed distinctiveness has been found to be a reliable predictor of adult autobiographical memory (Betz & Skowronski, 1997; Brewer, 1986; Linton, 1979). A variety of non-verbal and verbal procedures have been used to investigate distinctiveness in infants, toddlers, and young children (Adler et al., 1998; Bauer, 1995; Boyer, Barron, & Farrar, 1994; Fivush & Schwarzmueller, 1998; Howe, 1997; Meltzoff, 1995; Myers et al., 1994), and have shown that distinctive events are well remembered even over lengthy delays.

Howe (1997), for example, found that young children (5- and 7-year-olds) more easily learned and retained a distinctive item over a 3-week delay than items that were part of a context-setting category. Fivush and Schwarzmueller (1998) also found that highly distinctive events that occurred in early childhood were well remembered over long periods of time. A small group of 8-year-olds were interviewed about events that they had previously reported at various time points, some of which occurred when children were as young as 40 months of age. The events consisted primarily of positive non-traumatic events, such as excursions (e.g., to restaurants, train rides), amusement parks (e.g., Disney World, circus), and family occasions (e.g., births, weddings), as well as some negative events, such as having a tooth pulled or having an operation. It was found that those distinctive events that were verbally reportable at the time of occurrence were well recalled several years later.

Traumatic experiences are often distinctive, and therefore more likely to be retained over time than less distinctive events. As Howe argues, comparisons of traumatic and non-traumatic experiences across studies, may, therefore, reflect differences in the significance or salience of the events, rather than qualities associated specifically with trauma. Hence his call for more carefully controlled studies in which the memorability of traumatic and other significant events are compared across age groups and various delays, before unique characteristics are attributed to traumatic memories. Additionally, Howe (1997) suggests that a longitudinal study comparing
memories of mundane but significant experiences and traumatic experiences may help resolve some of these issues. Indeed, we need many such studies, comparing different kinds of traumatic and mundane experiences, under carefully controlled conditions.

**Reminders**

In addition to distinctiveness, some traumatic experiences may be associated with numerous reminders, whereas other traumatic experiences may have few, if any reminders. It is interesting to note that in the studies reviewed above, which show traumatic experiences to be well recalled over long delays, children were likely exposed to repeated reminders, providing opportunities for reactivation of the memory (e.g., Fivush et al., in press; Peterson & Whalen, 2001). We know from studies of infants, for example, that reinstatement and reactivation can be powerful determinants of the time period over which a memory is retained. Even relatively brief reminders can be a major determinant of whether an experience is forgotten or remains accessible over long time periods.

Following language acquisition, verbal reminders are likely to be particularly important in maintaining explicit memories. In the set of studies reported by Howe, Peterson, and colleagues, for example, children were interviewed about the injury and hospital visit on repeated occasions, and were thus exposed to potential reminders of the event that may have maintained memories that might otherwise have been forgotten. Although repeated interviewing per se may not be sufficient to ensure retention of memories (Hudson & Fivush, 1991; see Fivush & Schwarzmueller, 1995, for review), personal injuries and natural disasters, and the events surrounding them, nonetheless are likely to be subject to a multitude of reminders and opportunities for reactivation. For example, following an injury such as a fracture or burn, there is frequently physical evidence (e.g., cast, scars), which may occasion questions and discussion (“remember what happened when...”). It is interesting in this regard, that in the Peterson et al. studies it is the injury that is better remembered over time, rather than the hospital treatment. We might speculate that the details of the former are more likely to have been discussed, postincident, than the latter. In contrast, a medical procedure such as the VCUG, although “sanctioned,” seems less likely to become part of the family history, or the focus of shared reminiscing or discussion. Like sexual abuse, it may well be a topic to be avoided, rather than raised. If this is correct, we might expect greater forgetting of the VCUG than of other traumatic experiences.

We also speculate that, in the context of traumatic experiences, reminders have different effects on implicit versus explicit memories. Whereas repeated reminders in the absence of re-experiencing the trauma might facilitate long-term verbal recall, this may not be the case for implicit memories. In so far as implicit memories are reflected in emotional reactions, behavioral responses, or preferences, re-encountering the context of a traumatic event, but without the traumatic experience, may attenuate the non-verbal response. Indeed, this process is the basis of many clinical treatment approaches, for example, in relation to fears and phobias.
Summary

As we have shown, verbal, explicit memory for traumatic experiences follows the same developmental changes as for non-traumatic experiences, although direct comparisons are few and far between (see Howe, 1997). Traumatic experiences are no more likely than are other experiences to be remembered explicitly if they occur in the first 2 years of life, and there are marked changes across age in the children’s recall. With respect to delay, however, traumatic events may be better remembered over long delays than are more neutral or mundane experiences (Fivush et al., in press; Peterson, 1999, see also Peterson & Whalen, 2001). Further, although children typically show some evidence of forgetting of traumatic experiences over time, the change is often relatively small (e.g., Merritt et al., 1994; Peterson, 1999; Quas et al., 1999; but see, in contrast, Goodman, Hirschman, Hepps, & Rudy, 1991; Steward, 1993). Once in memory, stressful and traumatic events tend to be long-lived in children’s minds, changes in accuracy and in the cues required to elicit them notwithstanding. The durability of traumatic memories may result from a combination of variables that also influence memory of non-traumatic experiences, perhaps differing only in degree, but may also reflect processes uniquely associated with trauma as discussed in the following sections.

Thus far, we have seen evidence that memory for both traumatic and non-traumatic events share many characteristics. We now turn more specifically to the possibility of unique influences of trauma memory.

Are there unique influences on memories for traumas?

Although many of the same factors that affect the retention and retrieval of non-traumatic memories also affect people’s ability to recollect traumatic events, there may be some factors that are uniquely associated with traumatic events. In particular, traumatic experiences are associated with emotional reactions in children themselves as well as their caregivers, which may influence memory by serving as retrieval cues, restricting open discussion, or resulting in emotional disorders (Alexander, Quas, & Goodman, 2002; Foa & Hearst-Ikeda, 1996; Foa & Riggs, 1994; Goodman et al., 2003). In turn, these emotional and social effects may have adverse or positive consequences for memory development and for the long-term retention, accessibility, and retrieval of subsequent traumatic and non-traumatic experiences. Moreover, traumatic events may actually affect brain structures and brain function in profound ways. In the following sections, we discuss the social, clinical, and neurobiological consequences of trauma that may, in turn, contribute to altered memory functioning in later childhood and adulthood.

Social factors

Social factors, such as family support, parent–child conversations, and attachment styles, affect how children process and remember emotional events. During
the first years of life, children rely to a great extent on their caregivers for support and comfort when experiencing distress (Bowlby, 1980). Later, but perhaps not until middle childhood, children have the capacity to alleviate their own distress by using cognitive strategies, such as thinking pleasant thoughts, shifting attention, and reappraisal (Eisenberg, 1998; Harris, 1994; Thompson, 1994), and by the conscious use of cognitive inhibition strategies, namely suppression and intentional forgetting (e.g., Bjorklund, 2000; Koutstaal & Schacter, 1997). Until these capacities develop, however, considerable adult involvement is needed to allow young children the capacity to cope with traumatizing events.

It has been argued that the most accurate and long-standing event memories are of those events that are experienced directly and subsequently discussed, such as the conversations adults often engage in with children about past or ongoing events (Fivush, 1998c; Fivush et al., 1995; Haden & Fivush, 1996). Narratives provide organized frameworks from which children can assess the accuracy of their presuppositions, interpretations, and details. Discussions of a traumatic event, not only allow the adult to explain the event and correct misconceptions, but may also strengthen the event in the child’s memory (Fivush, 1998c; Fivush et al., 1997; Fivush & Schwarzmueller, 1995). Additionally, elaborative conversations can help children acquire the language and narrative skills that will allow them to talk about their experiences and thereby maintain memory accuracy (see Fivush, 1997). Yet, young children, with immature language skills and little narrative experience, often do not initiate such conversations (Fivush & Hamond, 1990; MacDonald & Hayne, 1996). If the parent is also unwilling to initiate a discussion, inaccuracies or distortions may occur (Goodman et al., 1994).

Parents’ readiness to talk about negative emotions with their children has been shown to be related to parent–child attachment patterns. Specifically, securely attached mother–daughter dyads tend to discuss both positive and negative past emotions, whereas insecurely attached mother–child dyads are more likely to discuss only positive emotions (Farrar, Fasig, & Welch-Ross, 1997). As a result, insecurely attached children may develop avoidant coping strategies, such as active avoidance of traumatic memories, due to the lack of opportunities to openly discuss the event (Eisenberg, Fabes, & Murphy, 1996; Gottman, Katz, & Hooven, 1997; Thompson, 2000).

Thus, socialization processes may have a marked effect on the way young children construe their memories of emotional experiences. Because parents differ substantially in how they deal with their young children’s experiences of trauma and how they socialize their children to cope with traumatic events, such socialization processes may provide special influences on young children’s trauma memory.

Clinical factors

Another potential unique influence on memory for traumatic events concerns the effects of early trauma on young children’s mental health. Specifically, mental health can affect how traumatic events are encoded and retrieved; memories of traumatic events, in turn, can affect mental health. Indeed, early trauma, especially in the
context of continued adversity, family dysfunction, and insecure attachment, is widely believed to result in psychopathology. Long-term psychological reactions to trauma include fear, anxiety, fatigue, sleeping and eating disturbances, alcohol and drug abuse, physical complaints, and mental disorders (see Myers et al., 2002, for review).

To take one example of the mental health consequences of trauma, we consider child maltreatment, an all too prevalent form of early trauma that has been the subject of intense study in recent years. Felitti et al. (1998) reported that, from a sample of 10,000 patients in a medical setting, individuals with a history of severe and repeated child maltreatment (e.g., psychological abuse, physical abuse, sexual abuse, and substance abuse) had a 4- to 12-fold increase in their risk for alcoholism, drug abuse, depression, and suicide attempts compared to patients who had no experience of child maltreatment. In a study examining the association between multiple types of trauma and different types of personality disorders (e.g., schizotypal, borderline, avoidant, and obsessive–compulsive), individuals suffering from borderline personality disorder reported the highest rate of traumatic exposure (particularly, child sexual abuse), the highest rate of posttraumatic stress disorder (PTSD), and of special importance to the present paper, youngest age of first traumatic event (Yen et al., 2002).

To examine the issues of mental health and memory more specifically, we next consider three hypothesized, emotional reactions to early trauma in relation to young children’s memory: repression, dissociation, and PTSD.

Repression

Much scientific and clinical thinking about trauma and memory has been dominated by the question of whether childhood traumatic experiences can be repressed (Pezdek & Banks, 1996; Read & Lindsay, 1997; van der Kolk & Fisler, 1995). According to psychoanalytic theory, traumatic memories that have negative implications for the self or “ego” may become inaccessible to conscious recall because they are repressed, or at least “split off” (Janet, 1907/1920) and not integrated into the psyche during childhood. The role of repression acts as a defense protecting the child (and later the adult) from conscious awareness of the trauma. According to Anna Freud (1946), young children are especially likely to use primitive defense mechanisms, including denial and repression. Denial itself (which can be considered as a type of cognitive avoidance) could serve to adversely affect young children’s memory for trauma, for instance, by limiting rehearsal opportunities and eliciting other-induced or self-induced misinformation, which could negatively affect the longevity and accuracy of memory. Controversy, however, has focused not on denial but on repression, which from the psychoanalytic perspective leaves the memory intact but inaccessible, until for whatever reasons (e.g., psychotherapy), the repressive force lifts.

The prediction that traumatic experiences are frequently repressed or “split off” is, of course, in direct contrast to the prediction that traumatic experiences will generally be well remembered because they are significant, distinctive, and salient. It is clear that the majority of traumatic experiences are available for later recall by both
children and adults, at least if they occur outside the period of infantile amnesia. Many recent reviews have challenged whether repression of trauma is as common as one might suppose on the basis of psychoanalytic writings, or indeed, if repression occurs at all (Loftus, 1994).

As we discussed earlier, infantile amnesia affects traumatic as well as non-traumatic memories. An important difference between infantile amnesia and repression is that with repression, the traumatic memory could potentially be accessed at a later time, whereas infantile amnesia research suggests that the original memory would likely be forever inaccessible to conscious recollection. At present, although infantile amnesia effects clearly exist and apply to both traumatic and non-traumatic events, it is less clear if repression exists. Nevertheless, scientists cannot rule it out (Goodman et al., 2002; Goodman et al., 2003).

**Dissociation**

Dissociation also has profound implications for young children’s memory for traumatic experiences. Dissociation is hypothesized to be a psychological mechanism that aids an individual’s ability to cope with extreme stressors. During, and immediately after a traumatic event, it is believed that some individuals experience temporary dissociative states (Marmar, Weiss, Metzler, & Delucchi, 1996), resulting in the formation of isolated memories for the event. If these isolated memories fail to integrate with each other, memory for the trauma will be less accessible to conscious recollection.

In adults, dissociation has been associated with general memory impairments, such as memory gaps in autobiographical memory, episodes of time loss, recall delays for abuse-related incidents, and even total memory loss or amnesia for the traumatic event (Goodman et al., 2003; Nijenhuis, 2001; Putnam, 1997, 2000). Even when memories of a particular trauma are encoded and stored in declarative memory, dissociation may prevent the rehearsal of such memories, leading to the decay of trauma-related details (Fivush & Schwarzmueller, 1995).

Dissociative coping is believed to be available early in infancy (Liotti, 1992). It has been suggested that young children are more likely to rely on dissociation as a coping mechanism and are therefore more vulnerable to the development of dissociative disorders than older children and adults (Lynn & Rhue, 1994; Putnam, 1995, 1997, 2000). Additionally, highly dissociative children may be at risk for chronic feelings of depersonalization and derealization, resulting in memories that have a dream-like quality.

Despite research with adults indicating an association between dissociation and false memory, and despite theory implying dissociation should be related to worse explicit memory for trauma, the few extant studies on dissociation and memory in children do not necessarily fall into place with such research and theory. Eisen, Goodman, Davis, and Qin (1999), for example, reported that child maltreatment victims, including children as young as 3 years of age, who scored higher on measures of dissociation were rated as having more (not less) detailed memories of their abuse experiences. These same children also expressed more (again, not less) negative
emotion when interviewed about abuse (Sayfan et al., 2002). Perhaps consistent with Foa's theory (Foa & Riggs, 1994) and much subsequent research with adults (e.g., McNally, 1999, 2003) on trauma and memory, there may be important differences in how child trauma victims remember trauma-related and non-trauma-related information, with dissociation resulting in more detailed memory of trauma. It is also possible that young children do not have the necessary cognitive inhibition (mediated by the frontal lobes) to dissociate (Bjorklund & Harnishfeger, 1990; Wilson & Kipp, 1998; see also Freeman, 1998). This will be an intriguing area of future research.

Overall, it is unclear how dissociation affects young children’s memory of traumatic events. A number of troublesome issues complicate research in this area (e.g., lack of valid, standardized measures for young children; inability to study children during traumatic events). Such obstacles would ideally have to be overcome if we are to gain a better scientific understanding of how dissociative processes affect memory for trauma in early childhood.

Posttraumatic stress disorder

Trauma has long been known to increase the risk of PTSD. Considerable research with adults has examined the relations between PTSD and memory, with fascinating results. Lack of established criteria for assessment of PTSD in very young children and a paucity of research, however, limits our ability to speak with confidence about the role of PTSD in young children’s memory for trauma.

Most of what is known about the effects of PTSD comes primarily from studies on adults and school-aged children. Adult research suggests that, consistent with Foa and Riggs’ theory (1994), individuals who develop PTSD show heightened orientation to trauma-related information (e.g., McNally, 1999; Vrana, Roodman, & Beckham, 1995), and in some instances evince worse memory for non-trauma-related information (e.g., Zoellner, Foa, Brigidi, & Przeworski, 2000). Goodman et al. (2002), for example, found that memory for the trauma of child sexual abuse was particularly accurate in young adults who developed PTSD (see also Alexander et al., 2002).

Relatively few studies exist on memory in children who have been diagnosed with PTSD. One study indicates that children with PTSD versus children without PTSD tend to have poorer indices of memory on measures that mainly tap short-term memory (Yasik, 1998). Another study suggests that children with PTSD have poorer overall memory on measures primarily tapping some aspects of long-term memory (Moradi, Doost, Taghavi, Yule, & Dalgleish, 1999; but see Beers & DeBellis, 2002, for null findings). In a study of memory for a real-life stressful event (an ano-gential examination), Eisen, Qin, Goodman, and Davis (2002) found that, for maltreated 3- to 17-year-old children, more PTSD symptoms were associated with more commission errors to specific and misleading questions, but with more correct information to free recall questions. In essence, PTSD symptoms were not a consistent predictor of event memory. Moreover, clinicians’ diagnoses of PTSD were not significantly related to memory performance.

Thus, at this point, firm conclusions about PTSD and young children’s memory are not possible because the extant research is too limited and too inconsistent.
Further research from a developmental and longitudinal perspective would be highly valuable.

Early traumatic experiences, memory, and associated brain structures

Recently, there has been tremendous interest in the relation between childhood trauma and the brain structures underlying memory. Many of these studies have focused on individuals with PTSD. Although a full discussion of this literature is well beyond the scope of this paper, brief mention of the relations between childhood trauma, the hippocampus, and the amygdala is warranted.

Several decades of research provide convergent support for the critical role of the hippocampus and amygdala on memory processes (e.g., Gabrielli, 1998). In the case of traumatic experiences, the hippocampus and amygdala are particularly affected by, or involved in, the body’s response. First, considering the hippocampus, stress hormones, specifically cortisol, may adversely affect hippocampal volume (Roozendaal, Quirarte, & McGaugh, 1997). Animal models, for instance, indicate that high levels of glucocorticoids released during times of stress leads to hippocampal damage (e.g., McEwen et al., 1992; Sapolsky, 1996). Although sometimes these changes in morphology are reversible, prolonged exposure to glucocorticoids is believed to result in irreversible hippocampal damage (Kerr, Campbell, Appelgate, Brodish, & Landfield, 1991; Mizoguchi, Kunishita, Chui, & Tabira, 1992; Sapolsky, Krey, & McEwen, 1985, 1986; Uno, Tarara, Else, Suleman, & Sapolsky, 1989). Of particular importance, in animals at least, stress-induced hippocampal damage has been associated with deficits in memory function (Luine, Villages, Martinex, & McEwen, 1994).

In adult humans, research findings suggest a similar possibility. For instance, studies with healthy adults have shown declines on explicit measures of memory with sustained increases in glucocorticoids (Bender, Lerner, & Poland, 1991; Lupien et al., 1994). Regarding the relation between trauma, hippocampal volume, and memory, Bremner (Bremner, Krystal, Southwick, & Charney, 1995a, 1995b, 1995c) reported both smaller hippocampal volume and deficits in short-term memory in women with child sexual abuse-related PTSD, as well as in war veterans who developed PTSD subsequent to combat trauma (but see Gilbertson et al., 2002).

There is much less known about the relations between early childhood trauma and the brain substrates essential for memory. Results to date do not clearly indicate that trauma in childhood is associated with reduced hippocampal volume. For example, De Bellis, Hall, Boring, Frustaci, and Moritz (2001) examined hippocampal size in a small number \( (n = 9) \) of prepubescent children with maltreatment-related PTSD compared to an equally small number of non-maltreated children who did not suffer from PTSD. At baseline, when the children averaged about 10.6 years of age, and again 2 years later, there were no significant differences in hippocampal volume among the groups. There is, however, some preliminary indication that children who are exposed to prolonged stress, including that associated with sexual abuse in girls (De Bellis et al., 1994), experience dysregulation of the glucocorticoid regulatory mechanisms. In general, the few studies that have examined memory functioning in young children who have experienced trauma fail to reveal much in the way of
significant memory differences (e.g., Eisen et al., 2002; Howe, Cicchetti, Toth, & Cerri
to, 2003). It is possible that the adverse effects of trauma on hippocampal function-
ing may be evident at longer delays than those examined in the extant studies and are
thus more likely to be expressed in adulthood than in childhood (Goodman, Ghetti,
& Castelli, in press). More research is clearly needed on this crucial topic.

Another important brain structure involved in memory for traumatic and stress-
ful events is the amygdaloid complex (AC). The AC plays a central role in mod-
ulating memories for stressful experiences (Cahill & McGaugh, 1998; McGaugh,
1995), often by enhancing memory (e.g., Bennett, Liang, & McGaugh, 1985; Le-
Doux, 2000; Liang, Bennett, & McGaugh, 1985). In adults, the amygdala appears
to be especially attuned to fear-inducing stimuli. The amygdala, therefore, may
play a particularly important role in memory for trauma and may be responsible
for the greater durability and detail of memory for stressful and traumatic, events.
In effect, a special memory system for traumatic events might in some sense exist
via the amygdala.

Some studies, however, suggest that normal children do not evince an enhanced
amygdala response to fear-inducing stimuli. Thomas et al. (2001a), for instance,
found that adults, but not normal children, showed enhanced amygdala response
to fear faces. Rather, children generally showed an increased amygdala response
to neutral faces. Thomas et al. (2001b) did find that children with anxiety or depres-
sion showed enhanced amygdala activation to fear faces, perhaps because they are
particularly prone to interpret ambiguous stimuli as negative or fearful. It is possible,
however, that administration of less ambiguous fear-eliciting stimuli, would result in
greater amygdala activation in children generally and perhaps enhanced memory
(Melinder, Korsnes, Cordón, Goodman, & Gabrielli, 2003). If, as found by Thomas
et al., the amygdala of young children has a subdued response to fear-evoking stim-
uli, then traumatic events in early childhood may not result in the forms of memory
enhancement that have been observed in adults.

In summary, traumatic experiences that occur in early childhood can be retained
and recalled over significant periods, once the barrier of infantile amnesia is passed.
Prolonged periods of stress in early childhood, however, may have negative conse-
quences on hippocampal structures and therefore may adversely affect early memory
development, although findings are far from clear that this indeed occurs. Addition-
ally, although the amygdala has been found to enhance memory for emotional expe-
niences, it is unknown whether young children experience memory enhancement for
emotional events in the same way that adults appear to do. Only future research will
help us to better delineate how trauma and neurological mechanisms interact to
influence the retention and retrieval of early traumatic experiences.

Conclusions

At the outset of this paper, we raised several questions regarding children’s mem-
ory for traumatic experiences. Will traumatic events that occur in early childhood be
accessible for recollection at later stages of development? Are traumatic events more
memorable than non-traumatic events? Are early traumatic memories sensitive to the same factors that influence children's memories for other kinds of events? What are the long-term consequences of traumatic events for later health and brain development? The research reviewed here points to clear answers to some of these questions, but also highlights that definitive answers to some of the most intriguing questions concerning memory for childhood trauma are not yet possible.

An important issue that arises when considering memory accessibility and durability for events occurring in early childhood concerns how recollection is measured. Although verbal recall provides the most unambiguous demonstration of memory, reliance on explicit measures of recollection may not provide a complete picture of the durability and accessibility of memories, particularly for events that occur in the first 2 or 3 years of life. A variety of non-verbal measures clearly show that even infants encode, store, and retain information over relatively lengthy delay periods. Information relating to traumatic events is also likely to be retained in some form, even in the absence of verbal recall. Therefore, we should be open to possible non-verbal indicators of memory for traumatic experiences. Indeed, both the experimental and clinical research, involving both non-traumatic and traumatic events, suggests that these are likely. This having been said, we must reiterate our earlier caution regarding the difficulty of interpreting non-verbal indicators of memory. There is no one-to-one relation between trauma and specific behavioral or physiological reactions, and future studies will need to address the issue of appropriate comparison conditions if strong claims relating to non-verbal memories of trauma are to be made. This is a potentially fruitful area for further research, and the systematic study of infant memory based on non-verbal measures provides an excellent illustration of how the study of memory need not be constrained by a reliance on verbal recall.

With respect to verbal recall, there is compelling evidence that, in many respects, memories of traumatic and non-traumatic experiences have much in common. In particular, the same variables that influence memory for non-traumatic events, such as age, delay, and the nature of the event, are also important determinants of memory for early childhood trauma. Age at the time of the event emerges as a crucial factor in the ability to consciously access memory for traumatic events. Both scientific and clinical studies provide converging evidence that stressful and traumatic events occurring before age 2 are quite unlikely to be available for later verbal recall. There is little evidence to indicate that explicit memory for traumatic events is more likely to traverse the infantile amnesia barrier than explicit memory for non-traumatic events. Thus, it seems doubtful that traumatic events prior to age 2 will become part of our conscious autobiographical memory system, even though these events may continue to influence behavior in the years to come. Once outside the period of infantile amnesia, however, there is some evidence that traumatic events are remembered better over longer delays than mundane or neutral events. Some stressful and traumatic memories appear to be long-lived in childhood and perhaps adulthood, although the accuracy and cues required to elicit these memories may change over time.

In addition to cognitive factors, traumatic incidents are associated with physiological states, emotional reactions, and social factors that may positively or adversely influence memory and memory development and that, in some instances, are likely to
be unique to traumatic events. Emotional reactions to traumatic events, such as dissociation and PTSD, indicate that traumatic experiences have mental health sequelae that in certain ways may pose a threat to healthy memory development or at least may bias the types of information attended and retained. The neuroscience literature indicates that stressful and traumatic events may adversely affect the brain structures important for memory. Hormones released during times of stress lead, it appears, to damage of the hippocampus, a structure crucial to the establishment of memories. Such research with young children, however, is quite limited and as yet has not reliably shown the damage or declines in memory performance that have been observed in animals and adult humans. Little is known about the modulating effects of the amygdaloid complex on memory for experiences, whether non-traumatic or traumatic, occurring in early childhood. Clearly, more research is needed to understand how these brain structures influence, or are influenced by, traumatic experiences in early childhood.

Not all traumatic experiences are well remembered in the long term, but when they are remembered over time, should we conclude that such memories are somehow special? In so far as traumatic experiences are, almost by definition, distinctive, significant, salient, and associated with intense emotional reactions, what we know about memory more generally suggests they are frequently likely to be well remembered. Moreover, traumatic events are often experiences that punctuate our life stories, perhaps becoming a part of who we are, marking turning points, closing options, and changing directions. Explanations concerning the longevity of traumatic memories do not necessarily call upon processes that are unique to memory for trauma—to the contrary, these same cognitive and social processes influence memory for more mundane or positive life events. Conclusions as to whether there are variables relating to stress and trauma that uniquely contribute to the memorability of traumatic experiences, or whether it is the convergence of several variables related to memory generally, await further research.

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