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When Does Memory Monitoring Succeed Versus Fail? Comparing Item-Specific and Relational Encoding in the DRM Paradigm

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We compared the effects of item-specific versus relational encoding on recognition memory in the Deese–Roediger–McDermott paradigm. In Experiment 1, we directly compared item-specific and relational encoding instructions, whereas in Experiments 2 and 3 we biased pleasantness and generation tasks, respectively, toward one or the other type of processing. A read condition was tested in each experiment for comparison purposes. Across experiments, item-specific and relational encoding both boosted correct recognition relative to reading, but only item-specific encoding typically reduced false recognition. Signal-detection measures revealed that less information was encoded about critical items after item-specific than after relational encoding. In contrast, item-specific and relational encoding led to equivalent increases in strategic monitoring at test (e.g., use of a distinctiveness heuristic). Thus, monitoring at test was less successful after relational than item-specific encoding because more information had been encoded about critical lures.

Keywords: DRM paradigm, item-specific and relational processing, false recognition, distinctiveness heuristic, signal detection

A goal of memory research is to develop a set of procedures for improving memory. This set of encoding procedures now includes "deep" study tasks such as the levels-of-processing framework (LOP; Craik & Lockhart, 1972; see also Craik, 2002, for a review), item generation (Slamecka & Graf, 1978), and encoding based on fitness relevance (Nairne, Thompson, & Pandeirada, 2007). When memory performance is operationalized in terms of overall accuracy, manipulations that reduce memory errors become relevant. Memory errors can be reduced when conservative responding is emphasized through warnings or penalties (Gallo, Roediger, & McDermott, 2001; Huff, Meade, & Hutchison, 2011; McCabe & Smith, 2002) or via distinctive encoding tasks (Israel & Schacter, 1997). Our study investigated how one important processing distinction affects memory accuracy. Specifically, we examined how performing item-specific versus relational processing at encoding influences correct and false recognition in the Deese–Roediger–McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995).

In the DRM paradigm, participants' study lists of related words (e.g., *bed*, *rest*, *tired*, and so on) that each converge on a single nonpresented critical item (CI; e.g., *sleep*). At test, participants frequently report having studied the CIs. The DRM illusion is robust: False recall rate can approach 50% (e.g., Roediger & McDermott, 1995), and false recognition can match hit rates for studied items (e.g., Lampinen, Neuschatz, & Payne, 1999). Researchers have discovered many means of reducing the illusion (see Gallo, 2006, 2010, for reviews), yet it persists after repeated study trials (Benjamin, 2001; McDermott, 1996) and explicit warnings (Gallo et al., 2001; McCabe & Smith, 2002; Neuschatz, Benoit, & Payne, 2003; Neuschatz, Payne, Lampinen, & Toglia, 2001). Although such manipulations do not eliminate the DRM illusion, they often reduce it relative to a condition in which participants simply read or hear the DRM lists.

Performing distinctive encoding tasks can also reduce the DRM illusion. For example, Israel and Schacter (1997) found reduced false memory when list items shown on a screen were accompanied by a picture of their referents relative to when they were not. Participants in the picture conditions were said to adopt a global decision rule at test such that they deemed an item "old" only when its recognition was accompanied by the recollection of distinctive details (i.e., the picture)—a test strategy termed a *distinctiveness heuristic* (e.g., Dodson & Schacter, 2001, 2002; Schacter, Cendan, Dodson, & Clifford, 2001; Schacter, Israel, & Racine, 1999). Recollecting distinctive details provides diagnostic evidence that an item was studied, whereas the absence of such details leads participants to report that it was not studied (Gallo, 2004).

Benefits of distinctive encoding on the DRM illusion can arise at test through use of a distinctiveness heuristic (e.g., Gunter, Bodner, & Azad, 2007), but they can also arise at encoding, either by decreasing the activation of the CI (Roediger, Balota, & Watson, 2001) or by disrupting thematic consistency of the list (Brainerd & Reyna, 2002)—a process known as *impoverished relational encoding* (Arndt & Reder, 2003; Hege & Dodson, 2004; Hockley & Cristi, 1996). To compare these loci, some researchers have tested a within-subject condition. Schacter et al. (1999) had participants study one set of DRM

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lists with pictures and another set without pictures. Consistent with a global monitoring strategy at test, the DRM illusion was reduced for the CIs from both types of lists, whereas impoverished relational encoding should have reduced the illusion only for the picture lists.

Other studies have found evidence for impoverished relational encoding. Of particular relevance to the present study, McCabe, Presmanes, Robertson, and Smith (2004) examined the locus of the benefits of distinctive encoding by manipulating item-specific versus relational encoding (Hunt & Einstein, 1981; Hunt & McDaniel, 1993). *Item-specific encoding* occurs when participants focus on the unique characteristics of individual list items, whereas *relational encoding* occurs when participants focus on characteristics shared among list items. Participants studied DRM lists with instructions to relate the list items together (relational instructions) or to think of a unique characteristic for each item (item-specific instructions). Both conditions produced the same level of correct recognition, but false recognition was lower after item-specific instructions in both the between and within designs. McCabe et al. concluded that item-specific encoding decreased the amount of memory information encoded for the CIs from those lists, rather than globally increasing test-based monitoring. Additionally, Arndt and Reder (2003) found that the DRM illusion was selectively reduced for distinctive (vs. nondistinctive) fonts in both between and within designs.

An inclusion test has also been used to determine the locus of the effect of distinctive encoding (e.g., Gunter et al., 2007; Hege & Dodson, 2004; Hunt, Smith, & Dunlap, 2011; Pierce, Gallo, Weiss, & Schacter, 2005; Schacter et al., 2001). On this test, participants are asked to report (recall) or endorse (recognition) all items remembered from study or related to the study items. Under these instructions, it is argued that test-based monitoring is abandoned, leaving only the contribution of encoding processes. Inclusion tests have also yielded mixed results: Distinctive encoding reduced the DRM illusion in some studies (e.g., Hege & Dodson, 2004; Hunt et al., 2011) but not in others (e.g., Gunter et al., 2007; Pierce et al., 2005; Schacter et al., 2001).

A third method for contrasting study-based and test-based effects in the DRM paradigm was applied by Gunter et al. (2007), who compared the effects of generation (e.g., solving anagrams) to a read condition. Here, signal-detection indices of memory information (*d* prime, d') and memory monitoring (lambda) were used to examine the contributions of memory-based encoding processes and criterion-based test processes, respectively. Relative to the read condition, generation increased correct recognition by increasing memory information encoded about presented items at study, whereas it decreased the DRM illusion by increasing memory monitoring at test, consistent with use of a distinctiveness heuristic. Thus, the mirror-effect pattern that generation produced (e.g., Glanzer & Adams, 1990) had different loci for correct versus false recognition.

Although all three methods have been used to evaluate the effects of impoverished relational encoding versus a distinctiveness heuristic at test, the signal-detection approach offers the advantage of providing separate measures of both loci within the standard DRM paradigm. In contrast, in the within-subject approach, the presence of increased monitoring at test is based on a null difference between the distinctive and nondistinctive lists. Further, a within design cannot detect situations where an encoding manipulation impairs relational encoding *and* increases memory monitoring. Instead, if the within condition suggests an increase in memory monitoring (a null effect of list type) or impoverished relational encoding (an effect of list type), then by definition the other locus cannot be demonstrated, thus affirming a disjunction.

The inclusion test approach suffers from similar interpretation issues. Here, null effects are used to provide evidence for memory monitoring, thus this method cannot demonstrate contributions of both memory monitoring and impoverished relational encoding. The ability of an inclusion test for disentangling impoverished relational encoding versus use of a distinctiveness heuristic has also been criticized on other grounds. For example, Hege and Dodson (2004) suggested that inclusion tests lead participants to endorse CIs and other related items even when they have no memory information for those items that would not likely be endorsed on a recognition test.

McCabe et al.'s (2004) study of the effects of item-specific versus relational instructions on the DRM illusion left two issues unresolved. First, the absence of a read condition made it impossible to gauge whether item-specific instructions reduced false recognition or whether relational instructions increased false recognition. For example, the equivalence in correct recognition could mean either that both or neither type of instruction was effective. Second, given the previous critique of within conditions, the possibility that the effects of item-specific versus relational processing arose partially at encoding and partially at test could not be tested.

In the present work, we adopted Gunter et al.'s (2007) signal-detection approach to determine if changes in correct and false recognition following item-specific versus relational encoding are driven by a decrease in the encoding of memory information or by an increase in monitoring at test. We argue that reductions in the DRM illusion in previous studies were not due to the use of "distinctive" study tasks per se but were due instead to the extent to which the particular instantiations of those tasks induced item-specific versus relational processing. In addition to item-specific instructions (e.g., McCabe et al., 2004), a reduction in the DRM illusion has been found when list items are rated for pleasantness (Hunt et al., 2011), a task suggested to induce item-specific processing (Einstein & Hunt, 1980; Hunt & Einstein, 1981). Thus, item-specific encoding and distinctive encoding both operate to highlight the unique features of list items in the context of a related word list (Hunt, 2006).

Relational encoding, on the other hand, emphasizes similarities rather than differences among the list items. However, relational encoding might also increase correct recognition, as item-specific encoding does, given that both are "deep" tasks in so far as they both typically require processing of semantic information. Further, relational encoding may boost memory monitoring at test as much as does item-specific encoding, because both create types of memory information that participants can choose to monitor at test. The key difference is that item-specific encoding allows for the monitoring of unique information encoded at study, whereas relational encoding allows for monitoring of whether the test items were related to the studied lists. Thus, both encoding tasks likely increase memory monitoring relative to reading, but the type and efficaciousness of the information used for monitoring may differ.

In McCabe et al. (2004), these possibilities could not be evaluated because a read condition was not tested.

In Experiment 1, item-specific versus relational encoding was manipulated directly through an instructional manipulation, as in McCabe et al. (2004). Experiments 2 and 3 induced item-specific and relational encoding indirectly via different variants of pleasantness and generation tasks, respectively. Item-specific and relational encoding groups in each experiment were first compared with each other. Comparisons with the read condition were then used to triangulate and gauge the observed outcomes. We expected that item-specific and relational encoding would both increase correct recognition. On the basis of Gunter et al.'s (2007) results, we expected item-specific task variants to increase memory information encoded about list items, whereas the effects of relational task variants had not been previously tested.

For false recognition, we expected that item-specific encoding would result in lower false recognition relative to relational encoding, as McCabe et al. (2004) found. Signal-detection analyses and comparisons with the read condition were then used to elucidate the basis of this difference. For example, relative to reading, item-specific encoding might impair relational encoding, whereas relational encoding might or might not promote it. We also used the read condition to gauge whether memory monitoring increases following relational encoding as much as it does following item-specific encoding. If so, relational encoding might create a situation in which use of a strategic monitoring strategy at test, such as a distinctiveness heuristic, fails to reduce the DRM illusion. Increased monitoring might be ineffective when participants have encoded substantial information about the CIs in the service of a relational task.

Experiment 1: Item-Specific Versus Relational Instructions

In Experiment 1, the effects of item-specific and relational encoding instructions were compared. A read condition was also included to help elucidate the locus of observed effects. We predicted an increase in correct recognition in both the item-specific and relational encoding groups relative to the read group. Our second prediction, based on McCabe et al. (2004), was that item-specific encoding would decrease the DRM illusion relative to relational encoding. Signal-detection analyses were used to determine the bases of these predicted patterns.

Method

Participants. University of Calgary undergraduates participated for course credit. They were randomly assigned to the item-specific, relational, or read group (24 per group). Five participants were replaced for knowing about the DRM illusion, and one for not following test instructions.

Materials. The 20 DRM lists that produced the highest false recognition in Stadler, Roediger, and McDermott (1999) were divided into two sets of 10 lists. Across participants, the set that was studied (vs. new) was counterbalanced. Each list consisted of 12 words of at least four letters, presented in descending associative strength. An 80-item recognition test was presented in a randomized order for each participant that was composed of 30 list items (from Positions 2, 8, and 10 of each studied list), 30 list item controls from the nonstudied lists (from the same list positions), 10 CIs (one per studied list), and 10 CI controls (one per nonstudied list).

Procedure. Participants were tested individually via computer. All groups were instructed to read each list word aloud. The item-specific group was further instructed to "think of a unique characteristic of each word that differentiates it from the other words on the list." The relational group was further instructed to "concentrate on what the words in that list have in common and associate them together." The item-specific and relational encoding instructions were modeled after those used by McCabe et al. (2004). A practice list (the *cold* list) was then presented to allow participants to practice their study strategy aloud. After this list, the experimenter provided feedback and answered questions as needed to ensure that each participant completed the study strategy correctly. Participants then studied the 10 experimental lists for which the item-specific and relational tasks were performed silently. Each list was separated by the words "next list," which the experimenter read aloud. The recognition task immediately followed the study phase. Words appeared one at a time on the monitor, and participants pressed either the "old" or "new" button on a labeled response box.

Results

The $p < .05$ level of significance was used unless otherwise noted. For the signal-detection analyses, we adjusted false alarm rates of 0 and hit rates of 1 using MacMillan and Creelman's (1991) $1/2n$ correction. Mean recognition scores and signal-detection indices for Experiment 1 appear in Table 1.

Correct recognition. A one-way analysis of variance (ANOVA) showed a significant difference in correct recognition of list items across the three groups, $F(2, 69) = 23.78$, mean square error *(MSE)* = 0.01. Correct recognition was greater following item-specific encoding than relational encoding (.95 vs. .88), $t(46) = 3.24$, standard error of the mean (*SEM*) = 0.02. Relative to the read group, correct recognition was greater following both item-specific encoding (.76 vs. .95), $t(46) = 6.74$, $SEM = 0.03$, and relational encoding (.76 vs. .88), $t(46) = 3.68$, $SEM = 0.03$. We also conducted a one-way ANOVA on d' values to provide a measure of the amount of memory information encoded for list items relative to list item controls. These d' values were calculated by taking the z score of the hit rate for list items minus the z score of list item controls for each participant. The ANOVA pattern was the same as for raw correct recognition. There was a significant difference in d' across groups, $F(2, 69) = 43.14$, $MSE = 0.34$, reflecting more memory information for list items in the item-specific group compared with the relational group (3.54 vs. 2.90), $t(46) = 3.51$, $SEM = 0.18$, in the item-specific group compared with the read group (3.54 vs. 1.99), $t(46) = 10.38$, $SEM = 0.15$, and in the relational group compared with the read group (2.90 vs. 1.99), $t(46) = 5.38$, $SEM = 0.17$.

A final one-way ANOVA compared our index of memory monitoring at test for list items. We computed the lambda index by taking the z score of 1 minus the false alarm rate of list item controls. Higher lambda values indicate more conservative responding, which we took as evidence of increased stringency of memory monitoring at test (see Gunter et al., 2007; Wickens, 2002). Memory monitoring differed across groups, $F(2, 69) =$

Table 1
Experiment 1: Mean (SD) Proportion of "Old" Responses and Signal-Detection Indices for the Read, Item-Specific Instructions, and Relational Instructions Groups

	Instructions group		
Item type/index	Item-specific	Relational	Read group
List items	.95 (0.06)	.88 (0.09)	.76 (0.13)
List item controls	.04 (0.05)	.07 (0.07)	.14 (0.10)
List items *d′*	3.54 (0.59)	2.90 (0.69)	1.99 (0.45)
List items lambda	1.81 (0.43)	1.62 (0.48)	1.20 (0.47)
Critical items	.52 (0.22)	.73 (0.20)	.67 (0.18)
Critical item controls	.07 (0.10)	.10 (0.12)	.21 (0.17)
Critical items *d′*	1.46 (0.70)	1.99 (0.56)	1.39 (0.57)
Critical items lambda	1.38 (0.39)	1.29 (0.45)	.90 (0.55)

10.95, *MSE* = 0.21. Both the item-specific and relational groups did more monitoring than the read group (1.81 vs. 1.20), $t(46) = 3.05$, *SEM* = 0.13, and (1.62 vs. 1.20), $t(46) = 3.05$, *SEM* = 0.14, respectively. In contrast, monitoring of studied items at test was similar in the item-specific and relational groups (1.81 vs. 1.62), $t(46) = 1.45$, *SEM* = 0.13, $p = .16$. The nonsignificant differences we report were each further tested using a Bayesian estimate of the strength of evidence supporting the null hypothesis (Masson, 2011; Wagenmakers, 2007). This analysis compares a model that assumes an effect against a model that assumes no effect. In this case, the estimated probability that the null effect model was preferred over a model that assumes a monitoring difference was $p_{\mathrm{BIC}} = .71$, thus providing evidence in favor of the null hypothesis.

False recognition. A one-way ANOVA revealed differences in the mean proportion of old responses to CIs across groups, $F(2, 69) = 7.04$, *MSE* = 0.04. As McCabe et al. (2004) found, the item-specific group was less likely to falsely recognize CIs than the relational group (.52 vs. .73), $t(46) = 3.45$, *SEM* = 0.06. Comparisons to the read group were used to clarify the nature of this difference. Item-specific encoding resulted in lower false recognition than reading (.52 vs. .67), $t(46) = 2.64$, *SEM* = 0.06, whereas the relational encoding and read groups did not differ significantly (.73 vs. .67), $t(46) = 1.07$, *SEM* = 0.05, $p = .29$, $p_{\mathrm{BIC}} = .79$. We estimated the memory information encoded about CIs the d' difference between CIs (treated as hits) and CI controls (treated as false alarms; Gunter et al., 2007). It indexes the amount of information encoded about CIs when the corresponding list was studied relative to when it was not studied. A one-way ANOVA revealed differences in this index across groups, $F(2, 69) = 7.03$, *MSE* = 0.38. The item-specific group encoded less information about CIs than the relational group (1.46 vs. 1.99), $t(46) = 2.91$, *SEM* = 0.18. This index was similar for the item-specific and read groups (1.46 vs. 1.39), $t < 1$, $p_{\mathrm{BIC}} = .86$, whereas the relational group encoded more information about CIs than the read group (1.99 vs. 1.39), $t(46) = 3.74$, *SEM* = 0.16.

The lambda index for memory monitoring of CIs at test was based on the false alarm rate to CI controls. Again, higher lambda values indicate more conservative responding, which we took as evidence of increased stringency of memory monitoring at test (see Gunter et al., 2007; Wickens, 2002). This index differed across groups, $F(2, 69) = 6.98$, *MSE* = 0.22. Monitoring was similar in the item-specific and relational groups (1.38 vs. 1.29), $t < 1$, $p_{\mathrm{BIC}} = .84$, and both groups showed increased strategic monitoring at test relative to the read group (1.38 vs. .90), $t(46) = 3.45$, *SEM* = 0.14, and (1.29 vs. .90), $t(46) = 2.66$, *SEM* = 0.15, respectively.

Discussion

Item-specific and relational encoding instructions both increased correct recognition relative to reading. For the most part, prior studies have not examined the bases of correct recognition differences in the DRM paradigm (cf. Gunter et al., 2007). Our signal-detection analyses revealed that the benefit of item-specific and relational types of encoding arose from a combination of increased memory information about list items at encoding and increased monitoring at test. The added improvement for item-specific over relational encoding was due to increased memory information for list items, given that memory monitoring was equivalent.

Turning to the DRM illusion, we found that item-specific encoding reduced false recognition relative to reading, whereas relational encoding did not. We further showed that item-specific encoding resulted in less information being encoded about CIs than did relational encoding. As a result, even though item-specific and relational encoding both increased monitoring at test relative to reading, this monitoring was effective only after item-specific encoding. Thus, Experiment 1 provides the first reported evidence of the operation of an ineffective distinctiveness heuristic. Finally, we also found that the choice of comparison for gauging the effects of item-specific processing highlighted different effects of this type of processing. Specifically, the reduction in false recognition following item-specific encoding had an encoding locus relative to relational encoding (i.e., reduced relational processing) but had a test locus relative to reading (i.e., increased monitoring at test, replicating Gunter et al., 2007).

Experiment 2: Item-Specific Versus Relational Pleasantness Tasks

In Experiment 2, we compared the effects of item-specific and relational encoding by embedding each type of processing in an elaborative encoding task. We chose a pleasantness task because rating pleasantness has produced different patterns in the DRM paradigm. On the one hand, Toglia, Neuschatz, and Goodwin

(1999) found that pleasantness increased both correct and false memory (a *more-is-less pattern*), whereas Hunt et al. (2011) found an increase in correct memory coupled with a decrease in false memory (a *mirror-effect pattern*, Glanzer & Adams, 1990). Hunt et al. showed that these different patterns were likely due to the use of different comparison groups: a read control group (Hunt et al., 2011) versus a shallow LOP control group (Toglia et al., 1999). However, the type of processing recruited within the pleasantness task may also have contributed to the different patterns. Given our finding in Experiment 1 that the basis of the effects of item-specific encoding differed depending on whether it was gauged relative to relational encoding or reading, both types of comparison condition were again tested here.

In Experiment 2, we created item-specific and relational versions of a pleasantness task and tested whether the presence of more-is-less versus mirror-effect patterns is contingent on the type of encoding. Participants were asked to make pleasantness ratings by thinking of a unique reason for why an item was pleasant (item-specific group) or to rate an item's pleasantness relative to the other list items (relational group). Additionally, an absolute yes/no rating was used to further encourage item-specific encoding, whereas a relative 7-point rating was used to further encourage relational encoding.

We expected to replicate the correct recognition advantages for item-specific and relational pleasantness tasks relative to reading. We also expected lower false recognition after item-specific pleasantness relative to relational pleasantness. Relational pleasantness was again expected to result in a failed distinctiveness heuristic pattern: Increased memory monitoring without a concomitant reduction in false recognition. Signal-detection analyses and comparisons to a read group were again used to examine the bases of these expected patterns.

Method

Participants. Additional University of Calgary undergraduates were randomly assigned to the item-specific pleasantness group, the relational pleasantness group, or the read group (28 per group). Twelve participants were replaced for reporting knowledge about the DRM illusion.

Materials and procedure. The Experiment 1 materials and procedure were used with the following modifications. The item-specific pleasantness group was instructed to read each word aloud and "think of a unique reason why each word is pleasant or is not pleasant." They responded using keys labeled "yes" or "no" on the response box. The relational pleasantness group was instructed to read each word aloud and "rate the word's pleasantness relative to the other words on the list using a 1–7 scale, with 7 representing most pleasant." They were further instructed to "rate the pleasantness of the first word, but beginning with the second word, rate its pleasantness relative to the first, rate the third word relative to the first and second word, and so on." They made their ratings using keys labeled 1–7 on the response box.

Results

Table 2 reports mean recognition scores and signal-detection indices for Experiment 2. The data were analyzed as in Experiment 1.

Correct recognition. Correct recognition of list items varied across groups, $F(2, 81) = 35.69$, $MSE = 0.01$. Correct recognition was near ceiling following item-specific and relational pleasantness tasks thus no difference could be detected (.96 vs. .95), $t < 1$, $p_{\mathrm{BIC}} = .88$, and both groups outperformed the read group (.96 vs. .80), $t(54) = 6.37$, $SEM = 0.03$, and (.95 vs. .80), $t(54) = 6.38$, $SEM = 0.02$, respectively. The groups also differed on the d' index, $F(2, 81) = 59.46$, $MSE = 0.31$, reflecting the same pattern. More memory information was encoded for list items following item-specific pleasantness than relational pleasantness (3.72 vs. 3.36), $t(54) = 2.58$, $SEM = 0.14$, and both groups encoded more memory information about list items than the read group (3.72 vs. 2.18), $t(54) = 10.42$, $SEM = 0.15$, and (3.36 vs. 2.18), $t(54) = 7.57$, $SEM = 0.16$, respectively.

The groups also differed on the lambda index, $F(2, 81) = 27.77$, $MSE = 0.12$. Monitoring for studied items at test was greater in the item-specific pleasantness group relative to the relational pleasantness group (1.94 vs. 1.67), $t(54) = 3.21$, $SEM = 0.09$, and both of these groups monitored more than the read group (1.94 vs. 1.26), $t(54) = 7.88$, $SEM = 0.09$, and (1.67 vs. 1.26), $t(54) = 3.96$, $SEM = 0.10$, respectively.

False recognition. The DRM illusion differed across the groups, $F(2, 81) = 9.13$, $MSE = 0.05$. As in Experiment 1, the item-specific pleasantness group was less likely to falsely recognize CIs than the relational pleasantness group (.48 vs. .61), $t(54) = 2.18$, $SEM = 0.06$, or the read group (.48 vs. .72), $t(54) = 3.94$, $SEM = 0.03$. In contrast to Experiment 1, false recognition was lower after relational encoding than reading (.61 vs. .72), $t(54) = 2.34$, $SEM = 0.05$. The amount of memory information encoded about the CIs, as assessed via our d' index for CIs, was

Table 2

Experiment 2: Mean (SD) Proportion of "Old" Responses and Signal-Detection Indices for the Read, Item-Specific Pleasantness, and Relational Pleasantness Groups

	Pleasantness group		
Item type/index	Item-specific	Relational	Read group
List items	.96 (0.05)	.95 (0.04)	.80 (0.12)
List item controls	.02 (0.03)	.06 (0.05)	.12 (0.08)
List items d'	3.72 (0.50)	3.36 (0.50)	2.18 (0.61)
List items lambda	1.94 (0.25)	1.67 (0.38)	1.26 (0.39)
Critical items	.48 (0.27)	.61 (0.17)	.72 (0.18)
Critical item controls	.06 (0.09)	.05 (0.09)	.19 (0.13)
Critical items d'	1.37 (0.79)	1.75 (0.53)	1.59 (0.65)
Critical items lambda	1.43 (0.35)	1.45 (0.35)	.94 (0.46)

marginally different across groups, $F(2, 81) = 2.36$, $MSE = 0.44$, $p = .10$. The item-specific group encoded less memory information about the CIs than the relational group (1.37 vs. 1.75), $t(54) = 2.14$, $SEM = 0.18$, but the comparisons to the read group did not reach significance (1.37 vs. 1.59), $t(54) = 1.16$, $SEM = 0.19$, $p = .25$, $p_{\mathrm{BIC}} = .79$, and (1.75 vs. 1.59), $t(54) = 1.01$, $SEM = 0.16$, $p = .32$, $p_{\mathrm{BIC}} = .82$.

Strategic memory monitoring (lambda) differed across groups, $F(2, 81) = 15.60$, $MSE = 0.15$. As in Experiment 1, memory monitoring was similar for the item-specific and relational groups (1.43 vs. 1.45), $t < 1$, $p_{\mathrm{BIC}} = .88$, and each group monitored more at test than the read group (1.43 vs. .94), $t(54) = 4.47$, $SEM = 0.11$, and (1.45 vs. .94), $t(54) = 4.70$, $SEM = 0.11$, respectively.

Discussion

As with the instructional manipulation in Experiment 1, item-specific and relational pleasantness tasks both increased correct recognition relative to reading, and signal-detection analyses showed that increased memory information and memory monitoring both contributed to this pattern. Although item-specific pleasantness increased memory information relative to relational pleasantness, this did not result in an increase in correct recognition, possibly because both groups performed near ceiling (cf. Experiment 3, however).

In terms of the DRM illusion, as in Experiment 1, false recognition was lower following item-specific encoding than relational encoding, and this was shown to be due to a reduction in the amount of information encoded about the CIs. The comparisons to the read group were not significant, but directionally the item-specific group encoded less information about the CIs than the read group, whereas the relational group encoded more. Relative to the read group, the reductions in false recognition in both the item-specific and relational groups were primarily due to increased monitoring at test, rather than to differences at encoding. Thus, as in Experiment 1, the locus of the decrease in the DRM illusion depended on the comparison condition used (see Hunt et al., 2011, for a related point).

Unlike in Experiment 1, relational encoding also reduced false recognition relative to reading, though to a lesser extent than item-specific encoding. This result is perhaps unsurprising, given that pleasantness tasks have traditionally been used to induce both deep and item-specific processing. Our relational pleasantness task procedure likely also induced some item-specific encoding, given that participants had to consider and rate each item's pleasantness relative to the other items on a given list. Experiment 2 reinforces our suggestion that encoding tasks are not inherently item-specific or relational. Rather, to the extent that a given encoding task emphasizes one or the other type of processing, different outcomes for false recognition will be obtained.

Experiment 3: Item-Specific Versus Relational Generation Tasks

Our primary goal in Experiment 3 was to extend the generality of the different outcomes of item-specific and relational encoding found with instructions (Experiment 1) and a pleasantness task (Experiment 2) to an additional encoding task. As reviewed in our introduction, generation can reduce the DRM illusion relative to a read condition, due to an increase in test-based memory monitoring (Gunter et al., 2007; McCabe & Smith, 2006). We suggested that these effects were driven by the generation task's requirement to engage in item-specific processing rather than by the requirement to generate per se. If so, then manipulating the generation task to emphasize either item-specific or relational processing should yield different outcomes. As in Experiments 1 and 2, we predicted that both versions of the generation task would improve correct recognition compared with a read condition. For false recognition, we predicted that item-specific generation would selectively decrease the DRM illusion relative to the read condition.

A secondary goal was to revisit Gunter et al.'s (2007) finding that generation reduced the DRM illusion solely via increased strategic monitoring at test and did not lead to impoverished relational encoding. To this end, we created a more demanding item-specific anagram generation task by having participants solve anagrams without the aid of a letter-switching rule. Relative to a read condition, this item-specific generation task was expected to increase monitoring *and* impair relational encoding. A relational generation task was also created to emphasize semantic relations during generation. To this end, we presented a cue word with each studied word on a given list that was related to each list's items (but not directly related to the CI) and asked participants to use the cue word to help them solve each anagram. Our relational generation task was expected to increase monitoring (as in the relational groups in Experiments 1 and 2), but this monitoring was expected to fail, given that substantial memory information about the CIs should have already been encoded in the service of the relational task.

Method

Participants. Additional University of Calgary undergraduates were randomly assigned to the item-specific generation group, the relational generation group, or the read group (30 per group). Four participants were replaced for solving fewer than 90% of the anagrams, even with specific hints.

Materials and procedure. The Experiment 1 materials were used. We engineered anagrams from list items by swapping the first and third or second and fourth letters resulting in two anagram types (Gunter et al., 2007); each list was composed of an equal number of these two anagram types. For the relational generation task, a cue word was selected from the Nelson, McEvoy, and Schreiber's (1999) word-association norms by taking the strongest associate of the critical word that was not already on the list. Given these criteria, the cue word possessed little or no backward associative strength (i.e., association from the list word to the cue word) according to the norms. A list's cue word was presented beside each word on that list (e.g., *BAGEL—tubter*, *BAGEL—fdoo*). The item-specific generation group solved the same anagrams but without the presence of a cue word (e.g., *tubte*r, *fdoo*).

The Experiment 1 procedure was used except as follows. The item-specific generation group was instructed to solve each anagram. The relational generation group was further instructed to use the related cue word to assist them in solving each anagram. Neither generation group was explicitly informed of the rule used to construct the anagrams (cf. Gunter et al., 2007). Our thought was that not providing the rule would lead the item-specific group to focus more on each list item and would lead the relational group to rely more on the cue word. If an anagram could not be solved within a few seconds, participants were told the first letter of the solution. The experimenter labeled each anagram trial as "correct" if the anagram was accurately solved, as "hint" if solved when the participant was given the first letter, or as "pass" if the anagram was not solved with a hint. On pass trials, the experimenter read aloud the solution, which was then verbally repeated by the participant. Participants then completed the same recognition test used in Experiments 1 and 2.

Results

The mean anagram completion rate was 94% in the item-specific group and 96% in the relational group, including trials in which a hint was provided. The respective hint rates were 7% and 4%. The analyses were not conditionalized on correct generation or hints. Table 3 presents the mean recognition scores and signal-detection indices for Experiment 3.

Correct recognition. Correct recognition differed across the groups, $F(2, 87) = 5.01$, $MSE = 0.02$. The item-specific and relational generate groups showed equivalent correct recognition (.84 vs. .84), $t < 1$ $p_{\mathrm{BIC}} = .89$, and recognition was off ceiling (cf. Experiment 2). Significant generation effects also occurred: Correct recognition was greater in both the item-specific and relational groups than in the read group (.84 vs. .75), $t(58) = 2.68$, $SEM = 0.03$, and (.84 vs. .75), $t(58) = 2.69$, $SEM = 0.03$, respectively. The d' measure for studied items also differed across groups, $F(2, 87) = 11.08$, $MSE = 0.38$, reflecting the same pattern: Memory information was equivalent for item-specific and relational generation (2.73 vs. 2.79), $t < 1$ $p_{\mathrm{BIC}} = .88$, and each was greater than for the read group (2.73 vs. 2.11), $t(58) = 3.79$, $SEM = 0.16$, and (2.79 vs. 2.11), $t(58) = 4.18$, $SEM = 0.16$.

The groups also differed on the lambda index, $F(2, 87) = 4.20$, $MSE = 0.23$. Monitoring of studied items at test was equivalent following item-specific and relational generation (1.67 vs. 1.65), $t < 1$, $p_{\mathrm{BIC}} = .88$, and both groups monitored more than the read group (1.67 vs. 1.36), $t(58) = 2.41$, $SEM = 0.13$, and (1.65 vs. 1.36), $t(58) = 2.46$, $SEM = 0.12$.

False recognition. The DRM illusion differed across groups, $F(2, 87) = 7.83$, $MSE = 0.06$. False recognition was lower in item-specific generation group than in the relational generation group (.39 vs. .54), $t(58) = 2.41$, $SEM = 0.06$. Compared with reading, item-specific generation reduced false recognition (.63 vs. .39), $t(58) = 4.21$, $SEM = 0.06$, but relational generation did not (.63 vs. .54), $t(58) = 1.37$, $SEM = .06$, $p = .18$, $p_{\mathrm{BIC}} = .75$. The d' measure for CIs also differed across groups, $F(2, 87) = 4.77$, $MSE = 0.54$, reflecting the same pattern: The item-specific group encoded less information about CIs than the relational group (1.03 vs. 1.61), $t(58) = 2.92$, $SEM = 0.20$, or the read group (1.03 vs. 1.34), $t(58) = 2.16$, $SEM = 0.17$, whereas the latter two groups were similar (1.61 vs. 1.39), $t(58) = 1.08$, $SEM = 0.06$, $p = .29$, $p_{\mathrm{BIC}} = .81$.

The lambda measure for CIs also differed between groups, $F(2, 87) = 6.99$, $MSE = 0.23$. Monitoring for CIs was similar in the item-specific and relational generation groups (1.34 vs. 1.47), $t(58) = 1.06$, $SEM = 0.12$, $p = .30$, $p_{\mathrm{BIC}} = .81$, and both groups monitored more than the read group (1.34 vs. 1.02), $t(58) = 2.47$, $SEM = 0.13$, and (1.47 vs. 1.02), $t(58) = 3.68$, $SEM = 0.12$.

Discussion

Generation increased correct recognition, regardless of the type of processing used to solve the anagrams. These generation effects were shown through signal-detection analyses to be due to increased memory encoding and increased monitoring at test, as in Experiments 1 and 2.

In contrast to their similar effects on correct recognition, item-specific generation reduced false recognition but relational generation failed to do so. Moreover, for the first time, the reduction following item-specific encoding was shown to have two loci relative to reading: reduced memory information encoded for the CIs and increased memory monitoring at test. In contrast, Gunter et al. (2007) found only the latter locus using their generation task. We attribute this difference to Gunter et al. having provided participants with a rule for solving the anagrams. We surmise that because we did not provide this rule, our participants were required to perform more item-specific processing that prevented them from engaging in relational processing. Relational generation also increased monitoring at test relative to reading, but this monitoring failed to reduce false recognition. We attribute this failure to the relational generation group having already encoded as much memory information about the CIs as the read group. This failure is nonetheless curious, given that postencoding warnings designed to increase monitoring at test have sometimes reduced the DRM illusion

Table 3

Experiment 3: Mean (SD) Proportion of "Old" Responses and Signal-Detection Indices for the Read, Item-Specific Generation, and Relational Generation Groups

	Generation group		
Item type/index	Item-specific	Relational	Read group
List items	.84 (0.11)	.84 (0.13)	.75 (0.13)
List item controls	.06 (0.07)	.06 (0.06)	.11 (0.08)
List items d'	2.73 (0.60)	2.79 (0.58)	2.11 (0.67)
List items lambda	1.67 (0.46)	1.65 (0.40)	1.36 (0.52)
Critical items	.39 (0.22)	.54 (0.27)	.63 (0.22)
Critical item controls	.09 (0.14)	.05 (0.13)	.17 (0.15)
Critical items d'	1.03 (0.64)	1.61 (0.87)	1.39 (0.66)
Critical items lambda	1.34 (0.49)	1.47 (0.42)	1.02 (0.52)

(e.g., Gallo et al., 2001) or other types of memory errors (e.g., Chambers & Zaragoza, 2001).

General Discussion

Implementing Hunt and Einstein's (1981) classic distinction between item-specific and relational encoding produced consistent dissociations between correct and false recognition in the DRM paradigm. Relative to reading, item-specific encoding produced a mirror effect: increased correct recognition and decreased false recognition. Relational encoding also increased correct recognition relative to reading; however, it generally failed to reduce false recognition. Signal-detection analyses revealed quite consistent bases for these patterns. The boosts to correct recognition from item-specific and relational encoding were due to a combination of increased encoding of memory information for list items and increased memory monitoring at test. Relative to relational encoding, item-specific encoding reduced false recognition by reducing the amount of memory information encoded about the CIs (consistent with a study-based impoverished relational encoding account; e.g., Arndt & Reder, 2003). Relative to reading, in contrast, item-specific encoding consistently reduced false recognition by increasing memory monitoring at test (consistent with a test-based distinctiveness heuristic account; e.g., Schacter et al., 1999). Relational encoding also elevated memory monitoring at test relative to reading; however, it typically failed to reduce false recognition, except as discussed in Experiment 2.

Our inclusion of a read condition in each experiment (cf. McCabe et al., 2004) revealed that item-specific encoding decreased the DRM illusion, whereas relational encoding was usually equal to reading. Furthermore, the read condition allowed us to assess the locus of the item-specific reduction in false recognition. McCabe et al.'s within condition results led them to conclude that the item-specific reduction was due to encoding-based factors. Our signal-detection analyses confirmed this locus but also demonstrated increased monitoring at test after both types of encoding. Moreover, relative to reading, the item-specific reduction was due to increased monitoring at test, consistent with a distinctiveness-heuristic account (e.g., Dodson & Schacter, 2001, 2002; Schacter et al., 2001). It is important to note that different effects of item-specific and relational processing were revealed when these two conditions were compared with each other versus with the read condition (see Hunt et al., 2011, for a similar point). The use of both comparisons thus revealed effects that might have otherwise been missed.

Although the DRM illusion was consistently greater after relational encoding than item-specific encoding, it never exceeded the level in our read group. This outcome is curious, given that our relational encoding instructions/tasks were designed to lead participants to process the list themes and hence to induce the more-is-less pattern (Toglia et al., 1999). Why relational encoding did not "backfire" remains to be determined. One possibility is that the read groups naturally engaged in substantial relational processing even when not given explicit instruction to do so, particularly once they became aware that list items were related. The idea that relational encoding of related list items occurs spontaneously is not new (Einstein & Hunt, 1980; Hunt & Einstein, 1981). Therefore, both the read and relational groups may have performed equivalent relational processing (assuming neither engaged in much item-specific processing), resulting in similar rates of false recognition.

A second possibility is that relational encoding led to more encoding of the CIs at study than reading but was countered by more (or by more effective) memory monitoring at test. Consistent with this possibility, in Experiment 1, we found an increase in both encoded memory information and strategic monitoring for CIs at test in the relational group relative to the read group. However, in Experiments 2 and 3, monitoring was elevated following relational encoding, but encoded memory information for CIs was equal to the read group. A pooled analysis of Experiments 2 and 3 confirmed that relational encoding ($M = 1.68$) did not lead to more encoding of memory information about the CIs than reading ($M = 1.49$), $t(114) = 1.47$, $SEM = 0.06$, $p = .15$, $p_{\mathrm{BIC}} = .74$. Given that generation and pleasantness tasks typically recruit item-specific processing (Gunter et al., 2007; Hunt et al., 2011), our relational versions of these encoding tasks likely required some item-specific processing that worked against finding a more-is-less pattern.

Our study highlights the utility of a signal-detection approach for measuring two key loci that can mitigate the DRM illusion. In our experiments, item-specific encoding reduced memory information encoded for the CIs relative to relational encoding, and it also increased monitoring at test relative to relative to reading. Using a procedure to eliminate monitoring for a subset of items at test, Hanczakowski and Mazzoni (2011) also recently found that both encoding and retrieval processes can reduce the DRM illusion. Other methods, such as use of within-subject designs or inclusion instructions, can only reveal one or the other locus and thus may contribute conflicting results (e.g., Arndt & Reder, 2003; Hege & Dodson, 2004; Hunt et al., 2011; Schacter et al., 2001). In contrast, our signal-detection approach revealed that impoverished relational encoding and increased memory monitoring can operate in tandem to reduce the DRM illusion.

Our signal-detection approach is not beyond reproach. For example, using lambda to measure monitoring at test provides a quantitative measure of the use of a qualitative distinctiveness-heuristic strategy, which may seem incongruous. Thus, our signal-detection approach, as with within-subject designs and inclusion tests, can only test whether monitoring is globally greater in one condition than in another, rather than evincing qualitatively difference bases for recognition decisions. However, it is also possible that participants convert qualitative aspects of their recognition experiences into a quantitative index against which they set their response criterion, as others have argued for how recollection (qualitative information) and familiarity (quantitative information) are combined in recognition memory models (e.g., Clark & Gronlund, 1996; Verde & Rotello, 2007; Wixted & Stretch, 2000). This is an issue worthy of research attention.

An advantage of our lambda measure over traditional response bias measures (e.g., *c* parametric measure) is that it is not affected by the position of the target distribution because its computation does not include a hit rate. This is important in our experiments because our processing manipulations were designed to change the location of the target distributions, which in turn would influence traditional bias measures. Thus, lambda measures the amount of evidence that is required by participants to accept a test item as studied without being influenced by changes to the position of the target distribution. However, as our reviewers noted, although we have claimed that changes in lambda reflect criterion changes, they could instead reflect changes to the position of the lure distribution across conditions. We grant this possibility, but functionally, the same outcome is realized whether item-specific processing leads to more monitoring (criterion shift) or more effective monitoring (if the new distribution is weaker)—namely, reduced false recognition.

Experiments 2 and 3 highlighted quite different effects of item-specific versus relational variants of two standard encoding tasks. Traditionally, pleasantness and generation have been deemed item-specific tasks (see Gunter et al., 2007; Hunt & Einstein, 1981); however, we demonstrated that the processing recruited by these tasks ultimately depends on how they are structured. To our knowledge, only one pair of studies has compared something akin to item-specific and relational encoding versions of the same study task in the DRM paradigm (Foley, Hughes, Librot, & Paysnick, 2009; Foley, Wozniak, & Gillum, 2006). Participants in Foley et al.'s experiments either created mental images of individual DRM list items (item-specific imagery) or integrated images of sets of four list items (relational imagery) at study. Relative to control groups tested in separate experiments, groups using item-specific imagery showed reduced false recognition, consistent with our findings. Relational imagery also appeared to reduce false recognition, though to a lesser degree (as in our Experiment 2). We suggest that their relational imagery task may have recruited item-specific processing given the instruction in the integrated imagery condition to "describe something that might be done with the objects in the image" (Foley et al., 2006, p. 1130). Thus, item-specific processing may have contributed to the reduction in false recognition they obtained using integrated imagery.

Given the preceding discussion, it should be obvious that we are not proposing that either our item-specific or relational task variants were "process pure." Instead, we attempted to bias the processing within our pleasantness and generation tasks toward one or the other kind of processing. Unfortunately, independent measures of item-specific and relational processing (see Burns, 2006, for a review), such as assessing item gains and losses over cumulative recall tests (Burns, Jenkins, & Dean, 2007; Burns & Schoff, 1998) or performing adjusted-ratio-of-clustering analyses (Hunt & Einstein, 1981; Roenker, Thompson, & Brown, 1971) are restricted to recall tasks. But fortunately, the biased versions of our tasks largely replicated Experiment 1, which had a direct instructional manipulation, thus providing converging evidence for our claim that we indeed manipulated item-specific versus relational processing in Experiments 2 and 3.

To date, different effects of item-specific versus relational encoding have only been shown using encoding tasks that typically promote item-specific processing (e.g., imagery, generation, and pleasantness). Future research could examine whether the same patterns also occur in tasks that are traditionally deemed to induce relational processing (e.g., category sorting, narrative construction). Further, deep LOP tasks (e.g., Rhodes & Anastasi, 2000; Toglia et al., 1999) and perhaps even survival processing (Nairne et al., 2007; Otgaar & Smeets, 2010) may increase the DRM illusion by promoting relational processing. In other words, deep LOP and survival processing may have been conflated with relational processing in prior studies. In contrast, shallow LOP tasks, such as letter counting, likely require item-specific processing and thus may work to reduce false recognition (Tussing & Greene, 1997). Deep and shallow LOP tasks could likely be modified to induce either item-specific or relational processing and may produce modulations of the DRM illusion similar to what we have shown here.

In conclusion, we suggest that using signal-detection analyses and more than one comparison condition provide useful tools for interpreting changes in correct and false recognition. Using these approaches, we demonstrated that (a) item-specific processing can reduce false recognition by reducing memory information encoded about CIs or by increasing memory monitoring at test, and (b) memory monitoring at test can reduce the DRM illusion but only if substantial relational encoding has not already taken place.

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New Editors Appointed, 2015–2020

The Publications and Communications Board of the American Psychological Association announces the appointment of 6 new editors for 6-year terms beginning in 2015. As of January 1, 2014, manuscripts should be directed as follows:

- *Behavioral Neuroscience* (http://www.apa.org/pubs/journals/bne/), **Rebecca Burwell, PhD,** Brown University
- *Journal of Applied Psychology* (http://www.apa.org/pubs/journals/apl/), **Gilad Chen, PhD**, University of Maryland
- *Journal of Educational Psychology* (http://www.apa.org/pubs/journals/edu/), **Steve Graham, EdD,** Arizona State University
- *JPSP: Interpersonal Relations and Group Processes* (http://www.apa.org/pubs/journals/psp/), **Kerry Kawakami, PhD,** York University, Toronto, Ontario, Canada
- *Psychological Bulletin* (http://www.apa.org/pubs/journals/bul/), **Dolores Albarracin, PhD,** University of Pennsylvania
- *Psychology of Addictive Behaviors* (http://www.apa.org/pubs/journals/adb/), **Nancy M. Petry, PhD,** University of Connecticut School of Medicine

Electronic manuscript submission: As of January 1, 2014, manuscripts should be submitted electronically to the new editors via the journal's Manuscript Submission Portal (see the website listed above with each journal title).

Current editors Mark Blumberg, PhD, Steve Kozlowski, PhD, Arthur Graesser, PhD, Jeffry Simpson, PhD, Stephen Hinshaw, PhD, and Stephen Maisto, PhD, will receive and consider new manuscripts through December 31, 2013.