

## Research Report

# Children (but Not Adults) Can Inhibit False Memories

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**ABSTRACT**—*The role of inhibition in children's (5-, 7-, and 11-year-olds') false memory illusions in the Deese-Roediger-McDermott (DRM) paradigm was examined using a list-wise directed-forgetting procedure. Children studied either a single DRM list (control) or two DRM lists in succession with a directed-remembering instruction or a directed-forgetting instruction between list presentations. The findings indicated that, like adults, children effectively suppressed the output of true memories when given a directed-forgetting instruction. Unlike adults, whose false memories are not attenuated in directed-forgetting conditions, children suppressed false memories at recall in the directed-forgetting condition. Because recognition data indicated that the children did generate false memories regardless of instruction, it appears that although adults' false memories are generated automatically and do not become part of their conscious experience, children's false memories are produced with greater effort and conscious processing, and as a result are easier to suppress at output.*

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That human memory is subject to illusory recollective experiences is a matter of scientific fact (Brainerd & Reyna, 2005). Recent studies of memory illusions have focused on the Deese-Roediger-McDermott, or DRM, paradigm (Deese, 1959; Roediger & McDermott, 1995). In this paradigm, participants study word lists whose members are easily associated and are then asked to recall as many words as they can from each list just after it is presented. The key outcome is that in addition to correctly recalling the words that were on the list, people also falsely recall critical, unrepresented words that are thematically related to the list items. Older children are more susceptible to false memory illusions than are younger children (Brainerd, Reyna, & Forrest, 2002; Dewhurst & Robinson, 2004; Howe, Cicchetti, Toth, & Cerrito, 2004).

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Most theorists agree that items on a DRM list activate related but unrepresented concepts that are consistent with the theme or gist of the list. This activation happens during study and occurs automatically and unconsciously, and these concepts are erroneously produced at output because participants cannot discriminate them from other members of the original list (Gallo & Seamon, 2004; Raaijmakers & Zeelenberg, 2004; Roediger, Balota, & Watson, 2002). According to fuzzy-trace theory, because DRM words repeatedly cue certain meanings, strong gist memories are created, and these gist memories increase the likelihood of false memories being generated (Brainerd & Reyna, 2005). Further, because gist processing abilities are limited in young children, false memories should increase with age as children become better able to process familiar gists and connect those gists across list items.

Although fuzzy-trace theory is consistent with extant data, there is evidence that children can and do extract gist across list items, but do so more slowly than adults using a less automatic processing strategy. First, it is well known that young children can use semantic information to aid recall when category or gist relations are made salient, as, for example, when item presentation is blocked by category (Bjorklund, 1987; Howe, Brainerd, & Kingma, 1985). Blocking items by category is similar to the DRM procedure in that all of the items on a DRM list share a single associative meaning. Indeed, when such categorized lists are used in a traditional DRM task, false memories are no less likely in younger than older children (Seamon, Luo, Schlegel, Greene, & Goldenberg, 2000). Thus, it does not seem that young children fail to process the gist of individual items or fail to process gist across list items, especially when related items are blocked at presentation, as in the DRM procedure.

Second, children's cognitive processing occurs less automatically and with greater cognitive effort than does adults' (Dempster & Brainerd, 1995). Although the semantic activation of false information in DRM illusions is relatively automatic for adults, such processing is effortful for children. The products of such effortful processing (false items) are conscious and are treated like other episodically encoded information from the learning event. Interestingly, it may be more difficult to inhibit

the output of false information if that false information arose automatically than if it was produced effortfully and has become part of the consciously experienced list. Thus, it could be that children, although less likely than adults to produce false memories, are better able to inhibit their output because false items become part of children's conscious, episodic experience.

The present study tested this idea by adding a directed-forgetting manipulation to the standard DRM task to isolate the episodic and semantic contributions to false memories that are associated with this task. The procedure adopted here, like that in Kimball and Bjork (2002), involves a list-wise directed-forgetting manipulation in which participants are instructed to forget entire lists. Participants are presented with two lists sequentially (List 1 and List 2) and are told at the outset to remember items on the first list. Following presentation of this first list, a directed-remembering or directed-forgetting instruction is administered; participants are told either that they should continue remembering the first list while they also try to remember the second list (directed remembering) or that the first list was practice and should be forgotten, and that they should simply try to remember the next list (directed forgetting).

The reason this manipulation is relevant to episodic and semantic processing in the DRM paradigm is that directed forgetting selectively affects retrieval on free-recall tasks. Tasks that minimize the contribution of retrieval processes, such as recognition (Basden, Basden, & Gargano, 1993), relearning (Geiselman & Bagheri, 1985), word fragment completion (Bjork & Bjork, 1996), and word association (Basden et al., 1993), show few if any performance differences between to-be-remembered and to-be-forgotten items. The absence of directed-forgetting effects on indirect tests of memory suggests that the "forget" cue does not affect semantic activation of studied items. Thus, if directed forgetting affects episodic access but not semantic activation, such instructions should have different effects on recall of true and false items on DRM lists. That is, directed-forgetting instructions should affect (lower) the amount of true recall (episodic access), but have no effect on false recall (semantic activation). This is exactly what Kimball and Bjork (2002) found with adults. That is, true List 1 memories were suppressed in the directed-forgetting condition relative to control and directed-remembering conditions, but false memories were not.

The fundamental assumption involved in explanations of these directed-forgetting results is that continued semantic activation of associated but false items occurs automatically at the time DRM lists are studied. Although this assumption is common in the literature on false memories in adults, conscious awareness of the intruded items might play a role in the DRM illusion in populations for which these DRM associates are not automatically activated (e.g., children). According to Underwood's (1965) implicit-associative-response (IAR) theory, such items, when generated, enter conscious awareness and are treated as list members. Because children are relatively inefficient at inhibiting irrelevant and false information from entering consciousness,

but can inhibit its output given a list-wise directed-forgetting instruction (e.g., Howe, 2002, 2004; Wilson & Kipp, 1998), children given a list-wise directed-forgetting instruction should inhibit false memories to the same degree as true memories. In contrast, as already noted, directed-forgetting instructions have differential effects on true and false memories in adults.

## METHOD

### Participants

Of the 306 children who participated (142 males, 164 females), 103 were from kindergarten (5-year-olds;  $M = 5$  years 3 months), 108 from Grade 2 (7-year-olds;  $M = 7$  years 2 months), and 95 from Grade 6 (11-year-olds;  $M = 11$  years 2 months). All of the children (predominantly White and middle class) who were tested had parental consent and had themselves assented to the procedure.

### Design

A mixed design was used. Interlist cue (forget, remember, or control) and test order (List 1 or List 2 tested first) were manipulated between subjects. List study position (first vs. second) was manipulated within subjects for participants in the forget and remember conditions, but between subjects for control participants, who studied only one list.

### Materials and Procedure

Each child was presented with either one or two 14-item DRM lists, ones that have been used previously with adults (Stadler, Roediger, & McDermott, 1999) and children (Howe et al., 2004). List pairings were selected such that semantic associations between lists 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). Children were quasi-randomly assigned to the different between-subjects conditions keeping gender as equally distributed as possible.

At the start of the procedure, the 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 been just 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, the children were instructed to recall items from a specified list, either List 1 or 2. After recall of that list was completed, they were asked to recall items from the other list. Following recall, a recognition test was administered. Although the results of the recognition testing do not directly bear on the

hypotheses examined here, it is important to note that analyses 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 in all conditions.

Children in the control condition received only one list, in either the List 1 or the List 2 study position. In lieu of seeing the other list, they completed a task involving circling 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.

**RESULTS**

Because there were no effects due to counterbalancing variables (list-pair topics and within-list-pair presentation order) or gen-

der, these variables were eliminated from subsequent analyses. The mean percentages of targets correctly recalled and critical items falsely recalled are shown in Figures 1c and 1d, respectively. For purposes of contrast, Figures 1a and 1b show the results obtained using the same procedure with adults (Kimball & Bjork, 2002).

The main hypotheses associated with this study were tested by analyzing the percentages of targets correctly recalled (Fig. 1c) using a 3 (age: 5-year-olds vs. 7-year-olds vs. 11-year-olds)  $\times$  3 (interlist cue: remember vs. forget vs. control)  $\times$  2 (list study position: first vs. second) between-subjects analysis of variance (ANOVA). The analysis revealed a main effect for list study position,  $F(1, 270) = 8.51, p < .01, \eta^2 = .031$ ; fewer items were recalled on List 1 (31%) than List 2 (36%). There was also a main effect for interlist cue,  $F(1, 270) = 19.97, p < .001, \eta^2 = .129$ , with more items correctly recalled in the control condition

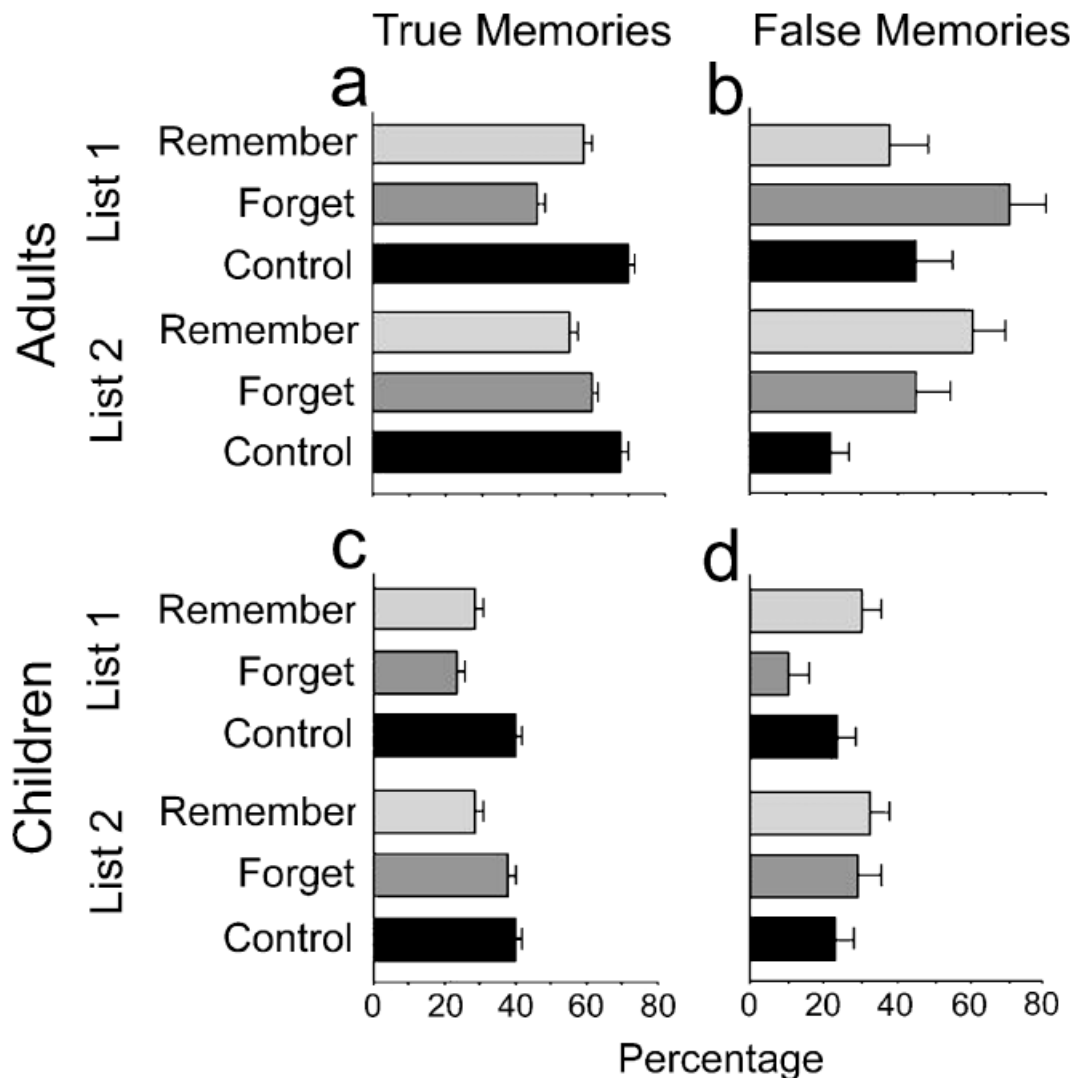


Fig. 1. Adults' true (a) and false (b) recall (adapted from Kimball & Bjork, 2002) and children's true (c) and false (d) recall in directed-remembering, directed-forgetting, and control conditions in a two-list Deese-Roediger-McDermott paradigm.

(40%) than either the remember (29%) or the forget (31%) condition, which did not differ. Age also had a significant effect,  $F(2, 270) = 63.48, p < .001, \eta^2 = .32$ , with 5-year-olds (22%) recalling less than 7-year-olds (33%), who recalled less than 11-year-olds (45%). There was an Interlist Cue  $\times$  List Study Position interaction,  $F(2, 270) = 7.36, p < .001, \eta^2 = .052$ ; post hoc tests revealed that for the control and remember conditions, there were no differences between the two list study positions, but in the forget condition, there were significantly fewer items correctly recalled on List 1 than List 2 (see Fig. 1c).

These effects are consistent with Howe's (2002) finding that young children can inhibit recall when instructed to do so. More important, these findings are identical to Kimball and Bjork's (2002) findings for adults, except, of course, that the rates of recall are lower for children. That is, the critical Interlist Cue  $\times$  List Study Position interaction was reliable, primarily because recall of the first list was impaired in the forget condition. Thus, for true recall, children's performance is reasonably consistent with adults'.

Next, the false recall of critical false items was examined (Fig. 1d). Because each child contributed only one observation to this analysis (i.e., there is only one critical false item per list), the data were first analyzed using chi-square analyses and the related weighted-least-squares method. As in Kimball and Bjork's (2002) study, these analyses and a separate between-subjects ANOVA yielded similar patterns of results. Because the ANOVA revealed the same pattern of findings as the nonparametric analyses, for ease of presentation and comparison with the results concerning true item recall, the ANOVA-based findings are presented here.

The analysis revealed a main effect for age,  $F(2, 270) = 6.69, p < .001, \eta^2 = .047$ ; post hoc tests showed that 5-year-olds (20%) falsely recalled the same percentage of critical false items as 7-year-olds (22%), and children of both these ages recalled significantly fewer critical false items than 11-year-olds (42%). The only other significant effect to emerge was the critical Interlist Cue  $\times$  List Study Position interaction,  $F(2, 270) = 3.63, p < .05, \eta^2 = .026$ . As can be seen in Figure 1d, and as was confirmed by post hoc analyses, the source of this interaction was the significantly reduced false recall production for List 1 when children were instructed to forget that list. That is, it seems that children, even 5-year-olds, inhibit false memory production when instructed to forget, just as they suppress true memories. Unlike adults (Fig. 1b), whose false recall production increases because of continued automatic semantic processing of the list, children appear to suppress all processing of the to-be-forgotten information. Note that the pattern of false recall for children is nearly identical to that of the adults in Kimball and Bjork's (2002) study with the one exception of false recall of the to-be-forgotten list.

## DISCUSSION

The issue addressed in the current experiment was whether children's lower propensity (relative to adults) to generate false

memories in the DRM paradigm arises from the more effortful, conscious processing that children use when false memories are generated and not from failure to process gist across items on a DRM list. As in prior research, children (in this case, 5- through 11-year-olds) produced true and false memories, with the numbers of both increasing significantly with age. More important, the results confirmed the current hypothesis that children treat false items as members of the episodic lists. That is, children from all three age groups produced fewer true and false memories for DRM lists they were instructed to forget than for DRM lists they were instructed to remember. Specifically, although recognition data clearly showed that children, like adults, generated false memories, unlike adults, children were able to inhibit both true and false memories during recall. Interestingly, these inhibition effects did not vary significantly with age. The absence of age effects in children's inhibition has been reported before in a directed-forgetting task (Howe, 2002), and the lack of such effects in the present case may reflect the fact that significant age effects may not emerge until children are much older than those tested in this study. Indeed, some researchers have argued that age differences in effortful processing may not appear until early adolescence on some tasks (e.g., Wilson & Kipp, 1998). Whatever the case, the present data are consistent with the idea that children do generate false memories in the DRM paradigm and treat those false memories as part of the episodically studied lists.

These findings are compatible with Underwood's (1965) IAR view of false memory, in which false information generated during study becomes part of the person's conscious, episodic list experience. However, such effortful, conscious processing is the hallmark of children's false memory production in the DRM task and is what separates children from adults, whose processing of semantically related, false information is relatively automatic. These findings are also consistent with the more general idea that part of what accounts for children's cognitive development is the greater automaticity of processing that occurs with age. As shown here, children can and do extract meaning across items on DRM (and categorized) lists; it is just that they do so with greater cognitive effort than adults. Thus, perhaps age-related increases in spontaneous false memories in the DRM paradigm are driven not simply by developmental advances in the ability to generate across-item gist per se, but also by the increasing automaticity with which children generate such gist.

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