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Categorization and Memory: Representation of Category Information Increases Memory Intrusions

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Abstract

False recognition of verbal information has long been established with word lists. Current research examines the phenomenon of false recognition with pictorial stimuli. Experiment 1 demonstrated that similar to word-lists, pictorially presented information elicits memory intrusions, and that rates of intrusions differ across stimuli sets. Experiment 2 investigated the effects of focusing on category-level versus item-specific information on the rates of false recognition. Results of Experiment 2 suggest that memory accuracy decreases dramatically when participants perform category-based processing compared to item-based processing. Experiment 3 confirmed that processing manipulations rather than other extraneous factors influence levels of false recognition in Experiment 2.

Introduction

People strive for accurate and reliable memories; however their memories often get distorted. Although forgetting is one of the most obvious types of memory distortions, it is not the only one. There is much research demonstrating that people often distort memories in systematic and predictable ways. For example, prior knowledge has previously been implicated in memory distortions: people often falsely recognize new information when it is consistent with their knowledge (e.g., Alba & Hasher, 1983). For instance, after reading a story describing a famous person, participants tended to falsely recognize statements that were not part of the story they had read, but were thematically related to this person. (Sulin & Dooling, 1974).

Systematic memory distortions are not limited to sentence information, and are often found with word lists. These types of memory distortions were first demonstrated by Deese (1959), who presented participants with word-lists (e.g., "bed", "rest", and "awake") consisting of associates of a single non-presented word (e.g., "sleep"). When asked to recall the words from the list, participants often erroneously recalled words consistent with the overall theme of the list, which was never actually presented. Deese's fundings were followed up by Roediger and McDermott (1995), who replicated Deese's results, demonstrating that memory intrusions of non-presented words persist in recall as well as in recognition, thus giving the name of DRM (for Deese-Roediger-McDermott) to this phenomenon. However, the nature of the phenomenon is still unclear.

According to one explanation, during recognition, participants perceive both studied items, and semantically related critical lures, to be more familiar than unrelated distracters. Because familiarity strongly affects the decision criterion for accepting items as studied or "old", those items that have elevated familiarity are more likely to be accepted both correctly and erroneously. This increased familiarity may stem from a summary or "gist" representation that reflects the general meaning of the list (in addition to representing individual items in the list), with critical lures being consistent with the gist (Brainerd, Reyna, & Mojardin, 1999). Therefore, on a recognition test, item-specific representations drive hits or correct acceptance of studied items, whereas "gist" representations drive both hits and false alarms on critical lures (i.e., erroneous acceptance of items semantically related to studied items).

According to another explanation, processing of items (either at study or at test) activates a critical lure, an item strongly associated with studied items. However, during recognition participants fail to monitor the source of this activated information, and as a result of confusing internally generated and externally presented information, participants falsely recognize critical lures (Gallo & Roediger, 2002; Koutstaal & Schacter, 1997; Roediger, et al., 2001).

If participants can represent both the "gist" and individual items (Brainerd, et al., 1999), and distortions (or false alarms) are driven by the gist representations, then it should be possible to facilitate the formation of either representation by focusing participants on the overall theme or on individual items. If our contention is correct, then a manipulation focusing on a gist representation should lead to elevated memory distortions (due to an elevated level of false alarms on critical lures).

This manipulation can generate evidence capable of distinguishing between the two theoretical positions because the source confusion explanation does not predict these effects.

Note, however that much of DRM-based research has been based on word-lists rather than pictures (see Koutstaal & Schacter, 1997; Seamon Luo, Schlegel, Greene, & Goldenberg, 2000, for notable exceptions). At the same time, pictures are well suited for this manipulation: participants could be focused on an entire category (e.g., *Cats*) or on individual items, such as a picture of a particular cat.

Another advantage of pictorially presented information is that pictures can drastically decrease the tendency to make source monitoring errors: it is highly unlikely that one would spontaneously generate a particular unique picture serving as a critical lure (see Koutstaal & Schacter, 1997, for related arguments). Therefore, persistence of memory intrusions with pictures would further suggest that these intrusions do not stem solely from source monitoring errors.

It has been previously demonstrated that pictures do generate memory intrusions (Koutstaal & Schacter, 1997; Seamon, et al., 2000). However some of these findings are based on a procedure that used large 120-study-item stimuli sets, and a 3-day delay between the study and the recognition phases. In this research, we will use the procedure that follows more closely the DRM procedure with word lists: we present participants with a reasonably small stimulus set, and impose no delays between the study and recognition phases. We have demonstrated elsewhere (Sloutsky & Fisher, in press) that false recognition of information presented pictorially can be obtained in a procedure that closely follows the original DRM task. However, these results were obtained with a single picture set, and it is unclear how well they can be generalized to a greater number of categories.

Overall, the reported research has two goals: (1) to examine whether or not pictorially-presented information can generate DRM-type phenomena and, if yes, then (2) whether false recognition in DRM stems from source-monitoring errors or from gist representation of information.

The goal of Experiment 1 was to replicate these findings using multiple categories. Experiment 2 had a more theoretically important goal: to generate evidence capable of distinguishing among the proposed theoretical accounts of the DRM-effect. Recall that finding increased memory intrusions as a result of processing manipulations would support the position that DRM-type memory intrusions stem from gist-type representations, while weakening the position that these intrusions stem from source-monitoring errors.

Experiment 1

Method

Participants Participants were introductory psychology students at a large Midwestern university (N = 103, *M* age= 19.7 years, *SD* = 1.8 years; 51 women and 52 men) who received a partial course credit for participation.

Design, Materials and Procedure Materials were 90 color photographs of animals presented against a white background. The photographs represented five different animal categories (*Cats*, *Bears*, *Squirrels*, *Fish*, and *Birds*) with 18 photographs per category.

The task consisted of a study and a recognition phase. During the study phase participants were presented with 30 pictures from three different animal categories: 10 items from the Target category, and 20 items from the two Filler categories. Participants were instructed to remember the presented pictures as accurately as possible for a f uture recognition test. During the recognition phase, which immediately followed the study phase, participants were presented with 28 pictures: 14 previously studied pictures (7 from the Target category and 7 from one of the Filler categories), and 14 new pictures (7 new pictures from the Target category, and 7 pictures from a novel category, which served as control items). Participants were asked to determine whether each picture presented during the recognition phase was “old” (i.e., exactly the same as previously seen in the study phase) or “new”.

The categories that were designated to be Targets were rotated such that *Cats*, *Bears*, *Squirrels*, *Fish*, and *Birds* served as Targets in one of five between-subject conditions. All participants were tested individually, and had all instructions and stimuli presented to them on a computer screen in a self-paced manner.

Results and Discussion

Some participants did not reliably reject control items (i.e., at least 5 out of 7 correct), and their data were excluded from further analyses; 11 participants were excluded overall. The rest of the participants were very accurate in recognizing previously studied items (on average over 88% of correct recognitions across the target categories) and in rejecting items from novel categories (over 97% of correct rejections across categories).

Most importantly, participants often mistakenly recognized new items from the Target category, or critical lures. Proportions of “old” responses to previously studied items from the Target category (Hits), to new items from the Target category (False Alarms), and to novel items from a novel category (Control Items) are presented in Figure 1.

Data in the figure indicate that (a) although for all categories, the proportion of Hits was significantly higher than the proportion of False Alarms (FA), all paired-sample *t*s > 6, *p*s < .0001, some pictorially presented categories (e.g., *Bears*) elicited sizable memory intrusions (Hits = .86, FA = .54, Hits –FA = .32), and (b) proportions of memory intrusions varied across the categories, ranging from relatively high for *Bears* to almost non-existent for *Birds*. To examine the significance of differences across categories, accuracy measures (i.e., Hits – FA) were subjected to a one-way between-subjects ANOVA with Target category as a factor. The results point to significant differences in accuracy across the Target categories, F (4, 91) = 27.3, MSE = 0.04, p < .0001, with the following pattern of accuracy *Birds* > *Fish* = *Squirrels* = *Cats* > *Bears*, post-hoc Tukey test, for all differences *p*s < .05. Therefore, major DRM phenomena that were previously found with word-lists are replicable with pictures. First, pictures generated substantial levels of memory intrusions. And second, similar to word-lists, pictures elicited different levels of memory intrusions across different target conditions: while little false recognition occurred for the Target category *Birds,* other Target categories (*Bears, Cats, Fish, and Squirrels*) elicited sizeable levels of false recognition.

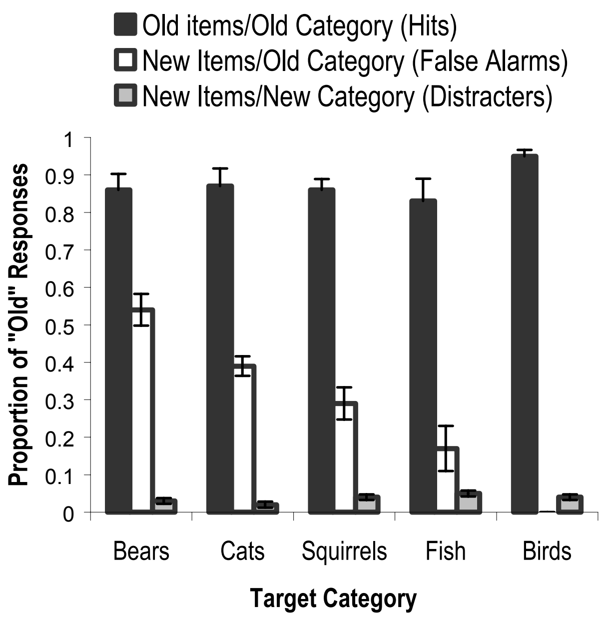

Figure 1: Mean proportions of "Old" responses across target types in the recognition memory test of Experiment 1

It could be argued, however, that Birds were an odd category that stood out in the context of mammals, which resulted in a more accurate processing of this odd category. To test this alternative, we conducted an additional experiment, using *Cats* as the Target category presented in the context of reptiles, with *Frogs* and *Alligators* used as Filler Categories. When *Cats* were an odd category, the level of false recognition of critical lures was statistically equivalent to that in Experiment 1 (42% versus 39%, respectively).

It is also possible that during the study phase, participants spontaneously labeled species of birds (but not cats, squirrels, fish, or bears), which dramatically reduced memory intrusions for the Target category *Birds*. To rule out this possibility we asked 23 undergraduates to label pictures of birds used in Experiment 1: no more than 4 out of 18 birds received unique labels, which was comparable to the labeling of cats.

Overall, these results suggest that DRM-type memory distortions are a robust phenomenon independent of the mode of presentation. More importantly, the fact that patterns of memory intrusions are similar for verbally and pictorially presented stimuli suggests that DRM-type memory intrusions do not stem solely from source monitoring errors. The goal of Experiment 2 was to examine directly whether a task that facilitates category-level processing will lead to an increase in memory intrusions compared to the baseline of Experiment 1.

Experiment 2

Method

Participants Participants were introductory psychology students at a large Midwestern university (N = 134, *M* age= 20.26 years, *SD* = 2.5 years; 64 women and 70 men) who received a partial credit for participation.

Design, Materials and Procedure Materials in Experiment 2 were identical to Experiment 1, however the study phase of the experiment was different. Participants were first presented with a picture of an animal from a Target category, and informed that the animal had "beta-cells inside its body". Participants were then presented with 30 pictures (10 from the Target category and 20 from two Filler categories), and asked to determine whether each presented animal also had beta-cells inside. Participants were provided with feedback, which indicated that only animals from the Target category had the property in question, whereas animals from the Filler categories did not. Participants were not warned about an upcoming recognition test.

Similar to Experiment 1, during the recognition phase participants were presented with 28 pictures: 14 previously studied pictures (7 from the Target category and 7 from one of the Filler categories), and 14 new pictures (7 new pictures from the Target category, and 7 pictures from a novel category). Participants were asked to determine whether each picture presented during the recognition phase was "old" (i.e., exactly the same as previously seen in the study phase) or "new".

The categories that were designated to be Targets were rotated such that *Cats*, *Bears*, *Squirrels*, *Fish,* and *Birds* served as Targets in one of five between-subject conditions. All participants were tested individually, and had all instructions and stimuli presented to them on a computer screen in a self-paced manner.

Results and Discussion

Some participants did not reliably reject control items (i.e., at least 5 out of 7 correct), and their data were excluded from further analyses; 35 participants were excluded overall. The rest of the participants were very accurate in recognizing previously studied items (on average over 83% of correct recognitions across the target categories) and in rejecting items from novel categories (over 97% of correct rejections across categories).

However, the rates of false recognition in each target condition increased substantially, compared to the baseline in Experiment 1. Proportions of hits (i.e., correct recognitions), false alarms on Target distracters (FA), and accuracy scores (Hits – FA) for each target category are presented in Table 1.

Table 1: Proportions of false alarms (FA), and Accuracy scores (Hits – FA) across target categories in Experiment 2.

Target Category	Hits	FA	Accuracy (Hits – FA)
Birds	.84	.50	.34
Fish	.80	.47	.33
Squirrels	.80	.61	.19
Cats	.80	.62	.18
Bears	.88	.79	.09

Overall results of Experiments 1 and 2 are presented in Figure 2. Data in the figure indicate that recognition accuracy markedly decreased in Experiment 2 compared to Experiment 1. This differential accuracy was the result of a processing manipulation introduced in Experiment 2 (i.e., an induction task) that focused participants on the category-level properties of stimuli, as opposed to item-specific properties in Experiment 1. Data in the figure also suggest that the decrease in accuracy in Experiment 2 was not proportional to the level of performance in Experiment 1. This task by condition interaction, F (4, 181) = 3.7, MSE = .21, p < .05, suggests that when participants are focused on category-level properties, they form mainly category-level representations, as opposed to mainly item-level representation in the Baseline. However, it is possible that decrease in memory accuracy obtained in Experiment 2 can be explained by increased task demands of Experiment 2 compared to Experiment 1 (performing an induction task versus no task during the study phase). It is also possible that overall accuracy in Experiment 2 decreased because participants were not warned about a subsequent memory test. Experiment 3 was designed to test these alternative explanations.

Experiment 3

The goal of Experiment 3 was to eliminate potential confounds of Experiment 2 by introducing a task that would force participants to engage in item-based processing. Similar to Experiment 2 participants were not warned about a subsequent memory test. Therefore, if accurate memory performance is obtained in Experiment 3, both of alternative explanations for the results of Experiment 2 will be eliminated.

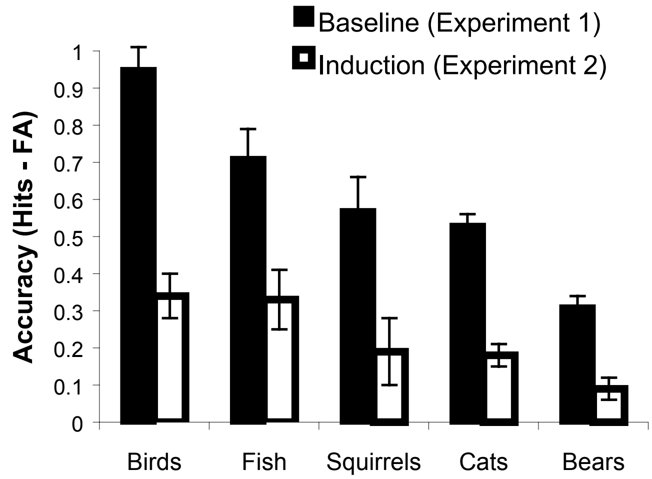

Figure 2: Mean accuracy (Hits – FA) across target categories in Experiment 1 and 2.

Method

Participants Participants were introductory psychology students at a large Midwestern university (N = 24, M age= 20.2 years, SD = 1.6 years; 9 women and 15 men) who received a partial credit for participation.

Design, Materials and Procedure Overall structure of the task was similar to Experiment 2, however only one target category (*Cats*) was tested, and participants were presented with a different question during the study phase. Participants were first presented with a picture of a cat, and told the animal was young. Then they were presented with 30 pictures of animals from 3 different categories (10 cats, 10 bears, and 10 birds), and asked to determine whether each animal was young or mature. Participants received random feedback, thus blocking any possible categorization. Similar to Experiment 2, participants were not warned about a subsequent memory test.

During the recognition phase participants were presented with 28 pictures: 14 previously studied pictures (7 cats and 7 bears), and 14 new pictures (7 novel cats and 7 squirrels, which served as control items). Participants were asked to determine whether each picture presented during the recognition phase was "old" (i.e., exactly the same as previously seen in the study phase) or "new".

All participants were tested individually, and had all instructions and stimuli presented to them on a computer screen in a self-paced manner.

Results and Discussion

Three participants did not reliably reject control items (i.e., at least 5 out of 7 correct), and their data were excluded from further analyses. The rest of the participants were very accurate in recognizing previously studied items (over 87% of correct recognitions versus 86% in Experiment 1), and in rejecting items from novel categories (95% and 99% of correct rejections respectively). Levels of false recognitions were also comparable to the baseline in Experiment 1 (38% and 33% respectively). Results of Experiment 3 suggest that differential accuracy on a recognition memory test in Experiment 1 and 2 cannot by attributed to the difference in task demands or difference in instruction, since memory performance in Experiments 3 was very close to performance in Experiment 1, despite a task added to the study phase, and a lack of warning about a subsequent memory test. These findings indicate that the level of processing required by a task (item-specific versus category-specific) influences the level of false recognition on a recognition memory test.

General Discussion

The present study replicated earlier findings that DRM-type intrusions are possible with pictorially presented stimuli, and generalized these earlier findings to multiple categories. The study also demonstrated that processing manipulations (rather than differential task demands) influence the levels of false recognition. Specifically, tasks that focus participants on category-level properties result in category-level representations, and lead to decreased memory accuracy compared to the tasks that focus participants on the item-specific properties of stimuli. This decrease, however, is not proportional to the level of memory performance in the Baseline condition: as a result of performing induction, memory accuracy decreases drastically, and becomes more comparable for all types of Targets.

The reported findings, indicating that DRM-type memory intrusions persist even with pictures, seem to weaken the source monitoring explanation of memory intrusions. Even if source-monitoring errors play a role in memory intrusions with word-lists, these errors are highly unlikely to generate recognition errors when stimuli are presented pictorially. Therefore, assuming that the same mechanism underlies DRM-type intrusion with verbally and pictorially presented materials, it seems reasonable to conclude that monitoring errors are unlikely to be the only source of DRM-type intrusions with verbally presented materials. Given that memory intrusions with pictures are isomorphic to those with word-lists (i.e., both modes of presentation elicit high levels of false recognition and different intrusion rates across different lists), the assumption does not seem unreasonable. Therefore, the reported results seem to support the idea that that DRM-type intrusions stem from category-level or "gist" representations rather than from source monitoring errors.

The finding that performance on an induction task results in an increased level of memory intrusions is theoretically important for the study of inductive reasoning as well as memory. In particular, researchers debate whether or not induction is category-based at different points of development (see Sloutsky, 2003), and the study of effects of induction on memory accuracy may bring critical evidence to this debate.

In short, the reported research brings new evidence to research on memory and induction: category-based induction results in the formation of category-level or "gist" representations, which in turn increase false recognition of new items from studied categories.

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