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RESEARCH REPORT

Automaticity of Basic-Level Categorization Accounts for Labeling Effects in Visual Recognition Memory

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Are there consequences of calling objects by their names? Lupyan (2008) suggested that overtly labeling objects impairs subsequent recognition memory because labeling shifts stored memory representations of objects toward the category prototype (representational shift hypothesis). In Experiment 1, we show that processing objects at the basic category level versus exemplar level in the absence of any overt labeling produces the same qualitative pattern of results. Experiment 2 demonstrates that labeling does not always disrupt memory as predicted by the representational shift hypothesis: Differences in memory following labeling versus preference are more likely an effect of judging preference, not an effect of overt labeling. Labeling does not influence memory by shifting memory representations toward the category prototype. Rather, labeling objects at the basic level produces memory representations that are simply less robust than those produced by other kinds of study tasks.

Keywords: recognition memory, labels, categorization, depth of processing, representational change

Why do we give objects names? In addition to facilitating communication, names exert a powerful influence on how we learn about and understand objects and categories. For example, infants categorize better when the same name is paired with objects from the same category (Yoshida & Smith, 2005), even when these objects are perceptually dissimilar (Plunkett, Hu, & Cohen, 2008). Names also facilitate category learning for adults, even when names are not actively used during the learning task (Lupyan, Rakison, & McClelland, 2007).

Category names can also influence object perception, as in categorical perception, where discrimination between two perceptually similar stimuli is easier if they cross a boundary determined by linguistic categories (Gilbert, Regier, Kay, & Ivry, 2006; Roberson & Davidoff, 2000). The discrimination advantage for cross-category pairs is reduced when participants perform a concurrent verbal, but not visual, task (Gilbert et al., 2006; Roberson & Davidoff, 2000), implying that categorical perception depends on the ability to use category names.

Categorical perception demonstrates a clear effect of having names. What effects might using names have on object representations? Lupyan (2008) suggested that labeling objects systematically affects how objects are represented in memory and obtained a particularly provocative result that we focus on here.

Lupyan (2008) briefly presented participants pictures of chairs and lamps. In different blocks, they were asked to press a key denoting the object's name ("chair" vs. "lamp") or their preference ("like" vs. "don't like"). During a surprise old–new recognition memory test, participants were presented with studied items (old) and lures (new) that differed only subtly from the study item (see Figure 1). Recognition memory was lower for labeled objects than for objects that were judged for preference. This difference in recognition memory was driven by fewer hits for labeled objects, without any difference in false alarms.

Lupyan (2008) explained these results with a *representational shift hypothesis*: Overtly labeling an object activates features associated with prototypical examples from the object's category. In a top-down manner, these features become coactive with the visual features of the perceived object, systematically altering the object representation stored in long-term visual memory. Specifically, overt labeling shifts the stored object representation toward the category prototype. When that same object is viewed at test, its representation no longer matches the shifted representation in memory. That study–test mismatch leads to a false sense that the old object is new, resulting in fewer hits.

The representational shift hypothesis is similar to the category adjustment model (Huttenlocher, Hedges, & Vevea, 2000), according to which representations become biased toward the center of the category. In cases of inexact or incomplete representations,

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Figure 1. Examples of target–lure pairs used in Experiments 1 and 2. The top two examples show chairs. The bottom two examples show lamps. Paired lures might be a different color from the target, differ in the presence or absence of a feature (e.g., armrests), or have a different height–width ratio. (Note: The last pair of lamps differed in color). Adapted from http://www.ikea.com. Copyright 1999–2011 by Inter IKEA Systems B.V.

category information provides a meaningful basis for drawing inferences about a category exemplar. In certain ways, the representational shift hypothesis extends this model, suggesting that overt labeling magnifies these prototype biases. Unlike the category adjustment model, where category biases arise when objects are reconstructed during memory retrieval (Crawford, Huttenlocher, & Engerbretson, 2000), the representational shift hypothesis posits that category information modifies how objects are stored in visual long-term memory.

The representational shift hypothesis provides a provocative explanation for the effects of labeling on object memory. More broadly, the representational shift hypothesis has potentially important implications for understanding any cognitive processes that rely on object representations stored in memory, potentially falsifying many models of object recognition, memory, and categorization. While some models have proposed interactive activation between category names and object representations of the sort used to explain representational shift (e.g., Rogers & Patterson 2007), many others have assumed instead a largely feed-forward process of object recognition and categorization (e.g., see Palmeri & Tarr, 2008).

In Experiment 1, we tested whether it is the act of overt object labeling that is critical or whether representational shift is simply a consequence of object categorization more generally. In Experiment 2, we asked whether differences in memory following labeling versus preference can be explained by differences in the quality or strength of memory traces created by those different study tasks, without requiring that object representations be systematically shifted by labeling.

Experiment 1

The representational shift hypothesis postulates an effect of overt labeling on object representations. Lupyan (2008) argued that this effect cannot be attributed to categorization on its own: Any effect of categorization should lead to differences in false alarms because only category-relevant features are encoded. The representational shift hypothesis assumes that objects are encoded the same way but that the stored visual memory representations are distorted by activating the category label. This leads to a difference in hits, not false alarms. Therefore, according to Lupyan (2008), although categorization is certainly a component of labeling, it is the overt act of labeling that produces representational shift, not categorization.

However, in Lupyan (2008), labeling and categorization were confounded: Participants labeled objects as chairs or lamps by pressing one of two response keys. Therefore, it is impossible to link the memory effects uniquely to overt labeling and not to categorization. Experiment 1 demonstrated that impaired recognition memory can arise from category-level processing on its own, in the absence of any overt labeling or explicit categorization response, and that this impairment is driven by a difference in hits, not false alarms.

We eliminated explicit labeling by using a sequential matching task with chairs and lamps. In different blocks, participants judged whether or not two sequentially presented items were from the same category (category matching) or were the exact same exemplar (exemplar matching). We hypothesized that memory for objects seen during category matching may be similar to effects of labeling since only category-level information is relevant, whereas memory for objects seen during exemplar matching may be similar to effects of preference judgments since attention to details of the object is required. Two objects were presented on every trial, and whether the second object was a chair or lamp was randomized with respect to whether the correct response was "same" or "different." Consequently, participants were required to consider category membership during category-matching blocks without making any explicit labeling or categorization response.

Both category-matching and exemplar-matching blocks contained the same number of trials in which the same image was presented consecutively and the correct response was "same." For both kinds of study blocks, memory was only tested for objects presented on these "same" trials. Although we manipulated study task, the only difference between test objects during recognition was the task context in which these otherwise identical trials were presented.

Method

Participants. Twenty-four Vanderbilt University (Nashville, TN) undergraduates received course credit for participation. Data from four participants were discarded for below-chance performance.

Stimuli. Stimuli were 144 color pictures of chairs and lamps from www.ikea.com. Each picture was 250 × 250 pixels, showing a single chair or lamp on a white background. There were 72 pairs of chair and lamp pictures (36 per category), with each target matched with a paired lure. Paired lures differed from targets in small but noticeable ways (see Figure 1). Pictures were sorted into four sets. Two sets contained 20 target–lure pairs and were designated *target sets.* Assignment as a target or lure was counterbalanced. Target objects were presented twice during the study phase, with both presentations within the same trial. Two other filler sets contained 16 object pairs. Both objects in each filler set pair were shown once during the study phase and were used to create either the category-matching or exemplar-matching context. One target set and one filler set were assigned to the category-matching block and another target and filler set to the exemplar-matching block for each participant (counterbalanced).

Procedure. On each matching trial, a fixation cross (500 ms) was followed by the first image (300 ms), a random pattern mask (500 ms), and the second image (300 ms). A question mark then cued participants to respond. Participants had 700 ms to respond and heard a tone if they responded too slowly, at which point the trial timed out.

In the category-matching block, participants pressed *1* if the two objects were from the same basic-level category or *2* if they were from different basic-level categories. In the exemplar-matching block, participants pressed *1* if the two objects were the exact same object or *2* if they differed in any way. Participants completed one exemplar-matching and one category-matching block (order counterbalanced). A five-trial practice block where participants judged if two sequentially presented tables were the same or different shape preceded the experimental blocks.

There were 52 trials in each study block (see Figure 2 for trial types and their frequency). In both blocks, there were 20 target trials (created with targets from the target object set). On these trials, the same image was presented consecutively, and the correct response was "same." The remaining 32 trials in each block were created from objects in the filler sets and were designed to create either a category-matching or exemplar-matching context. For category-matching blocks, the remaining 32 trials consisted of 16 noncritical "same" trials, where the two objects were different exemplars from the same category, and 16 "different" trials, where the two objects were from different categories. For the exemplar-matching block, the remaining 32 trials consisted of matched object pairs from the filler set and required a "different" response. In this way, subtle differences needed to be detected on different trials in the exemplar-matching block, and participants could not rely on global similarity. Prior to the experiment, participants were shown examples of "same" and "different" trials for each task.

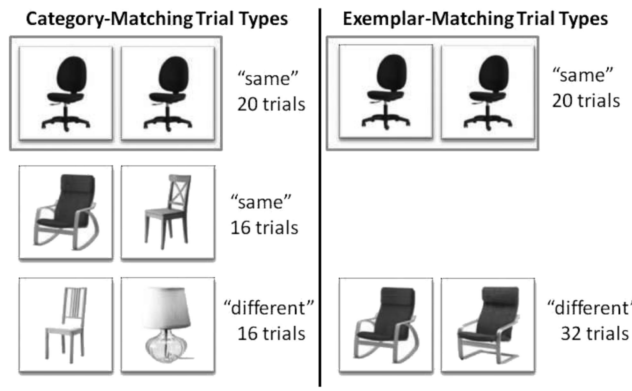

Figure 2. Trial types and their frequency in the category-matching (left) and exemplar-matching (right) study blocks in Experiment 1. Both blocks contain an equal number of target trials (shown in a box). Images adapted from http://www.ikea.com. Adapted from http://www.ikea.com. Copyright 1999–2011 by Inter IKEA Systems B.V.

After participants completed both matching blocks, a surprise recognition memory test followed. They were informed that some of the pictures would be old, exactly the same as those in the study phase, and some would be new, differing only subtly in details such as shape or color. Pictures were presented on the screen one at a time, and participants were instructed to press *1* if the object was "old" or *2* if the object was "new." Pictures remained on the screen until participants made a response. Recognition memory was only tested for objects presented on target trials where the same image was shown consecutively, requiring a "same" response (from both category-matching and exemplar-matching blocks); tested items only differed in the task context in which they were presented. There were 80 test trials presented in a random order.

Results

As shown in Figure 3, there were significantly more hits and false alarms for objects in the exemplar-matching versus category-matching block, hits: $t(19) = 4.66$, $p < .001$, $d = 1.51$; false alarms: $t(19) = 2.90$, $p < .01$, $d = 0.94$. There was also a trend toward higher overall recognition memory performance (d') for objects in the exemplar-matching than category-matching block, $t(19) = 2.03$, $p = .056$, $d = 0.66$, and correct response times (RTs; see Table 1) were significantly faster for objects presented in the exemplar-matching than category-matching block, $t(19) = 2.87$, $p = .01$, $d = 0.93$. In contrast to Lupyan (2008), we observed some of the memory effect in RTs, not just d'.

Discussion

Recognition memory was worse for objects studied in the context of category matching than objects studied in the context of

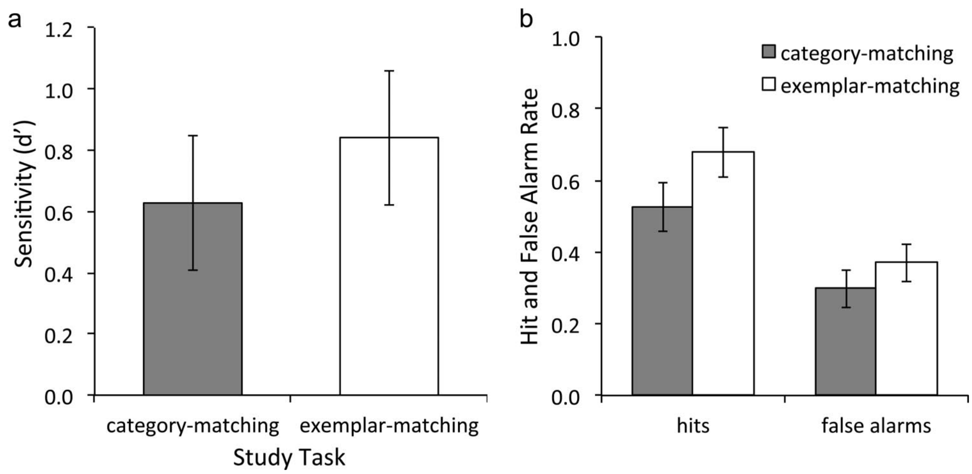

Figure 3. Overall performance (d'; Panel a) and hit and false-alarm rates (Panel b) on the recognition memory test for objects presented in the category-matching and exemplar-matching blocks in Experiment 1. Error bars show 95% confidence intervals for the paired-sample t tests.

exemplar-matching as reflected in longer RTs and marginally lower d'. Our findings are qualitatively similar to differences between labeling and preference (Lupyan, 2008), as hits were higher for exemplar matching versus category matching, and show that overt labeling of objects is not necessary to obtain the pattern of results used to support representational shift; category-level processing without any overt labeling is sufficient.

Lupyan (2008) characterized impaired recognition from labeling as a direct result of overt labeling, not simply categorization. Recognizing that overt labeling in his studies involved categorization, he argued that actively using a category label has an additional influence on subsequent memory above and beyond categorization. Lupyan's main argument was that the memory effect is observed in hits, while any categorization effect should be observed in false alarms. The false-memory literature suggests that categorization leads to coarse encoding of category-relevant features, resulting in false alarms to lures from the same category that share these features (Koutstaal et al., 2003; Koutstaal & Schacter, 1997; Sloutsky & Fisher, 2004).

While we observed a small difference in false alarms in Experiment 1, it was in the opposite direction from what the false-memory literature would predict based on coarse encoding: False memory suggests a higher false-alarm rate for objects studied during category matching (Koutstaal & Schacter, 1997; Koutstaal et al., 2003; Sloutsky & Fisher, 2004). We observed a higher false-alarm rate for objects studied during exemplar-matching, not category matching. Therefore, a categorization effect in memory is not necessarily indexed by an increase in false alarms for categorized items. Impaired memory for labeled objects can just as well be explained by impaired memory for objects categorized at a relatively coarse basic level, with or without any overt labeling.

Table 1
Correct Response Times on the Recognition Memory Test for Objects Presented in Each Study Task and Their Matched Lures in Experiment 1

Study task	Response times (ms)
Category matching	1,231
Exemplar matching	1,080

Experiment 2

The representational shift hypothesis suggests that overt labeling impairs recognition memory (Lupyan, 2008). However, an alternative account is that preference judgments enhance recognition memory. Indeed, what makes Lupyan's (2008) hypothesis so intriguing is that one might expect labeling to have almost no systematic influence as a study task because names are automatically activated by objects all the time (Kikutani, Roberson, & Hanley, 2010; Meyer & Damian, 2007; Morsella & Miozzo, 2002). Unfortunately, impairment for labeling versus enhancement for preference cannot be distinguished in Lupyan because there were only two tasks and no baseline.

Experiment 2 tested these competing possibilities. Participants made two judgments for each object on every study trial. One group labeled all objects (*primary labeling group*). On most trials, after labeling, participants also reported the location of the image on the screen (i.e., above or below fixation). On a small proportion of trials, after labeling, participants made a preference judgment too. A second group of participants did the converse. They made preference judgments for all objects (*primary preference group*) and then either made a location judgment or labeled the object.

For all participants, some objects were given both labels and preference judgments. Other objects were given labels and location judgments (primary labeling group) or preference and location judgments (primary preference group). Which judgment rules the day?

According to the representational shift hypothesis, memory will be worse for any objects that are labeled at study, regardless of whether labeling is accompanied by a location or preference judgment. Labeling distorts representations stored in long-term visual memory, regardless of the other encoding task. The representational shift hypothesis predicts better memory for objects judged for preference and location because those objects do not also include overt labeling (see Figure 4, left). Any labeled objects suffer from a representational shift, which produces a decrease in hits during recognition.

An alternative account is that differences in memory following preference versus labeling arise due to differences in memory strength, without requiring that object representations are systematically shifted. According to this memory strength account, preference judgments might enhance memory, perhaps because judging preference is less automatic than labeling and requires more effort. By this account, memory is equally good for any of the three study-–task combinations that incorporate a preference judgment, even when it is combined with labeling, but is relatively worse for the combination of labeling and location (see Figure 4, right). Note that we were not testing why preference judgments enhance memory. Whatever the explanation, the pattern of results predicted by a memory strength account is inconsistent with a representational shift account.

Method

Participants. Twenty-four members of the Vanderbilt University community were given monetary compensation ($10) for participation. Participants were randomly assigned to either the primary labeling ($n = 12$) or primary preference group.

Stimuli. Stimuli were 80 pictures of chairs and lamps (20 target–lure pairs per category) created in the same manner as Experiment 1. Images were sorted into four sets (five target–lure pairs per category). For each participant, one object set (counterbalanced) was designated as the 25% second task set.

Procedure. On each trial, participants saw a picture of a chair or lamp presented above or below fixation (300 ms). Participants in the primary labeling group were then probed to label the object, pressing one key for "chair" and another for "lamp." On 75% of trials, they were then probed to indicate the location where the object was presented relative to fixation, pressing one key for "above" and another for "below." On 25% of trials, following the labeling judgment, participants were probed to make a preference judgment, pressing one key for "like" and another for "dislike." The two response probes were presented sequentially, with each prompt remaining on the screen until a response was made.

The procedure was identical for participants in the primary preference group, except that their first response was always to rate their preference for the object, they judged location on 75% of trials, and they labeled the object on 25% of trials.

Participants in each group knew which judgment they would always be making first (labeling or preference). Although they were not informed of the exact proportion of location judgments versus other second judgments (labeling or preference), they were told that the location judgment would be probed more frequently. The second task was probabilistic to ensure that participants were not generating both the location and critical second responses (labeling or preference) on every trial.

For each response type, one response was made with the left hand and the other with the right hand. The same two keys were used for all response types. The response probes were the words "NAME?", "RATE?", or "PLACE?" printed in the center of the screen for the labeling, preference, and location tasks, respectively. The two response options were displayed on the bottom left and right of the probe image.

Each object was presented twice during the study phase (once above and once below fixation) for a total of 80 trials. The primary judgment (e.g., labeling) was followed by a location judgment on 60 trials, and the primary judgment (e.g., labeling) was followed by the other judgment (e.g., preference) on 20 trials.

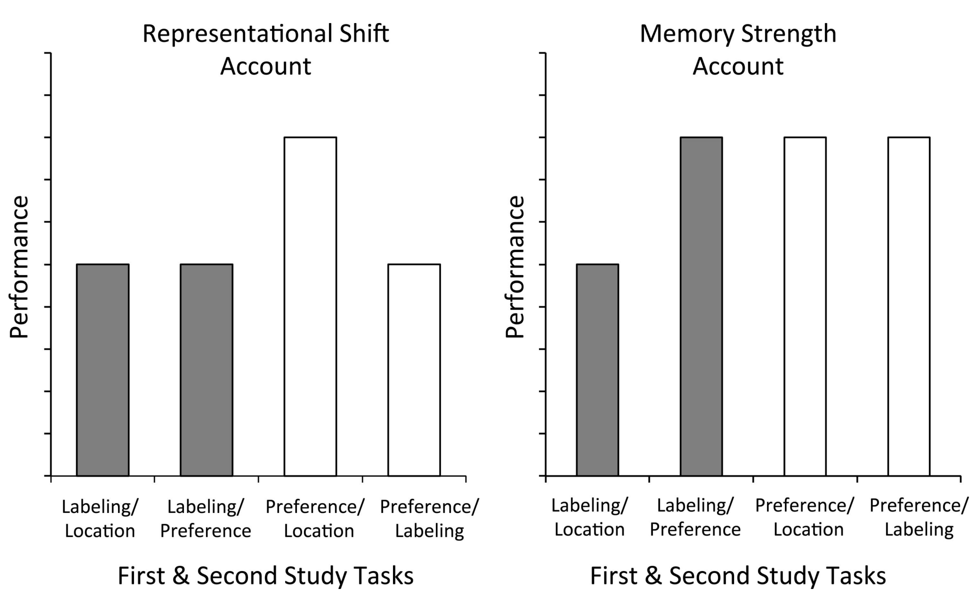

Figure 4. Predicted recognition memory performance in Experiment 2 based on the representational shift account (left) and the alternative memory strength account (right).

The test phase was identical to Experiment 1, with the exception that memory was tested for all objects presented during the study phase.

Results

A 2 × 2 mixed factors analysis of variance (ANOVA) on overall memory performance (d'; see Figure 5) with second task (within-subjects) and primary task (between-subjects) as factors revealed that overall performance was significantly worse when the second task was a location judgment compared with either labeling or preference, $F(1, 22) = 29.34$, $p < .001$, $\eta_p^2 = .57$. Although there was no significant interaction in d', the representational shift account predicts that performance should be worse when the second task is labeling compared to location for the primary preference group. However, the opposite pattern of results was observed, $t(11) = 2.83$, $p = .016$, $d = 1.21$. Overall memory performance supports the alternative account because memory was better when the second task was preference compared to location for the primary labeling group, $t(11) = 4.94$, $p < .001$, $d = 2.11$. Correct RTs did not differ significantly between conditions (see Table 2).

The hit rate data (see Figure 5b) also support the alternative account. A 2 × 2 mixed factor ANOVA conducted on hit rates revealed a main effect of second task, $F(1, 22) = 7.39$, $p = .01$, $\eta_p^2 = .25$, and a Second Task × Primary Task interaction, $F(1, 22) = 9.74$, $p < .01$, $\eta_p^2 = .31$. In line with the alternative account that preference judgments improve memory, there was no significant difference in hit rates between the two second tasks (location and labeling) when the primary task was preference, but hit rates were significantly lower for the location versus preference task when the primary task was labeling, $t(11) = 4.28$, $p = .001$, $d = 1.82$. Moreover, hit rates were lower following the location task

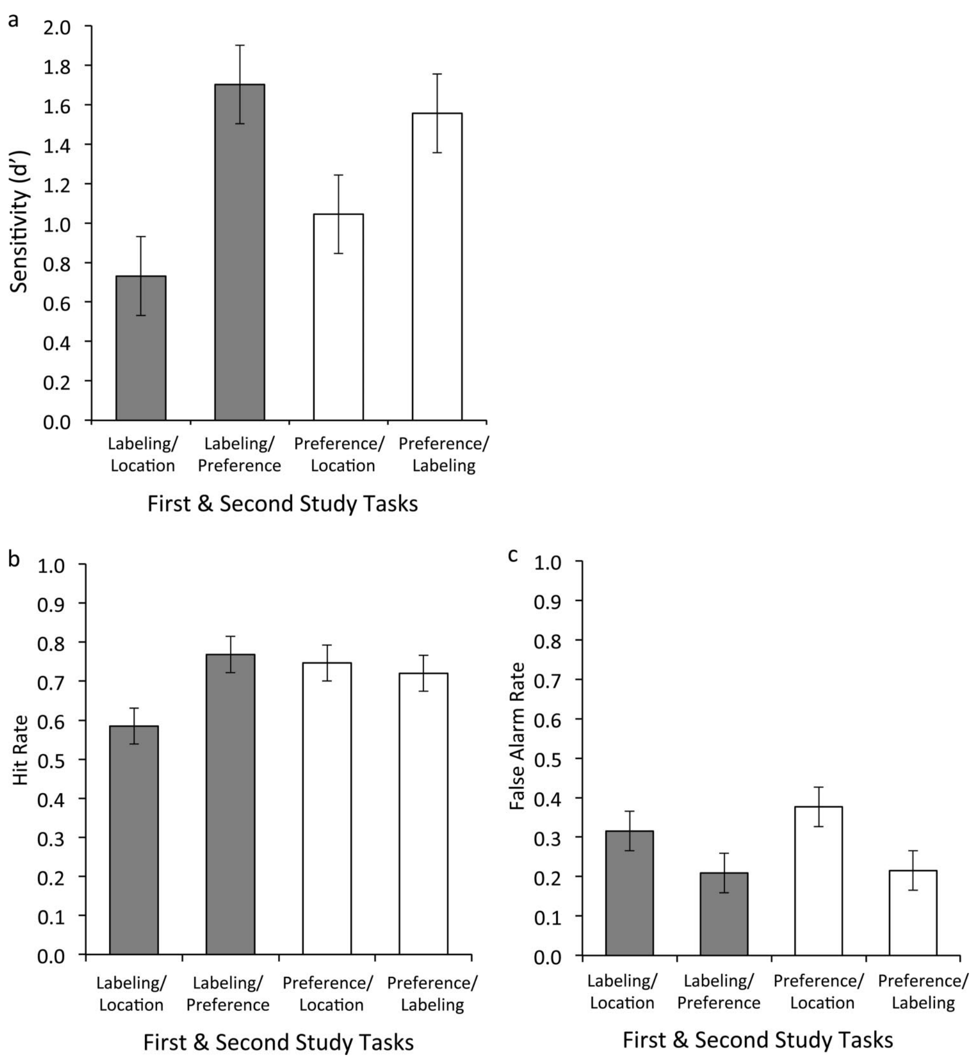

Figure 5. Overall performance (d'; Panel a), hit rates (Panel b) and false-alarm rates (Panel c) on the recognition memory test in Experiment 2 for all combinations of first (primary) and second study tasks. Grey bars show performance for the primary labeling group and white bars show performance for the primary preference group. Error bars show 95% confidence intervals of the within-subjects effects.

Table 2
Correct Response Times on the Recognition Memory Task in Experiment 2 for All Combinations of First and Second Study Task

First (primary) study task	Second study task	Response time (ms)
Labeling	Preference	1,299
	Location	1,326
Preference	Labeling	1,412
	Location	1,200

when the primary task was labeling versus preference, $t(22) = 3.54$, $p < .01$, $d = 1.51$, while the hit rates following the labeling or preference second task did not differ between groups. Hit rates were the same for any condition that included a preference judgment but were significantly lower for the single condition where no preference judgment was made.

The same ANOVA conducted on false-alarm rates (see Figure 5c) revealed more false alarms following the location task compared with when the second task was either labeling or preference, $F(1, 22) = 13.08$, $p < .01$, $\eta_p^2 = .37$. Accordingly, a between-subjects interaction was not observed in d' because both groups had more false alarms for the location task.

Discussion

The hit rate data clearly challenge the representational shift hypothesis: Participants in the primary preference group judged preference for every object, but there was no difference in hits depending on whether they also judged location or labeled the object. This is inconsistent with the representational shift hypothesis, which predicts fewer hits whenever objects are explicitly labeled. The hit rate data do support the alternative account, based on memory strength: Correct recognition of a previously studied item was better any time an object was judged for preference, regardless of whether it was also labeled or not. Unfortunately, the d' data are difficult to interpret because of higher false alarms following location judgments. However, even in the d' data, it is clear that labeling did not uniformly impair memory. If anything, the combination of labeling and preference produced the highest d' scores.

Why might preference judgments enhance memory compared to labeling? One possibility is that rating preference is more effortful than labeling, requiring attention to subtle visual details, resulting in a stronger and more persistent visual memory trace. This happens whether preference is the first judgment or the second judgment within a trial. By contrast, labeling or naming objects is automatic—and therefore relatively effortless—particularly in the context of a memory task. For example, memory errors for ordered recall tend to correspond to auditory confusions (e.g., recalling B instead of D) for letters (Conrad, 1964), words (Coltheart, 1993) and pictures (Coltheart, 1999; Schiano & Watkins, 1981), but this phonological similarity effect is eliminated if participants engage in an irrelevant articulatory task (e.g., counting; Schiano & Watkins, 1981). Moreover, the amount of time participants look at an object is significantly correlated with the number of syllables in the object name and spoken name duration (Zelinsky & Murphy, 2000). Thus, participants may automatically encode familiar objects verbally. Perhaps, in the present experiments, the labeling response required less additional object processing (the correct response is prepared automatically) compared with making a preference judgment, leading to differences in the quality of the resulting long-term visual memory representations. Also, because labeling occurs so quickly, labeling responses might be activated concurrently with perceptual processing (Kikutani, Roberson, & Hanley, 2008, 2010). Consequently, perceptual encoding may not be complete at the time that a labeling response is generated, resulting in a weaker and less perceptually detailed representation.

This memory strength account is similar to a classic depth of processing explanation (Craik & Lockhart, 1972; Craik & Tulving, 1975). Lupyan (2008) attempted to rule out depth of processing by changing response-selection demands so that study RTs were longer for labeling than preference. However, study RTs do not necessarily correlate with depth (Craik & Tulving, 1975). Of course, depth of processing explanations for memory effects have been heavily criticized (e.g., Baddeley, 1978). It is unclear exactly how a preference judgment improves memory. It is also unclear whether two successive judgments about an object held briefly in visual working memory (e.g., labeling following by preference or vice versa) create a single memory representation from both judgments or two memory representations from each separate judgment. Regardless of the precise mechanism, Experiment 2 demonstrated that differences in correct recognition (hits) between objects that are overtly labeled and objects judged for preference are more likely driven by a memory enhancement following preference judgments, rather than a memory impairment following labeling.

General Discussion

Lupyan (2008) proposed that overtly labeling objects impairs subsequent recognition memory because the stored object representation becomes altered by top-down feedback evoked by using the category name. By this representational shift hypothesis, this leads to a reduced hit rate in a subsequent recognition memory test for labeled objects because the same object shown at test no longer matches the representation stored in memory.

The experiments presented here challenge the representational shift hypothesis. Experiment 1 demonstrated that overt labeling is not necessary to obtain the pattern of results used to support the representational shift hypothesis: Category-level processing in the absence of any explicit labeling also led to fewer hits relative to a study task encouraging exemplar-level processing. Experiment 2 demonstrated that differences in recognition memory between labeled and preference objects are driven by improvements in memory following preference judgments and not by impairments following overt labeling. Experiment 2 also revealed that labeling does not universally lead to a decrease in hits, as suggested by representational shift.

Our results suggest a simpler memory strength account, where recognition memory depends on the nature of study tasks, which in turn influences the strength of the memory trace (Craik & Lockhart, 1972). Arguably, naming objects at a basic level is relatively effortless. The basic level has been characterized as the default level of abstraction at which we parse the world (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976), and basic-level categorization occurs relatively automatically (Mack, Gauthier, Sadr, &

Palmeri, 2008). Processing objects at finer levels of abstraction requires more time and effort (Jolicoeur, Gluck, & Kosslyn, 1984). Like fine-grained categorization, preference judgments likely require more detailed and deliberative processing. The question posed was not whether participants liked chairs or lamps generally but whether they liked this particular chair or lamp. Memory traces are weaker for objects processed with relatively automatic encoding compared to objects that require more effortful encoding. In this way, differences in recognition memory between labeling and preference can be explained by general principles of memory, rather than a special process related to overt labeling.

If supported, the representational shift hypothesis would have challenged many theories of object recognition and object categorization, namely, those that propose little within-trial interactivity between object representations and category names. To be clear, we are not suggesting that feedback from top-down knowledge cannot influence lower level processing. On the contrary, there are many demonstrations of conceptual information (e.g., Gauthier, James, Curby, & Tarr, 2003; Goldstone, 1994), including names (e.g., Gilbert et al., 2006; Mitterer, Horschig, Musseler, & Majid, 2009), influencing perception and perceptual decision making. Yet, once names or labels have been acquired, the act of volitionally and overtly using them does not shift the long-term visual memory representations of labeled objects toward the category prototype. Indeed, overtly labeling objects may have little negative impact on memory representations because objects are labeled according to their basic-level category all the time.

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