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A Transfer-Appropriate Processing Account of Context Effects in Word-Fragment Completion

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The claim that priming on implicit memory tasks such as word-fragment completion is sensitive to context effects was tested by using homographs (e.g., *board*) to manipulate context. On the basis of previous findings, it was assumed that presentation of only the perceptual cue at test (*_oa_d*) should activate the dominant meaning, thereby creating the same context for homographs encoded for their dominant encoding and a different context for homographs encoded for their nondominant meaning. As expected, little or no effect of varying context was observed on a perceptual implicit task (Experiments 1–2B). When explicit retrieval instructions were given in Experiment 3, same-context encoding led to greater recall of homographs from word-fragment cues relative to different-context encoding. These results are consistent with the predictions of the transfer-appropriate-processing view because little advantage for the same-context condition was obtained in implicit tests in the absence of conceptual cues.

Dissociations between explicit and implicit memory tests are now ubiquitously documented in memory research. Explicit memory tasks are those in which instructions are given to subjects to retrieve the items from the study episode. Standard examples of some explicit tasks are free recall, cued recall, and recognition. In implicit memory tasks, subjects are simply asked to complete the task with the first solution that comes to mind, to identify speeded presentations of stimuli, or to respond as quickly as possible. For example, in an implicit memory task such as word-fragment completion, subjects complete fragments of studied and nonstudied items (*s _ ea_ _r*) with the first solution that comes to mind (*sweater*). Effects of prior study are calculated in these tasks by subtracting the proportion of correct completions for the nonstudied (baseline) fragments from that for the studied fragments, and this measure of implicit memory is referred to as *priming*.

A comparison of explicit and implicit memory tasks has held the interest of memory investigators because a number of independent variables have dissociative effects on these two types of memory tests (see Roediger & McDermott, 1993, for a review). For example, explicit tasks such as free recall and recognition greatly benefit from conceptual elaboration of material compared with encoding that focuses on perceptual features in the standard levels-of-processing manipulation (e.g., Craik & Tulving, 1975). In contrast, in implicit tasks such as speeded word identification, word-stem completion, and word-fragment completion, this conceptual advantage is not obtained; priming on these implicit tests is usually equally facilitated following conceptual or perceptual encoding of the target word (e.g., Graf & Mandler, 1984; Jacoby & Dallas, 1981; Roediger, Weldon, Stadler, & Riegler, 1992).

The transfer-appropriate-processing account provides a comprehensive analysis of such dissociations between explicit and implicit memory tasks in memory-intact subjects (Roediger, 1990; Roediger, Weldon, & Challis, 1989). This framework postulates the following principles to explain the dissociative effects of independent variables on explicit and implicit memory tasks. First, memory performance is assumed to benefit to the extent that processes used during study are captured by the task used at test. Second, standard explicit and implicit tasks typically require different retrieval operations at test and, therefore, are sensitive to different types of encoding. Specifically, most explicit memory tasks use conceptual processes, whereas most implicit memory tasks depend on perceptual processes. This assumption predicts facilitatory effects of semantic elaboration at encoding in standard explicit tasks and an absence of such effects in standard (data-driven) implicit memory tasks. Accordingly, the extant data show that performance on explicit tasks is enhanced by study manipulations that involve elaborative encoding (Craik & Lockhart, 1972), imagery (Paivio, 1986), and generation of targets (Jacoby, 1978; Slamecka & Graf, 1978), whereas implicit tasks such as word-fragment completion appear to be relatively insensi-

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tive to semantic elaboration at encoding (Blaxton, 1989; Jacoby, 1983; Jacoby & Dallas, 1981; Srinivas & Roediger, 1990). Instead, in these implicit tasks, changes in perceptual features across study and test have adverse effects on performance. For instance, a change in the modality from auditory to visual presentation reduces the magnitude of priming (Blaxton, 1989; Graf & Mandler, 1984; Jacoby & Dallas, 1981; Rajaram & Roediger, 1993; Srinivas & Roediger, 1990), as does a change in the domain from pictures to words (Weldon & Roediger, 1987). Such specificity effects have also been documented when subjects solve fragments at study (*e_e_h_n_* for *elephant*) and are then presented with the same (*e_e_h_n_*) or a different (*e_ep_ _n_*) fragment at test (Gardiner, Dawson, & Sutton, 1989; see also Srinivas, 1993). In such cases, enhanced priming is obtained in the former condition when the fragments match between study and test occasions.

On the basis of these findings, it has been argued that tasks such as word-fragment completion require a perceptual match between study and test for successful performance, whereas conceptual elaboration leaves performance unaffected (Roediger & Srinivas, 1993; see also Tulving & Schacter, 1990). According to the transfer-appropriate-processing framework, although explicit tasks in general are conceptually driven and implicit tasks in general are data driven or perceptual in nature, there is no necessary correlation between the task instructions (explicit and implicit) and the underlying processes (conceptual and perceptual) (Blaxton, 1989; Roediger & Blaxton, 1987). In other words, although task instructions per se may foster a particular type of processing—that is, explicit retrieval strategies are typically conceptually based—explicit tasks with perceptual cues (and instructions to retrieve perceptually related items) would benefit from prior perceptual encoding, and implicit tasks with conceptual cues would benefit from prior conceptual encoding. Indeed, dissociations within explicit tasks and within implicit tasks as a function of the match and mismatch of processing requirements have been demonstrated (Blaxton, 1989; Hamann, 1990; Rappold & Hashtroudi, 1991; Srinivas & Roediger, 1990; Weldon & Roediger, 1987; see Roediger, Srinivas, & Weldon, 1989, for a review).

Thus, a great deal of evidence supports these basic tenets of the processing account: Effects of semantic encoding have been demonstrated with explicit and implicit tasks that are a priori designated as conceptually driven tasks, and effects of perceptual changes have been demonstrated on explicit and implicit tasks that are a priori designated as data-driven tasks (see Roediger & McDermott, 1993; Roediger, Srinivas, & Weldon, 1989; Roediger, Weldon, & Challis, 1989, for reviews.) With regard to the perceptual implicit tests, similar predictions are made by a systems approach to memory (e.g., Schacter, 1990; Tulving, 1983; Tulving & Schacter, 1990). Here, performance on perceptual implicit memory tests, such as word-fragment and word-stem completion, is assumed to be mediated by the perceptual representation system (PRS), which is unaffected by conceptual manipulations (see Tulving & Schacter, 1990). Thus, the influence of the PRS on performance in the systems theory is similar to that of data-driven processes in the transfer-appropriate-processing theory.

Some recent findings, however, have reported effects of conceptual manipulations on implicit memory tests that are primarily believed to be perceptual tests. We focus here on certain context effects reported on perceptual implicit memory tests (Bainbridge, Lewandowsky, & Kirsner, 1993; Lewandowsky, Bainbridge, & Kirsner, 1989) because these findings are most pertinent to the experiments reported in this article. The basic logic behind the experiments reported in these earlier articles is as follows: If perceptual implicit tests are insensitive to conceptual manipulations, then a change in conceptual context across study and test should not impair priming in these tasks relative to a condition in which the conceptual context is preserved across study and test.

In this paradigm, effects of the same versus a different context on priming for pre-existing semantic and lexical information were examined using homographs. Lewandowsky and his colleagues (Bainbridge et al., 1993; Lewandowsky et al., 1989) reported context-specificity effects in certain implicit memory tests by manipulating different meanings of homographs. In these studies, the format of presentation across study and test involved sentence structures. Specifically, subjects were presented with *The teller worked at the . . . bank* (same context), *The robber held up the . . . bank* (similar context), or *The fisherman slid off the . . . bank* (different context), and a lexical decision was required for the last word, *bank*. During the second presentation, subjects again made lexical decisions for the word *bank*, which was presented in the sentence *The teller worked at the . . . bank*. Beneficial effects of repetition were obtained for homographs presented in same- or similar-context conditions compared with the different-context condition, and Lewandowsky et al. (1989) subsequently replicated these effects in an implicit word-stem-completion task.

Lewandowsky et al. (1989) argued that these context effects in implicit tasks are problematic for the transfer-appropriate-processing account of implicit memory tests. According to the transfer-appropriate-processing framework, implicit measures such as lexical decision (or word-stem completion) should show equivalent priming for words such as *bank* regardless of the meaning that is activated between study and test. Because these tests are assumed to be sensitive to a match in the perceptual features of the item between study and test, and because this match occurs equally well for items presented in the same context or in a different context, changes in the meaning of the activated item would be expected to have no effects on priming on these tests. Lewandowsky et al. therefore argued that implicit measures tap sense-specific representations of words that are not purely perceptual representations of word shape; rather, they include specification of word meaning as well (see also Bainbridge et al., 1993). In this article, we refer to this view as the sense-specific view of perceptual priming.

A potential problem for this sense-specific view, however, is that it is based on implicit tests that do not consist purely of visually degraded cues, as is required for a perceptual implicit test (see Roediger, Weldon, & Challis, 1989). For example, in the study by Lewandowsky et al. (1989), the cue at test in the word-stem completion task consisted not only of the stem ban __, but also of a cue word that biased the same or different meaning of the homograph. (Such conceptual cues were also provided in the lexical-decision task as described earlier.) This use of conceptual cues (i.e., the word cues that biased the meaning of the homograph) was necessitated by the design of the experiments, because these investigators attempted to vary or hold constant the context across study and test. However, we believe that the stem-completion and the lexical-decision tasks used in these experiments were modified from the traditional form of the test so as to be influenced by conceptual processes. The addition of the sentence frame (or a single word) used to bias the conceptual interpretation of the target added a conceptually driven component to the lexical-decision and stem-completion tests.

In specifying the processes engendered by a task, Roediger, Weldon, & Challis (1989) clearly stated that "reading a word without an appropriate semantic context involves data-driven processing, whereas generating a word from an associate or synonym involves conceptually driven processing" (p. 24). Furthermore, they added that "reading a word in context (hot–COLD) . . . presumably involves both data-driven and conceptually driven processing" (p. 24). Roediger et al. also specified that in data-driven processing, "procedures are directed more at surface features of stimuli during study *and test* [italics added]" and in conceptual processing "at the deeper meaning of the stimuli" (p. 23). These clearly stated assumptions indicate that an implicit test ceases to be strictly perceptual when a conceptual context is added to the retrieval cues at test. Essentially, when the retrieval cues include conceptually related information, or when the retrieval instructions (as in explicit tests) engender conceptual processing, the retrieval task can no longer be considered a strictly perceptual task.

The critical issue then is whether contextual effects can arise on perceptual (data-driven) tests. Therefore, we sought to design an experiment in which effects of encoding different interpretations of homographs could be tested in an implicit task that consisted only of perceptual cues presented in isolation. In other words, our aim was to examine the effects of different encoding contexts on perceptual implicit memory by using a task that was uncontaminated by the influence of conceptual cues.

The encoding instructions used in our experiments were similar to those used by Lewandowsky et al. (1989). Subjects were presented with a phrase and a homograph, and their task was to determine on a 5-point scale how meaningfully related the phrase and the word were. In our experiments, the encoding context was manipulated such that half of the studied homographs were preceded by phrases that biased the dominant meaning of the homograph, and the remaining half of the studied homographs were preceded by phrases that biased the nondominant meaning. At test, only the fragmented versions of the homographs (and no additional cues) were presented to the subjects with the instructions to complete the fragments with the first solution that came to mind. At study, some of the fragmented homographs were encoded for their dominant meaning, others for their nondominant meaning, and some had not been presented during the study phase (i.e., nonstudied items). The perceptual implicit task used in our experiments—the word-fragment completion task—is very similar in nature to the word-stem completion task, as previously demonstrated in a series of experiments (Rajoram & Roediger, 1993; Roediger et al., 1992). Specifically, manipulation of levels of processing, modality, and symbolic form (pictures vs. words) has the same effects on both word-fragment-completion and word-stem-completion tasks in memory-intact subjects. By presenting only the fragment of the critical targets (the studied and nonstudied homographs), we eliminated any conceptual cues at test that might have contaminated the perceptual nature of our implicit memory task.

With this design, we were able to examine the effects of maintaining the same context or changing the context between study and test because of certain special properties of lexical access of homographic words. Specifically, it has been shown across different paradigms that in the absence of a biasing context, the dominant meaning of a homograph is activated more quickly than the nondominant meaning (Forster & Bednall, 1976; Simpson & Krueger, 1991), and this meaning stays activated for a long period of time in lexical-decision tasks (e.g., Pacht & Rayner, 1993; Simpson, 1981; Simpson & Burgess, 1985; Simpson & Krueger, 1991; Yates, 1978).

Furthermore, the bulk of evidence also suggests that even when instructions direct subjects to activate the nondominant meaning of a homograph during the first encounter, subjects show a strong tendency toward accessing the dominant meaning during the second encounter with the homograph. For example, Winograd and Geis (1974) presented subjects with a list of homographs twice and required them to write down the first word that came to mind in response to each homograph. Winograd and Geis found that subjects were more likely to repeat the production of the dominant meaning across the two attempts. Furthermore, they also found that for polarized homographs (where one meaning is dominant and the other is nondominant, as was the case in our study), the probability of producing the nondominant meaning on the second attempt given that the dominant meaning was produced on the first attempt was much lower than the probability of producing the dominant meaning on the second attempt given that the nondominant meaning was produced on the first attempt. These results indicate that subjects are more likely to access the dominant meaning on the second attempt even if the homograph was earlier encoded for its nondominant meaning.

Similar findings in favor of activation of dominant meaning despite earlier activation of the nondominant meaning were reported by Gee (1997) in a cued-recall task. In fact, on the basis of the findings from three experiments, Gee concluded that "in the absence of modifying context, the most frequent (dominant) meaning of the homograph is accessed" (p. 31). Finally, using an eye-monitoring paradigm, Rayner, Pacht, and Duffy (1994) found that access to the nondominant meaning in the second encounter is not facilitated even after selective access to the nondominant meaning in the first encounter, suggesting that access to the dominant meaning of a homograph takes precedence over any effects of encoding of alternate interpretations (similarly see Simpson & Adamopoulos, 1996; but also Simpson & Kang, 1994).

On the basis of the findings from these studies that used a number of different paradigms, the present argument then is that access to the lexical item *bank* from the fragmented *b_n_* at test would be biased toward the dominant interpretation rather than the nondominant interpretation. This would be the case even when subjects earlier encoded the homograph for its nondominant meaning (on the basis of the findings from Gee, 1997; Rayner et al., 1994; and Winograd & Geis, 1974). If encoded context is assumed to influence perceptual tasks such as word-fragment completion, as suggested by Lewandowsky et al. (1989), then priming for homographs encoded in their dominant interpretation should exceed priming for homographs encoded in their nondominant interpretation, because in the dominant encoding condition, the sense of the word that is activated at encoding matches the sense assumed to be activated at test.

Conversely, according to Roediger, Weldon, & Challis's (1989) transfer-appropriate-processing account, there should be no effects of encoded context on perceptual implicit tasks, provided that they do not also include conceptual cues at test. Regardless of the meaning that was processed at encoding, the perceptual word form represented by the test item should be identical to that of the studied word, and in the absence of any conceptual cues, priming should be a function of the available perceptual features. Thus, according to the transfer-appropriate-processing framework, priming for homographs encoded in their dominant interpretation should be equivalent to priming for homographs encoded in their nondominant interpretation on a standard test of implicit word-fragment completion. We tested these predictions in Experiments 1–2B.

Experiment 1

Method

Subjects. Forty-two Rice University undergraduates participated in this experiment in partial fulfillment of a course requirement.

Design and materials. Type of encoding was manipulated in a within-subject design at three levels: dominant study context, nondominant study context, and nonstudied. The last condition served as the baseline against which priming for the two study conditions was measured. The dependent measure was the proportion of correctly completed fragments in the three conditions.

We selected 60 homographs from norms collected by Nelson, McEvoy, Walling, and Wheeler (1980). The dominant meaning selected for these 60 homographs was produced in these norms with an average frequency of 35.0, and the nondominant meaning was produced with an average frequency of 6.4. Frequency here refers to the number of subjects who provided responses with those particular meanings of the homographs. These average frequency values for dominant and nondominant meanings of the selected homographs were reliably different, $t(59) = 26.46$, $SE = 1.08$, $p < .05$. Three lists were constructed such that each list contained 20 randomly selected homographs from the pool of 60 homographs just described. During study, 20 homographs were presented with either a word or a phrase constructed to bias the dominant meanings of the homographs, 20 homographs were presented with a word or a phrase constructed to bias the nondominant meanings of the homographs, and the remaining 20 homographs served as nonstudied items to be included only in the test phase (see the Appendix for the materials). These three sets of homographs were rotated across subjects for purposes of counterbalancing, such that each homograph appeared in each of the three conditions just described.

Each study list consisted of 20 homographs and their dominant interpretations (e.g., *card game: poker*), 20 homographs and their nondominant interpretations (e.g., *metal rod for kindling fire: poker*), and an additional 40 filler words accompanied by phrases (e.g., *an article of clothing: sweater*) to cover the true purpose of the encoding manipulation. In front of each phrase–word pair, a scale with values from 1 to 5 was printed for rating the relatedness of each phrase with the target word. The test list consisted of 100 fragments of which 40 fragments were constructed from the studied homographs, 20 fragments were constructed from the nonstudied homographs, and an additional 40 fragments were constructed from words that served as filler items that were not presented previously in the study list. Of the 40 filler fragments, 10 appeared at the beginning of the test list to serve as buffer fragments. Thus, with the inclusion of the filler fragments, the proportion of studied fragments to nonstudied fragments was 2:3. The test list was constructed in this manner to discourage explicit recollection while subjects solved fragments (see Roediger & McDermott, 1993).

Both the study and test lists were printed on booklets so that subjects could expose one item at a time. The arrangement of study and test items within the respective booklets was random with respect to the conditions. Two tapes were used for timing the exposure of the items during study and test; on the tapes a beep occurred at regular intervals to pace subjects through the study and test lists.

Procedure. Subjects were tested in small groups of 2 to 5. At study, subjects were given a blank cover sheet and were asked to expose one item at a time. Subjects were instructed to indicate how well the phrase and the word related in meaning on a scale from 1 (*pairs not related*) to 5 (*pairs highly related*). Each pair was exposed for 5 s. In the following 5-min retention interval, subjects were asked to write down the names of the U.S. presidents. Before the beginning of the test phase, subjects were instructed to complete the fragments with the first solution that came to mind. They were told that only a limited amount of time would be given to them, and therefore it was important to complete the fragments as soon as they could think of a solution. If subjects completed a fragment quickly, they were asked to wait until the beep prompted them to move to the next fragment. The experimenter monitored the performance of the subjects to ensure that subjects did not work on any previous fragments that had not been completed. Each fragment was exposed for 15 s, and if the subjects were unable to come up with a solution within the allotted time, they were asked to move to the next fragment in the booklet. After the completion of the experiment, subjects were debriefed. The entire experiment lasted approximately 50 min.

Results and Discussion

Figure 1 presents the mean proportions of fragments correctly completed in the three conditions of this experiment. Error bars in the figure represent 95% confidence intervals based on the within-subject mean square error (Loftus & Masson, 1994). Priming scores were calculated by

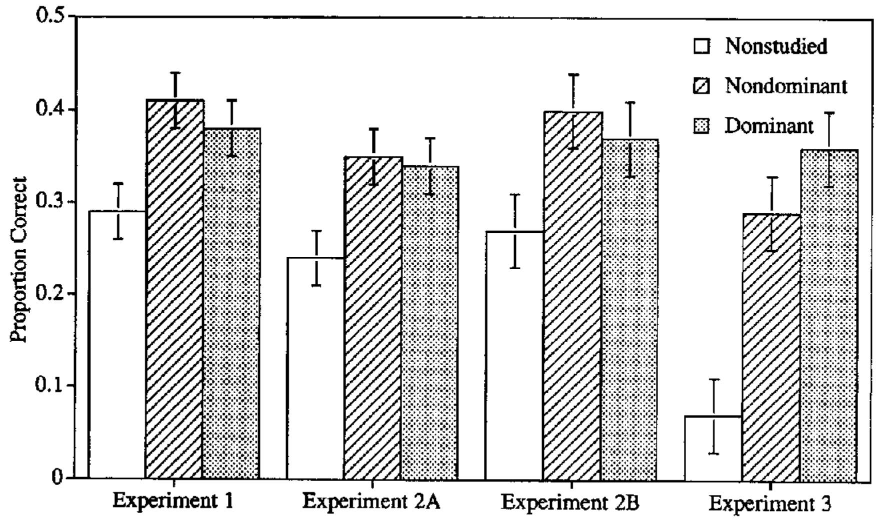

Figure 1. Mean fragment-completion rates in the dominant encoding, nondominant encoding, and nonstudied conditions in Experiments 1, 2A, 2B, and 3. Error bars represent 95% confidence intervals based on the within-subject mean square error.

subtracting the completion rates in the nonstudied condition from those in the studied conditions. The alpha level for this and the following experiments was set at $p < .05$ unless noted otherwise.

A one-way repeated measures analysis of variance (ANOVA) revealed that the fragment-completion rates differed significantly across the three studied conditions, $F(2, 82) = 18.50$, $MSE = 0.01$. Paired comparison t tests revealed significant priming for homographs studied in the dominant study context (a 9% effect), $t(41) = 3.68$, $SE = 0.02$, and for homographs studied in the nondominant study context (a 12% effect), $t(41) = 5.98$, $SE = 0.02$. Thus, priming was observed for homographs studied in both conceptual contexts. The critical comparison for our purposes was the difference, if any, in the priming scores for the dominant and the nondominant study contexts. There was a 3% difference in favor of the nondominant study context that just met the significance level, $t(41) = 2.05$, $SE = 0.02$, $p = .05$.

As expected, perceptual priming was obtained for studied homographs regardless of the context used at encoding. The findings from this experiment contradicted the predictions from Lewandowsky et al.'s (1989) sense-specific theory of priming, namely that retrieval of studied homographs on a standard implicit task is influenced by conceptual similarity between study and test context. Because the fragmented homographs were presented in the absence of any conceptual cues at test, we argued that the dominant interpretation of the homograph would be automatically accessed at test and would therefore benefit most from encoding the same dominant interpretation at study, if the sense-specific view is correct. Our results failed to support this prediction; if anything, we obtained a small advantage for homographs encoded in their nondominant interpretation at study. This latter result was also inconsistent with the transfer-appropriate-processing view, which predicts no difference between the encoding contexts. However, because the reversed context effect was small, we sought to replicate these findings in the next experiment.

Experiments 2A and 2B

The aim of Experiments 2A and 2B was to replicate the unexpected reversed context effect obtained in Experiment 1. These experiments were a direct replication of Experiment 1 with the following change: Experiments 2A and 2B were conducted on IBM-compatible PCs to allow the recording of response latency at test. Response latency was included as a dependent variable to obtain a converging measure of the context effect. Furthermore, because subjects in Experiment 1 had 15 s to complete the fragmented items, the potential for the use of explicit strategies was increased. We therefore recorded both accuracy and latency to discourage subjects from using such strategies. Experiments 2A and 2B were identical in all respects, except that they used a different group of participants to ensure that the predicted null effect of context was replicable.

Method

Subjects. Forty-eight undergraduates from the State University of New York (SUNY) at Stony Brook took part in Experiment 2A, and 30 SUNY at Stony Brook undergraduates participated in Experiment 2B, in partial fulfillment of a course requirement.

Design and materials. The design and materials used in these experiments were identical to those used in Experiment 1.

Procedure. The procedure used in these experiments was similar to that of Experiment 1 except for changes necessitated by computerizing the experiment. Up to 3 subjects were tested at a time. The presentation of the study pairs (5 s each) and the test fragments (a maximum of 15 s each) was controlled by a program written in Micro-Experimental Laboratory (MEL; Schneider, 1990). At study, each pair was preceded by a warning signal for 1 s.

Subjects were instructed to rate the pairs for relatedness as before. At test, each fragment was displayed for a maximum of 15 s, and the subjects were instructed to press the key labeled *Y* as soon as the first solution came to mind. This keypress recorded the time in ms taken for that fragment and also removed the fragment from the screen. The computer prompted the subjects to type in the solution. The typing time was not recorded. The experimenter monitored the subjects' performance so that they started typing immediately after pressing the *Y* key.

Results and Discussion

Experiment 2A. The mean proportion of correctly completed fragments across the three conditions of this experiment are presented in Figure 1. A one-way repeated measures ANOVA revealed that the fragment-completion rates for the accuracy measure differed significantly across the three studied conditions, $F(2, 94) = 15.67$, $MSE = 0.01$. Paired comparison t tests revealed significant priming for homographs studied in the dominant study context (a 10% effect), $t(47) = 4.14$, $SE = 0.02$, and for homographs studied in the nondominant study context (an 11% effect), $t(47) = 4.97$, $SE = 0.02$. Thus, priming was observed for homographs studied in both conceptual contexts. Given the findings from Experiment 1, the critical comparison once again was the difference, if any, in the priming scores for the dominant and the nondominant study contexts. In this experiment, there was a nonsignificant 1% difference in favor the nondominant study context, $t(47) = 0.59$. $SE = 0.02$.

For the latency data, a one-way repeated measures ANOVA revealed significant differences in the RTs for the three conditions: dominant study context = 4,084 ms (priming = 576 ms), nondominant study context = 3,980 ms (priming = 680 ms), and nonstudied = 4,660 ms, $F(2, 94) = 3.47$, $MSE = 1{,}856{,}505$. Paired comparison t tests revealed significant differences in RTs between the dominant and nonstudied conditions, $t(47) = 2.03$, $SE = 284.21$, and between the nondominant and nonstudied conditions, $t(47) = 2.11$, $SE = 322.75$. However, the difference between the RTs in the dominant and nondominant conditions (104 ms) was not significant, $t(47) = 0.48$, $SE = 216.95$.

As expected, significant priming measures demonstrated the benefits of study for both dominant and nondominant study items. However, the statistically significant, although small, reversal in the context effect observed in the accuracy measure in Experiment 1 was not replicated in Experiment 2A, either for accuracy or for latency measures. Because we obtained a small reversal in the context effect (3%) in Experiment 1 and essentially none (1%) in Experiment 2A, in Experiment 2B we sought to gain further evidence about whether the small reversed effect in Experiment 1 is reliable.

Experiment 2B. The mean proportions of correctly completed fragments across the three conditions of this experiment are presented in Figure 1. For the accuracy measure, a one-way repeated measures ANOVA demonstrated that the fragment-completion rates were significantly different across the three conditions, $F(2, 58) = 12.93$, $MSE = 0.01$. Paired comparison t tests demonstrated significant priming for the homographs studied in the dominant study context (a 10% effect), $t(29) = 4.06$, $SE = 0.02$, and for homographs studied in the nondominant study context (a 13% effect), $t(29) = 4.52$, $SE = 0.03$. Given that a small context effect was obtained in Experiment 1 and none was obtained in Experiment 2A, the critical comparison once again was the difference, if any, in the priming scores for the dominant and the nondominant study contexts. In this experiment, a 3% difference in favor of the nondominant study context was obtained, but this difference was not significant, $t(29) = 0.98$. $SE = 0.03$.

For the latency data, a one-way repeated measures ANOVA revealed marginally significant differences in the RTs for the three conditions: dominant study context = 3,403 ms (priming = 2,320 ms), nondominant study context = 3,516 ms (priming = 2,207 ms), and nonstudied = 5,723 ms, $F(2, 58) = 2.79$, $MSE = 18{,}426{,}234$, $p = .07$. Paired comparison t tests also revealed marginally significant differences in RTs between the dominant and the nonstudied conditions, $t(29) = 1.77$, $SE = 1{,}313.32$, $p = .09$, and between the nondominant and the nonstudied conditions, $t(29) = 1.62$, $SE = 1{,}362.04$, $p = .11$. It should also be noted that the difference between the RTs in the dominant and nondominant conditions (113 ms) was in the *opposite* direction from the pattern obtained in the accuracy data in the present experiment and the RT data in Experiment 2A, and that it was not significant, $t(29) = 0.35$, $SE = 317.52$. Not only were the nonsignificant context effects in RTs in different directions across Experiments 2A and 2B, the magnitude of priming was also considerably higher in Experiment 2B (in the 2,000-ms range) than in Experiment 2A (in the 600-ms range). In general, the RT data varied across the two experiments.

Taken together, the results from Experiments 1–2B show that context effects are difficult to obtain in implicit tasks that are largely perceptual in nature. We did obtain a small context effect in Experiment 1, but it was in the opposite direction from the pattern predicted by the sense-specific view. Furthermore, we failed to replicate this reversed pattern in two subsequent experiments. Because Experiments 2A and 2B were virtually identical in design and procedure (except for the subjects participating in the experiments), as well as in the pattern of results, we analyzed the accuracy data from these experiments together to determine whether the reversed context effect would surface with a larger subject pool ($N = 78$). A one-way repeated measures ANOVA demonstrated that the fragment-completion rates were significantly different across the three conditions, $F(2, 154) = 28.67$, $MSE = 0.01$. Paired comparison t tests demonstrated that compared with the nonstudied fragments (.25), fragment completion was higher for the homographs studied in the dominant study context (.35), $t(77) = 5.73$, $SE = 0.02$, as well as for the homographs studied in the nondominant study context (.37), $t(77) = 6.73$, $SE = 0.02$. The critical comparison once again was the difference, if any, in the priming scores for the dominant and the nondominant study contexts. In this pooled analysis of Experiments 2A and 2B, the 2% difference in favor of the nondominant study context was not significant, $t(77) = 1.09$, $SE = 0.02$. As noted before, the sense-specific view of priming (Lewandowsky et al., 1989) predicts a context effect in priming in favor of dominant encoding compared with nondominant encoding of homographs, but we consistently failed to find this pattern both in accuracy and in RTs across three experiments. Furthermore, to the extent that there was any trend in accuracy data for priming, albeit weak, it was in the opposite direction from the predicted pattern. We return to this issue in the General Discussion.

It is interesting that Masson and MacLeod (1992, Experiment 5) have reported findings from another perceptual implicit memory test that agree with the results of our Experiments 1–2B, even though there are a number of procedural differences between their experiment and ours. In their experiment, subjects encoded either the dominant or the nondominant meanings of homographs by completing fragmented versions of homographs that were presented in biasing sentence contexts at study (e.g., *cough syrup is hard to s_ _ll_w*; *the tiny bird was a s_ _ll_w*). In a third study condition, subjects simply read the target homograph (*swallow*) without any context. At test, the studied (and nonstudied) homographs were presented in isolation at rapid rates, and subjects were asked to simply identify the words. Note that the encoding conditions, as well as the specific perceptual test used in this study, differed from ours, but one aspect of their study is notable for present purposes. As in our study, the homographs were presented at test in isolation; therefore, the implicit memory task was predominantly perceptual in nature. Masson and MacLeod found equivalent priming for homographs generated from the dominant context, from the nondominant context, and from reading in this perceptual implicit task. This finding and the results from our Experiments 1–2B do not support the sense-specific view of priming proposed by Lewandowsky and colleagues (Bainbridge et al., 1993; Lewandowsky et al., 1989) for perceptual data-driven tests. Although Masson and MacLeod's results converge with ours, their interpretation of equivalent priming across the three conditions was different from the one we favor.

Specifically, Masson and MacLeod (1992) interpreted the lack of an effect of encoded meaning on their perceptual identification task to indicate that words presented for masked identification do not necessarily access their dominant meanings at test. Rather, they interpreted equivalent priming for dominant and nondominant encoding to indicate successful reactivation of the encoded meaning at test, whether it was dominant or nondominant. Although not identical, this view is more consistent with the sense-specific view (Bainbridge et al., 1993; Lewandowsky et al., 1989) than with the transfer-appropriate-processing view. To reiterate, we interpreted equivalent priming for dominant and nondominant encodings to indicate a lack of any context effects in perceptual implicit memory tests.

Note that the predictions we derived for the sense-specific view regarding contextual effects on perceptual data-driven tests hinge on our assumption that homographs presented in the absence of any context automatically access their dominant interpretation. Previous findings from studies with intact words strongly support this assumption (Forster & Bednall, 1976; Gee, 1997; Pacht & Rayner, 1993; Rayner et al., 1994; Simpson & Burgess, 1985; Simpson & Krueger, 1991). However, our assumption of access to dominant meanings with fragmented homographs requires empirical verification.

Taken together, two issues remain to be examined before we can conclude that predominantly perceptual tasks are insensitive to contextual changes. One, we need to demonstrate that fragmented homographs that are presented in isolation do access the dominant meaning. Two, we need to examine whether the interpretation offered by Masson and MacLeod (1992) or the assumptions of the transfer-appropriate-processing view better account for the equivalent priming in the dominant and nondominant conditions.

A test of dominant-meaning access by fragments was carried out by presenting word fragments in Experiment 4 with instructions that would add conceptual processing. Specifically, we asked participants to use the fragments of homographs to consciously retrieve previously studied items. It is now well established that explicit test instructions naturally engender conceptual processing of the items at test, even when the items are perceptually degraded (e.g., Weldon, Roediger, & Challis, 1989). Thus, for example, explicit word-fragment and word-stem recall are affected by conceptual manipulations such as levels of processing, whereas implicit word-fragment and word-stem completion are unaffected by this conceptual manipulation, despite the fact that the same perceptual cues are presented at retrieval on both tests (Roediger et al., 1992). On the basis of these results, we reasoned that in an explicit word-fragment recall test, we should obtain an advantage in the recall of words encoded in their dominant meaning at study, if homographs preferentially access their dominant meaning even when they are presented in a perceptually degraded form.

This manipulation also provided an opportunity to test the two alternate interpretations just described. If the fragmented homographs (presented in isolation) access the dominant meaning as intact homographs do, then an advantage in recall for homographs encoded for their dominant meaning would be obtained. This outcome would support the transfer-appropriate-processing view. However, if fragmented homographs (presented in isolation) reactivate the encoded meaning, then we should once again obtain equivalent recall for homographs encoded for their dominant as well as their nondominant meanings. This outcome would support the interpretation favored by Masson and MacLeod (1992).

Finally, note that a comparison between implicit and explicit word-fragment tests in our experiments has the additional advantage of maintaining the exact same cue on both tasks, while manipulating only the type of processing (perceptual or perceptual plus conceptual) performed by the subjects on the two tasks. Thus, the interpretation of our results across the four experiments can be safely attributed to processing differences rather than to the procedural differences that often occur in across-study comparisons.

Experiment 3

Method

Subjects. A new group of 30 undergraduates from SUNY at Stony Brook took part in this experiment in partial fulfillment of a course requirement.

Design and materials. The same design and materials were used in this experiment as in Experiment 2B, with one difference mentioned in the *Procedure* section.

Procedure. The procedure used in this experiment was similar to that of Experiment 2B with one critical change: At test, subjects were asked to think back to the study list and fill in the fragments only with studied items. They were told not to guess. Therefore, any correct responses to nonstudied items constituted intrusions in this experiment.

Results and Discussion

The mean proportions of correctly recalled fragments across the three conditions of this experiment are presented in Figure 1. The scores shown in Figure 1 are the accuracy data for the recall rates in the nonstudied condition (intrusions) and each of the studied conditions (correct recall). The critical comparison in this experiment was the difference, if any, between correct recall for the dominant and nondominant study contexts. Contrary to the results obtained in Experiments 1–2B, the 7% advantage for the dominant study context compared with the nondominant study context was significant, $t(29) = 4.29$, $SE = 0.02$.

For the latency data, the RTs for the three conditions were as follows: dominant study context = 4,582 ms, nondominant study context = 5,158 ms, and false alarms = 5,821 ms. The 576-ms numerical advantage for the dominant study context over the nondominant study context was not significant, $t(29) = 0.93$, $SE = 470.25$.

As predicted by the transfer-appropriate-processing view, the results from the explicit word-fragment-recall task indicated a significant advantage for homographs encoded with their dominant meaning. This finding supports the hypothesis that in the absence of a biasing context at test, fragmented homographs automatically access the dominant meaning. Because the same meaning was accessed by the dominant encoding at study and the isolated presentation at test, performance in this condition was enhanced by the conceptual processing engendered by the use of explicit retrieval strategies.

The results of this experiment can be contrasted with the results of Experiments 1–2B in which perceptual cues did not yield the predicted context effect. In fact, the interaction between the implicit and explicit instructions and the context effects was found to be statistically reliable for accuracy when we compared the results of Experiments 2B and 3 in a two-way ANOVA treating experiments as a between-subjects variable and same versus different context as a within-subject variable, $F(1, 58) = 10.81$, $MSE = 0.01$. Thus, consistent with earlier reports, our results demonstrate that a change in retrieval instructions can dramatically influence reliance on conceptual processing, even on tasks that are primarily perceptual with implicit instructions (Roediger et al., 1992). Our results also demonstrate that the advantage for the same context over a different context emerges when both perceptual and conceptual processes operate in a task (our Experiment 3) and not when only perceptual processes operate (our Experiments 1–2B).

General Discussion

The aim of this article was to examine whether maintaining the same conceptual context across study and test would affect performance on a perceptual implicit memory task. The sense-specific theory of priming predicts greater priming from a match in conceptual context across study and test compared with a condition in which the conceptual context is mismatched, whereas the transfer-appropriate-processing view predicts no difference. We examined the effects of encoding the dominant or the nondominant interpretations of homographs on a word-fragment-completion task. On the basis of published evidence, we assumed that fragments of homographs presented in an unbiased context at test would tend to access their dominant interpretation, thereby producing a conceptual match across study and test when homographs had been encoded in their dominant interpretation at study.

In Experiments 1–2B, we found no hint that the items encoded in their dominant sense provided greater priming than those encoded in their nondominant sense. In fact, if anything, the opposite trend (greater priming following nondominant encoding compared with dominant encoding) appeared in our data. This small, and often negligible, reversal may be attributable to the differences in the processing of homographs. As noted earlier, a number of prior studies have demonstrated that the dominant meaning of the homograph is not only activated faster (Forster & Bednall, 1976) and for a longer period (Pacht & Rayner, 1993; Simpson & Krueger, 1991), but is also more strongly facilitated (Simpson & Burgess, 1985) than the nondominant meaning. These findings suggest that homographs encoded for their dominant meaning receive stronger conceptual processing than homographs processed for their nondominant meaning. In other words, encoding of the dominant homographs may occur at a less perceptual level than encoding of the nondominant interpretation. This difference, although quite small, may account for slightly larger priming for the nondominant interpretations on perceptual implicit tests. This explanation of the trend for a reversal in the context effect on perceptual implicit tasks is also consistent with the tenets of the transfer-appropriate-processing account. In summary, the results from Experiments 1–2B supported the predictions derived from the transfer-appropriate-processing framework (Roediger, Weldon, & Challis, 1989) or the PRS view (Tulving & Schacter, 1990). Specifically, in all three experiments we failed to obtain an advantage in priming for the same-context condition (encoding of the dominant interpretation) over the changed-context condition (encoding of the nondominant interpretation).

Furthermore, our assumption that the dominant-encoding condition provided the same conceptual context across study and test was confirmed in Experiment 3 in which explicit retrieval instructions resulted in an advantage for the dominant-encoding condition over the nondominant-encoding condition. Thus, on tasks that require the use of conceptual operations (i.e., explicit word-fragment recall), a match between the dominant interpretation encoded at study and the dominant meaning presumably invoked at test, even with fragmented homographs, results in the best performance.

Our findings from Experiment 3 are also consistent with a number of published studies that report superior explicit memory for the dominant meaning of intact homographs. In one study, Winograd and Conn (1971) presented subjects with a list of homographs for study without presenting any context. At test, subjects were presented with these homographs in a dominant-meaning context, a nondominant-meaning context, or no context. Recognition memory was equivalent for conditions in which the dominant context or no context was provided and was significantly poorer for the condition in which nondominant context was provided. Because explicit recognition was as high in the absence of context as in the presence of dominant context, these findings are consistent with the results of Experiment 3 in that in the absence of context, dominant meaning is better recalled than nondominant meaning.

In another study, Gee (1997) reported that the switch from nondominant encoding to a dominant retrieval cue on the one hand, and from dominant encoding to a nondominant retrieval cue on the other, did not produce symmetrical results in a cued-recall task. Specifically, if subjects encoded a homograph for its nondominant meaning (*MEASUREMENT–FOOT*) and were later given the dominant interpretation as the retrieval cue (*LEG*–), then their recall was much higher than if the encoded meaning was dominant (*LEG–FOOT*) and the retrieval cue provided the nondominant interpretation (*MEASUREMENT*–). In fact, following nondominant encoding, the dominant cues were as effective for recall as the nondominant cues. Thus, regardless of the encoded meaning, recall of the dominant meaning appears to be the natural outcome in the processing of homographs, and these findings are again consistent with the results of our Experiment 3.

The most recent evidence in support of the idea that dominant meaning is better recalled in explicit tests, comes from findings reported by Rajaram (1996, in press). Homographs encoded for their dominant meaning were recognized better and were given more "remember" responses (Tulving, 1985) than homographs encoded for their nondominant meaning in a recognition memory task. Taken together, all these studies provide strong support for the idea that explicit memory for dominant meaning is likely to be better than for the nondominant meaning and are consistent with our results from Experiment 3.

In conclusion, the experiments reported in this article provide strong support for the transfer-appropriate-processing framework and the PRS account of priming. In keeping with the tenets of these frameworks, the conceptual effects predicted by the sense-specific view of priming (Lewandowsky et al., 1989) were not obtained in a largely perceptual implicit task, whereas conceptual effects predicted by the transfer-appropriate-processing view (Roediger, Weldon, & Challis, 1989) were obtained in a cued-recall task with word-fragment cues. Our evidence that meaning plays little role in mediating performance on implicit measures agrees with data reported in a bilingual study using English and Spanish materials (Gerard & Scarborough, 1989). In this study, bilingual subjects made language-specific lexical decisions to cognate words (i.e., words that have the same spelling pattern and the same meaning across the two languages, e.g., *actual*), homographic noncognates (i.e., words that have the same spelling pattern but different meanings across the two languages, e.g., *red*), and noncognates (i.e., words that have different spelling patterns but the same meaning across the two languages, e.g., *dog* and *perro*). If both meaning and orthographic patterns influence priming in the lexical-decision task when the item is presented for the second time, then maximal facilitation should be observed for cognates. However, the results showed that equivalent levels of facilitation were obtained for cognates and homographic noncognates (e.g., *red*), which have the same orthographic patterns in English and Spanish, and that there was no facilitation for noncognates (i.e., words that share a meaning but not an orthographic pattern across the two languages; see also Durgunoglu & Roediger, 1987).

The results obtained in the present experiments are in conflict with those of previous investigators (Bainbridge et al., 1993; Lewandowsky et al., 1989) who found an effect of changed meaning between study and test on implicit memory tests. However, the test cues in these cases, either perceptually degraded items or items requiring speeded responses, were preceded by a semantically related cue. The semantically related cue probably engendered conceptual processing, leading to the observation of conceptual effects on the test. Our study used only perceptually degraded cues and thereby led to test cues being processed in a data-driven manner (see also Masson & MacLeod, 1992). Therefore, we conclude that the meanings of stimuli play little or no role in perceptual implicit tests.

The dissociations reported in our experiments between implicit and explicit word-fragment tests are particularly impressive because the implicit and explicit tasks were identical in all respects except for the task instructions provided to the subjects, thereby meeting the retrieval intentionality criterion (Schacter, Bowers, & Booker, 1989). Our findings demonstrate that even with perceptually degraded cues, a change from an implicit to an explicit retrieval orientation can introduce conceptual effects (Roediger et al., 1992; Weldon et al., 1989). Providing explicit retrieval instructions seems to engage meaningful, conceptual retrieval processes, unless special steps are taken to overcome them (as, e.g., in Morris, Bransford, & Franks's, 1979, rhyme recognition test or Blaxton's, 1989, graphemic cued-recall test). These findings underscore the importance of carefully analyzing both the types of cues provided on retrieval tests and the instructions subjects are given in assessing the perceptual and conceptual processing demands of memory tests.

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Appendix

Homographs and the Orienting Phrases Used at Study in Experiments 1, 2A, 2B, and 3

Homograph	Dominant interpretation	Nondominant interpretation
block	to obstruct as in football	division of street into a square
board	plank used in surfing	supervisory bureau of directors
bound	tied and gagged	headed for, or intended to go (e.g., homeward _____)
break	ruin or smash	intermission (e.g., coffee _____)
bridge	span across water (e.g., the Golden Gate)	_____ card game
charge	form of payment (e.g., by card)	a legal accusation
chest	body part	bureau or cabinet (e.g., _____ of drawers)
coast	sea shore	glide (without engines)
count	to add numbers	nobleman or baron
crook	thief	curve of the arm or elbow
digit	a number	appendage, as in fingers or toes
draft	select for the army	preliminary writing of a paper
drill	a dentist's tool	a military exercise
fence	barrier around a field	to dual as in a sport
figure	shape	to calculate a number
fleet	an armada of ships	swift (e.g., _____ of foot)
front	anterior or ahead	a brave _____ or facade
grade	evaluative scale in school	steep incline or _____
grave	burial place	somber and serious
green	name of a color	inexperienced or naive (e.g., _____ behind the ears)
ground	the earth or _____	the basis or foundation
habit	frequent, conditioned behavior	costume of a nun
letter	post or mail a _____	part of the alphabet
lobby	hotel lounge for registration	to promote a legislation
novel	a book, usually fiction	something new or unusual
plane	an aircraft or a _____	flat three dimensional geometric surface
poker	a game of cards	a metal rod for kindling fire
present	a gift or a _____	the opposite of absent
prune	a dried fruit	to cut or trim hedges
quiver	to tremble or shudder	a container for arrows
riddle	a conundrum or puzzle	to perforate (e.g., with bullets)
ruler	a measuring instrument for length	an emperor or a king
scrap	a fragment or a chit	a quarrel or a _____
screen	blinds on a window	to project a movie or to _____
sharp	a pointed or _____ object	pungent (e.g., New York _____ cheddar cheese)
shell	the outer covering (e.g., of an egg)	explosive
shift	to change position (as in gears)	a chemise or a slip

(*Appendix continues*)

Appendix (*continued*)

Homograph	Dominant interpretation	Nondominant interpretation
shower	to bathe	light rain or drizzle
slide	to slip or fall	a photograph or _____
spell	say the letters in a word	trance, or casting a _____
spring	a season	a small river
square	a geometric shape	a math operation (e.g., to multiply a number by itself)
stable	a shelter (for horses)	steady and not fluctuating
stage	a platform in the theater	a vehicle now obsolete (e.g., _____-coach)
stalk	to pursue or hunt prey	the stem of a plant
staple	office supplies (e.g., a binder)	a basic commodity (e.g., bread)
state	a political territory within a country	to say or to claim
steer	ox or cattle	to direct or to guide
stick	rod (usually of wood)	adhesive
story	a fable	elevation of a building
strain	an effort or labor	type of bacteria or _____ of virus
strike	to hit	to stop work or picket
swallow	to ingest food	a bird that is associated with summer
swamp	marsh lands	to overwhelm with work
toast	bread for breakfast	to drink to someone
train	transports by railroad	to instruct or teach
trunk	place to store luggage in a car	an elephant's nose
vault	bank safe	to leap (especially over a pole)
vessel	ship or boat	hollow tube (or blood _____)
yellow	name of a color	cowardly or chicken

Note. The underlined letters were not presented when the homographs were shown in the fragmented form to subjects at test.

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