Visual Distinctiveness and the Development of Children's False Memories

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Abstract

Distinctiveness effects in children's (5-, 7-, and 11-year-olds) false memory illusions were examined using visual materials. In Experiment 1, developmental trends (increasing false memories with age) were obtained using Deese-Roediger-McDermott lists presented as words and color photographs but not line drawings. In Experiment 2, when items were photographed with heterogeneous-colored backgrounds, developmental trends were eliminated relative to words and homogeneous backgrounds. Experiments 3 and 4 examined whether the conceptual nature of the background mattered and presented items in neutral (color only), theme-congruent, or theme-incongruent contexts. The results showed that the nature of the context did not matter, only whether the backgrounds were homogeneous or heterogeneous. Apparently, children use distinctive perceptual, but not conceptual, features to attenuate false memory illusions.

Keywords: False memory, memory development, DRM paradigm, visual memory, picture memory.

False memory illusions are robust in children and adults (Brainerd & Reyna, 2005; Gallo, 2006). Recent studies using the Deese-Roediger-McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995) have not only shown that people falsely recall associatively related items that were not presented on a list, but that for children, older, not younger, participants are more susceptible to these illusions (Dewhurst & Robinson, 2004; Howe, 2005, 2006b; Howe, Cicchetti, Toth, & Cerrito, 2004). For example, participants study lists of concepts (e.g., truck, bus, train, automobile, and so forth) that are all associated with the unpresented concept CAR. Later, when memory is tested for the studied items, children and adults not only correctly recall and recognize many of the studied concepts but also falsely recall and recognize the highly associated but unpresented concept (also referred to as the critical target or critical lure).

Most theorists agree that these related but unpresented concepts are falsely remembered because items that are on the DRM list activate their representations in memory. For example, in fuzzy trace theory (FTT) it is assumed that because DRM words repeatedly cue certain meanings, strong gist memories across list items are created and these are more apt to be retrieved on memory tests (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.

Of course, false memories can be avoided or at least reduced (e.g., edited from output queues) given that a second type of memory, verbatim, is activated during encoding (Brainerd & Reyna, 2005). When specific surface information is available during encoding, concepts that are related to the presented items can be discriminated better (either because list items are more distinct in storage or can be better discriminated during retrieval) if they do not possess those verbatim or surface characteristics. For example, if the list contains black and white line drawings instead of words, false memory rates tend to decline. This is because related but unpresented concepts do not contain the same pictorial information as true list members. Hence false items can be easily edited at output because they do not contain the requisite pictorial properties. Such findings are well established in the literature (e.g., Ghetti, Qin, & Goodman, 2002; Seamon, Luo, Schlegel, Greene, & Goldenberg, 2000; for a review, see Brainerd & Reyna, 2005; for an alternative interpretation of picture effects, see Howe, 2006b).

The idea that additional verbatim information can reduce false memories is not unique to FTT. Both the activation-monitoring (Roediger, Watson, McDermott, & Gallo, 2001) and the distinctiveness-heuristic (Schacter & Wiseman, 2006) accounts make similar predictions. For example, in the activation-monitoring account, false memories are based on (backward) associative links that are activated between each list item and an unpresented item contained in memory. For adults, these items are activated automatically and unconsciously and if they are not edited at retrieval, become part of the output queue and are considered by the participant to have been part of the studied list (e.g., Roediger et al., 2001). For children, although backward associative strength may also predict false recall and recognition rates, it is not clear that these processes are fully automatic (Howe, 2005, 2006b). Indeed, it may be changes in the automaticity of these processes that is responsible for the age trends seen in children's false memory rates (see Howe, 2005, 2006b). Regardless, additional surface information should help participants (both children and adults) recall true items and reject false items by increasing the distinctiveness or discriminability of the true items during encoding and retrieval processes.

The idea that verbatim or distinctive traces reduce false recollections is an important one. For example, it leads to the prediction that as long as we keep our memories refreshed and accurate, we should be able to reduce falsehoods in our recollections. As well, it also suggests that the more verbatim or distinctive information that is encoded during the study phase the better true, and the less false, recall and recognition should be. Of course, not all quantitative increases in information are necessarily good for memory. Indeed, what the literature on distinctiveness effects in memory with both adults (Hunt, 2006) and children (Howe, 2006a, 2006c) shows is that qualitative changes in the information presented may be more important than mere quantitative changes. More specifically, increasing item-specific information may lead to greater improvements when discriminating true from false memories whereas increases in relational (between item) information may increase both true and false recollection (Hunt, 2006). What this line of reasoning implies is that by increasing the amount of verbatim or surface information it may be possible to increase, not decrease, the rate of false recollection. Specifically, if the additional information increases the similarity of studied items either amongst themselves or within the more general context of memory itself (i.e., information already possessed by the participants studying the lists), then false recollections should increase not decrease. That is, although adding information to presented items may provide a quantitative increase in the amount of information available at encoding, such information may not make traces more distinctive if that information leads to greater relational than item-specific processing.

For example, if instead of simply presenting list members verbally, one also informs participants that the words are related because they belong to the same category, this should increase relational processing and result in better true recall but also higher rates of false recall (for exceptions to this, see Howe, 2006b). Similarly, for visual materials, presenting color photographs of objects rather than black and white line drawings should increase the amount of verbatim or distinctive information available at encoding, increasing true recall but decreasing false recall. However, by presenting information in a more realistic manner (i.e., photographs more closely resemble the manner in which we might typically view such objects on a day to day basis, at least relative to viewing them as schematic black and white line drawings) we might actually be increasing relational processing not between items on the list themselves but between the list items and representations of these items in memory. Indeed, it is well known in the distinctiveness literature that there are at least two sources of similarity, that generated within the to-be-remembered materials (e.g., as in a list of animal names versus a list of unrelated concepts) and that provided by what already exists in memory (e.g., remembering material that is script-consistent versus script-inconsistent) (see Howe, 2006a, 2006c; Hunt, 2006). It is the latter similarity that we are concerned with initially in this article. That is, to the extent that photographs more closely resemble the everyday context in which we view these objects, such presentations might also more closely resemble our memory representations for these items, making them and other, associatively related but unpresented items more confusable in storage and less discriminable during the output phase. This in turn should increase, not decrease, the probability of false recall.

The former similarity (i.e., within the to-be-remembered materials) is also of interest across the four experiments in this article. In particular, if it is true that photographs of everyday objects more closely resemble their memorial counterparts, thereby increasing false memory rates, will the background context also influence false memory rates if it is conceptually related to the gist of the list? Specifically, if the background against which a studied object is photographed is gist- or theme-congruent (e.g., if items on the CAR list are presented in a garage) as opposed to a neutral (e.g., pictured against a blank background) or theme-incongruent (e.g., pictured in a kitchen) setting, does this across-the-list-gist increase false memories? Of course, to provide a proper answer to this question, perceptual similarity (all of the backgrounds being homogeneous for list items) will have to be controlled. That is, conceptual or theme congruence will be crossed with variation in the background (i.e., heterogeneous or different backgrounds for the same list items although all backgrounds are theme congruent, neutral, or theme incongruent). For example, rather than have all items from the CAR list presented against the same theme congruent, neutral, or theme incongruent backdrop, each item will be presented against a different backdrop that is theme congruent (e.g., a garage, a driveway), theme neutral (i.e., different, single color (e.g., yellow, blue, red) plain backgrounds), or theme incongruent (e.g., in a kitchen, on a roof).

Thus, across the four experiments children's true (studied items) and false (critical targets) memory rates will be examined when distinctiveness is manipulated both in terms of similarity between studied items and their representations in memory (words vs. line drawings vs. photographs) as well as across the studied items themselves by varying the similarity of background information both perceptually (homogeneous vs. heterogeneous backgrounds) and semantically (theme congruent vs. neutral vs. theme incongruent). In general, FTT predicts that increases in verbatim information (e.g., by presenting color photographs rather than words or line drawings) should lead to increases in true recall and decreases in false recall. Additionally, increases in across-the-list-gist (e.g., the use of theme congruent backgrounds) should increase false recall rates especially for younger children regardless of whether those themes are presented homogeneously or heterogeneously. According to the associative approach, increases in the amount or quantity of perceptual, verbatim information should not necessarily influence true and false recall directly. Rather, it is the quality of that information that matters, the degree to which it activates relevant memory representations, and the extent to which those representations are distinctive. The form of similarity that should increase false memory rates the most is the one that produces a higher degree of overlap between the stimuli and children's memory representations. This is because children may have greater difficulty discriminating presented from unpresented items at output (retrieval) when they are highly similar and more confusable in memory. This is consistent with predictions from trace-integrity theory (see Howe, 2000, 2006a, 2006c) in which trace discriminability in memory, controls rates of true and false remembering, and is the key to driving changes in processing that underlie much of children's memory development.

To test these ideas, a series of experiments is presented in which within-list similarity is varied perceptually and conceptually (across-the-list-gist) and similarity to background memory is manipulated visually. In the first of these experiments, standardized pictorial line drawings of DRM lists were presented to one group of children and to another group, color photographs of these same items were given. There was a third group who were presented DRM lists using the more traditional oral presentation procedure. Color photographs differ not only quantitatively from black and white line drawings in terms of verbatim or distinctive information, but also qualitatively inasmuch as they possess contrast, color, and perspective information. As Brainerd and Reyna (2005, p. 181) point out, "… because pictorial presentation is a surface-distinctiveness manipulation, rather than a meaning manipulation, pictorial presentation would be expected to suppress false alarms and intrusions in children." We know that this occurs with line drawings as pictures versus words (Ghetti et al., 2002; Howe, 2006b), but will the same effects pertain when photographs are used? If it is simply the amount of surface information provided that determines false memory rates and more verbatim information increases the discriminability of true from false information, then photographs should reduce children's false recall over line drawings. Although additional advantages of photos over line drawings may occur for true recall, such an effect is not predicted. That is, although verbatim information should reduce false recall, verbatim information does not always improve true recall (see Brainerd & Reyna, 2005). Moreover, from the current perspective (Howe, 2005, 2006b), there is no theoretical reason to expect gains in true recall with photos than line drawings. Rather, the gains (or losses) should occur exclusively in false recall. For FTT, photos compared to line drawings should reduce children's false memories. The alternative prediction espoused here is that age trends in children's false memory rates should remain intact if photographs are more representative of the objects themselves, especially in terms of how children might represent those objects in memory. This is because they should increase the overlap of list information with information already existing in memory and lead to more, not fewer, false memories. That is, because the format of the information studied overlaps more closely with how information is represented in memory when photos are used than when line drawings are used, children are more likely to confuse memory information that was activated but not presented with information that was presented, resulting in an increase in false recollection.

EXPERIMENT 1

Method

Participants. There were 334 children (168 males, 166 females), 116 5-year-olds (M = 5,1), 118 7-year-olds (M = 7,3), and 100 11-year-olds (M = 11,3). All of the children (predominantly White and middle class) who were tested had parental consent and had themselves assented to the procedure.

Design, materials, and procedure. A simple 3(mode: words versus line drawings versus color photographs) x 3(age: 5-, versus 7-, versus 11-year-olds) between-subjects design was used. Children were quasi-randomly assigned to the different conditions keeping the gender distribution in each as equal as possible. Each child was presented with 8, 12-item DRM lists, ones that have been used previously with adults (Stadler, Roediger, & McDermott, 1999) and children (Howe, 2005, 2006b; Howe et al., 2004). The DRM lists were comprised of either words, standardized line drawings normed for children (Cycowicz, Friedman, Rothstein, & Snodgrass, 1997), or color photographs of the actual objects themselves scaled to the same dimensions as that contained in the line drawings. All photographs contained only the specific object corresponding to the word or line drawing and was depicted against a neutral background (e.g., beige or pale yellow).

Children were given general memory instructions indicating that they were to try to remember the concepts presented on the list. Each item was presented and named by the experimenter at a 3-second rate. After the presentation of the last item in the first list, children were given a distractor task (circling pairs of letters) for 30 seconds and then were asked to recall the items from the list. Following termination of recall, the next list was presented. This study-distractor-recall procedure continued until all 8 of the lists were completed.

Results and Discussion

Because there were no effects due to gender, this variable was eliminated from subsequent analyses. The mean percentages of true (studied items) and false (critical target) recall are shown in Panels A and B, respectively, of

Figure 1 for words, line drawings, and photographs. To test the main hypotheses associated with this study, the data were analyzed using two 3(mode: words vs. line drawings vs. photographs) x 3(age: 5-year-olds vs. 7-year-olds vs. 11-year-olds) between-subjects analyses of variance (ANOVAs), one for true recall and one for false recall. For true recall (see Figure 1, Panel A), the analyses revealed two main effects, one for age, $F(2, 325) = 100.30$, $p < .001$, $(^2 = .382$, where post-hoc analyses ($p < .05$) showed that 5-year-olds (26.5%) recalled less than 7-year-olds (38.3%) who recalled less than 11-year-olds (51.2%), and one for mode, $F(2, 325) = 4.37$, $p < .02$, $(^2 = .026$, where post-hoc analyses showed that line drawings produced better recall (41.4%) than words (36.4%) and photographs (38.4%) did not differ from either words or line drawings. As can be seen in Figure 1 (Panel A), the Age x Mode interaction was not significant.

For false recall (see Figure 1, Panel B), the analyses revealed a main effect for age, $F(2, 325) = 6.63$, $p < .01$, $(^2 = .039$, where post-hoc analyses showed that 5-year-olds (12.4%) did not differ from 7-year-olds (16.4%) in false recall rates but both produced fewer false memories than 11-year-olds (31.4%). This age effect was modified by an Age x Mode interaction, $F(4, 325) = 5.43$, $p < .001$, $(^2 = .063$. As can be seen in Figure 1 (Panel B), and was confirmed by post-hoc tests, the locus of this Age x Mode interaction was the elimination of age trends in false recall when line drawings served as stimuli. That is, age increases in false recall were observed for words and photographs, but there were no age differences in false recall for line drawings. Age increases for words and no age effects for line drawings is consistent with previous findings in children's false recall (e.g., Ghetti et al., 2002; Howe, 2006b; Seamon et al., 2000). The interesting finding here is that age increments in false recall occurred for photographs as well. Indeed, it would appear that words and color photographs were equally confusable as rates of false recall did not vary reliably across these items at any age.

The issue addressed in the first experiment was whether increasing the quality and quantity of visually-based (verbatim) information would decrease children's false recall in the DRM paradigm. Like prior research, children from all three age groups produced true and false memories. As well, consistent with prior research, when items were presented as black-and-white line drawings, age increases in true recall were accompanied by no age differences in false memories (Ghetti et al., 2002; Howe, 2006b). More important, when the quantity and quality of visual information was increased, there were no changes in the amount of true recall although true recall increased with age as predicted. However, unlike line drawings, when photographs served as stimuli, the rates of false memories increased with age in a manner comparable to that with verbal stimuli.

At first blush, these findings may appear incompatible with Brainerd and Reyna's (2005) fuzzy-trace theory. That is, that more verbatim detail gives rise to more not less false recall, especially in older but not younger children, suggests that not all verbatim information is created equal. Although it is clear that photographs do increase the amount of verbatim or surface information available at encoding relative to words and line drawings, no one would disagree with the assertion that they also contain more realistic, perceptual details that may allow children better access to conceptual or gist information in memory. From an FTT perspective, this means that presentation of DRM items in photographs may increase access to both verbatim and gist information in memory. Therefore, presenting DRM items in photographs should (a) increase direct access (due to more verbatim information) to memory traces which, in turn, should increase true recall and (b) increase reconstructive processing (due to greater gist processing), increasing false recall rates. Perhaps because the present experiments focused on more gist-based measures of recollection (recall rather than recognition), the only effects observed were for false recall. That is, higher rates of false recall were observed for photographs than line drawings, but there were no differences in rates of true recall. However, as demonstrated in subsequent experiments in this article, perceptual information contained in photographs does affect children's true recall.

A more parsimonious explanation of the current findings is that it is not the quantity of surface information that is important but rather the quality of that information. Consistent with research on distinctiveness effects in adults' (Hunt, 2006) and children's (Howe, 2006a, 2006c) memory, to the extent that the additional information increases item-specific discriminability it will reduce false memory recollection. However, to the extent that additional surface information decreases discriminability, either by increasing between-item similarity across the list items themselves or by increasing the similarity between list items and information already stored in a participant's knowledge base, false memory production will increase. Such findings fall directly out of trace-integrity theory's predictions concerning the importance of item discrimination in children's memory (Howe, 2000).

Although these results are easily interpreted within the framework of distinctiveness effects in memory, and perhaps most theories can be adjusted to accommodate these findings, it is clear that not all increases in surface or verbatim information are good for reducing memory errors, perhaps especially when that information more closely maps onto the real world. Indeed, perceptually rich color photographs produced similar rates of false recall to the more impoverished verbal presentation. It is worrisome that color photographs of the objects themselves would produce more false memories than simple black and white line drawings of those objects. Although the latter are clearly more distinct given the rarity with which children see black and white line drawings of objects these days, it is still surprising that the amount of additional detail in the color photographs did not lead to a greater reduction in false recall rates. It is perhaps some comfort to know that this result is consistent with other findings in the false memory literature in which it has been found that false memories are more likely in contexts that are consistent with the participant's background knowledge and beliefs (Pezdek, Finger, & Hodge, 1997; Pezdek & Hodge, 1999; but see Strange, Sutherland, & Garry, 2006). More important, it links findings using the DRM paradigm with other false memory studies and underscores the importance of the participant's knowledge base when considering false memory production. That is, even in the DRM paradigm, it is not just the similarity across items on the list that needs to be considered when making predictions about false memory rates, but also the mapping of those list items onto the background memory that participants bring with them to the experimental setting.

EXPERIMENT 2

Although the results of the first experiment provide for some interesting possibilities concerning the nature of children's true and false memories for visual materials, the color photographs, like the line drawings, were presented against a single, homogeneous background. That is, objects in the photographs were pictured against a blank wall of a unitary color (e.g., beige or pale yellow). Perhaps it was the unitary nature of the background that led to "perceptual" similarity among pictured items that led to decreased discriminability or distinctiveness and not just the greater similarity to representations in memory. That is, items in color photographs could have been "categorized" perceptually as the "same" given their common backgrounds. This might account for the absence of better true recall and age-related increases in false recall as the common background decreased item-specific processing and increased perceptually-based relational processing within the list. That similar effects were not observed for the homogeneous backgrounds used for the black-and-white line drawings has more to do with the uniqueness of the line drawings themselves, as noted in prior studies (e.g., Ghetti et al., 2002; Howe, 2006b). That is, for color photographs, the objects depicted in them more closely resemble real objects they are intended to represent, whereas in line drawings, they do not. Thus, line drawings and color photographs may have differed in how they were distinctive.

To examine this hypothesis a second experiment was conducted. Here, like Experiment 1, words and color photographs were presented except that there were two versions of photographs – one set as before with homogenous backgrounds (e.g., all yellow, all red, all green) and a different set in which the background colors were heterogenous across list members (i.e., they varied for each item within the list, e.g., yellow, red, green). By eliminating artificial background or "perceptual" similarity across list members in the heterogeneous condition, it was hypothesized that item-specific processing might be more likely, increasing distinctiveness effects, and that true recall should increase and false recall decrease. As well, like line drawings, this distinctiveness effect should result in the elimination of age trends in false memories.

Method

Participants. There were 153 children (75 males, 78 females), 51 5-year-olds (*M* = 5,3), 51 7-year-olds (*M* = 7,8), and 51 11-year-olds (*M* = 11,5). All of the children (predominantly White and middle class) who were tested had parental consent and had themselves assented to the procedure.

Design, materials, and procedure. A simple 3(mode: words versus homogeneous neutral background color photographs versus heterogeneous neutral background color photographs) x 3(age: 5-, versus 7-, versus 11-year-olds) between-subjects design was used. As before, objects in the photographs were scaled to the same size as that used previously and only the specific object corresponding to the word was contained in the photograph. Children were quasi-randomly assigned to the different conditions keeping the gender distribution in each as equal as possible. Each child was presented with 8, 12-item DRM lists used previously in Experiment 1. For the homogeneous backgrounds, all of the items within a list were photographed using a single colored background, whereas for the heterogeneous backgrounds, items were photographed using a unique color for each list member (e.g., yellow, red, green, blue). The same colors were used in the homogeneous and heterogeneous backgrounds to eliminate any color preference confounds. As there were no differences in performance due to color, data were collapsed across the different color lists in the homogeneous condition. As in Experiment 1, children were given general memory instructions, items were presented and named by the experimenter at a 3-second rate, using the same study-distractor-recall procedure.

Results and Discussion

Because there were no effects due to gender, this variable was eliminated from subsequent analyses. The mean percentages of true and false recall are shown in Panels A and B, respectively, of Figure 2 for words, homogenous background photographs, and heterogeneous background photographs. To test the main hypotheses associated with this study, the data were analyzed using two 3(mode: words vs. homogeneous neutral background color photographs vs. heterogeneous neutral background color photographs) x 3(age: 5-year-olds vs. 7-year-olds vs. 11-year-olds) between-subjects ANOVAs, one for true recall and one for false recall. For true recall (see Figure 2, Panel A), the analyses revealed two main effects, one for age, $F(2, 144) = 42.25$, $p < .001$, (^{2} = .370, where post-hoc analyses ($p < .05$) showed that 5-year-olds (34.3%) recalled less than 7-year-olds (47.8%) who recalled less than 11-year-olds (53.7%), and one for mode, $F(2, 144) = 6.44$, $p < .01$, (^{2} = .082, where post-hoc analyses showed that words (47.7%) and homogeneous background photographs (47.5%) did not differ from each other and produced significantly better recall than heterogeneous background photographs (40.7%). As can be seen in Figure 2 (Panel A), the Age x Mode interaction was significant, $F(4, 144) = 8.75$, $p < .001$, (^{2} = .196. Post-hoc tests confirmed that this interaction was the result of the youngest children performing poorly on heterogeneous background items. That is, for 7- and 11-year-olds, there were no differences in true recall as a function of stimulus modality (words, homogeneous or heterogeneous photographs), but 5-year-olds were particularly poor at recalling photographs presented with heterogeneous backgrounds.

For false recall (see Figure 2, Panel B), the analyses revealed a main effect for age, $F(2, 144) = 4.85$, $p < .01$, (^{2} = .063, where post-hoc tests showed that like Experiment 1, 5-year-olds (28.0%) did not differ from 7-year-olds (28.5%) in false recall rates but both produced fewer false memories than 11-year-olds (44.3%). There was also a main effect for mode, $F(2, 144) = 24.78$, $p < .001$, (^{2} = .256, where post-hoc tests showed that there were no differences in false recall rates for words (32.5%) and photographs with homogeneous backgrounds (32.0%), but both produced more false recall than photographs with heterogeneous backgrounds (12.0%). Finally, these main effects for age and mode were modified by an Age x Mode interaction, $F(4, 144) = 8.85$, $p < .01$, (^{2} = .053. As can be seen in Figure 2 (Panel B), and was confirmed by post-hoc tests, the locus of this Age x Mode interaction was the elimination of age trends in false recall when photographs with heterogeneous backgrounds served as stimuli. That is, age increases in false recall were observed for words and photographs with homogeneous backgrounds, but there were no age differences in false recall for photographs with heterogeneous backgrounds.

Thus, the results of Experiment 2 showed that for older children (7- and 11-year-olds) stimulus presentation mode did not affect true recall. Specifically, like Experiment 1, photographs and words were recalled equally well. Similarly, for these same children, it did not matter whether objects were pictured against homogeneous or heterogeneous backgrounds when it came to true recall. However, color photographs with heterogeneous backgrounds were recalled more poorly by the youngest (5-year-olds) children in this study. This may be because older, but not younger, children are less susceptible to interference effects from irrelevant (background) information or, in other words, are better at inhibiting the processing of irrelevant background information (e.g., see chapters in Dempster & Brainerd, 1995). If younger children's resources were being "swamped" during encoding, then semantic processing of episodic material may be less efficient leading to poorer true (and perhaps false) recall. Because semantic activation may not be automatic and unconscious in younger children (Howe, 2005), it may be that when encoding conditions are complex (e.g., heterogeneous backgrounds), attentional resources may become "overloaded" and the ability to discriminate and process relevant rather than irrelevant information becomes taxed (see also Bjorklund & Harnishfeger, 1990).

Concerning false recall, as predicted heterogeneous backgrounds eliminated age trends in children's false memory. That is, although words and color photographs with homogeneous backgrounds exhibited the same age increases in false recollection as Experiment 1, altering background colors for objects within a list increased item distinctiveness leading to decreases in false recall, particularly for the older (7- and 11-year-olds) children. Similar effects were observed for younger children to the extent that their false recollection rates were lower for items presented against heterogeneous backgrounds than for words and items presented against homogeneous backgrounds. Although the reduction in false memory rates for younger children may be due to their poorer encoding (due to inefficient inhibition), perhaps these same effects for older children were due to enhanced item-specific processing at encoding. That is, if older children are better at automatically encoding background information, perhaps the different backgrounds for same-list items resulted in more distinctive traces for items with heterogeneous than homogeneous backgrounds. If so, then false memory rates should be reduced and age trends in the DRM illusion eliminated.

EXPERIMENT 3

It was argued following Experiment 1 that one reason why color photographs might lead to more false memories than line drawings was that the presentation mode more closely resembled children's memory representations for those items leading to reduced discrimination and greater confusability. However, the results of Experiment 2 also suggest that increased rates of false recollection may have been an artifact of the design. That is, the use of homogeneous backgrounds may have artificially increased within-list item similarity and promoted relational processing of list members. Hence, color photographs were not more distinctive than line drawings when they were shown against a perceptually homogeneous background.

This raises the question, if background information can have such a profound perceptual impact on children's false recollection (as well as an affect on younger children's true recall, as seen in Experiment 2), perhaps similar conceptual effects may exist. That is, what would happen if rather than just increasing (homogeneous background) or decreasing (heterogeneous background) perceptual similarity, conceptual similarity was varied. Perhaps additional theme-congruent information provided as part of the background might increase children's use of relational processing over and above that associated with homogeneous perceptual backgrounds. It has been argued that theme (gist, schema)-congruent information may increase conceptual and therefore relational processing of items on a list leading to increases in false recall (e.g., Brainerd & Reyna, 2005), at least for verbal material. For example, using a procedure that embedded DRM lists in a story format, Dewhurst, Pursglove, and Lewis (in press) found that false memory rates increased dramatically in 5-year-olds. Although it is not clear whether these effects occur with visual as well as verbal information, given that children are often better at processing visual information than verbal information (e.g., the well known picture superiority effect; see Mandler & Robinson, 1978; Ritchey, 1980), and that even very young (3.5- and 5-year-olds) children are able to benefit from the presentation of stimuli in unitized scenes even if the arrangement of objects is arbitrary (Horowitz, Lampel, & Takanishi, 1969), it may be reasonable to suppose that children's relational processing should be enhanced by having theme-congruent information in the background of color photographs.

To test this idea, objects were photographed against a theme-congruent context. For example, items on the DRM fruit list were photographed in context relevant to a kitchen. Here, list members might all be depicted (individually) in a bowl, a refrigerator, or on a kitchen table. In Experiment 3, objects were presented in color photographs with either a neutral context or a theme-congruent context. Like Experiment 2, the background was either homogeneous (all items within a list presented against one color or in one theme-congruent context) or heterogeneous (each item presented against a different color or against a different theme-congruent context; e.g., an apple might be depicted in a bowl, juice in a refrigerator, and so forth). If children can use theme-congruent contexts to enhance semantic (relational) processing, then more false memories should be generated in theme-congruent contexts than neutral ones, regardless of background homogeneity/heterogeneity. As well, compared to heterogeneous backgrounds, homogeneous backgrounds should increase perceptual similarity (as seen in Experiments 1 and 2), leading to more false memories.

Method

Participants. There were 198 children (96 males, 102 females), 66 5-year-olds (*M* = 5,5), 66 7-year-olds (*M* = 7,4), and 66 11-year-olds (*M* = 11,8). All of the children (predominantly White and middle class) who were tested had parental consent and had themselves assented to the procedure.

Design, materials, and procedure. A 2(background: homogeneous photographs versus heterogeneous photographs) x 2(context: neutral versus scene) x 3(age: 5-, versus 7-, versus 11-

year-olds) between-subjects design was used. Children were quasi-randomly assigned to the different conditions keeping the gender distribution in each as equal as possible. Each child was presented with 8, 12-item DRM lists used previously in Experiments 1 and 2. As before, for the homogeneous backgrounds, all of the items within a list were photographed using a single background, whereas for the heterogeneous backgrounds, items were photographed using a unique background for each list member. For context, neutral contexts were the solid colors used in Experiment 2. For the theme-related scenic contexts, items were depicted in a scene consistent with the general list theme. For homogeneous backgrounds, all list items (e.g., fruit items) were photographed with the same background (e.g., in a refrigerator). For heterogeneous backgrounds, each item (e.g., fruit) was photographed in a different theme-related background (e.g., refrigerator, bowl, kitchen table). As before, all of the items were depicted to scale and were identical in size across contexts. For photographs that contained background information other than just color, the amount of background detail was kept to the minimum necessary to identify the nature of the context. This was done in order to control for extraneous background information. In addition, any extraneous differences in the amount of background information were eliminated in this design because all of the contexts used in the heterogeneous condition were also used in the homogeneous condition. Because there were no differences in the homogeneous conditions as a function of context, the data were collapsed across the various contexts. As in the previous experiments, children were given general memory instructions. Each item was presented (on a laptop computer using powerpoint) and named by the experimenter at a 3-second rate with a one second interstimulus interval using a study-distractor-recall procedure.

Results and Discussion

Again, because there were no effects due to gender, this variable was eliminated from subsequent analyses. The mean percentages of true and false recall are shown in Panels A and B, respectively, of Figure 3. To test the main hypotheses associated with this study, the data were analyzed using two 2(background: homogeneous photographs vs. heterogeneous photographs) x 2(context: neutral vs. scene) x 3(age: 5-, vs. 7-, vs. 11-year-olds) between-subjects ANOVAs, one for true recall and one for false recall. For true recall (see Figure 3, Panel A), the analyses revealed two main effects, one for age, $F(2, 186) = 61.88$, $p < .001$, (^{2} = .400, where post-hoc analyses ($p < .05$) showed that 5-year-olds (33.2%) recalled less than 7-year-olds (47.1%) who recalled less than 11-year-olds (55.8%), and one for background, $F(2, 186) = 27.67$, $p < .001$, (^{2} = .129, where homogeneous background photographs (49.8%) were better recalled than heterogeneous background photographs (40.9%). As can be seen in Figure 3 (Panel A), the Age x Background interaction was significant, $F(4, 186) = 18.88$, $p < .001$, (^{2} = .169. Like Experiment 2, post-hoc tests confirmed that this interaction was the result of the youngest children performing poorly on heterogeneous background items. Although there were no differences in true recall as a function of background or context for 7- and 11-year-olds, 5-year-olds were particularly poor at recalling photographs presented with heterogeneous backgrounds. Interestingly, there was no effect for context or any interactions involving context. It would seem that whether the context was neutral or theme-congruent had no effect on children's true recall.

For false recall (see Figure 3, Panel B), the analyses revealed a main effect for age, $F(2, 186) = 4.84$, $p < .01$, (^{2} = .059, where post-hoc tests showed that like previous experiments, 5-year-olds (21.3%) did not differ from 7-year-olds (24.7%) in false recall rates but both produced fewer false memories than 11-year-olds (34.7%). There was also a main effect for background, $F(2, 186) = 51.67$, $p < .001$, (^{2} = .217, where photographs with homogeneous backgrounds (40.7%) produced more false recall than photographs with heterogeneous backgrounds (10.6%). Finally, these main effects for age and background were modified by an Age x Background interaction, $F(4, 186) = 8.81$, $p < .01$, (^{2} = .119. As can be seen in Figure 3 (Panel B), and was confirmed by post-hoc tests, the locus of this Age x Background interaction was the elimination of age trends in false recall when photographs with heterogeneous backgrounds served as stimuli. Like Experiment 2, age increases in false recall were observed for photographs with homogeneous backgrounds, but there were no age differences in false recall for photographs with heterogeneous backgrounds. Like true recall, there were no differences in false recall as a function of context. That is, differences in true and false recall did not depend on whether the context was a neutral color or a theme-relevant scene.

Thus, the results of Experiment 3 are straightforward and both replicate and extend the trends found in Experiment 2. Specifically, there were no effects of context (neutral versus theme-congruent), younger children (5-year-olds) exhibited poorer true recall for items that had heterogeneous backgrounds than homogeneous backgrounds whereas there were no such differences for older (7- and 11-year-olds) children, and regardless of context there were age increases in false recall for items presented in homogeneous, but not heterogeneous, backgrounds. Apparently, for children, the conceptual content of the background information does not influence rates of true or false recall. It would appear that background information simply acts to enhance perceptual but not conceptual grouping effects and that heterogeneous but theme-congruent information leads to distinctiveness effects not semantic relational processing resulting in less false recall.

EXPERIMENT 4

An important result from Experiment 3 was that patterns of true and false recall were no different for theme-congruent than theme-neutral contexts. This is curious given extant evidence that children can and do process information from scenes (e.g., Dirks & Neisser, 1977; Horowitz et al., 1969; Pezdek, 1977), even those that are not well organized (Mandler & Robinson, 1978). Perhaps children do process the conceptual context but only when contrasted with theme-incongruent scenes not neutral contexts. That is, it could be that children’s performance is controlled more by perceptual than conceptual similarity when the context is neutral or theme-congruent. So, although children are processing the conceptually congruent contextual information, such processing does not provide an additional performance advantage over and above that conferred by perceptual similarity.

This is the final question examined in this article. Experiment 4 used the same materials as Experiment 3 but theme-incongruent contexts were added. Specifically, in addition to depicting items in neutral and theme-congruent contexts, they were also presented in theme-incongruent contexts (e.g., fruit items were presented in a bathroom or in a car rather than a kitchen). It was hypothesized that theme-congruent contexts should be more likely processed and converted to performance advantages in the presence of theme-incongruent contexts, the latter perhaps leading to distinctiveness effects (better true recall and less false recall) especially for older children. To provide a stringent test of this hypothesis, context was manipulated within subject this time, with each participant viewing lists that had neutral, theme-congruent, and theme-incongruent contexts. As before, background (homogeneous versus heterogeneous) was manipulated between subjects.

Method

Participants. There were 99 children (47 males, 52 females), 33 5-year-olds (M = 5,7), 33 7-year-olds (M = 7,6), and 33 11-year-olds (M = 11,9). All of the children (predominantly White and middle class) who were tested had parental consent and had themselves assented to the procedure.

Design, materials, and procedure. A 3(context: neutral versus theme-congruent scene versus theme-incongruent scene) x 2(background: homogeneous photographs versus heterogeneous photographs) x 3(age: 5-, versus 7-, versus 11-year-olds) design was used where the first factor was within-subject and the latter two factors were between-subjects. Children were quasi-randomly assigned to the different conditions keeping the gender distribution in each as equal as possible. Each child was presented with 12, 14-item DRM lists used previously in experiments. As before, for the homogeneous backgrounds, all of the items within a list were photographed using a single background, whereas for the heterogeneous backgrounds, items were photographed using a unique background for each list member. For context, neutral contexts were the solid colors used in Experiments 2 and 3. For the theme-congruent scenic contexts, items were depicted in a scene consistent with the general list theme as they were in Experiment 3. Again, for homogeneous backgrounds, all list items (e.g., fruit items) were photographed with the same background (e.g., in a refrigerator). For heterogeneous backgrounds, each item (e.g., fruit) was photographed in a different theme-related background (e.g., refrigerator, bowl, kitchen table). Theme-incongruent scenes were constructed in the same fashion except that the homogeneous and heterogeneous backgrounds were not consistent with the list theme. For example, fruit items might be depicted in the context of a bathroom (on the lid of a toilet), an automobile (on the seat or dashboard), and so forth. Like the previous experiments, all of the items were depicted to scale, were identical in size across contexts, and the amount of background detail was kept to the minimum necessary to identify the nature of the context. Again, extraneous differences in the amount of background information were eliminated because all of the contexts used in the heterogeneous condition were also used in the homogeneous condition. Because there were no differences in the homogeneous conditions as a function of context, the data were collapsed across the various contexts. As in Experiment 3, children were given general memory instructions, items were presented (on a laptop computer using powerpoint) and named by the experimenter at a 3-second rate with a one second interstimulus interval, using a standard study-distractor-recall procedure. Each child received 4 neutral background lists, 4 theme-congruent lists, and 4 theme-incongruent lists.

Results and Discussion

Like the other 3 experiments, because there were no effects due to gender, this variable was eliminated from subsequent analyses. The mean percentages of true and false recall are shown in Panels A and B, respectively, of Figure 4. To test the main hypotheses associated with this study, the data were analyzed using two 3(context: neutral vs. theme-congruent scene vs. theme-incongruent scene) x 2(background: homogeneous photographs vs. heterogeneous photographs) x 3(age: 5-, vs. 7-, vs. 11-year-olds) mixed ANOVAs, one for true recall and one for false recall, where the first factor was a repeated measures factor and the latter two, between-subjects. For true recall (see Figure 4, Panel A), the analyses revealed two main effects, one for age, $F(2, 93) = 70.77$, $p < .001$, (^{2} = .603, where post-hoc analyses ($p < .05$) showed that 5-year-olds (33.1%) recalled less than 7-year-olds (46.2%) who recalled less than 11-year-olds (58.6%), and one for background, $F(1, 93) = 35.54$, $p < .001$, (^{2} = .276, where homogeneous background photographs (50.0%) were better recalled than heterogeneous background photographs (41.6%). As can be seen in Figure 4 (Panel A), the Age x Background interaction was significant, $F(2, 93) = 19.88$, $p < .001$, (^{2} = .299. Like Experiments 2 and 3, post-hoc tests confirmed that this interaction was the result of the youngest children performing poorly on heterogeneous background items. Although there were no differences in true recall across different backgrounds or contexts for 7- and 11-year-olds, 5-year-olds were particularly poor at recalling photographs presented with heterogeneous backgrounds. Interestingly, there was no effect for context or any interactions involving context. It would seem that whether the context was neutral or theme-congruent had no effect on children’s true recall.

For false recall (see Figure 4, Panel B), the analyses revealed a main effect for background, $F(1, 93) = 56.79$, $p < .001$, (^{2} = .379, where photographs with homogeneous backgrounds (38.3%) produced more false recall than photographs with heterogeneous backgrounds (10.0%). This main effect background was modified by an Age x Background interaction, $F(2, 93) = 20.04$, $p < .001$, (^{2} = .260. As can be seen in Figure 4 (Panel B), and was confirmed by post-hoc tests, the locus of this Age x Background interaction was the elimination of age trends in false recall when photographs with heterogeneous backgrounds served as stimuli. Like Experiments 2 and 3, age increases in false recall were observed for photographs with homogeneous backgrounds, but there were no age differences in false recall for photographs with heterogeneous backgrounds. Like true recall, there were no differences in false recall as a function of context. That is, differences in true and false recall did not depend on whether the context was a neutral color, theme-relevant scene, or a theme-irrelevant scene.

Thus, the results of Experiment 4 confirm and extend those of the earlier experiments. That is, context (neutral, theme-congruent, and theme-incongruent) did not affect children's true or false recall. Instead, the main variable controlling recall patterns was the homogeneity or heterogeneity of background information. Here, background homogeneity resulted in better true recall for 5-year-olds than background heterogeneity and age differences in false recall were present for homogeneous but not heterogeneous backgrounds.

GENERAL DISCUSSION

Together, these experiments provide converging evidence about the variables affecting children's false memories for visual representations. Experiment 1 showed that black-and-white line drawings produced better memory performance (higher true and lower false recall rates) than words or color photographs, both of which had lower true recall and age-appropriate increases in false recall. There are two ways in which these effects can be explained, one encoding-based and the other retrieval-based. Concerning retrieval, because line drawings are more distinctive than words or color photographs, associated but unpresented items can be rejected at output because they do not possess the same representational characteristics as presented items. Concerning encoding, because line drawings promote item-specific processing rather than relational processing, it is less likely that associatively related, unpresented items would be activated during presentation and hence are not available for output.

Although the picture-word findings replicate previous research (e.g., Ghetti et al., 2002; Howe, 2006b), the interesting finding was that color photographs, despite possessing more surface or verbatim information than words or line drawings, evidenced the same true and false recall patterns as words. These effects could have been due to the fact that color photographs more closely resemble item representations in memory and therefore, relational processing at encoding was facilitated. Alternatively, if color photographs are more like children's mental representations of objects, there was less distinctive information available at retrieval and unpresented items were not easily discriminated from presented items during the output process. However, like line drawings, color photographs contained homogeneous backgrounds and it may have been this similarity if the nature of this background that promoted relational processing and not the isomorphism between stimulus presentation and memory representation.

Experiment 2 provided a direct test of this hypothesis by using homogeneous and heterogeneous colored backgrounds and found that the use of heterogeneous backgrounds negatively affected 5-year-olds' true recall (but not older children), reduced false recall for all children regardless of age, and eliminated age trends in false memory. Interestingly, younger children's poor true recall of items from heterogeneous backgrounds may have been due to inefficient inhibition of irrelevant stimulus attributes (e.g., Bjorklund & Harnishfeger, 1990). Specifically, younger but not older children may have difficulty ignoring the irrelevant background information in the stimulus display and therefore spend fewer resources processing the relevant, to-be-recalled stimulus attributes. This, in turn, compromises encoding rates leading to poorer true recall. This should also lead to poorer false recall if unpresented items are activated primarily during encoding. This was exactly what was found. That is, younger children produced fewer false memories for lists presented against heterogeneous than homogeneous backgrounds.

Interestingly, although there were no differences in older children's true recall of items from homogeneous and heterogeneous background lists, they too produced fewer false memories for heterogeneous than homogeneous lists. Moreover, for older children, the typical age increases seen in children's false recollection were eliminated for heterogeneous background lists. What this suggests is that unlike younger children, older children may be able to use this "irrelevant" background information to automatically construct object-color associations during the encoding phase. If so, then heterogeneous, but not homogeneous, conditions may provide more distinctive information at encoding where each object is associated with a unique color. During retrieval in homogeneous conditions, all of the recollected items have the same color background so that an unpresented item cannot be easily discriminated from presented items. However, items in the heterogeneous conditions each have a unique color background and it is less likely that a falsely retrieved, unpresented item would have such a unique background associated with it and may be more easily discriminated from presented items. Taken together, these results suggest that perceptually heterogeneous background information (a) reduces younger children's true and false memories due to poorer encoding of the relevant stimulus attributes and (b) reduces older children's false memories because this information can be automatically processed at encoding and used at retrieval to discriminate presented from unpresented items.

That children use perceptual information sometimes at the expense of conceptual or associative information is not new (e.g., see discussion of children's clustering in recall and knowledge base development in Bjorklund, 1987, 2004). Indeed, younger children are much more likely to use perceptually-based classification schemes when organizing and recalling objects than older children (Bjorklund, 1987, 2004). Moreover, even young children's false memories are more likely to be based on perceptual (e.g., phonological) than conceptual (e.g., associative) stimulus properties (see Dewhurst & Robinson, 2004). The current findings are consistent with these trends reported for children's memory more generally. Indeed, the results of the first two experiments (as well as Experiments 3 and 4, see below) provided strong evidence that the critical factor controlling children's false memories for visual stimuli was perceptual.

In order to examine the claim that perceptual information "swamped" conceptual information in children's memory for visually-presented information, in Experiments 3 and 4 the nature of the context was changed. That is, rather than presenting simple color information, objects were placed in theme-congruent (Experiments 3 and 4) and theme-incongruent (Experiment 4) contexts where the background was either homogeneous or heterogeneous. Concerning true recall, regardless of context (neutral, theme-congruent, or theme-incongruent), young children's performance was again poorer for heterogeneous than homogeneous backgrounds. However, the key result was that all children's false recall was reduced, and age trends were eliminated, in conditions in which the objects were placed in heterogeneous backgrounds rather than homogeneous ones, not only when the context was neutral (simple colors), but also when the contexts were conceptually relevant (Experiments 3 and 4). That is, regardless of whether the context was neutral, theme-congruent (matching the gist of the list), or theme-incongruent (inconsistent with the gist of the list), children's false recall (and young children's true recall) was related only to whether the backgrounds were homogeneous or heterogeneous across items within the list. This finding is inconsistent with gist-based theories of children's false memory development, because theme-congruent contexts, especially when repeated across list items, should increase false memories relative to contexts that were neutral. Moreover, theme-congruent contexts should have produced more false memories than theme-incongruent contexts when manipulated within subject (Experiment 4). However, once again the only effects were those due to the homogeneity/heterogeneity of the background and not the conceptual context in which the item was placed. It would appear that children were relying primarily on the perceptual characteristics of the display and not its conceptual properties.

Interestingly, this is not the first time the addition of conceptual information has not increased children's true or false recall. Howe (2006b) added category labels at study and found that this additional gist cuing did not increase children's true or false recall. Howe, Gagnon, and Plumpton (2007) added gist-based cues for both DRM lists and category lists and again obtained no changes in children's false recall rates. Indeed, the only effect predicting false memory rates in these studies was mean backward associative strength, the same variable that predicts false recall and recognition in adults (Roediger et al., 2001). The current experiments add to the list of gist manipulations that do not affect children's true and false memory rates. More important, the current experiments extend the range of these findings to children's visual, not just verbal, processing and show quite convincingly that children's false recall is not purely gist-based. Indeed, independent of list gist, young children's true recall and all children's false recall depended more on perceptual than conceptual characteristics of the visual display. When that display background was homogeneous regardless of content, associative processing produced age trends in false memory. However, when that background was heterogeneous, regardless of content, these trends were eliminated. For younger children, these effects were likely due to processing limitations (e.g., inefficient inhibition) that restricted encoding stimulus-relevant features leading to poorer true and false recall. For older children, perceptually homogeneous backgrounds may have promoted across-item relational processing, leading to a robust DRM illusion whereas heterogeneous backgrounds may have induced more item-specific processing, reducing the magnitude of the DRM illusion and eliminating age trends.

It could be argued that heterogeneous backgrounds distract children's attention from the focal object (the DRM item). If processing the focal item is key to producing false memories, then reducing attention to the focal item should reduce false recall, a pattern observed across the experiments in this article. However, this single process, attentional interpretation also implies that true recall should be reduced in heterogeneous background conditions because encoding the focal item is necessary for correct recollection. However, it was only the youngest (5-year-olds) children in this article for whom true recall was compromised by the use of heterogeneous backgrounds. Thus, it would seem that two different mechanisms are required to explain these effects across age.

Overall, then, children's false memory illusions for visually-presented stimuli are affected by variations in perceptual features contained in the visual display. For younger children, both true and false recall was reduced when irrelevant background information could not be inhibited during encoding. For older children, this same background information could be processed automatically, enhanced item-specific processing and perceptual distinctiveness, reducing the magnitude of the false memory effects. More important, the conceptual relevance of the background information to the overall theme of the list did not affect children's true or false recall. It would seem that, for children like adults, false recall rates are linked to associative links between presented items and critical targets and not gist/theme congruent cues. This holds not only when items are presented verbally (e.g., Howe, 2006b; Howe et al., 2006) but, as the current study shows, when items and relations are presented visually. Together these findings, and those of previous studies, impose serious constraints on gist-based theories of the development of children's true and false recollection regardless of whether the task involves verbal or visual materials. A more parsimonious approach is one that relies on the relative distinctiveness of information processed and stored in memory and the development of mechanisms that bring about changes in trace discriminability (both perceptual and conceptual) in children's memory (e.g., trace-integrity theory; Howe, 2000, 2006a, 2006c).

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Figure Captions

Figure 1. Children's true (Panel A) and false (Panel B) recall of words, line drawings, and photographs in Experiment 1.

Figure 2. Children's true (Panel A) and false (Panel B) recall of words, photographs with homogeneous neutral backgrounds, and heterogeneous neutral backgrounds in Experiment 2.

Figure 3. Children's true (Panel A) and false (Panel B) recall of photographs having either neutral or theme-congruent contexts and either homogeneous or heterogeneous backgrounds in Experiment 3.

Figure 4. Children's true (Panel A) and false (Panel B) recall of photographs having either neutral, theme-congruent, or theme-incongruent contexts and either homogeneous or heterogeneous backgrounds in Experiment 4.