

Examining Differences in the Levels of False Memories in Children and Adults Using Child-Normed Lists

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Several previous studies have demonstrated that children, when compared with adults, exhibit both lower levels of veridical memory and fewer intrusions when given semantically associated lists. However, researchers have drawn these conclusions using semantically associated word lists that were normed with adults, which may not lead to the same level of activation or gist generation in children. In the current study, the authors used similar associative word lists normed with children and then evaluated the memory of children and adults using these newly normed lists as well as the typical adult-normed lists. Results indicate that children showed lower true and false memories with both the child-normed and adult-normed lists. Thus, these data suggest that the negative relationship between age and false memories in the Deese–Roediger–McDermott (DRM; J. Deese, 1959; H. L. Roediger & K. B. McDermott, 1995) paradigm is not an artifact of the age group used to construct the lists.

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Well over the past decade of memory research has seen a substantial increase in work aimed at documenting errors in memory accuracy (for reviews, see Jacoby & Rhodes, 2006; Koriat, Goldsmith, & Pansky, 2000; Roediger, 1996). A great deal of this research has utilized the Deese–Roediger–McDermott (DRM; Deese, 1959; Roediger & McDermott, 1995) paradigm as a method for reliably eliciting memory errors. In the DRM paradigm, participants are presented with a list of words (e.g., *door, glass, pane, shade, ledge, glass, house*) that converge on a central theme word (e.g., *window*), the critical lure, that is not presented. The consistent finding across a number of studies (e.g., Anastasi, Rhodes, & Burns, 2000; Rhodes & Anastasi, 2000; Roediger & McDermott, 1995) is that participants frequently recognize or recall the critical lure, often at levels comparable with presented list items. However, the developmental literature has revealed a significant exception to this pattern: Children, particularly young children, are generally less susceptible to the DRM illusion than adults (e.g., Brainerd, Forrest, Karibian, & Reyna, 2006; Brainerd & Reyna, 1996; Brainerd, Reyna, & Forrest, 2002; Dewhurst & Robinson, 2004; Holliday & Weekes, 2006; Howe, 2005; but see Ghetti, Qin, & Goodman, 2002). That is, memory errors in the DRM paradigm appear to be negatively correlated with age, such that children are less likely to recall or recognize critical lures than are adults or adolescents.

These conclusions have primarily been drawn by researchers using lists developed with adults (Roediger & McDermott, 1995;

Stadler, Roediger, & McDermott, 1999), leaving open the possibility that the negative relationship between age and the probability of errors in the DRM paradigm is due to the use of adult-normed lists. That is, younger children may be more likely to exhibit false memories if they were exposed to lists developed with children. Several prior studies have demonstrated changes in children's memory performance when child-appropriate materials are employed. For example, Lindberg (1980) examined adults' and third graders' recall of two types of categorized lists. One list was developed on the basis of interviews with third graders and included categories such as their favorite books and movies, whereas another list was developed with adult category norms. Whereas adults recalled more items from the adult-normed lists than did children, the opposite pattern was apparent for third-grade lists, as children's recall was superior to that of adults. Bjorklund and Thompson (1983) reported similar findings. They observed that children recalled more exemplars from categorized lists that had been normed with children than a similar list that had been normed with adults, leading them to conclude that "... the degree of knowledge children possess with respect to the to-be-remembered items can have important consequences for performance on memory tasks" (p. 341). Other work demonstrating enhancements in memory performance when to-be-remembered items are consistent with children's expertise further support this claim (e.g., Chi, 1978; Schneider & Bjorklund, 1992).

We know of only two studies in which researchers have examined this issue with respect to the DRM paradigm by using age-appropriate lists. Metzger et al. (2008) had third graders and college students engage in a free association task to several words (e.g., *sleep, foot*). The most common associates reported by third graders were then used as stimuli in a subsequent experiment that tested memory across a range of age groups (second graders, third graders, fifth graders, eighth graders, and college students). Results showed that the youngest age group, second graders, was less likely to recall or recognize the critical lure than older age groups,

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replicating prior findings (e.g., Brainerd et al., 2002, 2006; Dewhurst & Robinson, 2004). However, participants were only tested on lists created on the basis of child norms,¹ making it impossible to directly compare performance on child- and adult-normed lists.

In a second study, Carneiro, Albuquerque, Fernandez, and Esteves (2007; Experiment 2) evaluated preschoolers and preadolescents using Portuguese free association norms from these age groups. They found that preschoolers were more likely to recall critical lures with preschool-normed lists, whereas preadolescents recalled more critical lures with preadolescent-normed lists. However, it is unclear whether this pattern of findings will extend to the more typical DRM lists used in most investigations of false memories and whether this pattern will likewise extend to comparisons between adults and children.

In the current study, we attempted a more stringent test of developmental increases in false memory production by using age-appropriate, DRM-type lists. Specifically, we tested children and adults using lists normed with adult populations and lists that were normed with children. A repeated measures design was used, with all participants exposed to both child- and adult-normed lists, permitting us to make direct comparisons of performance. If the negative relationship between age and the probability of errors in the DRM paradigm in past studies is due to the use of adult-normed lists, then employing lists developed with children should increase false memories in children, thus minimizing age differences in false memories between children and adults. However, if false memories do not differ between the adult- and child-normed DRM lists, this would provide strong support for the generality of the negative relation between age and false memories in the DRM paradigm. We examine the implications of our findings for developmental theories of false memories in the Discussion section.

Method

Participants

Sixty-two individuals participated in the current study, including 30 children between the ages of 5 and 8 years (mean age = 6.6 years, $SD = 0.7$) and 32 young adults (mean age = 24.7 years, $SD = 5.8$) enrolled at Arizona State University West. Children were tested at local elementary schools and after-school programs from a predominately middle-class suburban setting in the Phoenix (Arizona) area and received small toys or stickers for their participation. Both the children (53% male) and young adults (46% male) had a nearly equal mix of male and female participants. All participants reported being native English speakers.

Materials and Procedure

The lists used in the current study were 12 lists taken from Roediger and McDermott (1995) that were developed and normed with adult participants, and 12 additional lists that were developed and normed by Anastasi, Lewis, and Quinlan (2007) with children using the same critical lures used by Roediger and McDermott. Specifically, Anastasi et al. gave 5- to 8-year-old children (mean age = 6.4 years, $SD = 1.1$) each of the 24 critical lures and asked them to say aloud the first three words that came to mind. Similar to the adult DRM lists, the 15 most common associates generated made up the child-normed lists (see the Appendix). In the current

study, we used the Roediger–McDermott and Anastasi–Lewis–Quinlan lists that were based on the *Window, Smell, Rough, Sleep, Music, River, Rubber, City, Fruit, Car, Lion, and King* critical lures. Overall, 26% of the words on the child-normed lists are also included on the adult-normed lists.

Each participant was tested individually and received a total of 12 lists. Half of the participants were given 6 adult-normed lists followed by 6 child-normed lists, whereas the remaining participants received the opposite order. Participants were instructed to pay attention to each of the list items as they were read aloud at approximately a 2-s rate. Following each list, participants were told to say aloud as many words from the list as they could remember.² Each of the items recalled was checked off on a pre-prepared testing sheet, whereas any extralist items were written down. After participants indicated that they could not remember any additional list items, they were given the next list in the same manner. This process was continued for each of the 6 initial lists. Immediately after the sixth recall test, participants were given a 36-item yes/no recognition test (18 list items, 6 critical lures, and 12 nonlist items) for all of the previous 6 lists. Participants were instructed to indicate whether they remembered each of the items said aloud by the experimenter. Participants' answers were recorded on a pre-prepared testing sheet. After a short break, participants were given the remaining 6 lists and were tested in an identical manner.

Results

Recall Data

The proportion of list items and critical lures recalled by children and adults (see Table 1) was analyzed with a 2 (Age: children, adults) \times 2 (List Norm: child-normed, adult-normed) \times 2 (Item Type: list, critical lure) mixed-factor analysis of variance. (The alpha level for all statistical tests was set to .05.) Results show that adults ($M = 0.38$) recalled reliably more items than children ($M = 0.24$), $F(1, 62) = 39.63$, $\eta_p^2 = .35$. Participants also exhibited higher levels of recall for adult- ($M = 0.33$) compared with child-normed ($M = 0.29$) lists, $F(1, 62) = 8.35$, $\eta_p^2 = .12$. Furthermore, list items ($M = 0.39$) were recalled more frequently than critical lures ($M = 0.23$), $F(1, 62) = 67.52$, $\eta_p^2 = .52$. An Age \times Item Type interaction, $F(1, 62) = 4.06$, $\eta_p^2 = .06$, was also present. In particular, adults ($M = 0.28$) recalled reliably more critical lures than children ($M = 0.18$), $F(1, 62) = 7.49$, $\eta_p^2 = .11$. Furthermore, adults ($M = 0.48$) recalled substantially more list items than children ($M = 0.30$), $F(1, 62) = 93.52$, $\eta_p^2 = .60$. Finally, List Norm interacted with Item Type, $F(1, 62) = 21.57$, $\eta_p^2 = .26$. Specifically, the difference in recall of list items and critical lures was greater for the child-normed lists, $F(1, 62) = 100.10$, $\eta_p^2 = .62$, than for the adult-normed lists, $F(1, 62) = 13.15$, $\eta_p^2 = .18$. No other interactions were reliable ($ps > .50$).

¹ A group of college students also provided free association data. However, all lists were created in descending order of associative strength on the basis of third graders' norms.

² Because many of the children were not adept at reading and writing, the list items and memory tests were administered orally to both children and adults to ensure that any differences between children and adults were not due to encoding and output methods.

Planned comparisons showed that adults recalled the same proportion of list items from the child- and adult-normed lists, $F(1, 33) = 1.27, p = .27, \eta_p^2 = .04$, but fewer critical lures from the child- than adult-normed lists, $F(1, 33) = 6.64, \eta_p^2 = .17$. However, children recalled more list items from the child- than adult-normed lists, $F(1, 29) = 19.62, \eta_p^2 = .40$, but, like adults, they recalled more critical lures from the adult- than child-normed lists, $F(1, 29) = 10.00, \eta_p^2 = .26$. These data indicate that although the child-normed lists increased children's veridical recall, they did not result in elevated levels of false recall.

Recognition Data

The proportion of list items, critical lures, and nonlist items recognized are displayed in Table 2. We calculated A' scores (see Table 3; for details of the calculation, see Snodgrass & Corwin, 1988) for each participant, and we analyzed them using the same factors described for the analysis of the recall data.³ Results show that adults' discriminability ($M = 0.88$) exceeded that of children ($M = 0.80$), $F(1, 62) = 17.20, \eta_p^2 = .22$. Discriminability was reliably better for list items ($M = 0.86$) than for critical lures ($M = 0.82$), $F(1, 62) = 25.80, \eta_p^2 = .29$, but it did not differ between adult-normed ($M = 0.85$) and child-normed ($M = 0.83$) lists, $F(1, 62) = 2.85, p = .10, \eta_p^2 = .04$. However, a significant List Norm \times Item Type interaction was present, $F(1, 62) = 7.56, \eta_p^2 = .11$. In particular, whereas list item discriminability was virtually identical for child- and adult-normed lists ($M = 0.86$), $F < 1$, critical lure recognition was significantly greater for adult-normed ($M = 0.84$) compared with child-normed ($M = 0.79$) lists, $F(1, 62) = 6.29, \eta_p^2 = .09$.

Planned comparisons showed that adults' list item recognition did not differ between adult-normed and child-normed lists, $F(1, 33) = 2.72, p = .11, \eta_p^2 = .08$. However, adults' critical lure recognition was greater for adult-normed than child-normed lists, $F(1, 33) = 4.38, \eta_p^2 = .12$. Neither children's list item recognition, $F(1, 29) = 1.44, p = .24, \eta_p^2 = .05$, nor their critical lure recognition, $F(1, 33) = 2.15, p = .15, \eta_p^2 = .07$, differed between adult-normed and child-normed lists. Thus, only adults' false recognition was sensitive to the type of list studied.

Child Subgroup Analyses

The children tested in the current study came from a broader age range (5- to 8-year-olds) than that typically used in investigations of developmental trends in false memories. To further examine

Table 1
Proportion of List Items and Critical Lures Recalled

Participant age	Adult-normed lists		Child-normed lists	
	List items	Critical lures	List items	Critical lures
Children	.27 (.08)	.23 (.20)	.32 (.08)	.12 (.14)
Adults	.48 (.09)	.33 (.21)	.49 (.08)	.23 (.20)

Note. Standard deviations are in parentheses. The average number of nonlist intrusions recalled by children was .36 and .31 for each adult-normed and child-normed list, respectively. Adults recalled an average number of .36 and .34 nonlist intrusions for each adult-normed and child-normed list, respectively.

Table 2
Proportion of List Items and Critical Lures Recognized

Participant age	Adult-normed lists		Child-normed lists	
	List items	Critical lures	List items	Critical lures
Children	.57 (.21)	.54 (.27)	.63 (.19)	.46 (.25)
Adults	.82 (.11)	.74 (.25)	.79 (.14)	.63 (.22)

Note. Standard deviations are in parentheses. The proportion of nonlist items children recognized was .14 and .18 for the adult-normed and child-normed lists, respectively. Adults recognized .16 and .22 nonlist items for the adult-normed and child-normed lists, respectively.

possible differences between children of different ages, we divided children into two age groups (5- to 6-year-olds, $n = 14$; and 7- to 8-year-olds, $n = 16$) and examined recall and recognition performance. In the interest of brevity, we report only those results that pertain to Child Age Group.⁴ First, recall data for children were analyzed in a 2 (List Norm: child-normed, adult-normed) \times 2 (Item Type: list, critical lure) \times 2 (Child Age Group: 5–6, 7–8) mixed-factor analysis of variance. Results show that Child Age Group did not interact with any variables ($ps > .20$). An analysis that used the same factors for A' scores revealed a marginally reliable Child Age Group \times Item Type interaction, $F(1, 28) = 3.76, p = .06, \eta_p^2 = .12$. In particular, for the 5- to 6-year-olds, list item recognition ($M = 0.82$) exceeded critical lure recognition ($M = 0.75$), $F(1, 13) = 6.17, \eta_p^2 = .32$. In contrast, for 7- to 8-year-olds, list item recognition ($M = 0.82$) did not differ reliably from critical lure recognition ($M = 0.80$), $F(1, 15) = 1.46, p = .25, \eta_p^2 = .25$. Thus, whereas 5- to 6-year-olds recognized the same proportion of list items as 7- to 8-year-olds, they exhibited lower levels of false recognition.

Discussion

Children in the current study exhibited lower levels of false memories than adults on both recall and recognition measures, consistent with a number of other studies (e.g., Brainerd et al., 2002, 2006; Brainerd & Reyna, 1996; Dewhurst & Robinson, 2004; Holliday & Weekes, 2006; Howe, 2005). Of greater importance, the negative relation between age and false memories was evident for both adult-normed and child-normed lists. Thus, the finding that children are less likely than adults to falsely recall or recognize the critical lure in the DRM paradigm is not an artifact of the specific type of lists used in previous studies and generalizes to lists that were developed with children. However, it should be noted that these data are inconsistent with Carneiro et al. (2007), who reported that false recall was dependent on the specific list norms used. It is unclear whether this difference is due to the use

³ The manner of calculation renders it such that list item performance is calculated with recognition of nonlist items as false alarms. Likewise, performance for the critical lure was assessed by first entering critical lure recognition as "hits" in the formula and recognition of nonlist items as "false alarms." Thus, high values of A' for critical lures are indicative of high levels of false memories for the critical lure.

⁴ The full set of data and analyses are available upon request from Jeffrey S. Anastasi.

Table 3
A' Values for List Items and Critical Lures for Adult- and Child-Normed Lists

Participant age	Adult-normed lists		Child-normed lists	
	List items	Critical lures	List items	Critical lures
Children	.81 (.13)	.80 (.12)	.83 (.11)	.76 (.13)
Adults	.91 (.05)	.88 (.08)	.89 (.06)	.83 (.11)

Note. Standard deviations are in parentheses.

of different lists, different languages, different age groups, or some other potential factor. Thus, more research investigating these developmental trends in false memories is warranted.

How do the current findings fit within the primary theories—fuzzy-trace theory (Brainerd & Reyna, 1996, 1998; Reyna & Brainerd, 1995) and activation-monitoring theory (AMT; Gallo, Roediger, & McDermott, 2001; McDermott & Watson, 2001; Roediger & McDermott, 1995; Roediger, Watson, McDermott, & Gallo, 2001)—used to explain false memories? On the surface, both may provide equally plausible explanations of the current findings. Fuzzy trace theory suggests that encoding results in a verbatim and gist representation of the original experience. Verbatim representations refer to the specific details of an experience, whereas gist representations correspond to the general content or meaning of an experience. In the context of the DRM paradigm, verbatim representations would comprise the actual items presented (e.g., *sill*, *pane*, *door*), whereas a gist representation would comprise the central theme word that is not presented (e.g., *window*). Thus, memory for list items reflects the strength of the verbatim (and potentially gist) representation, whereas false memories for the critical lure are supported by a gist representation. Accordingly, developmental increases in false memories occur because the ability to extract the gist increases with age (Brainerd & Reyna, 1996, 1998). Consistent with this, several studies have reported that young children exhibit less category clustering in free recall than do older children and adults (e.g., Bjorklund & Hock, 1982; Bjorklund & Jacobs, 1985), likely because they are less sensitive to the general thematic content of lists. By extension, the lower levels of false memories exhibited by children in the current study for both types of lists may have occurred because the young children were less likely to extract the gist of the presented lists. Thus, fuzzy-trace theory provides a good explanation for lower levels of false memory production for children compared with adults.

AMT accounts for false memories as the product of implicit activation of related associates during the list presentation (cf. Underwood, 1965). In particular, viewing a list of associates of a central theme word increases the probability of activating that central theme word (e.g., *window*) as each list item is presented. This frequent activation makes it highly likely that the central theme will be misattributed to the presented study list. Later instantiations of AMT proposed that false memories were the product of a tradeoff between such activation and the efficiency with which the rememberer monitors items during retrieval (Gallo et al., 2001; McDermott & Watson, 2001; Roediger et al., 2001), with proficient monitoring reducing the probability of exhibiting false memories. Thus, AMT suggests that false memories result from mistakenly reporting or endorsing a critical lure that has been activated during study or retrieval and when

participants are unable to counter activation of the critical lure with proficient monitoring.

On the basis of AMT, one might presume there would be developmental decreases in false memories if they were the product of monitoring deficiencies, rather than the developmental increases in false memories that are observed. However, with the addition of one assumption that is not explicitly stated by the AMT theory, AMT also provides a relatively simple explanation of this counterintuitive finding (Carneiro et al., 2007). Several researchers have posited that children are less likely to activate critical lures than adults because of a potentially less developed associative network than adults (see Bjorklund, 1987; Carneiro et al., 2007; Howe, 2006). This activation mechanism alone would predict fewer false memories in children compared with adults. However, monitoring should lead to an age-related decline in false memories because of the fact that children are less adept at source monitoring than adults (Foley & Johnson, 1985; Foley, Johnson, & Raye, 1983). Thus, source monitoring deficiencies in children may be masked by having to judge less frequently whether an activated critical lure was presented during study. One potential weakness of AMT is the vagueness of these mechanisms. For example, it is unclear whether activation or monitoring is the more important mechanism at any given time, what the contribution of each would be, and when the balance between the two would change.

Nevertheless, an important feature of AMT is that it suggests that false memories result from associative activation and not the development of a gist representation. One form of evidence for this are studies demonstrating that the best predictor of false recall is the probability that a list item activates the critical lure (i.e., backward associative strength; *BAS*). For example, across 55 lists examined by Roediger et al. (2001), *BAS* was the single best predictor of false recall ($r = .73$) and, to a lesser extent, false recognition ($r = .43$). In the current study, *BAS* was likewise a strong predictor of false recall for both adults ($r = .50$) and children ($r = .75$) for adult-normed lists. *BAS* also predicted children's false recognition ($r = .48$) with adult-normed lists but was not a strong predictor of adult false recognition ($r = -.07$). However, comparable child norms providing *BAS* data are not currently available, making it impossible to evaluate how well *BAS* predicts performance on child-normed lists.⁵ This is a critical issue, as children's associative networks are not identical to those of adults (cf. Howe, 2006). For example, Bjorklund (1987) noted that the strength and number of links to particular items increase with age, likely as the product of greater exposure to particular items. Thus, *BAS* measures derived from adults may not adequately reflect the associative networks of younger children.

Given that *BAS* was a strong predictor of false memories, the evidence would seem to favor such an interpretation of the results of the current study. However, associative strength may be confounded with thematic activation, making it difficult to tease the

⁵ Using the adult *BAS* norms from Roediger et al. (2001) and Nelson, McEvoy, and Schreiber (1998), we found that the average *BAS* values for the adult-normed lists in the current study were .26, whereas average *BAS* values for child-normed lists were .20. However, it should be noted that *BAS* values were available for 80% of the items on the adult lists but only 46% of the items from the child lists. Thus, there may be some bias in these estimates because these data are based only on adult *BAS* norms.

two apart. For example, the *sleep* list produces false recall at a very high level ($M = 0.61$) and likewise has a high mean *BAS* value ($M = 0.43$). However, this list would also be expected to result in high levels of false recall on the basis of strong levels of thematic activation resulting from its constituent list items (e.g., *bed, rest, awake, tired, dream, etc.*). Hutchison and Balota (2005) have reported a potential solution to this problem. Specifically, participants in several experiments studied lists that all converged on a single meaning, akin to the typical DRM lists used, and they also studied lists that converged on two different meanings (*homographic lists*). For example, the homographic lists for the critical lure *fall* consisted of items related to the “stumble” meaning (*stumble, slip, trip, etc.*) and items related to the “autumn” meaning (*autumn, season, spring, etc.*). If false memories are the result of thematic activation, one would expect false memories to be more prevalent for lists that converge on a single meaning (DRM lists) than lists that converge on multiple meanings (homographic lists). However, if false memories are the result of associative activation, then the number of associates and not singularity of meaning should be the crucial factor. Results are consistent with the latter prediction. In particular, false recall and recognition did not differ between DRM and homographic lists, whereas veridical recall was sensitive to thematic organization, with recall superior for lists that converged on a single meaning (see Howe, 2006, for a similar pattern with children). Thus, the evidence seems to suggest that associative activation is the primary causal factor in false memories. By this account, the lower probability of exhibiting false memories for child-normed lists in the current study may be the product of weaker associative relations between the critical lure and list items for such lists.

In summary, the current study, like many previous studies, has demonstrated that children display fewer false memories in the DRM paradigm compared with adults. This lower level of false memories was found even when we used word lists developed and normed with other similarly aged children. Thus, the typical finding of lower rates of false memories in children does not appear to be a product of the type of list used to evaluate their memory in the DRM paradigm.

References

- Anastasi, J. S., Lewis, S., & Quinlan, F. (2007). *Normative data for semantically associated word lists that create false memories in children*. Unpublished manuscript.
- Anastasi, J. S., Rhodes, M. G., & Burns, M. C. (2000). Distinguishing between memory illusions and actual memories utilizing phenomenological measurements and explicit warnings. *American Journal of Psychology, 113*, 1–26.
- Bjorklund, D. F. (1987). How age changes in knowledge base contribute to the development of children's memory: An interpretive review. *Developmental Review, 7*, 93–130.
- Bjorklund, D. F., & Hock, H. S. (1982). Age differences in the temporal locus of memory organization in children's recall. *Journal of Experimental Child Psychology, 32*, 347–362.
- Bjorklund, D. F., & Jacobs, J. W. (1985). Associative and categorical processes in children's memory: The role of automaticity in the development of organization in free recall. *Journal of Experimental Child Psychology, 39*, 599–617.
- Bjorklund, D. F., & Thompson, B. E. (1983). Category typicality effects in children's memory performance: Qualitative and quantitative differences in the processing of category information. *Journal of Experimental Child Psychology, 35*, 329–344.
- Brainerd, C. J., Forrest, T. J., Karibian, D., & Reyna, V. F. (2006). Development of the false-memory illusion. *Developmental Psychology, 42*, 962–979.
- Brainerd, C. J., & Reyna, V. F. (1996). Mere memory testing creates false memories in children. *Developmental Psychology, 32*, 467–476.
- Brainerd, C. J., & Reyna, V. F. (1998). Fuzzy-trace theory and children's false memories. *Journal of Experimental Child Psychology, 71*, 81–129.
- Brainerd, C. J., Reyna, V. F., & Forrest, T. J. (2002). Are young children susceptible to the false-memory illusion? *Child Development, 73*, 1363–1377.
- Carneiro, P., Albuquerque, P., Fernandez, A., & Esteves, F. (2007). Analyzing false memories in children with associative lists specific for their age. *Child Development, 78*, 1171–1185.
- Chi, M. T. H. (1978). Knowledge structures and memory development. In R. Siegler (Ed.), *Children's thinking: What develops?* (pp. 73–96). Hillsdale, NJ: Erlbaum.
- Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology, 58*, 17–22.
- Dewhurst, S. A., & Robinson, C. A. (2004). False memories in children: Evidence for a shift from phonological to semantic associations. *Psychological Science, 15*, 782–786.
- Foley, M. A., & Johnson, M. K. (1985). Confusions between memories for performed and imagined actions: A developmental comparison. *Child Development, 56*, 1145–1155.
- Foley, M. A., Johnson, M. K., & Raye, C. L. (1983). Age-related changes in confusion between memories for thoughts and memories for speech. *Child Development, 54*, 51–60.
- Gallo, D. A., Roediger, H. L., & McDermott, K. B. (2001). Associative false recognition occurs without strategic criterion shifts. *Psychonomic Bulletin and Review, 8*, 579–586.
- Ghetti, S., Qin, J. J., & Goodman, G. S. (2002). False memories in children and adults: Age, distinctiveness, and subjective experience. *Developmental Psychology, 38*, 705–718.
- Holliday, R. E., & Weekes, B. S. (2006). Dissociated developmental trajectories for semantic and phonological false memories. *Memory, 14*, 624–636.
- Howe, M. L. (2005). Children (but not adults) can inhibit false memories. *Psychological Science, 16*, 927–931.
- Howe, M. L. (2006). Developmentally invariant dissociations in children's true and false memories: Not all relatedness is created equal. *Child Development, 77*, 1112–1123.
- Hutchison, K. A., & Balota, D. A. (2005). Decoupling semantic and associative information in false memories: Explorations with semantically ambiguous and unambiguous critical lures. *Journal of Memory and Language, 52*, 1–28.
- Jacoby, L. L., & Rhodes, M. G. (2006). False remembering in the aged. *Current Directions in Psychological Science, 15*, 49–53.
- Koriat, A., Goldsmith, M., & Pansky, A. (2000). Toward a psychology of memory accuracy. *Annual Review of Psychology, 51*, 481–537.
- Lindberg, M. A. (1980). Is knowledge base development a necessary and sufficient condition for memory development? *Journal of Experimental Child Psychology, 30*, 401–410.
- McDermott, K. B., & Watson, J. M. (2001). The rise and fall of false recall: The impact of presentation duration. *Journal of Memory and Language, 45*, 160–176.
- Metzger, R. L., Warren, A. R., Shelton, J. T., Price, J. D., Reed, A. W., & Williams, D. (2008). Do children “DRM” like adults? False memory production in children. *Developmental Psychology, 44*, 169–181.
- Nelson, D. L., McEvoy, C. L., & Schreiber, T. A. (1998). *The University*

- of South Florida word association, rhyme, and word fragment norms. Retrieved from <http://w3.usf.edu/FreeAssociation/>
- Reyna, V. F., & Brainerd, C. J. (1995). Fuzzy-trace theory: An interim synthesis. *Learning and Individual Differences, 7*, 1–75.
- Rhodes, M. G., & Anastasi, J. S. (2000). The effects of a levels-of-processing manipulation on false recall. *Psychonomic Bulletin and Review, 7*, 158–162.
- Roediger, H. L. (1996). Memory illusions. *Journal of Memory and Language, 35*, 76–100.
- Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 803–814.
- Roediger, H. L., Watson, J. M., McDermott, K. B., & Gallo, D. A. (2001). Factors that determine false recall: A multiple regression analysis. *Psychonomic Bulletin and Review, 8*, 385–407.
- Schneider, W., & Bjorklund, D. F. (1992). Expertise, aptitude, and strategic remembering. *Child Development, 63*, 461–473.
- Snodgrass, J. G., & Corwin, J. (1988). Pragmatics of measuring recognition memory: Application to dementia and amnesia. *Journal of Experimental Psychology: General, 117*, 34–50.
- Stadler, M. A., Roediger, H. L., & McDermott, K. B. (1999). Norms for word lists that create false memories. *Memory & Cognition, 27*, 494–500.
- Underwood, B. J. (1965). False recognition produced by implicit verbal responses. *Journal of Experimental Psychology, 70*, 122–129.

Appendix

Twelve Child-Normed Lists Used in the Current Study in Descending Order of Associative Strength

Window	River	Car	Sleep	Rubber	Lion
<i>glass</i> (2)	<i>water</i> (1)	wheel	<i>bed</i> (1)	<i>stretchy</i> (15)	<i>roar</i> (11)
<i>see</i>	<i>fish</i> (13)	<i>drive</i> (6)	pillow	band	fur
<i>house</i> (7)	<i>swim</i> (7)	seat	<i>blanket</i> (8)	<i>bounce</i> (2)	teeth
<i>open</i> (8)	<i>stream</i> (2)	fast	<i>tired</i> (4)	plastic	meat
blinds	<i>lake</i> (3)	steering	<i>dream</i> (5)	squishy	eat
outside	ocean	engine	<i>snore</i> (11)	toys	scary
tree	<i>flow</i> (8)	gas	<i>nap</i> (12)	duck	tail
<i>doors</i> (1)	frog	school	<i>rest</i> (2)	goo	zoo
metal	beach	doors	awake	hard	hair
air	wet	radio	comfortable	smooth	growl
clear	<i>bridge</i> (14)	tires	covers	weird	loud
square	clear	horn	lay	wheels	<i>mane</i> (8)
wood	drown	light	quiet	<i>ball</i> (5)	big
<i>curtains</i> (9)	land	motorcycle	room	pop	cat
breakable	long	people	afternoon	break	<i>jungle</i> (3)
Smell	City	Fruit	Rough	Music	King
good	buildings	<i>apple</i> (1)	hurt	dance	<i>crown</i> (3)
stink	people	eat	<i>smooth</i> (1)	<i>sing</i> (4)	<i>queen</i> (1)
<i>nose</i> (1)	houses	<i>banana</i> (8)	<i>bumpy</i> (2)	loud	castle
food	skyscrapers	healthy	wall	<i>sound</i> (2)	<i>royal</i> (13)
flowers	<i>town</i> (1)	<i>orange</i> (3)	fight	drum	boss
<i>scent</i> (9)	<i>state</i> (3)	grape	scratch	guitar	princess
sneeze	work	sweet	hit	nice	ruler
taste	hotels	watermelon	mad	play	<i>throne</i> (8)
allergies	store	seeds	wrestling	<i>instrument</i> (10)	<i>prince</i> (4)
body	animals	taste	argument	listen	cape
breathe	lights	<i>vegetable</i> (2)	boys	quiet	<i>leader</i> (14)
candle	small	food	brother	<i>radio</i> (5)	rich
cookie	loud	hungry	houses	<i>piano</i> (3)	sword
diaper	parks	<i>juice</i> (12)	kick	relaxing	clothes
oven	<i>street</i> (5)	peach	nice	songs	suit

Note. Items in bold font indicate the critical lures for each 15-item list. Items in italics indicate those words that are also included in Stadler, Roediger, and McDermott's (1999) adult norms. The number in parentheses indicates that item's rank within Stadler et al.'s lists.

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