Research Article

False Memories in Children

Evidence for a Shift From Phonological to Semantic Associations

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ABSTRACT—*Memory illusions in children of three age groups (5-, 8-, and 11-year-olds) were investigated using a modified version of the Deese-Roediger-McDermott (DRM) procedure. Children from each age group falsely recalled nonpresented items related to the study lists. However, the nature of the intrusions varied across the different groups. The 5-year-olds were more likely to falsely recall words that rhymed with the studied items than to recall unrelated items, whereas the 11-year-olds were more likely to falsely recall words that were semantically related to the list theme than to produce either rhyming or unrelated intrusions. Intrusions made by the 8-year-olds were equally likely to be semantic, rhyming, or unrelated to study items. The results are consistent with the notion of a developmental shift from phonological to semantic associations, leading to qualitatively different memory distortions in children of different ages.*

False memories and memory distortions are currently topics of considerable interest to memory researchers. One of the most widely used procedures for investigating false memories in the laboratory is the Deese-Roediger-McDermott (DRM) paradigm. This procedure, first used by Deese (1959) and later revived and extended by Roediger and McDermott (1995), involves presenting lists of words that are semantic associates of a critical word that is not itself presented (e.g., participants hear words such as *bed*, *rest*, *awake*, *tired*, and *dream*, which are all associates of the nonpresented word *sleep*). Roediger and McDermott found that participants falsely recalled the nonpresented items, with the level of false recall equaling (Experiment 1) or exceeding (Experiment 2) the correct recall of items that were presented in the middle of the lists. This memory illusion has subsequently been replicated by a number of researchers and has been found to occur in both recall and recognition memory (e.g., McDermott & Roediger, 1998; Payne, Elie, Blackwell, & Neuschatz, 1996). We refer to this memory illusion henceforth as the DRM effect.

Roediger and McDermott (1995) explained the DRM effect in terms of the implicit-associative-responses hypothesis proposed by Underwood (1965). According to this hypothesis, participants presented with lists of words make associations to studied items. For example, participants generate *cold* when the word *hot* is presented. The generated items are subsequently retrieved at test and are falsely believed to have been presented at encoding. The memory illusions produced by the DRM procedure have thus been interpreted as errors of source monitoring (Johnson, Hashtroudi, & Lindsay, 1993) in that participants erroneously attribute the critical items to external rather than internal sources.

Some recent interesting research using the DRM procedure has investigated individual differences in susceptibility to the DRM effect. For example, Balota et al. (1999) investigated false memories in healthy older adults and in adults with dementia of the Alzheimer's type. They found that susceptibility to the DRM effect increased with both the age of the participant and the severity of the dementia. Melo, Winocur, and Moscovitch (1999) found that amnesic patients with damage to the medial temporal lobes and diencephalic regions and nonamnesic patients with frontal lobe damage showed greater susceptibility to the DRM relative to control subjects. More recently, Clancy, Schacter, McNally, and Pitman (2000) reported an enhanced susceptibility to the DRM effect in women who claim to have recovered memories of sexual abuse. These and similar findings clearly indicate that some groups are more susceptible than others to the memory illusion produced by the DRM procedure.

One group that does not appear to show susceptibility to the DRM effect, however, is children. The activation-monitoring account of false memories proposed by Roediger and McDermott (1995) predicts that young children should be

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particularly prone to the DRM effect owing to their relatively poor source-monitoring skills (Foley, Johnson, & Raye, 1983). However, Brainerd, Reyna, and Forrest (2002) found that false memories produced by the DRM procedure were at near-floor levels in 5- and 7-year-olds and below adult levels in young adolescents. Brainerd et al. interpreted their results in terms of fuzzy-trace theory (Brainerd & Reyna, 1996, 2001; Reyna & Brainerd, 1995, 1998), which postulates the formation of two separate representations of experience: a verbatim trace of the surface form of experience and a gist trace of nonspecific semantic information. Fuzzy-trace theory predicts that young children will not show susceptibility to the DRM effect because they fail to create gist memories of the semantic relatedness of the DRM lists. The findings of Brainerd et al. are consistent with this view.

The claim that young children do not extract the gist of the DRM lists is consistent with previous findings that children do not attend to semantic information to the same degree as adults (e.g., Bjorkland & Hock, 1982; Schneider & Pressley, 1989). However, previous research suggests that rather than showing a simple developmental increase in attention to semantic information, children undergo a shift from phonological to semantic processing. For example, Hasher and Clifton (1974) presented second graders (7-year-olds), sixth graders (11-year-olds), and undergraduates with 25-word lists in each of which a critical sequence of 4 words was embedded. The critical sequences were of three types: phonological (a sequence of 4 rhyming words), semantic (a sequence of 4 words from the same semantic category), and unrelated (neither rhyming nor semantically related). The main finding was that the second graders recalled more rhyming words than either semantic or unrelated words, whereas the sixth graders recalled more semantic words than either rhyming or unrelated words. Undergraduates recalled more semantic and rhyming words than unrelated words, and recalled the semantic and rhyming words equally well. Hasher and Clifton concluded that different attributes of words are salient to children of different ages. Specifically, they argued that the sound of a word is more salient than its meaning for second graders, whereas for sixth graders the reverse is true.

If a developmental shift from phonological to semantic processing occurs, it is not surprising that young children fail to show a false memory effect in a paradigm that relies on semantic associations. However, there is evidence that young children are susceptible to memory distortions produced by phonological associations. For example, Bach and Underwood (1970) presented lists of 40 words to second graders and sixth graders and then gave them a forced-choice recognition test containing studied and nonstudied items, presented in sets of four. Each set of four consisted of one studied item and three lure items: a semantic associate, an acoustically similar word, and an unrelated word (e.g., the studied word *bad* was presented with the lures *good*, *bag*, and *dot*). The participants' task was to identify which of the four words had been presented at study. The critical finding was that second graders were more likely to falsely recognize the phonological lures than the semantic lures, whereas sixth graders showed the opposite pattern. Bach and Underwood concluded that there are developmental changes in the dominance of word attributes, with semantic attributes becoming more dominant than acoustic attributes as children grow older.

The aim of the present study was to further investigate the possibility that young children are susceptible to memory distortions created by the processing of phonological associations. In particular, the aim was to reconcile recent findings that children are not susceptible to the DRM effect with the earlier findings that they are susceptible to false memories based on phonology. To this end, children of three age groups (5-, 8-, and 11-year-olds) were given a variant of the DRM task. The children were shown lists of words that were taken from Roediger and McDermott (1995) but adapted to allow both phonological and semantic associations. This was achieved by restricting the selection of words to those that had at least one rhyme. Our main prediction was that the nature of false recall intrusions would change with age, with younger children producing mainly phonological intrusions and older children producing mainly semantic intrusions.

METHOD

Participants

Fifty-seven children (27 girls and 30 boys) were recruited from a local primary school. The cohort consisted of nineteen 5-year-olds, eighteen 8-year-olds, and twenty 11-year-olds. All were native English speakers with no reported history of speech or hearing difficulties.

Stimuli and Design

Five lists of eight words each were selected from Roediger and McDermott (1995). Each list was associated with a semantic theme, and all the words in each list had at least one rhyme. For example, the *sleep* list consisted of the words *nap*, *bed*, *rest*, *peace*, *wake*, *dream*, *doze*, and *snore*. The themes of the other four lists were *anger*, *cold*, *foot*, and *river*. Words were chosen on the basis that they would be familiar to children and would allow both semantic and phonological (rhyme) associations. All the words were monosyllabic and between three and six letters long. Selection of stimuli was further constrained by the need to avoid rhymes that were also semantically related to the list theme. Age was the between-subjects independent variable, and the dependent variables were the numbers of words correctly and falsely recalled.

Procedure

The children were tested individually in the school hall, which was unoccupied during the test procedure but open to view in order to maximize the security and well-being of the children.

The children were told they would hear five lists of words and that they were to try to remember each list after they heard it. The words were read aloud by the experimenter at a rate of one every 2 s. At the end of each list, the child was asked to recall the words he or she had just heard, and the responses were recorded on an audiocassette. At the end of the test, children were thanked and told they had done well.

RESULTS

Prior to statistical analysis, the numbers of correctly recalled items and intrusion errors were calculated for each child. Intrusions were then divided into semantic errors (semantically related to the list theme), phonological errors (rhymes of words in the study list), and unrelated errors (neither rhyming nor semantically related). Semantic intrusions included the critical items (e.g., *sleep*) and other words that were semantically related to the list themes. These were combined in the analysis in order to enable comparison with the phonological errors, which were potentially more numerous. An error was classed as unrelated if it did not rhyme with words in the study list and was not clearly related to the list theme. An alpha level of .05 was used in all statistical analyses. Effect sizes measured by eta-squared (η^2) are also given.

The total numbers of correctly recalled items were entered into a three-way analysis of variance (ANOVA) with age as the between-groups factor. This ANOVA showed a significant main effect, $F(2, 54) = 54.66$, $MSE = 1{,}079.06$, $\eta^2 = .67$, with overall levels of correct recall increasing with age. Pair-wise comparisons (Tukey's honestly significantly difference, HSD, test) showed that the 11-year-olds recalled more words correctly than the 8-year-olds ($q = 5.57$), who in turn recalled more words correctly than the 5-year-olds ($q = 9.36$). Figure 1 shows mean correct recall per list as a function of age.

The numbers of intrusions were entered into a 3 × 3 mixed ANOVA. The between-groups factor was age, and the within-groups factor was error type (semantic, phonological, or unrelated). The main effect of age was marginally significant, $F(2, 54) = 2.96$, $MSE = 4.25$, $p = .06$, $\eta^2 = .10$, with 8-year-olds making more intrusions overall than 5- and 11-year-olds. The main effect of error type was significant, $F(2, 54) = 6.51$, $MSE = 6.89$, $\eta^2 = .11$, with semantic errors occurring most often and unrelated errors occurring least often. This effect was qualified by a significant interaction between age and error type, $F(4, 54) = 5.01$, $MSE = 5.31$, $\eta^2 = .16$. The interaction was explored by a series of Tukey HSD pair-wise comparisons. For the 5-year-olds, there were significantly more phonological intrusions than unrelated intrusions ($q = 4.01$); numbers of semantic and unrelated intrusions did not differ significantly. For the 8-year-olds, the numbers of rhyming, semantic, and unrelated intrusions did not differ reliably. Finally, for the 11-year-olds, there were significantly more semantic intrusions than phonological and unrelated intrusions ($q = 6.74$ and 5.43, respectively). Pair-wise comparisons of the three age groups showed that both the 5- and the 8-year-olds made significantly more phonological errors than the 11-year-olds ($q = 3.48$ and 3.51), whereas the 11-year-olds made significantly more semantic errors than the 5-year-olds ($q = 3.68$). Figure 2 shows the mean numbers of phonological, semantic, and unrelated intrusions per child as a function of age group.

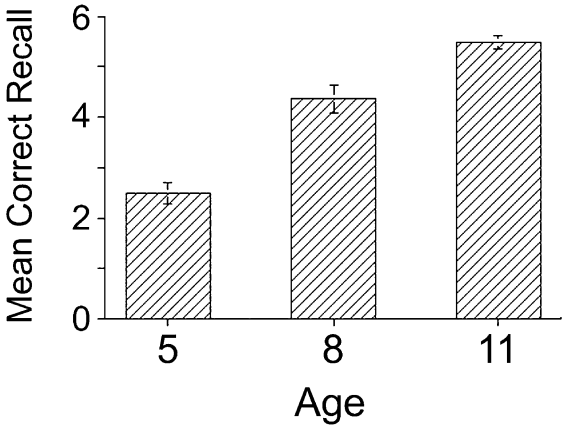

Fig. 1. Mean number of words correctly recalled per list (with standard errors) as a function of age group.

DISCUSSION

The present study used a variant of the DRM procedure to investigate memory illusions in children of different ages (5-, 8-, and 11-year-olds). The main finding was that children from all three age groups produced false memories, but the nature of the false memories varied as a function of age. Five-year-olds were

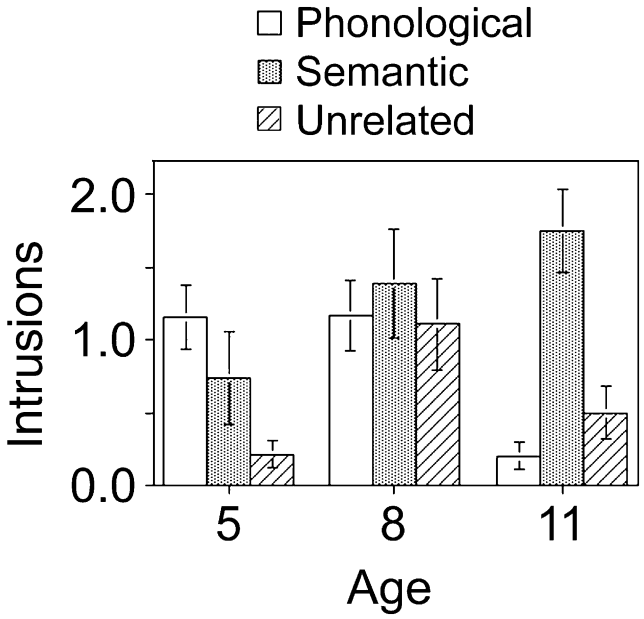

Fig. 2. Mean numbers of phonological, semantic, and unrelated intrusions per child (with standard errors) as a function of age group.

more likely to falsely recall words that were phonologically related to the words they heard at study than to recall unrelated words, whereas 11-year-olds were more likely to falsely recall words that were semantically related to the words they heard than to produce phonological or unrelated intrusions. Eight-year-olds made the highest numbers of intrusions overall, though these were equally likely to be phonological, semantic, or unrelated to the study items. These findings are consistent with the notion of a developmental shift from phonological to semantic processing. Hasher and Clifton (1974) found that younger children are more likely to recall words that are phonologically similar than to recall words that are semantically related, whereas older children show the opposite trend. Similarly, Bach and Underwood (1970) found that younger children were more likely to falsely recognize words that were acoustically similar to the target words than to recall semantically related words, whereas the pattern was reversed in older children. The present results showed the same developmental trend in false recall.

The number of phonological errors was surprisingly high, given that the study lists did not particularly emphasize phonological encoding. In their phonological lists, Hasher and Clifton (1974) presented children with sequences of four rhyming words, but in the present study, none of the study lists contained words that rhymed with each other. Despite this, both 5- and 8-year-olds produced high levels of phonological intrusions. It is likely that phonological intrusions will increase if study lists are changed to increase the potential for phonological encoding, for example, if sequences of rhyming words are presented. We are currently investigating this possibility.

Brainerd et al. (2002) discussed the absence of a DRM effect in children in terms of fuzzy-trace theory, suggesting that young children fail to extract the gist of the DRM lists. The present findings are consistent with this account, as gist representations in older children and adults are presumably semantic in nature. Brainerd et al. also reported that the most common intrusions produced by the young children in their study were words that were unrelated to the list themes. This finding is consistent with the results for 8-year-olds in the present study, whose intrusions were equally likely to be semantic, phonological, or unrelated. However, the 5-year-olds in the present study produced primarily phonological intrusions, and very few unrelated intrusions. This pattern suggests that the 5-year-olds had a specific tendency to make phonological associations, rather than (or in addition to) an inability to extract the semantic gist of the study lists.

The present findings are broadly consistent with the idea that, through development, semantically driven encoding and retrieval processes gradually replace phonologically driven processes. Yet it is also possible that these two processing "styles" are at least partially independent. Thus, the age-related decline in phonological false memories may be at least partially dissociated from the age-related increase in semantic false memories. This would be consistent with the "overlapping waves" approach to cognitive development (Siegler, 1996), in suggesting that the different memory strategies are not necessarily exclusive. The fact that the 8-year-olds showed an increase in semantic intrusions while continuing to make phonological errors gives credence to this view, though clearly the nature of the developmental shift warrants further investigation.

How do the present results fit with the activation-monitoring account proposed by Roediger and McDermott (1995)? This account rests on the implicit-associative-responses hypothesis (Underwood, 1965), according to which participants in memory experiments generate words that are strongly related to the words presented at study. These associated items are then activated at retrieval and erroneously judged as old. The present results, together with those of Brainerd et al. (2002), suggest that young children do not make the semantic associations described by Underwood. However, in later work, Underwood (1969) discussed the memory attributes that would influence such associations, such as spatial, temporal, acoustic, and verbal attributes. He also discussed developmental changes in the nature of memory attributes and suggested that acoustic and spatial attributes are particularly salient to young children. When verbal stimuli are used, it is likely that young children will attend primarily to acoustic attributes. It is therefore likely that any associations they make will be acoustic (or phonological) in nature. If the DRM effect is caused by associations made at encoding, it follows that young children will make errors based on phonology. As is the case with adults, the children are then unable to distinguish between the items they heard and those they generated in response. For young children, however, this leads to errors that reflect phonological rather than semantic properties of the study lists.

Finally, it is noteworthy that the performance of the 8-year-olds differed from that of the 5- and 11-year-olds in that they were equally likely to make phonological, semantic, or unrelated errors. These findings may reflect a transitional stage between phonological and semantic processing, a stage in which children are prone to different types of memory distortions. Previous research into children's strategy use has shown that young children who have recently begun to use a strategy (e.g., verbal rehearsal) spontaneously often show a deficit in performance as a result of the attentional resources recruited by the strategy (Miller, 1990; see Flavell, Miller, & Miller, 1993, for a review). Miller referred to this transitional stage as a period of *utilization deficiency*. She suggested that the production of strategies is particularly effortful for novice strategy users and leaves insufficient attentional resources for learning. The performance of the 8-year-olds in the present study may thus reflect a period of utilization deficiency. It is possible that children undergoing a period of utilization deficiency involving a strategy related to verbal memory attempt to compensate by adopting a lower threshold for endorsing a word as studied. This possibility is consistent with the high levels of both correct and false recall observed in the 8-year-olds.

To summarize, the present study showed that children are susceptible to false memories, but the nature of the false memories they produce varies with age. Specifically, 5-year-olds falsely recalled words that rhymed with words in the study lists, whereas 11-year-olds showed patterns similar to those of adult participants and falsely recalled words that were semantically related to the study lists. Eight-year-olds made both phonological and semantic errors. The results are consistent with previous findings of a developmental shift from phonological to semantic processing. The present findings are consistent with the view that the memory illusion produced by the DRM effect is caused by the generation of associations to studied items. However, the associations made by children are qualitatively different from the associations made by adults, and give rise to qualitatively different false memories.

Acknowledgments—We wish to thank the staff and pupils of Sharples Primary School in Bolton, England, for their participation in this research.

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(RECEIVED 10/22/03; REVISION ACCEPTED 1/14/04)