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Can Maltreated Children Inhibit True and False Memories for Emotional Information?

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Abstract

We examined maltreated and nonmaltreated children's (6- to 12-year-olds) ability to inhibit true and false memories for neutral and emotional information using the Deese/Roediger-McDermott (DRM) paradigm. Children studied either emotional or neutral DRM lists in a control condition or were given directed-remembering or directed-forgetting instructions. The findings indicated that children, regardless of age and maltreatment status, could inhibit the output of true and false emotional information, although they did so less effectively than when they were inhibiting the output of neutral material. Verbal IQ was related to memory, but dissociative symptoms were not related to children's recollective ability. These findings add to the growing literature that shows more similarities among, than differences between, maltreated and nonmaltreated children's basic memory processes.

Can Maltreated Children Inhibit True and False Memories for Emotional Information?

Theoreticians, scientists, clinicians, and policy makers continue to debate whether basic memory processes operate differently in maltreated and nonmaltreated children. On the surface, there are many reasons why maltreatment might be expected to alter basic memory processes (Howe, Cicchetti, & Toth, 2006a; Howe, Toth, & Cicchetti, 2006b). For example, child abuse and neglect are highly stressful experiences that may lead to (1) physiological changes that can affect the neural mechanisms related to memory storage (e.g., Bremner, 2008; Navalta, Tomoda, & Teicher, 2008), (2) socioemotional consequences that include the development of insecure, often disorganized, attachment relationships (e.g., Carlson, Cicchetti, Barnett, & Braunwald, 1989) and deviations in symbolic and representational abilities that may affect the encoding and subsequent processing of memories (e.g., Lynch & Cicchetti, 1998; Rieder & Cicchetti, 1989; Toth, Cicchetti, Macfie, Rogosch, & Maughan, 2000), (3) distortions in encoding and subsequent processing of memories may also arise given failures in caregiving that can lead maltreated children either to distort or dissociate memories associated with their abusive and neglectful experiences (e.g., Cicchetti & Valentino, 2006), and (4) psychopathological consequences – maltreated children are at heightened risk for the development of trauma-related psychopathology, including Post-Traumatic Stress Disorder (PTSD) and dissociation, that may contribute to deficits in memory performance (for a review, see Howe et al., 2006a, 2006b).

Unfortunately, much of the speculation regarding the adverse consequences of child maltreatment has emanated from clinical contexts and has not been subjected to rigorous empirical testing. For example, in her discussion of child abuse Herman (1992) authoritatively states "The child's distress symptoms are not generally recognized. Altered states of consciousness, memory lapses, and other dissociative symptoms are not generally recognized." (p. 110). Such sweeping statements regarding the effects of maltreatment on memory processes historically have been assumed to be true in the absence of any data derived from methodologically rigorous research contexts. Given the extensive policy implications of assumptions about the effects of maltreatment on memory for legal contexts involving child testimony, the conduct of translational research on trauma and memory is particularly important.

A review of the relatively sparse literature on child maltreatment and memory reveals that the experience of child abuse and neglect does not change the operation of memory from that observed in nonmaltreated children (Howe et al., 2006a, 2006b). For example, investigations of maltreated children's memory for eyewitnessed events or their susceptibility to misinformation and suggestion have revealed differences only when psychopathology also has been present (Eisen, Goodman, Qin, Davis, & Crayton, 2007; Howe et al., 2006a, 2006b). Speculation exists that memories may be adversely affected as a result of stress and dissociation. Although research conducted on adults with histories of trauma have demonstrated associations between memory impairments and dissociation (Goodman, Bottoms, Rudy, Davis, & Schwartz-Kenney, 2001; Putnam, 2000), studies with children have not revealed such associations. In fact, investigations of maltreated children have shown that the presence of dissociative symptoms is related to more, not less, detailed memories of abuse (Eisen, Qin, Goodman, & Davis, 2002). Indeed, Eisen et al. (2002) found that it was age that was the major predictor of children's memory performance, not abuse status, and that maltreated children were no more likely to be misled than nonmaltreated children. Moreover, individual differences in psychopathology, intelligence, or dissociation did not predict memory errors or suggestibility rates. Given the discrepancies between the adult and child literatures and in view of the limited number of investigations of maltreatment, dissociation,

and memory with children, further research is needed.

Questions about whether maltreated and nonmaltreated children differ in their memory accuracy concerns more than just suggestibility. Because memory is reconstructive, it is prone to error, and includes errors of omission (forgetting something that happened) as well as errors of commission ("remembering" something that did not happen). Although maltreated children may at times exhibit fewer errors of omission than other children, at least when it comes to autobiographical recollection of abuse experiences, the question is also whether they vary in their susceptibility to false memory illusions. Recent investigations into the development of spontaneous (as opposed to implanted or suggested) false memories have focused on the Deese/Roediger-McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995). Here, children are presented with lists of related words (e.g., *doze, nap, dream, pillow, bed*) that are all associated with an unpresented word, the critical lure (e.g., *sleep*). Later, when asked to recall or recognize the words that had been presented, children will not only remember many of the presented words but will also falsely remember the unpresented critical lure (e.g., Howe, 2006, 2008). Developmentally, older children and adults are more susceptible to spontaneous false memory illusions than younger children (for a review, see Brainerd, Reyna, & Ceci, 2008a). That is, older children are more susceptible to the "illusory belief" that these unpresented but related items were actually part of the presented materials.

There are two main theoretical explanations of these developmental trends, fuzzy-trace theory (FTT; Brainerd et al., 2008a) and associative-activation theory (AAT: Howe, Wimmer, Gagnon, & Plumpton, 2009). In FTT, children are said to extract two very different types of memory traces, a verbatim trace that encodes surface features of the presented material (e.g., orthographic features) and a gist trace that encodes the meaning or theme of what has been presented. False memories occur when verbatim traces fade (which they do more rapidly than gist traces) and recollection relies primarily on gist traces. Older children and adults are more susceptible to false memory illusions than younger children because they are better at extracting the gist of the list.

AAT relies on a single, integrated memory trace, one that incorporates both surface and meaning characteristics in the same, distributed memory representation. Like activation-monitoring theory (AMT; Roediger, Balota, & Watson, 2001) that has been proposed to account for false memories in adults, AAT relies on a spreading activation mechanism to account for false memories. As concepts become active in memory through their presentation, other, related concepts are activated through their interconnections in an associative network. Associations consist of many different semantic relations including antonymy (e.g., *black-white*), entity (i.e., one term is an entity, *dog*, and another is a property of that entity, *fur*), introspection (i.e., one concept refers to a mental state, *depressed*, and another is a property related to that state, *low energy*), situational (i.e., concepts referring to the same situation, e.g., things to do with hospitals, *nurses, surgery*), synonymy (e.g., *couch-sofa*), and taxonomy (e.g., *vegetables, four-footed animals*) (see Wu & Barsalou, 2009). Because items on a list activate not only their own memory representations but also the representations of other, related concepts stored in one's knowledge base, errors of remembering can occur when output is not, or cannot be, properly edited or screened.

According to AAT, there are two factors that drive increases in false memory illusions with age. First, children's knowledge base not only changes in terms of the number of concepts it contains, but as new concepts are added (e.g., superordinate constructs), this knowledge base also gets reorganized to represent the effects of

learning and experience (e.g., Bjorklund, 1987, 2005). Indeed, when word lists are created that are consistent with children's word associations rather than with adults' word associations, developmental differences in false memory rates are attenuated (Anastasi & Rhodes, 2008; Carneiro, Albuquerque, Fernandez, & Esteves, 2007; Metzger et al., 2008). However, despite this attenuation, age differences are not eliminated. This is because, according to AAT, there is a second factor driving memory development, namely automaticity. Specifically, across a number of cognitive tasks (e.g., verbal memory, visual search, mental rotation, mental addition) children's performance get faster and more efficient (e.g., Kail, 1988, 1997; Kail & Park, 1994). Thus, it is not just the content and structure of children's developing knowledge base that drives increases in their susceptibility to false memory illusions but also changes in the speed with which they can access and activate concepts and their associations in that knowledge base.

Although both FTT and AAT agree that changes in knowledge base are key to understanding increases in children's spontaneous false memories with age, only AAT contains the additional assumptions about changes in automaticity and speed of processing. Recent research on the development of automaticity has confirmed AAT's predictions concerning the importance of automaticity when explaining changes in children's true and false memories (Howe, 2005; Wimmer & Howe, 2009). For example, using a modified free association task with 5-, 7-, and 11-year-olds, Wimmer and Howe (2009) demonstrated that children, like adults, can and do generate false memories automatically at encoding. Importantly, they showed that not only do the types of associations change with age (indicating growth and restructuring of children's knowledge base) but also that the speed with which these memories were activated increased with age. This finding is consistent with the assumption that increases in the automaticity with which associations are accessed and activated in children's knowledge base are correlated with increases in children's false memories.

Interestingly, although children generate false memories relatively automatically during encoding, there is evidence that they are not necessarily produced automatically during retrieval. To illustrate, consider a study in which participants are presented with either a single DRM list (control condition) or two DRM lists in succession. Interposed between the lists are instructions that ask participants to continue remembering the first list while studying the second one (a directed remembering instruction) or to forget the first list, as it was simply a practice list, and to remember only the second list (a directed forgetting instruction). Using this directed forgetting procedure with DRM lists, Howe (2005) found that children, like adults (Kimball & Bjork, 2002), could inhibit the output of presented words relative to participants in the control or directed remembering conditions. However, unlike adults whose false memory rates remained unchanged relative to the control and directed remembering conditions, children were also able to inhibit the output of false memories. According to Kimball and Bjork (2002), adults can inhibit the output of actually presented information (information that is in episodic memory) but cannot inhibit false memories because they are automatically activated in semantic memory and do not become part of the episodic list. Howe (2005) argued that for children, although false memories may be generated automatically, they become part of their episodic experience (something that they may become consciously aware of) and hence can be suppressed at output. Thus, not only does automaticity of children's false memories increase in speed during the encoding or generation phase (Wimmer & Howe,

2009), but so too does the automatic ability to access and output false memories during retrieval.

Because the DRM paradigm is so robust, it has become a very useful tool when trying to understand the development of children's spontaneous false memories. Indeed, a recent investigation of the effects of maltreatment experiences on memory has focused on the DRM paradigm to examine true and false memories (for reviews, see Howe et al., 2006a, 2006b). In an early study, Howe, Cicchetti, Toth, and Cerrito (2004) examined the memory performances of three groups of children on the DRM task: nonmaltreated children from middle-socioeconomic (SES) backgrounds, nonmaltreated children from low-SES families, and maltreated low-SES children. Howe et al. (2004) found the same pattern of results regardless of maltreatment status. Specifically, both maltreated and nonmaltreated children exhibited similar patterns of false recognition and recall. Similarly, in an examination of the neurobehavioral sequelae of child sexual abuse, Porter, Lawson, and Bigler (2005) found no significant differences in memory function between abused and nonabused children, despite elevations in psychopathology and diminished performance on measures of attention and executive function for the abused group.

The present research extends these efforts to understand the nature of any changes in basic memory processes as a consequence of child maltreatment by addressing two important questions. The first is whether the stress associated with childhood maltreatment makes maltreated children more susceptible to memory errors (e.g., false memories) for emotionally arousing information than nonmaltreated children and to ascertain whether increased susceptibility may be related to the presence of dissociative symptoms. Although recent studies have shown that false recollection rates generally increase with age throughout childhood and that these developmental trends are similar for maltreated and nonmaltreated children alike (Howe et al., 2004), these conclusions are based on children's memories for neutral word lists. There is evidence to indicate that maltreated children exhibit hypervigilance when it comes to processing emotional stimuli, particularly negative or threatening stimuli (e.g., Howe et al., 2006b; Pollak, 2003). Indeed, maltreated children are quicker to recognize angry facial expressions (Pollak & Kistler, 2002) and their arousal levels remain elevated for longer periods of time by anger in background situations (Pollak, Vardi, Bechner, & Curtin, 2005). It is possible that it is only when negatively valenced stimuli are used that differences in memory due to maltreatment will become apparent. Differences in memory for emotional stimuli are also important from a forensic perspective because the events maltreated children are asked to recollect and testify about are frequently, if not always, emotional in nature. It is critical, therefore, to determine whether differences between maltreated and nonmaltreated children's basic memory skills become apparent when the to-be-remembered material is emotional or stress-related in nature.

The second question concerns differences in maltreated and nonmaltreated children's ability to inhibit the output of true and false memories for both neutral and emotional information. As reviewed earlier, previous research has shown that children can inhibit the output of true and false memories using a directed-forgetting paradigm (Howe, 2005), but these results are also confined to neutral word lists and have only been examined with nonmaltreated children. Perhaps the stress associated with maltreatment alters children's ability to suppress the output of items from memory, particularly when those items are emotional in nature. Indeed, there is some evidence that patients suffering from acute stress disorder show enhanced directed forgetting of emotional material (e.g., Moulds & Bryant, 2005). Here, traumatized participants (e.g., motor vehicle accidents, nonsexual assaults) who either developed

acute stress disorder or did not were compared to nontraumatized participants on their ability to inhibit the output of word lists that contained positive, neutral, and trauma-related words. Adult participants were presented with a list of words and then some were instructed to forget that list and to remember only the second list presented following the directed forgetting instruction. The results showed that traumatized participants who developed acute stress disorder had poorer memory for the trauma-related words, especially in the directed forgetting condition. Thus, acute stress disorder that accompanies trauma is associated with greater inhibition of trauma-related concepts.

On the other hand, those suffering major depressive disorders show an enhanced sensitivity to emotional stimuli and a reduced ability to inhibit such material at output (e.g., Power, Dalgleish, Claudio, Tata, & Kentish, 2000). Here, participants suffering from depression and those who were not were presented word lists containing both positive and negative items. When some of the participants in each group were instructed to forget previously studied lists, those in the depressed group had greater difficulty inhibiting the output of negative words than nondepressed participants. Thus, depression-relevant information is more difficult to inhibit when depressed than other neutral or positive information.

In the current experiment, we examined maltreated and nonmaltreated children's ability to forget true and false memories that arise from studying DRM lists that were either neutral or emotional (negatively valenced). Our first hypothesis concerned whether differences would arise in maltreated and nonmaltreated children's true and false recall when emotional rather than neutral material serves as the to-be-remembered information. There is now considerable evidence that for recall (but not recognition), nonmaltreated children exhibit greater true and false recall for neutral than negative information (see Howe, 2007; Howe, Candel, Otgaar, Malone, & Wimmer, in press). However, if maltreated children are more hypervigilant for negative and threatening information, then their true and false recall of emotional words may be greater than for neutral words, an effect that is the reverse of that typically exhibited by nonmaltreated children.

Our second hypothesis focused on differences in maltreated and nonmaltreated children's ability to inhibit emotional and neutral true and false memories. Here, if maltreated children behave in a manner similar to adults suffering from acute stress disorder, then they should exhibit higher rates of inhibition for emotional than neutral memories whereas no differences will be observed for nonmaltreated children. Alternatively, if maltreated children behave in a manner consistent with clinically depressed adults, then they should exhibit a reduced ability to inhibit emotional memories relative to neutral ones and than that of nonmaltreated children. In all cases, the pattern for the inhibition of true recall should parallel that for false recall given that both maltreated and nonmaltreated children exhibit reduced automaticity in processing false memories at retrieval as that found previously for typically developing children (Howe, 2005).

Method

Participants

A total of 284 children (55% male) distributed between maltreated ($N = 141$) and nonmaltreated ($N = 143$) groups participated in this study. Participants were further divided into two age groups, 136 6- to 9-year-olds ($M = 8.23$, $SD = 1.08$) and 148 10- to 12-year-olds ($M = 11.12$, $SD = 0.78$). This age division was selected because the literature on spontaneous false

memory effects shows that children's susceptibility to this memory illusion differs maximally between these age ranges (for a review, see Brainerd et al., 2008a). Families were primarily of lower socioeconomic status (SES). Average income for families of the children in the sample was $21,800 ($SD$ = $11,496), with 24.4% of the sample reporting household income below $14,000. When taking into account the number of children in the family, average income per person was $5,141 ($SD$ = $2,836). The sample was ethnically diverse and predominantly of minority race, including African American (63.4%), European American (25.4%), and other racial groups (11.3%); 16.9% of the children were of Hispanic ethnicity. The children in the study resided in a large Northeastern US city. The demographics of study participants are comparable to those of children typically reported to authorities for child maltreatment in urban settings and consistent with prior research with respect to socioeconomic status, ethnicity, and the co-occurrence of multiple subtypes of abuse (Bolger & Patterson, 2001; Howe et al., 2006a, 2006b; Valentino et al., 2008; Valentino et al., 2009). Information on the specific types of maltreatment experienced are described below.

Comparisons among demographic variables revealed minimal differences between the nonmaltreated and the maltreated participants (see Table 1). Child gender across the two groups was evenly distributed, with 64 nonmaltreated females and 65 maltreated females, as well as 79 nonmaltreated males and 76 maltreated males, $(\chi^2(1, N = 284) = .05, p > .05$. For child age, maltreated (M = 9.85, SD = 1.71) and nonmaltreated (M = 9.64, SD = 1.74) children did not significantly differ, $t(282) = 1.07, p > .05$. There were also no significant differences between the groups on mother's age, $t(263) = .73, p > .05$, and family income, $t(277) = 1.32, p > .05$. Additionally, there were no significant group differences based on race, $(\chi^2(2, N = 284) = 2.70, p > .05$, or ethnicity, $(\chi^2(1, N = 284) = 3.41, p > .05$, or percentage of families receiving public assistance, $(\chi^2(1, N = 284) = 2.65, p > .05$.

All parents provided informed consent for their child's participation and for examination of any Department of Human Services (DHS) records pertaining to their family. Teachers of target children also provided informed consent to participate and child assent was obtained. Families were recruited via the Department of Human Services (DHS). Records were accessed via the Monroe County computerized system. Using a date of birth query the system yielded the records of families who were receiving Public Assistance (Temporary Assistance for Needy Families – TANF and Food Stamps) and had a child within the desired age range. Families then were randomly selected from the generated list to further consider as potential participants. The Monroe County computerized system was then used to determine if the family had any Child Protective Service (CPS) records. If the families had no record of CPS involvement, then they were contacted as potential nonmaltreating participants. If a family had indicated reports pertaining to the target child, then the family would be contacted as a potential maltreated participant. If more than one child within the age range had experienced maltreatment, then the target child was selected randomly. Any families with unfounded reports of maltreatment (e.g., those deemed to have insufficient evidence to substantiate the occurrence of maltreatment) were not utilized given the unclear nature of their backgrounds.

The DHS records of families with indicated Child Protective Service (CPS) reports were coded by raters using the Maltreatment Classification System (MCS; Barnett, Manly, & Cicchetti, 1993). The MCS allows the history of maltreatment experiences to be based on multiple informants. Informants could include caregivers, CPS workers, neighbors, or other community members such as physicians, teachers, or daycare providers. The records were coded by trained

research assistants and clinical psychologists who had been approved as reliable coders on a standard set of records. Acceptable levels of reliability were obtained for the current sample. Kappas between pairs of raters ranged from .77 to 1.0 for the presence of physical abuse, 1.0 for sexual abuse, .77 to 1.0 for neglect, and .72 to 1.0 for emotional maltreatment. Other investigators have demonstrated that the MCS is reliable and valid in classifying maltreatment, including emotional maltreatment, physical neglect, physical abuse, and sexual abuse (Bolger, Patterson, & Kupersmidt, 1998; English et al., 2005; Manly, 2005; Manly, Cicchetti, & Barnett, 1994; Manly et al., 2001; Smith & Thornberry, 1995). Subtypes of maltreatment were coded in accord with operational definitions contained in the MCS (Manly et al., 1994). *Neglect* was coded if records revealed a failure to provide for the child's basic physical needs for adequate food, clothing, shelter, and medical treatment. In addition to inadequate attention to physical needs, forms of this subtype include lack of supervision, moral-legal neglect, and educational neglect. Examples of typical neglect incidents included leaving young children alone, failing to seek appropriate medical care, maintaining unsanitary living conditions, and providing inadequate nourishment. *Emotional maltreatment* was coded when extreme thwarting of children's basic emotional needs for psychological safety and security, acceptance and self-esteem, and age-appropriate autonomy were present. Examples of emotional maltreatment include belittling and ridiculing the child, extreme negativity and hostility, exposure to severe marital violence, abandoning the child, and suicidal or homicidal threats in the child's presence. *Physical abuse* was coded for instances of the non-accidental infliction of physical injury on the child (e.g., bruises, welts, burns, choking, broken bones). Injuries range from minor and temporary to permanently disfiguring. Finally, *sexual abuse* was coded when attempted or actual sexual contact between the child and a family member or person caring for the child for purposes of that person's sexual satisfaction or financial benefit occurred. Events range from exposure to pornography or adult sexual activity, to sexual touching and fondling, to forced intercourse with the child.

In the current sample, the majority of maltreated children (58.1%) experienced more than one subtype of maltreatment. Thus, co-occurrence of maltreatment subtypes was frequent. Overall, 75.2% of the sample experienced neglect, 55.3% experienced emotional maltreatment, 26.2% were physically abused, and 2.8% were sexually abused. Because of the overlap of maltreatment subtypes in our sample, and because of the number of between-subjects cells needed to satisfy design requirements, we did not conduct subtype analyses on maltreated children's memory performance.

Procedure

The design of this study conformed to a 2(Age: 6- to 9-year-olds, 10- to 12-year-olds) x 2(Maltreatment status: maltreated, nonmaltreated) x 2(Valence: neutral, emotional) x 3(Interlist Cue: Remember, Forget, Control) x 2(List Study Position: 1st vs. 2nd) x 2(Item: true, false) mixed analysis of variance (ANOVA) where the first 4 factors were between-participants and the last 2 factors were within-participant. Study procedures were completed during two visits: One with the mother and one with the mother and child. During the initial visit, mothers of potential participants gave informed consent for their child's participation, signed a DHS release allowing project staff to review their DHS records, signed a consent permitting project staff to contact the target child's teacher, and completed the demographics interview. During the second visit

children met with a member of the project staff to complete the cognitive assessment and the DRM paradigm and their mothers completed the MMCI.

Measures

Wechsler Intelligence Scale for Children – IV (WISC-IV; Wechsler, 2003) and Wechsler Preschool and Primary Scale of Intelligence - III (WPPSI-III Wechsler, 2002). In order to obtain an assessment of cognitive functioning, children also completed the Verbal (Similarities, Vocabulary, Comprehension) and Perceptual (Block Design, Picture Concepts, Matrix Reasoning) subtests of the WISC-IV (Wechsler, 2003) or WPPSI-III (Wechsler, 2002), depending on their age.

Maternal Maltreatment Classification Interview (MMCI; Cicchetti, Toth, & Manly, 2002). In order to supplement information obtained from CPS records, mothers also completed the MMCI. Mothers were interviewed about experiences in their child's life that could have been more difficult for their child to cope with. Questions were framed to assess exposure to possible maltreatment without directly inquiring as to whether the child had been maltreated (i.e., "Has your child ever been home or in a situation where extremely angry interactions or violence have taken place?"), with specific follow-up queries designed to gather further information on the incident (i.e.: "How old was the child when this occurred?", "What led to the situation?"). If a mother who had been recruited as a nonmaltreating comparison family disclosed an event that qualified as maltreatment, then the family was disqualified from the study.

Child Dissociative Checklist (CDC; Putnam, Helmers, & Trickett, 1993). Teachers of study participants were asked to complete the CDC. The CDC documents observed behaviors related to dissociation. Behaviors are rated on a zero-to-two scale (i.e.: "child has intense outbursts of anger, often without apparent cause and may display unusual physical strength during these episodes", "child shows rapid regressions in age-level of behavior"). On average teachers had known the participants for nine months when they completed the CDC.

Deese/Roediger-McDermott Paradigm. A modified version of the DRM paradigm was utilized to include words that were affectively laden. Children were interviewed individually and listened to a recording of one or two of eight possible DRM lists. Four word lists consisted of non-emotional words (e.g., door, awake, apple, table) and four consisted of emotional words (e.g., bomb, rape, heroin, hate) (all of the lists are shown in the Appendix). The majority of these lists have been used before with adults (Stadler, Roediger, & McDermott, 1999) and with children ranging from ages 5 to 12 years old (Howe, 2007; Howe et al., 2004; Howe et al., in press). Independent evaluation of the words on these lists also confirmed that children in these populations and ages were familiar with these words inasmuch as they are often seen in their vocabulary and children frequently used "street slang" for some of the terms we presented (see Appendix). Although we did not directly control for the effects of word familiarity, concreteness, and meaningfulness across list valence, because there was no main effect for valence (see Results) any differences in these variables (or other factors potentially confounded with valence) did not affect children's true and false memory performance in this study.

List pairings were selected such that associations between them were minimized. This was done in order to reduce (or eliminate) across-list cuing, something that could have negative effects on the directed forgetting manipulation (Conway, Harries, Noyes, Racsma'ny, & Frankish, 2000). Each list consisted of 10 words; the words were presented in two-second intervals and narrated by the experimenter. Children were given general memory instructions indicating that they were to try to remember the concepts presented on the list. After the presentation of the last item in the first list, children in the remember condition were told to continue remembering the

concepts they just heard and to try to remember the items presented on the next (second) list. Children in the forget condition were told that the first list had just been a practice list so they should forget it and that they should remember the next (second) list as this would be the one they would be tested on later. Following presentation of the second list, children were instructed to recall items from a specified list, either List 1 or 2 (recall order was counterbalanced across children). After recall of that list was completed, they were asked to recall items from the other list. Children in the control condition received only one list, either in the List 1 or List 2 study position. In lieu of seeing the other list, they circled pairs of letters and in lieu of an interlist cue they received instruction regarding the second task. With these exceptions, the procedure was the same for the control children as for the children in the remember and forget conditions.

Following recall, a recognition test was administered. The results of the recognition testing do not bear directly on the hypotheses examined in this article and serve mainly to validate the recall findings. This is because recall tests are the measure of choice when examining directed forgetting with recognition tests being insensitive to directed forgetting manipulations (e.g., Kimball & Bjork, 2002). The only important point is that analyses of the recognition data indicated no differences in recognition performance (or A(scores) as a function of instruction. What this means is that children in this study did generate false memories across all of the conditions in this experiment and hence any differences in recall due to instruction are real differences due to inhibition of false memories that were generated during list presentation.

Results

Ten children were excluded from the analyses because IQ data were not available. Because each child contributed only one observation to the analysis of false recall data, we first analyzed those data separately using chi-square analyses and the related weighted-least-squares method. Like Kimball and Bjork (2002), a separate analysis of variance (ANOVA) yielded a similar pattern of results. Because this latter analysis revealed the same pattern of findings as the nonparametric analyses, for ease of presentation and because we wanted to directly compare true and false recall rates, the parametric analyses will be used throughout when comparing true and false recall rates. As well, because there were no effects due to counterbalancing variables (list-pair topics and within-list-pair presentation order) or to gender, these variables were eliminated from subsequent analyses. We begin by presenting the initial analysis of covariance. This is followed by an examination of our hypotheses concerning the effects of age and maltreatment status, interlist cuing, and interlist cuing and valence on children's true and false memories.

Analysis of Covariance

To test the main hypotheses associated with this study, the percentages of targets correctly recalled and critical items falsely recalled were analyzed using a 2(Age: 6- to 9-year-olds, 10- to 12-year-olds) x 2(Maltreatment status: maltreated, nonmaltreated) x 2(Valence: neutral, emotional) x 3(Interlist Cue: Remember, Forget, Control) x 2(List Study Position: 1st vs. 2nd) x 2(Item: true, false) mixed analysis of covariance (ANCOVA) where the first four factors were between-participants, the last two factors were within-participant, and the four covariates were the scores on the CDC, verbal IQ subscore, perceptual IQ subscore, and full-scale IQ. The analyses showed that one of the covariates, the verbal subscale of the IQ test, was significant, $F(1, 249) = 36.25$, $p < .001$, $(_p^2 = .127$. Because of the strength of this effect, and because of its obvious link to the DRM illusion, all analyses are conducted on the adjusted scores. Adjusted percentages and standard errors for true and false recall as a function of the main variables in this experiment (age, maltreatment status, and valence) are shown in Table 2.

Effects of Maltreatment Status and Age on Children's True and False Recall

With verbal IQ controlled, the analyses revealed no main effects for maltreatment status and no interactions involving maltreatment status as a variable. Thus, like previous research using the DRM paradigm (Howe et al., 2004), maltreated children do not differ from nonmaltreated children in their susceptibility to spontaneous false memory illusions. Also like this previous research, there was a main effect for Age, $F(1, 249) = 29.83$, $p < .001$, ($_p^2 = .32$, where 6- to 9-year-olds (16%) recalled less than the 10- to 12-year-olds (21%). This was modified by an Age x Item interaction, $F(1, 249) = 28.18$, $p < .001$, ($_p^2 = .102$, where post-hoc tests ($p < .05$) revealed that older children's true recall (41%) was better than younger children's (31%), but there were no age differences in false recall rates (13.5% and 12%). Thus, there was no effect of maltreatment status, older children correctly recalled more items than younger children, and there were no age differences in false recall.

Effects of Interlist Cue on Children's True and False Recall

As predicted, there was a main effect for Interlist Cue, $F(1, 249) = 5.47$, $p < .05$, ($_p^2 = .042$, where more items were recalled in the Control condition (21%) than either the Remember (18%) or Forget (18%) conditions, which did not differ, a finding replicating that obtained by Howe (2005). More importantly, there was an Interlist Cue x List Study Position interaction, $F(2, 249) = 12.37$, $p < .001$, ($_p^2 = .09$, where post-hoc tests ($p < .05$) revealed that there were no differences between the Control and Remember conditions across the two different List Study Positions, but there were significantly fewer items recalled in the Forget condition on List 1 than List 2. These effects are consistent with Howe's (2002) finding that young children can inhibit recall when instructed to do so and with previous findings using this paradigm with middle SES children (Howe, 2005). That is, the critical Interlist Cue x List Study Position interaction was reliable and the primary differences were localized in the Forget condition such that recall was impaired.

Effects of Interlist Cue and Valence on Children's Inhibition of True and False Memories

There was no main effect for valence. However, the Interlist Cue x List Study Position interaction above was modified by an Interlist Cue x List Study Position x Item interaction which in turn was modified by an Interlist Cue x List Study Position x Item x Valence interaction, $F(2, 249) = 3.33$, $p < .05$, ($_p^2 = .026$. The mean (adjusted) percentages of targets correctly recalled (Panel A) and critical items falsely recalled (Panel B) are shown Figure 1 for neutral lists and Figure 2 for emotional lists. As can be seen in these figures, and as was confirmed using post-hoc analyses, there were three outcomes of primary interest. First, like Howe (2005), children were able to suppress the output of both true and false items for both neutral and emotional materials. Second, when compared directly, true neutral items were more easily suppressed than emotional items (compare Panel A across Figures 1 and 2). That is, the magnitude of the decrease in true recall in the Forget condition for List 1 for neutral material was greater in magnitude than that for emotional material. It would seem then that emotional items, while suppressed at output, were harder to suppress than more mundane items. Third, for false recall, although suppression was evident for emotional items, the magnitude of this effect was considerably less than that for neutral items (compare Panel B across Figures 1 and 2). In fact, these suppression rates were even lower than that observed for true recall. However, this may be because of near floor effects in false recall rates for emotional material. This finding may not be all that unusual, with lower false recall rates for emotional material having been reported by Howe (2007) with middle SES children as well as in other experiments with both adults and children (Brainerd, Stein, Silveira, Rohenkohl, & Reyna, 2008b; Howe et al., in press).

Discussion and Conclusions

In accord with previous research, no differences were found in the basic memory processes of maltreated and nonmaltreated children, not for true recall or false recall. Despite the obvious statistical power in our study to detect such differences if they did exist (with the current *Ns*, this power was 70% and higher), when verbal IQ was controlled, both maltreated and nonmaltreated children were able to inhibit the output of true and false neutral information. This finding has been observed in an earlier study with nonmaltreated middle SES children (Howe, 2005). The critical feature of the current research is that it extends this finding to maltreated children and negatively valenced information. Interestingly, although children, regardless of age and maltreatment status, can inhibit the output of true and false emotional information, they do so less effectively than when they try to inhibit neutral information. Moreover, false recall rates for emotional lists were considerably less than that for neutral ones, a finding that is typical in this literature (e.g., Brainerd et al., 2008; Howe, 2007; Howe et al., in press). It may be because of these lower false recall rates that differences in children's ability to inhibit false memories of emotional material were not as strong as that observed for neutral information.

In addition, the current research shows that the ability to inhibit the output of true and false emotional information does not vary as a consequence of related psychopathology (e.g., dissociation, at least as measured by the CDC). This hitherto unreported finding converges on findings elsewhere in the literature where it has been shown that dissociation does not have a deleterious effect on maltreated children's susceptibility to misinformation. In fact, the only individual difference factor that was related to recall rates was verbal IQ. This finding is not new in the memory literature and is consistent with a number of previous studies (e.g., Dent, 1992).

Together, these findings are important because they extend the domain of memory similarity between maltreated and nonmaltreated children into the more ecologically valid arena of emotional stimuli. Moreover, these results clearly show that maltreated children do not exhibit the same patterns as that of patients with acute stress disorder, namely, enhanced directed forgetting of trauma-related words (e.g., Moulds & Bryant, 2005). In fact, they, like nonmaltreated children, were poorer at inhibiting true emotional stimuli than neutral stimuli. Nor do maltreated children exhibit the same pattern of findings as patients with depressive symptoms (e.g., Power et al., 2000) – that is, maltreated children were not more sensitive to emotional material as they were just as capable of inhibiting the output of emotional stimuli as nonmaltreated children. Although there are clear differences between the current study and those conducted with traumatized or depressed adults, it would seem that like the majority of other studies that have looked for differences in basic memory processes between maltreated and nonmaltreated children, there are none to be found. The important contribution of the current research is that these are the first findings to demonstrate that this similarity in memory processing extends to emotionally laden material.

One exception to the lack of differences between memory in maltreated and nonmaltreated children emerged in a recent investigation of *incidental* recall of stimuli involving maternal-referent words (Valentino, Cicchetti, Rogosch, & Toth, 2008). In that study, abused children demonstrated deficits in recall compared to neglected and nonmaltreated children. In the current study, for the most part, the operation of maltreated children's basic memory processes has not been found to differ from that of other, nonmaltreated children when measured using *intentional* recall and recognition measures (measures most often found in forensic situations), regardless of the emotional nature of the information. However, further work is needed to ascertain whether the type of material (e.g., maternal-referent words) to be recalled may differentially affect certain *incidental* recall processes in abused but not neglected children.

Despite its contributions, the current investigation did not examine possible differences due to psychopathology other than dissociative symptoms. For example, it may be important in future investigations to disentangle the possible effects associated with depression or PTSD in maltreated children. It is known that children with maltreatment-related PTSD, particularly males, have a smaller corpus callosum (De Bellis et al., 1999; Teicher, Ito, Glod, Andersen, Dumont, & Ackerman, 1997). Maltreatment-related PTSD is also associated with decreased cerebral volumes, attenuation of frontal lobe asymmetry, smaller cerebral and frontal cortices, less prefrontal white matter, and reduced right temporal lobe volumes (see Carrion et al., 2001; De Bellis et al., 2002).

Curiously, despite this evidence that child maltreatment related PTSD can have adverse consequences for neurological development, none of these studies found adverse effects specific to neurological structures associated with memory. Although smaller hippocampal volumes that have been reported for adults with child maltreatment-related PTSD (e.g., Bremner et al., 1997), similar findings have not been obtained in cross-sectional or short-term longitudinal studies of pediatric maltreatment-related PTSD (e.g., De Bellis, Hall, Boring, Frustaci, & Moritz, 2001) and there has been the suggestion that hippocampal volumes might actually be larger in pediatric PTSD (De Bellis, 2005). Although this discrepancy might be accounted for because there is a higher risk for alcohol and substance abuse in adolescence and adulthood (De Bellis, 2002), behaviors that are related to decreased hippocampal volume (e.g., De Bellis et al., 2000), it may simply be that (a) the adverse effects of chronic stress do not manifest themselves in the hippocampus until postpubertal development or (b) neurodevelopmental plasticity and normal developmental increases in the hippocampus may obscure any adverse effects of maltreatment on memory (for a review, see Bremner, 2008; Navalta et al., 2008). Consistent with these neurobiological findings, maltreated children in the current study showed more similarities than differences in memory functioning when compared with children who have not experienced maltreatment. Moreover, maltreated children did not exhibit inhibition patterns similar to those found for patients experiencing acute stress (Moulds & Bryant, 2005) or depression (Power et al., 2000).

Any future research aimed at disentangling psychopathological symptoms and memory may also benefit from dissevering valence and arousal, especially as these two components of emotion may have different effects on memory (Kensinger, 2009). However, in studies where valence and arousal have been manipulated orthogonally, valence (i.e., negative information) as manipulated in the current study, trumps arousal when it comes to predicting elevations in false memory production (Brainerd et al., 2008). It is important to note that dissociative symptoms were rated by teachers. Although preferable to parent-report given possible reporting biases present in maltreating caregivers, child self-report information would strengthen confidence in these findings. Finally, because the presence of insecure attachment also has been related to memory performance in both children and adults (cf. Alexander, Quas, & Goodman, 2002), and because maltreated children are at heightened risk for insecure attachment, future research on child maltreatment and memory processes also will benefit from attention to relationship functioning.

These caveats notwithstanding, the current investigation provides a critical and unique extension to the extant literature on the effects of maltreatment on children's memory development. Specifically, the absence of memory differences between maltreated and nonmaltreated children now includes emotional content. Moreover, it is

now clear that children, maltreated or not, can and do inhibit recall of both neutral and negative information when necessary. Thus, the current investigation contributes to the emerging literature that the experience of child maltreatment does not adversely affect, nor does it enhance, memory processes.

This body of evidence is particularly important when it comes to understanding maltreated children's ability to testify about events in the courtroom. Although the words used in this study may not mirror the range of events children testify about in court, there are some important similarities. Indeed, children often have to talk about crimes they have witnessed or been the target of, including sexual abuse ("rape" and our "crimes" list). Moreover, they often testify about drug abuse (our "drug" list), the use of weapons (our "weapons" list), as well as their feelings associated with the events they have experienced or witnessed (our "anger" list). Although discussing entire events may be different than remembering isolated words, there is some evidence that memory for lists and for entire events behaves in a very similar manner, at least when it comes to issues of valence and false memories (for a discussion, see Howe et al., in press).

This growing body of evidence concerning memory and maltreatment is also important for informing issues regarding the suggestibility of child victims' memories and it may affect decisions as to whether judges and lawyers are confident in relying on children's reports of abuse and neglect (cf. Toth & Valentino, 2009). The results of the current investigation also possess implications for forensic interviewing as they suggest that children who have experienced abuse-related trauma are capable of accurately reporting memories of their maltreatment, even when the memories are emotionally laden. Of course, as with any interviews with children, it is important to recognize that leading questions can interfere with recall and that memory accuracy increases with child age. Utilization of structured interview protocols developed for forensic contexts are integral to ensuring that interviewers do not inadvertently mislead children (Lamb, Hershkowitz, Orbach, & Esplin, 2008). As research on trauma and memory continues to develop, it will be increasingly possible to address its implications for legal and social policy arenas, particularly as this relates to the viability of child testimony in the courtroom.

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Authors' Note

Appendix
Emotional and Non-emotional Word Lists (critical lures in CAPITALS)

Non-emotional words

HOUSE	SLEEP	FRUIT	CHAIR
Door	Bed	Apple	Table
Garage	Relax	Vegetable	Sit
Window	Awake	Orange	Leg
Brick	Tired	Pear	Seat
Building	Dream	Banana	Couch
Family	Blanket	Berry	Desk
Boat	Snore	Cherry	Recliner
Chimney	Nap	Basket	Cushion
Street	Pillow	Bowl	Swivel
Key	Yawn	Salad	Stool

Emotional words

WEAPON	CRIME	DRUG	ANGER
Gun*	Robbery	Marijuana**	Mad
Knife	Murder	Cocaine***	Fear
Bomb	Rape	Heroin	Hate
Fist	Killing	Alcohol	Rage
Rifle	Drunk Driving	Crack	Temper
Blood	Jail	Stoned	Fury
Death	Arrest	High	Wrath
Cut	Court	Needle	Fight
Scar	Bars	Snort	Hatred
Explode	Handcuffs	Spoon	Mean

*Alternative terms accepted included: Gat
**Alternative terms accepted included: Weed, Pot
***Alternative terms accepted included: Coke

Table 1.
Demographic Characteristics.

	Maltreated ($N = 141$)	Nonmaltreated ($N = 143$)
	M (SD) or %	M (SD) or %
Gender (% male)	53.9 %	55.2 %
Age	9.86 (1.11)	9.64 (1.74)
Maternal Age	33.78 (6.13)	33.24 (6.03)
Race		
African-American	58.9 %	67.8 %
Caucasian	27.7	23.1
Other	13.5	9.1
Latino Ethnicity	12.8 %	21.0 %
Current Public Assistance	93.6 %	87.9 %
Family Income	$21,108 ($11,696)	$22,576 ($11,283)

Table 2.
Adjusted Mean Percentages (standard errors) of True and False Recall as a Function of Age, Maltreatment Status, and Valence.

| Age	Maltreated Children		Nonmaltreated Children	
	Valence		Valence	
	Neutral	Emotional	Neutral	Emotional
6-9 years				
True	32.3 (2.5)	31.7 (2.4)	31.4 (2.6)	30.2 (2.4)
False	16.8 (1.5)	10.7 (1.4)	15.6 (1.4)	10.7 (1.2)
10-12 years				
True	39.8 (2.4)	41.8 (2.2)	42.0 (2.1)	40.5 (2.4)
False	15.2 (0.5)	10.3 (0.4)	14.3 (0.4)	9.5 (0.5)
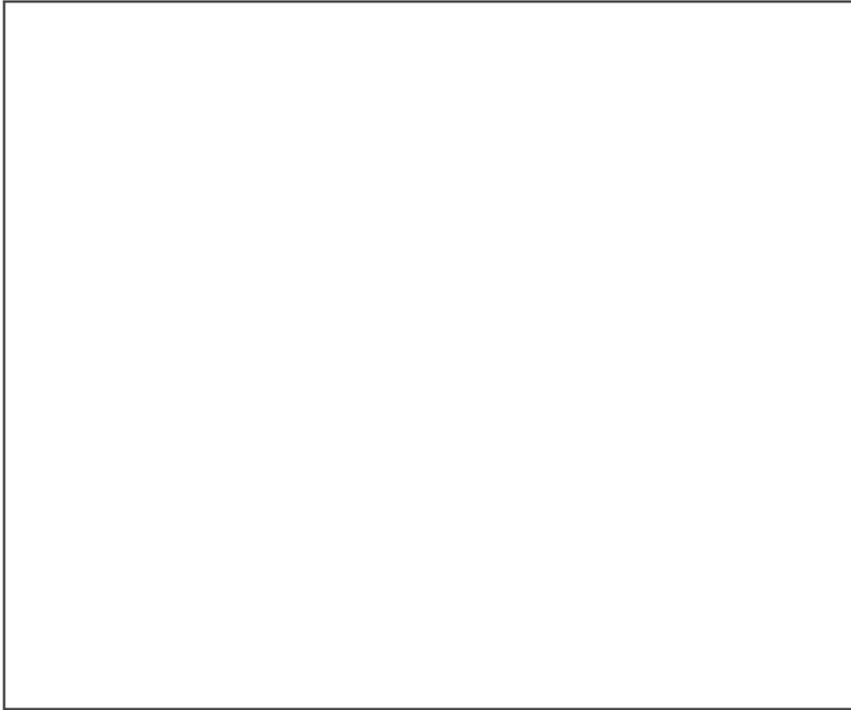
Figure 1. Children's True and False Recall for Neutral Material (with standard error bars).
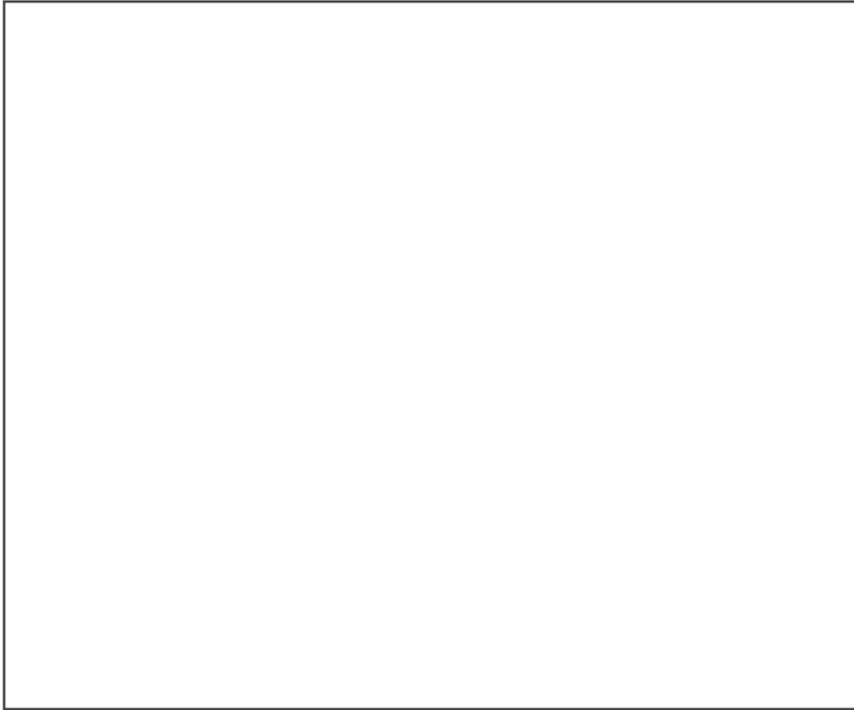
Figure 2. Children's True and False Recall for Emotional Material (with standard error bars).