Child Development, September/October 2004, Volume 75, Number 5, Pages 1402–1417

True and False Memories in Maltreated Children

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Differences in basic memory processes between maltreated and nonmaltreated children were examined in an experiment in which middle-socioeconomic-status (SES; $N = 60$), low-SES maltreated ($N = 48$), and low-SES nonmaltreated ($N = 51$) children (ages 5–7, 8–9, and 10–12 years) studied 12 Deese–Roediger–McDermott lists. Using recall and recognition measures, the results showed that both true and false memories increased with age and, contrary to some speculation, these trends did not differ as a function of maltreatment status. However, there were differences in overall memory performance as a function of SES. These results are discussed in the broader framework of children's memory development and the effects of the chronic stress associated with child maltreatment on basic memory processes.

Historically, there has been considerable debate about whether emotional experiences cause memory to operate differently from what is considered normal (Howe, 2000; Toth & Cicchetti, 1998). In an attempt to resolve this debate, some researchers have focused on two affective dimensions: arousal and valence. Both dimensions are represented as continua with arousal ranging from calm to excitement and valence ranging from pleasant to unpleasant (e.g., Bradley & Lang, 1994). Using these definitions, cognitive neuroscientists have found that information from emotional events may enjoy privileged access to processing resources, resources that may lead to the creation of superior memories (e.g., Dolcos & Cabeza, 2002). Although such research is key to our understanding of the theoretical mechanisms underlying memory for emotional events, the extent of emotion studied in the laboratory is necessarily limited to a restricted range on both the arousal and valence continua. If our goal is to understand how emotions associated with everyday experiences affect memory in general as well as memory for the emotional experiences themselves, then more extreme ends of these continua need to be examined.

In an attempt to study these extremes, especially trauma, two different research strategies have been used: (a) examination of memories for traumatic materials with individuals who either have or have not been traumatized, and (b) examination of changes in basic memory processes using neutral materials with individuals who either have or have not been traumatized. Here, some have found that the traumatic nature of an experience can enhance memory for the traumatic event itself (see McNally, 2003; Nadel & Jacobs, 1998); however, others have found that the stress that accompanies trauma may actually impair memory for the event by altering brain structure and function over extended periods (Bremner & Narayan, 1998; Sapolsky, 1992). These latter changes may affect not only memory for traumatic experiences themselves but also the basic processes that drive all of memory. Indeed, when posttraumatic stress disorder (PTSD) accompanies trauma, some have found that brain structures essential to long-term memory formation (e.g., the hippocampus) have been altered (e.g., Bremner et al., 2003) and that memory performance is poor in general even on measures of everyday memory (e.g., Moradi, Doost, Taghavi, Yule, & Dalgleish, 1999). Still others have found no such changes at a neurological level (e.g., De Bellis, Hall, Boring, Frustaci, & Moritz, 2001) nor have they found decrements in memory performance (e.g., Beers & De Bellis, 2002). It could be argued, however, that the discrepant results of the Bremner et al. (2003) and De Bellis et al. (2001) studies have to do with developmental differences in the samples tested (adults vs. children and adolescents, respectively). That is, the different outcomes of these studies could represent a true developmental difference in the biological sequelae

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Preparation of this article and the research reported herein were funded by grants from the Natural Sciences and Engineering Research Council of Canada to Mark Howe and from the Spunk Fund to Dante Cicchetti and Sheree Toth. We also thank the Monroe County Department of Human and Health Services for helping facilitate this research and the children who participated for their time.

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of stress exposure. The hippocampus continues to undergo maturation beyond adolescence; therefore, it is conceivable that there are corresponding changes in the vulnerability of the limbic-hypothalamic-pituitary-adrenal (LHPA) system.

Few studies have examined traumatized children. Instead, most examine memory in adults who retrospectively reported having been maltreated in their childhoods, adults with PTSD, or nontraumatized children in analog experiments (Toth & Cicchetti, 1998). For example, several have used the Deese–Roediger–McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995) to examine false memories in adults who either have or have not been traumatized. Bremner, Shobe, and Kihlstrom (2000) assessed memories for previously presented words in three groups of participants, including sexually abused women with or without PTSD and men and women without abuse or PTSD. Sexually abused women with PTSD had a higher frequency of false recognition memory than did participants in all other groups. In an examination of false recognition among women who varied in their memories of childhood sexual abuse (recovered memory vs. no memory vs. always remembered), as well as in women with no history of childhood sexual abuse, Clancy, Schacter, McNally, and Pitman (2000) found that women who had recovered memories of childhood abuse were more prone to false recognition using the DRM procedure than were women in all other groups. Finally, in a study that included 42 women, 14 who had been traumatized (sexual assault, physical assault, mugging, and/or robbery) and who met diagnostic criteria for PTSD, 14 who were traumatized and did not meet PTSD criteria, and 14 who were nontraumatized and non-PTSD, Zoellner, Foa, Brigidi, and Przeworski (2000) reported that traumatized participants with and without PTSD generated more false recalls than did nontraumatized individuals. Thus, studies using the DRM procedure in adults with histories of trauma converge to suggest that trauma may result in greater rates of false recall. It is important, however, that both the Bremner et al. (2000) and Clancy et al. (2000) studies relied on participant retrospective recall of abuse, a method that may confound recall and current memory capacities. Therefore, it is necessary for investigations of true and false memories to include an independent mechanism for assessing abuse.

In this article, we adopt the second strategy mentioned earlier and focus on the effects of trauma on basic memory processes, in particular, false memories in maltreated children. We begin by providing a brief overview of the scientific literature on children's memory for traumatic and stressful events, including what is known about memory in maltreated children. We then summarize the literature on false memories in children and present an experiment that addresses the issue of whether maltreated children are more or less susceptible to false memories than are children who have not been traumatized.

Children's Memory Development, Stress, and Maltreatment

The principles of memory development are derived mainly from restricted samples and types of events—nontraumatized middle-socioeconomic-status (SES) children recalling pleasant events (e.g., trips to Disneyworld or a museum). These results may not generalize to traumatized children, lower SES children, and stressful events. Concerning this latter criticism, there is a small literature on children's memory for stressful events (for a review, see Howe, 1998, 2000), but again, the focus has been on assessments of memory for short-lived traumatic experiences in generally nontraumatized populations of children, with the majority of these studies involving relatively acute and routine stressors (Eisen & Goodman, 1998). This research does show that children are generally able to remember stressful incidents regardless of whether the events were expected medical procedures (e.g., Bruck, Ceci, Francoeur, & Barr, 1995; Goodman & Quas, 1997) or unanticipated emergency room procedures (e.g., Howe, Courage, & Peterson, 1994, 1995). In general, as stress increases (to some optimal value), so, too, does memory for the central elements of an event. Some reports suggest that stress impairs children's memory and increases the likelihood of contamination by misinformation through suggestion (e.g., Bugental, Blue, Cortez, Fleck, & Rodriquez, 1992; Peters, 1987; but see Merritt, Ornstein, & Spicker, 1994). However, these reports are limited to information peripheral to the central event and it is not clear whether such elements were encoded in the first place.

Although acute stress may have a positive influence on the encoding and retention of critical, central details of an event, critics still admonish that the stressors being studied are not of the same intensity, nor do they carry the same negative attributes, as the events that traumatized children are typically asked to remember, namely, physical and sexual abuse. Although recollections of hospital experiences that involve genital touching (e.g., Goodman & Quas,

1997; Saywitz, Goodman, Nicholas, & Moan, 1991) or painful and unexpected physical interventions involved in emergency room treatment (Howe et al., 1994, 1995) do parallel some of the attributes associated with physical and sexual abuse, they do not carry the same psychological ramifications (e.g., shame, guilt, threat). Indeed, the participants in many of these studies are children who have not been exposed to repeated abusive experiences and are simply reporting a single, stressful experience. Again, we are left with having to generalize conclusions from populations and experiences that are only indirectly comparable to those we seek information about, namely, children's ability to recollect experiences of physical and sexual abuse. Thus, although important, this research needs to be complemented by work directed specifically at populations that have experienced severe or prolonged conditions of trauma, including chronic child maltreatment (e.g., see Beers & De Bellis, 2002; Bremner et al., 2003; De Bellis, 2001; De Bellis et al., 2001; Eisen, Qin, Goodman, & Davis, 2002; Moradi et al., 1999).

Indeed, we know little, if anything, about the prolonged effects of maltreatment on basic memory processes. As noted earlier, it is not clear what the effects of prolonged stress are on the neurological centers responsible for memory (cf. Bremner et al., 2003 and De Bellis et al., 2001). As McNally (2003) has suggested, a diagnosis of PTSD may need to accompany such long-term stress for such maltreatment to have a demonstrable impact on the brain regions responsible for memory. Indeed, such effects, although beginning in childhood (see De Bellis et al., 2001), may not become observable until adulthood when PTSD becomes more apparent. Although such long-term effects might impair memory for new events, it should not alter memory for the events that brought about the PTSD as they occurred before any changes that might impair memory formation (although PTSD might affect retrieval of these events). Moreover, if PTSD is a precondition for these memory deficits and PTSD occurs in only 15% of cases of individuals who are exposed to a traumatic stressor (Bremner et al., 2003), then these effects may be relatively infrequent even in maltreated individuals. Indeed, given the high comorbidity rates that frequently occur with PTSD (e.g., Yehuda & McFarlane, 1995), PTSD may not be the sole source of observed deficits in memory performance.

How might maltreatment and the emotional sequelae of abuse affect children's memory (see also Eisen et al., 2002)? On the one hand, those who have been traumatized may experience permanent changes to the ways their memory operates. For example, it has been suggested that memory performance may be enhanced. Specifically, maltreated adults and children may be hypervigilant for event details; for example, Carlson, Furby, Armstrong, and Shales (1997) noted that adults with a history of physical or sexual abuse experience hyperarousal (perhaps as a preparatory response to a heightened expectation of danger), which in turn could lead to heightened attention and perhaps better encoding. Such hypervigilance may extend beyond stressful situations and can potentially have a positive influence on memory processing in general (see Rieder & Cicchetti, 1989), especially for affectively arousing material that may be consonant with experiences of maltreatment.

On the other hand, there are reasons to suspect that memory (basic processes, susceptibility to misinformation, and storage and retrieval of traumatic events) is somehow worse in those who have been abused than in those who have not been abused. For example, a history of child maltreatment has recently been associated with core deficits in cognitive processing, leading to a greater impairment in memory for autobiographical events in adult women (e.g., Henderson, Hargreaves, Gregory, & Williams, 2002). As well, child maltreatment may adversely affect memory because of physiological changes to those neural mechanisms related to memory storage and retrieval (Bremner, Krystal, Southwick, & Charney, 1995; Cicchetti & Rogosch, 2001a, 2001b; Rausch, 1996; but see De Bellis et al., 2001; for a review, see Howe, 1998). In addition to these direct effects of maltreatment there is reason to suspect that maltreatment can have an indirect and adverse affect on memory. Specifically, trauma theorists contend that maltreated children's memory may be poorer than that of others because of stress and dissociation (e.g., Briere, 1992; Putnam, 1997). Although dissociation has been related to suggestibility in adults (e.g., Hyman & Billings, 1998), no associations have been uncovered in children (Eisen et al., 2002). As well, child maltreatment has been associated with lower IQ and vocabulary scores (e.g., Friedrich, Einbender, & Leucke, 1983; Tarter, Hegedus, Winsten, & Alterman, 1984), both of which predict memory performance, especially at the extremes of these scales (e.g., Dent, 1992). Finally, maltreatment has been associated with psychopathology and disturbed family and social relations (e.g., Cicchetti & Toth, 1993, 1995; Toth & Cicchetti, 1993), factors that have also been related to alterations in memory performance in adults and children (see Eisen et al., 2002).

For all of these reasons, then, there exists the very strong possibility that maltreated children will somehow be different (better or worse) in memory performance than children who have not been maltreated. As indicated throughout our review, what research does exist cannot help us decide between these two opposing alternatives. Overall, the research suggests that (a) there are no differences in maltreated children's memory for eyewitnessed events or in their degree of susceptibility to misinformation and suggestion unless additional indexes of childhood psychopathology are present (Bidrose & Goodman, 2000; Eisen, Goodman, Qin, & Davis, 1998; Eisen et al., 2002; Goodman, Bottoms, Rudy, Davis, & Schwartz-Kenney, 2001; Katz, Schonfeld, Carter, Leventhal, & Cicchetti, 1995; Sternberg, Lamb, Esplin, Orbach, & Hershkowitz, 2002); (b) increased levels of cortisol (a stress-responsive hormone that has been associated with damage to the hippocampus; see Sapolsky, 2000) have a negative effect on memory, particularly declarative memory (de Quervain, Roozendaal, Nitsch, McGaugh, & Hock, 2000; Kirschbaum, Wolf, May, Wippich, & Hellhammer, 1996; Newcomer et al., 1999), and when PTSD is diagnosed, memory performance is poor in children (Moradi et al., 1999) and there are noticeable declines in hippocampal volume, at least in adulthood (Bremner et al., 2003); and (c) increased levels of cortisol have a positive effect on memory (Beckwith, Petros, Scaglione, & Nelson, 1986; de Kloet, Oitzl, & Joels, 1999; Lupien, Gillin, & Hauger, 1999), particularly for emotional memory regardless of valence (e.g., Buchanan & Lovallo, 2001), and PTSD does not result in poorer memory performance (Beers & De Bellis, 2002) or changes in children's hippocampal volume (De Bellis et al., 2001).

Children's False Memories

A key issue in the recent literature on children's memory is whether young children are particularly prone to false memories. Evidence that they are comes from young children's spontaneous false memories in narrative recall, recall of real-life sequences, and recall and recognition of word and picture lists (for a review, see Brainerd & Reyna, 2002). However, empirical work using one of the most studied false memory procedures, at least with adults, the DRM paradigm (Deese, 1959; Roediger & McDermott, 1995), has shown that quite the opposite occurs—that is, older not younger children are more susceptible to false memory illusions (Brainerd et al., 2002; Price, Metzger, Williams, Phelps, & Phelps, 2001). This may be because older, but not younger, children are able to extract the gist necessary to generate false memories in the DRM procedure (see Brainerd et al., 2002).

In this procedure, participants study word (or picture) lists whose members are easily categorizable (e.g., *bed*, *rest*, *awake*, *tired*, *dream*, *wake*, *snooze*, *blanket*, *doze*, *slumber*, *snore*, and *nap* are all semantic associates of *sleep*). Participants are then asked to recall as many words as they can from the just-presented list. The key outcome is that in addition to recalling correctly the words that were actually on the list (e.g., *bed*, *rest*) at an average rate of 60%, there also tends to be very high levels (e.g., 48%; Roediger & McDermott, 1995) of false recall of the critical unpresented words (e.g., *sleep*). When recognition tests are administered, false alarm rates for critical unpresented words can rise to 76%, a figure that is not reliably different from hit rates for presented words (78%; Roediger & McDermott, 1995).

Although numerous studies have been conducted with adults using the DRM procedure, only three such studies have involved children (Brainerd et al., 2002; Ghetti, Qin, & Goodman, 2002; Price et al., 2001). Price et al. (2001) found that false recall and recognition of the critical unpresented words increased between childhood and adolescence and again between adolescence and adulthood. Although Brainerd et al. (2002) found the same developmental trend, Ghetti et al. (2002) found that false recall (but not recognition) decreased between 5 and 7 years of age and between 7 years of age and adulthood. Note, however, that this latter finding may have occurred because of procedural differences rather than representing a true reversal of the developmental trend. That is, Ghetti et al.'s DRM lists were shorter (7 words rather than the usual 14) and were presented differently, either as words presented orally or as pictures (presented visually) and words (presented orally). Most important for the present study, no DRM studies have examined maltreated or low-SES children.

The Present Study

There were two main purposes to this study. First, we wanted to provide additional evidence concerning the nature of developmental trends in false memories during childhood. Second, we were interested in whether these same patterns existed for maltreated children. Although maltreated children's susceptibility to suggestion and misleading information appears to follow the same trend as that established for nonmaltreated children (Eisen et al., 2002), this may not hold for false memories, partic-

ularly because false memories appear to follow a different developmental trajectory. To avoid certain methodological confounds, we examined true and false memories in three groups: low-SES maltreated children, low-SES nonmaltreated children, and middle-SES children. The first two groups were used to separate SES factors from maltreatment, and the latter group was used because it is typical of most other studies of memory and thus representative of the samples from which conclusions about children's memory for trauma and their susceptibility to false memories have been derived.

Method

Participants

There were 60 middle-SES children (30 males, 30 females), 51 nonmaltreated low-SES comparison children (22 males, 29 females), and 48 maltreated low-SES children (22 males, 26 females) across three age groupings: 5 to 7 years ($M = 6$ years 2 months), 8 to 9 years ($M = 8$ years 5 months), and 10 to 12 years ($M = 11$ years 2 months). The middle-SES children, like the middle-class samples in most memory studies, were predominantly White and were selected from schools in a mid-sized Canadian city located approximately 30 miles from the U.S. border. The low-income maltreated and nonmaltreated children were from an urban upstate New York setting located not far from the Canadian border. The maltreated children were selected from those reported to the local Department of Human and Health Services (DHHS) for concerns related to child maltreatment. Demographically comparable nonmaltreated children were recruited from the same neighborhoods where the maltreated children resided.

The two groups of low-income maltreated and nonmaltreated children were comparable on a range of demographic features. The gender distribution of the two groups, as reported previously, was equivalent $\chi^2(1) = 1.20$, *ns*. The majority of the children (84.8%) were of minority race/ethnicity, and the two groups did not differ significantly, $\chi^2(1) = 3.70$, *ns*. Additionally, the groups were comparable in terms of per capita family income, averaging $4,876 and $5,281, respectively, for the maltreated and nonmaltreated groups, $t(88) = 1.24$, *ns*.

All parents provided informed consent for their child's participation and all low-income families also gave consent for examination of any DHHS records pertaining to the family. Specifically, families identified as having a child between the ages of 5 and 12 years with a documented history of maltreatment were contacted by a DHHS liaison, who requested permission from consenting families for project staff to contact them regarding study participation. Determination of maltreatment status was based on detailed examination of Child Protective Service (CPS) and Preventive Services records at DHHS. Children in the maltreatment group had been identified by DHHS as having experienced child abuse or neglect. Although multiple perpetrators of maltreatment may have been present, mothers were named as a perpetrator in all reports for at least one type of maltreatment. Therefore, for example, although a male partner may have been the identified perpetrator of an occurrence of sexual abuse, the mother also would have been named as a perpetrator of neglect. The maltreated sample was representative of families receiving services at the county DHHS with respect to low-income and minority racial/ethnic status.

All existing DHHS records for these families were screened and coded by raters, using the Barnett, Manly, and Cicchetti (1993) nosological classification system for child maltreatment. Thus, the assessment of maltreatment history was based on multiple informants who could include caregivers, CPS workers, neighbors, and other community members (e.g., teachers, physicians, police, and day care providers). Prior investigations using this system have shown it to be reliable and valid in classifying incidents and in differentiating among maltreatment subtypes (e.g., Bolger & Patterson, 2001; Manly, Kim, Rogosch, & Cicchetti, 2001). Trained staff did the coding and adequate reliability was obtained (weighted kappas ranged from .86 to .98).

In accord with the Barnett et al. (1993) classification system for maltreatment subtype, *sexual abuse* was coded when any sexual contact or attempted sexual conduct occurred between a child and an adult. Coded incidents ranged from exposure to inappropriate sexual activities to forced intercourse. *Physical abuse* was rated if DHHS records indicated that a caregiver had inflicted a physical injury on a child by nonaccidental means. Physical abuse incidents ranged from corporal punishment that was deemed excessive because of bruising to permanently disfiguring injuries, such as severe burns. *Neglect* was coded if records indicated that a caregiver had failed to provide minimal care in meeting the child's physical needs or the necessary supervision to ensure the child's safety in and out of the home. Examples of typical neglect incidents included leaving a young child alone, failing to maintain sanitary living conditions, and lack of providing

adequate nourishment. *Emotional maltreatment* was coded for incidents involving persistent or extreme thwarting of children's emotional needs. Examples of incidents coded as emotional maltreatment included serious threats to injure a child, exposure to violent acts among family members, caregivers' attempts to commit suicide in the presence of the child, and repeated berating of the child.

The abuse and neglect experiences of the maltreated sample were diverse. In fact, 64.6% had been emotionally maltreated, 83.3% had been neglected, 31.3% had been physically abused, and 16.7% had been sexually abused. Consequently, the majority of maltreated children (68.8%) had experienced multiple subtypes of maltreatment, consistent with other samples of maltreated children and the nature of child maltreatment (Barnett et al., 1993; Cicchetti & Barnett, 1991). Because children had routinely experienced multiple subtypes of maltreatment, analyses focused exclusively on the effect of maltreatment and did not seek to delimit the possible relative effects of subtype of maltreatment.

Low-SES nonmaltreated children were recruited from families receiving public assistance (e.g., Temporary Assistance to Needy Families). These families were selected based on their similarity to the demographic characteristics of the maltreating families. Nonmaltreatment status was determined by confirmation through record searches of an absence of any CPS or Preventive Services records for the family and further verified by maternal report. During maternal interviews to provide an additional screen for child maltreatment, mothers were queried regarding any family involvement with CPS or Preventive Services. Additionally, all mothers were interviewed regarding the presence of child experiences that may have reflected the presence of maltreatment (according to the Barnett et al., 1993, classification). The interview format was open-ended to minimize the likelihood of defensive denial. For example, questions such as ''Has there ever been a time when your child experienced a lack of food, clothing, or shelter?'' or ''Has your child ever had an injury that was due to a non-accidental event?'' were asked to assess the presence of each possible subtype of maltreatment. If any questions were addressed affirmatively, specific follow-up probes (e.g., ''How old was the child when this occurred?'' ''Who or what was responsible for the injury?'') were used to determine whether the event involved maltreatment. Families were excluded from the nonmaltreatment group if there was any family history of DHHS involvement as indicated by record searches or maternal report.

Finally, to form a middle-SES sample based on selection procedures typically used in memory studies, so that their performance could be compared with prior studies, their maltreatment history was not examined. Thus, as in other studies of memory development, it is possible that some children had been maltreated.

Materials and Procedure

The methodology was based on a 3 (age: 5–7, 8–9, 10–12 years old) $\times$ 3 (sample: middle SES, low SES nonmaltreated, low SES maltreated) $\times$ 2 (list: high, low) $\times$ 2 (poststudy activity: recall, symbol mapping) design where the first two factors were between subjects and the last two factors were within subject. This last manipulation, poststudy activity, was introduced after the presentation of each DRM list. This was done to: (a) have a measure of false memories in recall and (b) control for the effects of recall on the terminal recognition test by having a nonmemory task for half of the lists instead of memory (recall) test before the recognition test.

Each child listened to recordings of twelve 14-item DRM lists, which have been used previously with adults (Stadler, Roediger, & McDermott, 1999) and children (e.g., Brainerd et al., 2002). (See the Appendix for the items used in this study. Note that the critical words and the 15th item from these lists were not presented at study.) Because the critical word was never presented for any of these lists, subsequent recall (or recognition) of the critical word was taken as evidence of false memory. Although it might be argued that age or sample differences in true and false memories, if obtained, might be an artifact of developmental and sample differences in word difficulty, there are several reasons these lists are appropriate for use with different-aged children in the different samples. First, Brainerd et al. (2002) conducted detailed analyses on these lists concerning the relation between word difficulty and magnitude of the DRM illusion and found no relation within or between age groups. Second, Reed, Mangan, Warren, Price, and Metzger (2003) used child-appropriate lists (generated by the children themselves) and obtained the same age trends found in Brainerd et al.'s study as well as those we obtained in the current experiment. Thus, these materials do not produce spurious age trends in true and false memories because of correlations between age and word difficulty. In addition, our own pilot testing indicated that children in all samples and across all age groups understood the meanings of the words used in this study. That is, a separate group of children (not

tested in the experiment reported here) from each of the Age × Sample combinations were presented with the words on the different lists and asked what they meant. Most of the children were able to tell us the meanings of most of the words on the lists.

As determined by previous research, six of the lists used here yielded the highest levels of false recall (incorrectly recalling critical words implied by the exemplars on the list but not presented during study—see the capitalized items in the Appendix) in children and adults (58%) and the other six yielded the lowest levels of false recall in children and adults (22%). Mean levels of true recall did not differ between these lists (61% vs. 62%). Each list was presented on an audio recording (2-s presentation rate). Children were given general instructions indicating that after some of the lists they heard they would be asked to recall as many of the words as possible and that for other lists they would be asked to engage in a symbol-mapping task (practice was given on this task). For half of the high and half of the low lists, children were asked (after list presentation) to recall as many words as they could from the list they had just heard. For the other half of the lists, children engaged in nonmemorial activity (symbol mapping). Following presentation of the 12th list, a simple yes–no recognition test was administered. Test words were presented one at a time on an audio tape and participants were instructed to say "yes" to old words that had previously appeared on the studied lists and to say "no" to new words that had not appeared on the study list (distractors). The test list was composed of 72 words: (a) 36 targets (3 selected at random from each of the 12 lists; e.g., *woman*, *husband*, *uncle*; see the Appendix), (b) 12 critical distractors for the presented lists (e.g., *man*; see the Appendix), (c) 12 other semantically related distractors (1 from each of the lists; e.g., the unpresented 15th list item, *old*; see the Appendix), (d) 6 unrelated distractors selected at random from among the targets on unpresented lists (e.g., *elastic*, *pin*, *loud*, *dark*; see Stadler et al., 1999, for other lists not used as study lists in this experiment from which these items were drawn), and (e) 6 unrelated critical distractors selected at random from the unpresented lists (e.g., *smoke*, *soft*, *black*, *army*; see Stadler et al., 1999, for other lists not used as study lists in this experiment from which these items were drawn). Distractors from Groups b and c were semantically related to the presented lists and the targets in Group a, whereas those from Groups d and e were not semantically related. Such distractors are included on recognition tests so that true memory for targets (Group a) and semantically based false memory (Groups b and c) can be discriminated from response bias (yea-saying). Distractors in Group d provide a response bias control for items in Groups a and c and distractors in Group e provide a response bias (yea-saying) control for items in Group b.

Results

Summary statistics (proportion correct) for recall and recognition are presented by status and age level in Table 1. Because recognition scores were affected by age differences in yea-saying (more for younger children), raw hit rates were not an appropriate measure for true memory, raw false alarm rates were not an appropriate measure for critical distractors, and false alarm rates for semantically related distractors were not an appropriate measure for meaning-based false memory. Instead, raw hit and false alarm rates were corrected for differences in yea-saying using the nonparametric signal detection statistic A' (see Brainerd et al., 2002; Snodgrass & Corwin, 1988). These scores are presented in Table 2. Because there were no specific predictions concerning gender effects in either the recall or recognition measures, and because preliminary analyses involving gender revealed no significant effects due to this factor, gender is not considered further in the analyses.

Recall

A 3 (age: 5–7, 8–9, 10–12 years) × 3 (sample: middle SES, low SES nonmaltreated, low SES maltreated) × 2 (type of recall: true vs. false) × 2 (list: high vs. low) analysis of variance (ANOVA) was computed using recall proportions for targets (recall of presented items) and critical distractors (false recall of implied but not presented items) as the dependent variable. The ANOVA produced a main effect for age, $F(2, 150) = 24.30$, $p < .001$, $\eta^2 = .245$, where post hoc tests ($p < .05$) showed that recall improved significantly across all age comparisons (5- to 7-year-old $M = .155$, 8- to 9-year-old $M = .221$, 10- to 12-year-old $M = .306$); a main effect for type of recall, $F(1, 150) = 49.67$, $p < .001$, $\eta^2 = .249$, where recall was significantly better for targets ($M = .291$) than for critical distractors ($M = .164$); and a main effect for list, $F(1, 150) = 6.10$, $p < .05$, $\eta^2 = .039$, where recall was significantly better on high ($M = .244$) than low ($M = .210$) lists.

For the most part, these findings are identical to those obtained by Brainerd et al. (2002). However, unlike Brainerd et al.'s results, we obtained a Type of Recall × List interaction, $F(1, 150) = 19.06$, $p < .001$, $\eta^2 = .113$. As might be expected, post hoc analyses

Table 1
Proportions of Different Types of Responses on the DRM Recall and Recognition Tests

	Sample								
	Middle SES			Low-SES nonmaltreated			Low-SES maltreated		
Age	5–7	8–9	10–12	5–7	8–9	10–12	5–7	8–9	10–12
Sample size	(20)	(20)	(20)	(22)	(14)	(15)	(15)	(18)	(15)
Condition/item									
				Recall test					
Correct recall									
High	.19	.26	.40	.20	.22	.31	.14	.40	.38
Low	.21	.31	.47	.26	.28	.35	.18	.32	.37
False recall									
High	.15	.20	.32	.17	.09	.22	.16	.26	.33
Low	.05	.07	.22	.08	.09	.13	.09	.15	.18
				Recognition test: Previously recalled lists					
Target									
High	.63	.62	.66	.52	.43	.65	.67	.69	.67
Low	.66	.63	.74	.58	.58	.69	.51	.74	.62
Critical distractor									
High	.65	.63	.87	.52	.55	.69	.80	.74	.70
Low	.62	.60	.75	.55	.38	.60	.62	.61	.60
Related distractor									
High	.53	.40	.37	.23	.14	.31	.47	.41	.33
Low	.58	.38	.25	.39	.36	.36	.44	.39	.38
				Recognition test: Previously unrecalled lists					
Target									
High	.60	.51	.59	.49	.36	.64	.61	.62	.53
Low	.68	.59	.62	.51	.56	.75	.59	.64	.64
Critical distractor									
High	.55	.63	.67	.55	.48	.69	.56	.65	.67
Low	.65	.62	.73	.56	.55	.44	.56	.74	.62
Related distractor									
High	.50	.35	.22	.30	.18	.24	.44	.43	.33
Low	.57	.40	.42	.39	.19	.38	.49	.48	.29

Note. DRM = Deese–Roediger–McDermott; SES = socioeconomic status.

($p < .05$) revealed that (a) recall of the targets was better than false recall of the critical distractors, (b) there were no reliable differences between recall of the targets for the high ($M = .277$) and low ($M = .304$) lists, and (c) there was significantly more false recall for the high ($M = .211$) than the low ($M = .117$) lists.

Finally, there was an Age × Sample interaction, $F(4, 150) = 3.01$, $p < .05$, $\eta^2 = .074$. As can be seen in Figure 1, the source of this interaction was straightforward. Like the main effect for age, recall differences were reliable between each age for the middle-SES and low-SES maltreated children, but in the low-SES nonmaltreated sample was significantly higher only between the 10- to 12-year-old group and the other two groups.

This pattern of findings for recall is important for three reasons. First, like other studies in this field (e.g., Brainerd et al., 2002; Price et al., 2001), there were age-related increases in both true and false memory (i.e., there was a main effect of age and it was not modified by an Age × Type of Recall interaction). Moreover, false memories were more likely with high than low lists although true recall did not differ. It is particularly notable that there were no differences in susceptibility to false memories as a function of maltreatment. Second, this pattern held for all samples regardless of SES. Third, and particularly notable, there were no differences in susceptibility to false memories as a function of maltreatment.

Table 2
A′ Values for the Different Types of Responses on the DRM Recognition Test

	Sample and age								
	Middle SES			Low-SES nonmaltreated			Low-SES maltreated		
	5–7	8–9	10–12	5–7	8–9	10–12	5–7	8–9	10–12
Condition/item									
				Previously recalled lists					
Target									
High	.61	.69	.83	.61	.72	.75	.61	.79	.76
Low	.69	.77	.85	.63	.78	.80	.49	.75	.74
Critical distractor									
High	.74	.79	.91	.63	.77	.78	.72	.74	.78
Low	.62	.76	.84	.68	.68	.72	.57	.66	.72
Related distractor									
High	.65	.60	.60	.43	.42	.51	.47	.59	.54
Low	.67	.64	.51	.62	.67	.57	.42	.50	.61
				Previously unrecalled lists					
Target									
High	.64	.57	.75	.62	.68	.79	.57	.70	.70
Low	.73	.70	.78	.60	.77	.74	.57	.72	.79
Critical distractor									
High	.62	.74	.73	.68	.72	.80	.55	.73	.71
Low	.68	.79	.82	.76	.82	.64	.52	.80	.79
Related distractor									
High	.58	.55	.40	.49	.38	.45	.44	.50	.56
Low	.65	.66	.62	.55	.41	.61	.45	.64	.62

Note. DRM = Deese–Roediger–McDermott; SES = socioeconomic status.

Recognition

Recall that because of age differences in yea-saying, nonparametric A' scores were used instead of raw recognition data. The formulas[1] for computing A' are straightforward (see Snodgrass & Corwin, 1988) and once calculated, a value of .5 indicates an absence of true recognition (low accuracy—no higher acceptance rates for targets than for unrelated distractors) or an absence of semantic false recognition (low levels of false memory—no higher acceptance rates for related distractors that preserve some of the meaning content of studied material than for unrelated distractors). A value of 1 indicates perfect true (high accuracy) or false (high levels of false memory) recognition. Using this metric, a 3 (age: 5–7, 8–9, 10–12 years) × 3 (sample: middle SES, nonmaltreated, maltreated) × 3 (type of item: target, critical distractor, related distractor) × 2 (list: high vs. low) × 2 (poststudy activity: recall vs. symbol mapping) ANOVA was computed and produced the following outcomes: a main effect for age, $F(2, 102) = 4.34$, $p < .05$, $\eta^2 = .062$, where post hoc tests ($p < .05$) showed that recognition increased significantly between 5 to 7 years of age ($M = .60$) and 8 to 9 years of age ($M = .73$) but did not change thereafter ($M = .70$ for 10- to 12-year-olds); a main effect for type of item, $F(2, 204) = 70.54$, $p < .001$,

[1]The use of the nonparametric statistic A' is common in the literature (see Brainerd et al., 2002) and is the counterpart of the more familiar signal detection statistic d' (Snodgrass & Corwin, 1988). For targets, $A' = .5 + [(H - FA_T)(1 + H - FA_T)] \div [4H(1 - FA_T)]$, where H is the proportion of hits for targets from presented lists and FA_T is the proportion of false alarms for targets from unpresented lists. This equation applies given that $H \geq FA$. When $H < FA$, the relevant equation is, $A' = .5 - [(FA_T - H)(1 - H + FA_T)] \div [4FA_T\ (1 - H)]$. For related distractors, $A' = .5 + [(FA_R - FA_T)(1 + FA_R - FA_T)] \div [4FA_R(1 - FA_T)]$, where FA_R is the proportion of false alarms for related distractors for presented lists and FA_T is the proportion of false alarms for targets from unpresented lists. This equation applies given that $FA_R \geq FA_T$. When $FA_R < FA_T$, the relevant equation is, $A' = .5 - [(FA_T - FA_R)(1 - FA_R + FA_T)] \div [4FA_T(1 - FA_R)]$. For critical distractors, $A' = .5 + [(FA_{CDP} - FA_{CDN})(1 + FA_{CDP} - FA_{CDN})] \div [4FA_{CDP}(1 - FA_{CDN})]$, where FA_{CDP} is the proportion of false alarms for critical distractors from presented lists and FA_{CDN} is the proportion of false alarms for critical distractors from unpresented lists. This equation applies given that $FA_{CDP} \geq FA_{CDN}$. If $FA_{CDP} < FA_{CDN}$, the relevant equation is, $A' = .5 - [(FA_{CDN} - FA_{CDP})(1 - FA_{CDP} + FA_{CDN})] \div [4FA_{CDN}(1 - FA_{CDP})]$.

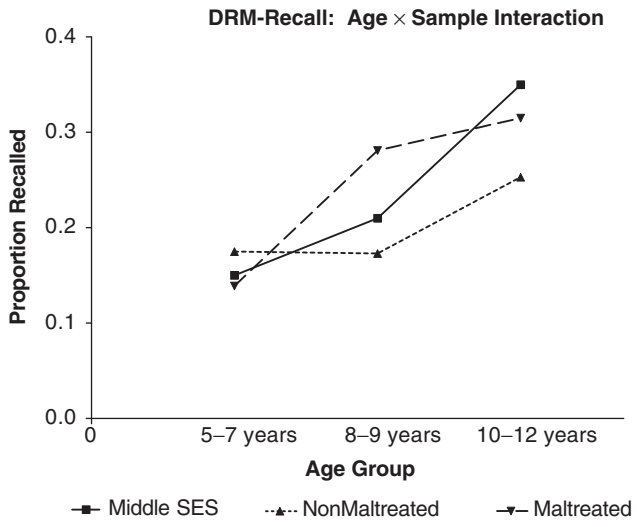

Figure 1. Mean proportion recalled as a function of age and sample. DRM = Deese – Roediger – McDermott; SES = socioeconomic status.

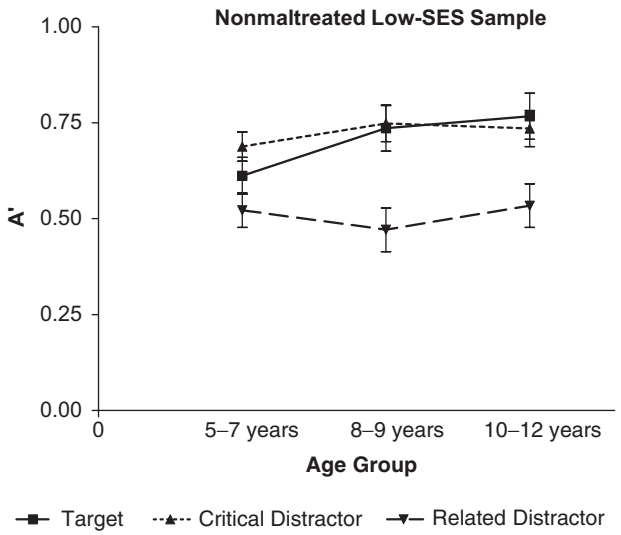

Figure 3. *A′* recognition scores for the nonmaltreated low-socioeconomic-status (SES) sample as a function of age.

$\eta^2 = .409$, where post hoc tests showed that true recognition was significantly better for targets ($M = .717$) and false recognition for critical distractors ($M = .740$) than for related distractors ($M = .565$); and a main effect for sample, $F(2, 102) = 3.36$, $p < .05$, $\eta^2 = .062$, where post hoc tests showed that recognition was significantly higher for middle-SES children ($M = .741$) than for either low-SES nonmaltreated ($M = .646$) or low-SES maltreated ($M = .634$) children, and the latter two groups did not differ.

In addition, there was a Type of Item × Age interaction, $F(4, 204) = 3.98$, $p < .01$, $\eta^2 = .072$, that was modified by a Type of Item × Age × Sample interaction, $F(8, 204) = 2.453$, $p < .05$, $\eta^2 = .088$. This latter interaction is shown in the next few figures and when analyzed using post hoc tests ($p < .05$) revealed the following pattern: significant age increases in both true (target) and false (critical distractor) recognition for middle-SES children (Figure 2), but no reliable age increments in either true (target) or false (critical distractor) recognition for low-SES nonmaltreated (Figure 3) or low-SES maltreated (Figure 4) children. Notice that although they may not be significant in all cases, age trends do exist in all of the populations sampled in this study. In fact, both true and false recognition scores increased for children in

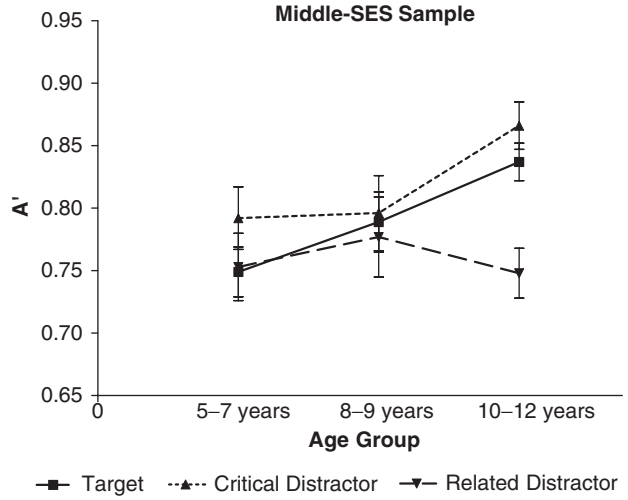

Figure 2. *A′* recognition scores for the middle-socioeconomic-status (SES) sample as a function of age.

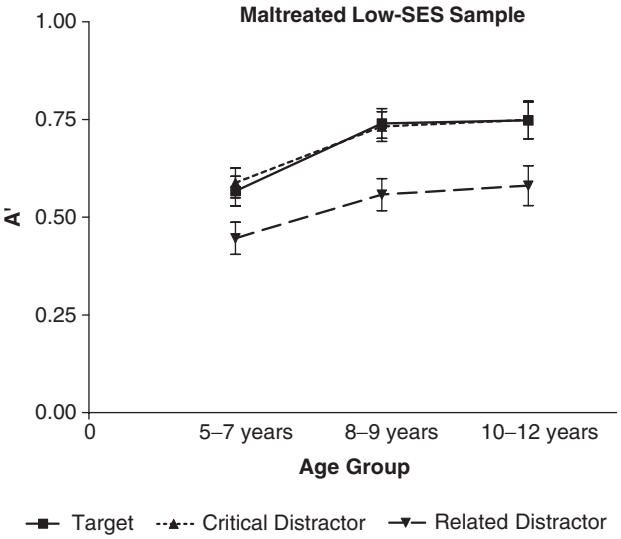

Figure 4. *A′* recognition scores for the maltreated low-socioeconomic-status (SES) sample as a function of age.

all groups. False recognition of related distractors either remained constant or declined for the middle-SES children or remained constant or increased for the low-SES children (both nonmaltreated and maltreated). Thus, although children falsely recognized the critical distractors, and there were developmental trends indicating that both true and false recognition increased with age, such increases were only statistically reliable for the middle-SES sample.

Discussion

For some time, it has been thought that maltreated children's memory processes are somehow fundamentally different from those of nonmaltreated children. Some of this speculation has been predicated on the idea that maltreated children's memory might be better than other children's memory because of changes in factors such as hypervigilance to aggressive stimuli (e.g., Rieder & Cicchetti, 1989). Others have speculated that a history of child maltreatment results in memory deficits, not advantages, that are driven primarily by physiological changes in the neural substrates that subserve memory (e.g., Bremner et al., 1995). These differing theoretical perspectives on memory and maltreatment notwithstanding, the limited body of empirical studies on this topic reveals no differences in basic memory processes as a function of child maltreatment (e.g., Eisen et al., 2002; Goodman et al., 2001). Indeed, as pointed out earlier, maltreated children appear to be no different from other children in their susceptibility to suggestion and misleading information (unless there are comorbidity differences in psychopathology; see Eisen et al., 2002).

The purpose of the current study was to: (a) provide converging evidence concerning the nature of developmental trends in children's false memories and (b) to extend the research on basic memory processes in maltreated children to another area critical to our understanding of the effects of chronic stress on memory, namely, false memories. Specifically, the development of maltreated and nonmaltreated children's true and false memories was examined using a standardized DRM procedure that has been intensively researched in recent years with adults but less so with children. This study is unique as it is the first to examine false memories using the DRM paradigm in maltreated and low-SES children. The results of this study are clear. First, both true and false memories tended to increase with age in all of the samples, maltreated and nonmaltreated. Second, all of the children, maltreated and nonmaltreated, exhibited false memories. That is, the data showed that, regardless of whether recall or recognition (A') measures were being analyzed, maltreated children were just as susceptible to the false memory illusion as nonmaltreated low- and middle-SES children.

These findings correspond well with what might have been anticipated on the basis of prior research. That is, the developmental trends in true and false memories are consistent with previously published studies that have also shown an increase with age (e.g., Brainerd et al., 2002). As well, that there were striking similarities in false recall and recognition performance for maltreated and nonmaltreated children is consistent with research that has looked at other basic processes in maltreated and nonmaltreated children's memory. Specifically, these results agree with the study by Eisen et al. (2002), who found that maltreated children were no more or less susceptible to suggestion and misleading information than nonmaltreated children.

The fact that low-SES maltreated and nonmaltreated children in the present study did not exhibit the same statistically reliable age increments as did middle-SES children in recognition scores may provide a source of dissimilarity in memory trends. Note, however, that these differences apparently are not related to maltreatment per se. That is, because the age trends were not statistically reliable in either of the lower SES samples, these differences may be under the control of factors associated with SES and not maltreatment. Although SES (middle and low) was confounded with country (Canada and the United States), there is no reason to believe that country (and not SES) would be the main source of these differences. This is because the words have the same meanings in both countries, all groups are educated in the English language, and the children share a similar North American environment (and lived in cities that were within 30 miles of the Canada–U.S. border). Moreover, conclusions about middle-SES children's memory for traumatic events and susceptibility to false memories have not differed substantially regardless of whether populations have come from Canada or the United States. Indeed, the results obtained here are consistent with that general literature.

As it turns out, SES differences in memory are reasonably well established. In a meta-analysis by Richardson (1998; see also Guadagno & Herrmann, 1998; Herrmann & Guadagno, 1997), it was shown that SES differences in memory are related to both what is being remembered (content) and the context in which it is being memorized. For example, Newcomb and Collins (1979) found that children of low SES remembered less about a television program

with a White middle-class family than did children of middle SES but more about a program with an African American lower-class family even when the child viewer's ethnicity was controlled. Overall, Richardson's analysis demonstrated that SES was more strongly related to retrieval of information previously stored in semantic memory than to the capacity to encode and retrieve new information from episodic memory.

Support for these arguments may be found in the findings from the current experiment. Recall that sample interacted with other design variables for the recognition measures but not for the recall measures. In recent years, differences between recall and recognition tests routinely have shown that semantic false recognition effects are typically high, whereas intrusions of the same semantic associates on recall tests are low. Seamon et al. (2002) suggested that hits and false alarms on recognition tests are based on gist memories for experience whereas performance on recall tests depends more on accessing verbatim traces of the presentation of individual targets. This raises the interesting possibility that the SES-related deficits in children's memories are localized within the ability to retrieve the meaning relations between targets, a suggestion consistent with the findings from Richardson's (1998) meta-analysis. This is also consistent with the observation that SES-related differences in memory could be the result of differences in prior experiences (see also Dartigues et al., 1992). Thus, although it is known that even the youngest children tested in this study are able spontaneously to use category or semantic information to improve memory performance (e.g., Howe, 2004), in the current study it may be that the necessary developments in semantic or gist processing that contribute to the increase in false memories using the DRM procedure (see Brainerd et al., 2002) may be occurring more slowly or in different domains in low- than middle-SES children. This in turn may be the result of different educational and life experiences. Regardless, age trends in true and false memories were evident in all groups in this study (just not statistically reliable in all of the groups). It is clear, however, that children in all groups were susceptible to false memories regardless of whether recall or recognition measures were being used, and like much of the previous research in this area (but see Ghetti et al., 2002), these trends tended to increase with age.

Despite the importance of these findings, limitations of the investigation also must be acknowledged. The fact that we did not analyze for differences by subtype of maltreatment precludes us from examining any differences in basic memory that may have been associated with the type of maltreatment experienced. To conduct such analyses, much larger samples of maltreated children are necessary. Moreover, although the use of a standardized DRM paradigm allowed this sample of maltreated children to be compared with the normative literature, it does not address the possibility that material more salient to trauma might affect memory differently. Finally, although work with adult populations has found that those with PTSD are more prone to false memories (cf. Bremner et al., 2000), the absence of assessments of PTSD on the children in our sample precludes our ability to address this matter.

In the main, these results indicate that recall and recognition of both true and false memories are no different in low-SES maltreated children than in low-SES nonmaltreated and middle-SES children. That is, regardless of group status, children were subject to false memories using the DRM procedure. The fact that false memories increased with age is consistent with other findings in children's memory research with the DRM procedure (e.g., Brainerd et al., 2002; Price et al., 2001) and is consistent with fuzzy-trace theory's gist-failure explanation. Here, because it is critical that gist relations among list items be extracted for false memories to be generated, younger children whose gist processing is less well developed than that of older children are less likely to be susceptible to the DRM illusion (Brainerd et al., 2002). Thus, contrary to the literature on children's suggestibility in which younger children are often portrayed as being more susceptible to misinformation than older children (see review by Bruck & Ceci, 1999), spontaneous false memories that are gist based are more likely in older than in younger children. The present study also indicates that this trend holds regardless of whether children have or have not been maltreated.

This is the first study to use the DRM procedure to investigate false memories in low-SES and maltreated children. The findings clearly indicate that for all children true and false memories increase with age and that although middle-SES children are better at remembering than low-SES children, there are no differences between maltreated and nonmaltreated children's true and false memories. These findings add to the growing literature concerning age increments in the magnitude of the DRM illusion in childhood (Brainerd et al., 2002; Price et al., 2001), as well as recent studies showing that basic memory processes are similar in nonmaltreated and maltreated children (Eisen et al., 2002). However, a

number of important questions remain. First, the false memories we studied here are not the same as those alleged by some to exist in forensic settings. That is, the materials used here were simple lists of concepts, not entire events, and had nothing to do with trauma or abuse. Although there is no reason to believe that research using the DRM procedure should not generalize to false memories in other settings that require gist processing including events, traumatic or otherwise, it is critical that caution be exercised when attempting to apply these findings to forensic proceedings. This may be particularly important inasmuch as the materials used here were not abuse related and it may be that abuse-relevant materials are more salient and memorable. Such an interpretation would be more consistent with the findings of Rieder and Cicchetti (1989), wherein maltreated children were better at recalling aggressive stimuli than were nonmaltreated children. Indeed, memories of abuse involve factors not represented in our study including betrayal of trust (e.g., Freyd, 1996) and secrecy (e.g., Bussey, Lee, & Grimbeek, 1993). Certainly, it may be more difficult to develop false memories for personally experienced traumatic events than it is to make gist-consistent errors on DRM lists. These differences notwithstanding, there is evidence that aspects of memories for real-life experiences can be false as well as evidence that memories for entire events can be false (e.g., Thomas & Loftus, 2002). Moreover, because traditional list-learning studies of memory frequently translate well into other real-world memory settings, the results of the present study may be representative of other false memory situations in which children, maltreated or not, may find themselves.

Second, in light of all the speculation concerning the effects of stress and trauma on basic memory processes, it is curious that such effects (positive or negative) are rare at least in studies of children's basic memory processes. Of course, this does not mean that they do not exist; rather, it is possible that the basic memory tasks used are not sensitive to the changes in memory that may have resulted from maltreatment. However, until such indicators have been unearthed there does not appear to be any empirical basis to the claim that maltreated children's basic memory processes differ significantly from their nonmaltreated counterparts, at least on the sort of task used here. Future research needs to use different paradigms and to vary dimensions such as the personal relevance and affective valence of materials to better inform policy and planning for victims of maltreatment.

References

Barnett, D., Manly, J. T., & Cicchetti, D. (1993). Defining child maltreatment: The interface between policy and research. In D. Cicchetti & S. L. Toth (Eds.), *Child abuse, child development, and social policy* (pp. 7–73). Norwood, NJ: Ablex.

Beckwith, B. E., Petros, T. V., Scaglione, C., & Nelson, J. (1986). Dose-dependent effects of hydrocortisone on memory in human males. *Physiological Behavior, 36*, 283–286.

Beers, S. R., & De Bellis, M. D. (2002). Neuropsychological function in children with maltreatment-related posttraumatic stress disorder. *American Journal of Psychiatry, 159*, 483–486.

Bidrose, S., & Goodman, G. S. (2000). Testimony and evidence: A scientific case study of memory for child sexual abuse. *Applied Cognitive Psychology, 14*, 197–213.

Bolger, K. E., & Patterson, C. J. (2001). Developmental pathways from child maltreatment to peer rejection. *Child Development*, *69*, 1171–1197.

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The self-assessment manikin and the semantic differential. *Journal of Behavior Therapy & Experimental Psychiatry, 25*, 49–59.

Brainerd, C. J., & Reyna, V. F. (2002). Fuzzy-trace theory and false memory. *Current Directions in Psychological Science*, *11*, 164–169.

Brainerd, C. J., Reyna, V. F., & Forrest, T. J. (2002). Are young children susceptible to the false-memory illusion? *Child Development*, *73*, 1363–1377.

Bremner, J. D., Krystal, J. H., Southwick, S. M., & Charney, D. S. (1995). Functional neuroanatomical correlates of the effects of stress on memory. *Journal of Traumatic Stress*, *8*, 527–553.

Bremner, J. D., & Narayan, M. (1998). The effects of stress on memory and the hippocampus throughout the life cycle: Implications for childhood development and aging. *Development and Psychopathology, 10*, 871–885.

Bremner, J. D., Shobe, K. K., & Kihlstrom, J. F. (2000). False memories in women with self-reported childhood sexual abuse: An empirical study. *Psychological Science*, *11*, 333–337.

Bremner, J. D., Vythilingam, M., Vermetten, E., Southwick, S. M., McGlashan, T., Nazeer, A., et al. (2003). MRI and PET study of deficits in hippocampal structure and function in women with childhood sexual abuse and posttraumatic stress disorder. *American Journal of Psychiatry, 160*, 924–932.

Briere, J. (1992). *Child abuse and trauma: Theory and treatment of lasting effects*. Newbury Park, CA: Sage.

Bruck, M., & Ceci, S. J. (1999). The suggestibility of children's memory. *Annual Review of Psychology, 50*, 419–439.

Bruck, M., Ceci, S. J., Francoeur, E., & Barr, R. (1995). "I hardly cried when I got my shot!": Influencing children's reports about a visit to the pediatrician. *Child Development*, *66*, 193–208.

Buchanan, T. W., & Lovallo, W. R. (2001). Enhanced memory for emotional material following stress-level

cortisol treatment in humans. *Psychoneuroendocrinology, 26*, 307–317.

Bugental, D., Blue, J., Cortez, V., Fleck, K., & Rodriguez, A. (1992). Influences of witnessed affect on information processing in children. *Child Development*, *63*, 774–786.

Bussey, K., Lee, K., & Grimbeek, E. J. (1993). Lies and secrets: Implications for children's reporting of sexual abuse. In G. S. Goodman & B. L. Bottoms (Eds.), *Child victims, child witnesses: Understanding and improving testimony* (pp. 147–168). New York: Guilford.

Carlson, E. B., Furby, L., Armstrong, J., & Shales, J. (1997). A conceptual framework for the long-term psychological effects of severe and chronic childhood abuse. *Child Maltreatment*, *2*, 272–295.

Cicchetti, D., & Barnett, D. (1991). Toward the development of a scientific nosology of child maltreatment. In W. Grove & D. Cicchetti (Eds.), *Thinking clearly about psychology: Essays in honor of Paul E. Meehl. Vol. 2: Personality and psychopathology* (pp. 346–377). Minneapolis, MN: University of Minnesota Press.

Cicchetti, D., & Rogosch, F. A. (2001a). Diverse patterns of neuroendocrine activity in maltreated children. *Development and Psychopathology, 13*, 677–694.

Cicchetti, D., & Rogosch, F. A. (2001b). The impact of child maltreatment and psychopathology upon neuroendocrine functioning. *Development and Psychopathology, 13*, 783–804.

Cicchetti, D., & Toth, S. L. (Eds.) (1993). *Child abuse, child development, and social policy.* Norwood, NJ: Ablex.

Cicchetti, D., & Toth, S. L. (1995). A developmental psychopathology perspective on child abuse and neglect. *Journal of the American Academy of Child and Adolescent Psychiatry, 34*, 541–565.

Clancy, S. A., Schacter, D. L., McNally, R. J., & Pitman, R. K. (2000). False recognition in women reporting recovered memories of sexual abuse. *Psychological Science*, *11*, 26–31.

Dartigues, J. F., Gagnon, M., Mazaux, J. M., Barberger-Gateau, P., Commenges, D., Letenneur, L., et al. (1992). Occupation during life and memory performance in nondemented French elderly community residents. *Neurology, 42*, 1697–1701.

De Bellis, M. D. (2001). Developmental traumatology: The psychological development of maltreated children and its implications for research, treatment, and policy. *Development and Psychopathology, 13*, 539–564.

De Bellis, M. D., Hall, J., Boring, A., Frustaci, K., & Moritz, G. (2001). A pilot longitudinal study of hippocampal volumes in pediatric maltreatment-related posttraumatic stress disorder. *Biological Psychiatry, 50*, 305–309.

Deese, J. (1959). On the prediction of occurrence of certain verbal intrusions in free recall. *Journal of Experimental Psychology, 58*, 17–22.

Dent, H. (1992). The effects of age and intelligence on eyewitness ability. In H. Dent & R. Flin (Eds.), *Children as witnesses* (pp. 1–13). Chichester, England: Wiley.

de Kloet, E. R., Oitzl, M. S., & Joels, M. (1999). Stress and cognition: Are corticosteroids good or bad guys? *Trends in Neuroscience*, *22*, 422–426.

de Quervain, D. J.-F., Roozendaal, B., Nitsch, R. M., McGaugh, J. L., & Hock, C. (2000). Acute cortisone administration impairs retrieval of long-term declarative memory in humans. *Nature Neuroscience*, *3*, 313–314.

Dolcos, F., & Cabeza, R. (2002). Event-related potentials of emotional memory: Encoding pleasant, unpleasant, and neutral pictures. *Cognitive, Affective, & Behavioral Neuroscience*, *2*, 252–263.

Eisen, M. L., & Goodman, G. S. (1998). Trauma, memory, and suggestibility in children. *Development and Psychopathology, 10*, 717–738.

Eisen, M. L., Goodman, G. S., Qin, J., & Davis, S. L. (1998). Memory and suggestibility in maltreated children: New research relevant to evaluating allegations of abuse. In S. Lynn & K. McConkey (Eds.), *Truth in memory* (pp. 163–189). New York: Guilford.

Eisen, M. L., Qin, J., Goodman, G. S., & Davis, S. L. (2002). Memory and suggestibility in maltreated children: Age, stress arousal, dissociation, and psychopathology. *Journal of Experimental Child Psychology, 83*, 167–212.

Freyd, J. (1996). *Betrayal trauma*. Cambridge, MA: Harvard University Press.

Friedrich, W. N., Einbender, A., & Leucke, W. J. (1983). Cognitive and behavioral characteristics of physically abused children. *Journal of Consulting and Clinical Psychology, 51*, 313–314.

Ghetti, S., Qin, J., & Goodman, G. S. (2002). False memories in children and adults: Age, distinctiveness, and subjective experience. *Developmental Psychology, 38*, 705–718.

Goodman, G. S., Bottoms, B. L., Rudy, L., Davis, S. L., & Schwartz-Kenney, B. M. (2001). Effects of past abuse experiences on children's eyewitness memory. *Law and Human Behavior*, *25*, 269–298.

Goodman, G. S., & Quas, J. A. (1997). Trauma and memory: Individual differences in children's recounting of a stressful experience. In N. L. Stein, P. A. Ornstein, B. Tversky, & C. J. Brainerd (Eds.), *Memory for everyday and emotional events* (pp. 267–294). Mahwah, NJ: Erlbaum.

Guadagno, M. A., & Herrmann, D. (1998). Further consideration of the role of socio-economic status in memory performance. *Applied Cognitive Psychology, 12*, 611–616.

Henderson, D., Hargreaves, I., Gregory, S., & Williams, J. M. G. (2002). Autobiographical memory and emotion in a nonclinical sample of women with and without a reported history of childhood sexual abuse. *British Journal of Clinical Psychology, 41*, 129–141.

Herrmann, D., & Guadagno, M. A. (1997). Memory performance and socio-economic status. *Applied Cognitive Psychology, 11*, 113–120.

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. (2000). *The fate of early memories: Developmental science and the retention of childhood experiences*. Washington, DC: American Psychological Association.

Howe, M. L. (2004). The role of conceptual recoding in reducing children's retroactive interference. *Developmental Psychology, 40*, 131–139.

Howe, M. L., Courage, M. L., & Peterson, C. (1994). How can I remember when "I" wasn't there: Long-term retention of traumatic experiences and emergence of the cognitive self. *Consciousness and Cognition*, *3*, 327–355.

Howe, M. L., Courage, M. L., & Peterson, C. (1995). Intrusions in preschoolers' recall of traumatic childhood events. *Psychonomic Bulletin & Review*, *2*, 130–134.

Hyman, I. E., & Billings, F. J. (1998). Individual differences and the creation of false childhood memories. *Memory*, *6*, 1–20.

Katz, S., Schonfeld, D., Carter, A., Leventhal, J. M., & Cicchetti, D. (1995). The accuracy of children's reports with anatomically correct dolls. *Developmental and Behavioral Pediatrics*, *16*, 71–76.

Kirschbaum, C., Wolf, O. T., May, M., Wippich, W., & Hellhammer, D. H. (1996). Stress- and treatment-induced elevations of cortisol levels associated with impaired declarative memory in healthy adults. *Life Science*, *58*, 1475–1483.

Lupien, S. J., Gillin, C. J., & Hauger, R. L. (1999). Working memory is more sensitive than declarative memory to the acute effects of corticosteroids: A dose-response study in humans. *Behavioral Neuroscience*, *113*, 420–430.

Manly, J. T., Kim, J. E., Rogosch, F. A., & Cicchetti, D. (2001). Dimensions of child maltreatment and children's adjustment: Contributions of developmental timing and subtype. *Development and Psychopathology, 13*, 759–782.

McNally, R. J. (2003). *Remembering trauma*. Cambridge, MA: Harvard University Press.

Merritt, K. A., Ornstein, P. A., & Spicker, B. (1994). Children's memory for a salient medical procedure: Implications for testimony. *Pediatrics*, *94*, 17–23.

Moradi, A. R., Doost, H. T. N., Taghavi, M. R., Yule, W., & Dalgleish, T. (1999). Everyday memory deficits in children and adolescents with PTSD: Performance on the Rivermead Behavioral Memory Test. *Journal of Child Psychology and Psychiatry, 40*, 357–361.

Nadel, L., & Jacobs, W. J. (1998). Trauma memory is special. *Current Directions in Psychological Science*, *7*, 154–157.

Newcomb, A. F., & Collins, W. A. (1979). Children's comprehension of family role portrayals in televised dramas: Effects of socioeconomic status, ethnicity, and age. *Developmental Psychology, 15*, 417–423.

Newcomer, J. W., Selke, G., Melson, A. K., Hershey, T., Craft, S., Richards, K., et al. (1999). Decreased memory performance in healthy humans induced by stress-level cortisol treatment. *Archives of General Psychiatry, 56*, 527–533.

Peters, D. P. (1987). The impact of naturally occurring stress on children's memory. In S. J. Ceci, M. P. Toglia, & D. F. Ross (Eds.), *Children's eyewitness memory* (pp. 122–141). New York: Springer-Verlag.

Price, J. L., Metzger, R. L., Williams, D., Phelps, N. Z., & Phelps, A. M. (2001, April). *Children produce as many false memories as adults (sometimes!)*. Poster presented at the biennial meeting of the Society for Research in Child Development, Minneapolis, MN.

Putnam, F. W. (1997). *Dissociation in children and adolescents*. New York: Guilford.

Rausch, R. (1996). Effects of surgery on cognitive functioning. In J. C. Sackellares & S. Berent (Eds.), *Psychological disturbances in epilepsy* (pp. 245–258). Boston, MA: Butterworth Heinemann.

Reed, A. W., Mangan, B. R., Warren, A. R., Price, J. D., & Metzger, R. L. (2003, April). *Age differences in false memories: Now you see them, now you don't*. Poster presented at the biennial meeting of the Society for Research in Child Development, Tampa, FL.

Richardson, J. T. E. (1998). Socio-economic status, social class and memory performance: A critical response to Herrmann and Guadagno (1997). *Applied Cognitive Psychology, 12*, 593–609.

Rieder, C., & Cicchetti, D. (1989). An organizational perspective on cognitive control functioning and cognitive affective balance in maltreated children. *Developmental Psychology, 25*, 382–393.

Roediger, H. L., III, & McDermott, K. B. (1995). Creating false memories: Remembering words not presented on lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*, 803–814.

Sapolsky, R. M. (1992). *Stress, the aging brain, and the mechanisms of neuron death*. Cambridge, MA: MIT Press.

Sapolsky, R. M. (2000). Glucocorticoids and hippocampal atrophy in neuropsychiatric disorders. *Archives of General Psychiatry, 57*, 925–935.

Saywitz, K. J., Goodman, G. S., Nicholas, E., & Moan, S. F. (1991). Children's memories of a physical examination involving genital touch: Implications for reports of child abuse. *Journal of Consulting and Clinical Psychology, 59*, 682–691.

Seamon, J. G., Luo, C. R., Schwartz, M. A., Jones, K. J., Lee, D. M., & Jones, S. J. (2002). Repetition can have similar or different effects on accurate and false recognition. *Journal of Memory and Language*, *46*, 323–340.

Snodgrass, J. G., & Corwin, J. (1988). Pragmatics of measuring recognition memory: Applications to dementia and amnesia. *Journal of Experimental Psychology: General*, *117*, 34–50.

Stadler, M. A., Roediger, H. L., III, & McDermott, K. B. (1999). Norms for words that create false memories. *Memory & Cognition*, *27*, 494–500.

Sternberg, K., Lamb, M., Esplin, P., Orbach, Y., & Hershkowitz, I. (2002). Using a structured protocol to improve the quality of investigative interviews. In M. Eisen, J. A. Quas, & G. S. Goodman (Eds.), *Memory and suggestibility in the forensic interview* (pp. 409–436). Mahwah, NJ: Erlbaum.

Tarter, R. E., Hegedus, A. M., Winsten, N. E., & Alterman, A. I. (1984). Neuropsychological, personality, and familial characteristics of physically abused delinquents. *Journal of the American Academy of Child Psychiatry, 23*, 668–674.

Thomas, A. K., & Loftus, E. F. (2002). Creating bizarre false memories through imagination. *Memory & Cognition*, *30*, 423–431.

Toth, S. L., & Cicchetti, D. (1993). Child maltreatment: Where do we go from here in our treatment of victims? In D. Cicchetti & S. L. Toth (Eds.), *Child abuse, child*

development, and social policy (pp. 399–438). Norwood, NJ: Ablex.

Toth, S. L., & Cicchetti, D. (1998). Remembering, forgetting, and the effects of trauma on memory: A developmental psychopathology perspective. *Development and Psychopathology, 10*, 589–605.

Yehuda, R., & McFarlane, A. C. (1995). Conflict between current knowledge about posttraumatic stress disorder and its original conceptual basis. *American Journal of Psychiatry, 152*, 1705–1713.

Zoellner, L. A., Foa, E. B., Brigidi, B. D., & Przeworski, A. (2000). Are trauma victims susceptible to "false memories"? *Journal of Abnormal Psychology, 109*, 517–524.

Appendix

Deese–Roediger–McDermott Lists Used in This Study: Critical Words (Distractors, in Capitals) With List Items 1 to 15 (From Stadler, Roediger, & McDermott, 1999)

MAN: woman, husband, uncle, lady, mouse, male, father, strong, friend, beard, person, handsome, muscle, suit, old

CHAIR: table, sit, legs, seat, couch, desk, recliner, sofa, wood, cushion, swivel, stool, sitting, rocking, bench

COLD: hot, snow, warm, winter, ice, wet, frigid, chilly, heat, weather, freeze, air, shiver, Arctic, frost

DOCTOR: nurse, sick, lawyer, medicine, health, hospital, dentist, physician, ill, patient, office, stethoscope, surgeon, clinic, cure

CUP: mug, saucer, tea, measuring, coaster, lid, handle, coffee, straw, goblet, soup, stein, drink, plastic, sip

SHIRT: blouse, sleeves, pants, tie, button, shorts, iron, polo, collar, vest, pocket, jersey, belt, linen, cuffs

SLEEP: bed, rest, awake, tired, dream, wake, snooze, blanket, doze, slumber, snore, nap, peace, yawn, drowsy

FRUIT: apple, vegetable, orange, kiwi, citrus, ripe, pear, banana, berry, cherry, basket, juice, salad, bowl, cocktail

GIRL: boy, dolls, female, young, dress, pretty, hair, niece, dance, beautiful, cute, date, aunt, daughter, sister

LION: tiger, circus, jungle, tamer, den, cub, Africa, mane, cage, feline, roar, fierce, bears, hunt, pride

THIEF: steal, robber, crook, burglar, money, cop, bad, rob, jail, gun, villain, crime, bank, bandit, criminal

SWEET: sour, candy, sugar, bitter, good, taste, tooth, nice, honey, soda, chocolate, heart, cake, tart, pie