Journal of Experimental Psychology:
Learning, Memory, and Cognition
1986, Vol. 12, No. 3, 432-444

0278-7393/86/$00.75

Effects of Elaborative Processing on Implicit and Explicit Memory for New Associations

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Previous research has demonstrated that priming effects on word-completion tests are influenced by newly acquired associations between normatively unrelated words. This phenomenon, which we call implicit memory for new associations, can occur independently of explicit remembering but requires elaborative processing of study materials. The present experiments explored further the relation between elaborative processing and implicit memory for new associations. Results indicated that implicit memory for new associations, like explicit memory, depended on encoding of meaningful relations between paired words in the study list. However, variations in degree and type of associative elaboration had a large effect on explicit memory, as revealed by performance on letter-cued recall and paired-associate tests, but had little effect on implicit memory, as revealed by performance on a word-completion test. Discussion focuses on the theoretical implications of the observed similarities and differences between implicit and explicit memory for new associations.

Memory research has traditionally focused on recall and recognition tests that require subjects to remember previously studied items in a conscious or deliberate manner. A growing number of experiments, however, have demonstrated that memory can also be expressed by facilitated performance on tests that do not require conscious recollection, such as word-fragment completion (e.g., Graf, Mandler, & Haden, 1982; Tulving, Schacter, & Stark, 1982; Warrington & Weiskrantz, 1974), word identification (e.g., Feustel, Shiffrin, & Salasoo, 1983; Jacoby, 1983; Jacoby & Dallas, 1981), lexical decision (e.g., McKoon & Ratcliff, 1979; Scarborough, Gerard, & Cortese, 1979), free association (Schacter, 1985a; Shimamura & Squire, 1984), and reading of inverted script (Kolers, 1975, 1976). These facilitations are generally known as *direct priming effects* (e.g., Cofer, 1967). We have used the descriptive terms *implicit* and *explicit* to distinguish between the forms of memory that are indexed by priming effects on the one hand and by performance on recall and recognition tests on the other (Graf & Schacter, 1985). Implicit memory occurs when test performance is facilitated without deliberate or conscious remembering of a study episode, whereas explicit memory occurs when test performance requires conscious recollection of the study episode.

Recent research has provided converging lines of evidence that performance on tests of implicit and explicit memory can be dissociated. For example, several studies have shown that experimental variables that have large effects on explicit memory have little or no effect on implicit memory (e.g., Graf et al., 1982; Graf, Squire, & Mandler, 1984; Jacoby & Dallas, 1981; Roediger & Blaxton, 1985; Scarborough et al., 1979; Tulving et al., 1982). It has also been demonstrated that the magnitude of priming effects on implicit memory tests can be statistically independent of explicit recall and recognition (e.g., Eich, 1984; Jacoby & Witherspoon, 1982; Tulving et al., 1982). Additional evidence for dissociations between implicit and explicit memory is provided by studies of patients with organic amnesia. Amnesic patients are severely impaired on standard tests of explicit memory, such as free recall, cued recall, and recognition (for review, see Moscovitch, 1982; Rozin, 1976; Schacter & Tulving, 1982; Squire, 1982). However, they show normal or near-normal performance on various tests of implicit memory (e.g., Cermak, Talbot, Chandler, & Wolbarst, 1985; Cohen & Squire, 1980; Diamond & Rozin, 1984; Graf et al., 1984; Jacoby & Witherspoon, 1982; Moscovitch, 1982; Schacter, 1985a, in press; Warrington & Weiskrantz, 1968, 1974). The data from amnesic patients, in conjunction with the dissociations observed in normal subjects, suggest that implicit and explicit forms of memory differ fundamentally.

One of the key findings from the foregoing research that implies a fundamental difference between implicit and explicit memory is provided by studies that have examined the effects of elaborative processing on these two forms of memory. It is well known that explicit recall and recognition benefit substantially from semantic elaboration during study (e.g., Craik & Tulving, 1975; Jacoby & Craik, 1979). In contrast, the results of several experiments suggest that performance on implicit memory tests does not benefit from elaborative processing rela-

The present research was supported by the Natural Sciences and Engineering Research Council of Canada Grant U0299 to Peter Graf and Grant U0361 to Daniel L. Schacter and by a Special Research Program Grant from the Connaught Fund, University of Toronto.

We are grateful to Mary Damianakis and Kelly Nakamura for experimental assistance and to Carol A. Macdonald for help with preparation of the manuscript. We thank Fergus Craik, Reed Hunt, Betty Ann Levy, Morris Moscovitch, Paul Muter, Norman Slamecka, and Endel Tulving for helpful comments and suggestions. We also thank Timothy Feustel and Teresa Blaxton for constructive reviews of an earlier version of the article.

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tive to nonelaborative processing. This finding was observed initially with a word-identification task, which requires subjects to identify words from extremely brief presentations (Jacoby & Dallas, 1981), and has since been demonstrated with various other implicit memory tests. For example, on a word-completion task, which requires completing fragments of recently presented words and new words (e.g., *rea___* for *reason*), the magnitude of priming effects is comparable after an elaborative study task (e.g., rating the pleasantness of a word) and a nonelaborative study task (e.g., counting the number of vowels in a word; Graf et al., 1982). Similarly, when subjects study linguistic idioms (e.g., *sour grapes*) and are then given a free association test (e.g., *sour*—?), they show similar amounts of priming following elaborative and nonelaborative study tasks (Schacter, 1985b). Finally, it has also been demonstrated that elaborative versus nonelaborative processing activities have little or no influence on priming effects in a lexical decision task (Carroll & Kirsner, 1982).

We recently reported an exception to the general finding that implicit memory is unaffected by elaborative versus nonelaborative processing of study materials in an experiment that explored implicit memory for newly acquired associations between unrelated words (Graf & Schacter, 1985; see also Carroll & Kirsner, 1982; Franks, Plybon, & Auble, 1982; McKoon & Ratcliff, 1979; Moscovitch, 1984; Schacter, 1985a; Schacter, Harbluk, & McLachlan, 1984). In our experiment, subjects were shown a list of normatively unrelated cue–target pairs (e.g., WINDOW—REASON) and then were given a word-completion test in which some target fragments appeared in the same context as in the study list (*window—rea___*) and others appeared in a different context (e.g., *officer—rea___*). We postulated that an associative influence on the word-completion task—implicit memory for new associations—would be demonstrated if subjects completed target fragments more often when they appeared in the same context than when they appeared in a different context. The results confirmed this hypothesis by showing that completion performance was higher in the same-context condition than in the different-context condition. However, we also found that this associative influence on word-completion performance occurred only when subjects engaged in elaborative processing at the time of study (i.e., generating a sentence for each critical word pair). When subjects did not engage in elaborative processing (i.e., comparing the number of vowels in the cue and target), they completed fragments with target words equally often in the same- and different-context conditions.

In a second experiment, we examined whether associative influences on word-completion performance could also be observed in a group of patients with organic memory disorders, who have little or no ability for explicit remembering of new associations. After studying a list of unrelated cue–target pairs under elaborative processing conditions, amnesic patients completed more items tested in the same context than in a different context. Moreover, the magnitude of the associative influence on their word-completion performance was comparable to that observed in a group of matched control patients and in a group of college students. On a subsequent cued-recall test, however, amnesic patients recalled only 2% of list targets, whereas matched controls recalled 35% and student controls recalled 64%. This pattern of results demonstrates that implicit memory for new associations does not depend on the level of explicit remembering.

The finding that an associative influence on word-completion performance requires elaborative processing of study materials appears to be inconsistent with previous demonstrations that performance on implicit memory tests is uninfluenced by elaboration. Most previous experiments, however, examined implicit memory for items that were already represented as integrated units in long-term or semantic memory prior to their appearance on a study list, such as familiar words (e.g., Graf et al., 1984; Tulving et al., 1982; Warrington & Weiskrantz, 1974), linguistic idioms (Schacter, 1985a), and highly related paired associates (Shimamura & Squire, 1984; Storms, 1958). By contrast, subjects in our experiments studied randomly paired words that had no preexisting unitary representation as pairs in long-term memory. It is therefore possible that elaboration is required to establish representations that mediate implicit memory for newly acquired associations but is not required to activate preexisting representations that mediate implicit memory of familiar items. However, at present we know little about the nature of the representations underlying implicit memory for new associations, the kinds of elaborative processes that may be involved in this type of memory, or the relation between these processes and those involved in explicit remembering of new associations.

The general objective of the present article is to gain insight into these issues by exploring further the relation between elaborative processing and implicit memory for new associations. To accomplish this objective, we examined the effects of different types of elaborative processing on subsequent performance on word-completion tests. We used the word-completion test to assess implicit memory because previous research has established some facts concerning the relation between elaborative processing and completion-test performance and has demonstrated that manipulations of elaborative processing have similar effects on word completion and other implicit memory tests (e.g., word identification, lexical decision). Nevertheless, when we refer to effects of elaborative processing on "implicit memory for new associations," we do so with the understanding that our findings may apply only to one of several implicit memory tests.

In order to delineate the relation between the implicit and explicit expression of newly acquired associations, we also investigated the effects of elaborative processing on explicit remembering. Two types of explicit memory tests were used. One is a letter-cued recall test that presents the stimulus word from a recently studied pair together with the first three letters of the response (e.g., *window—rea___* for *window—reason*), just as on the word-completion test. On this cued-recall test, however, subjects are instructed to try to remember the list target, rather than to write down the first word that comes to mind, as is required on the completion test. The second type of explicit memory test is a standard paired-associate recall task in which subjects are given the stimulus word (e.g., *window*) and are asked to try to remember the response. As we show in Experiments 1 and 2, elaborative processing has similar effects on both recall tests. Nevertheless, when we refer to the effects of elaborative processing on "explicit memory for new associations," we do so

with the understanding that our results may apply only to the particular explicit memory tests that we have examined.

One further point should be noted concerning the general logic of our experiments. As discussed earlier, implicit memory for newly acquired associations is demonstrated when subjects complete more fragments with study-list targets in a same-context condition (e.g., test cue *window—rea___* for study pair *window—reason*) than in a different-context condition (e.g., *officer—rea___* for *window—reason*).[1] Thus, in the present study we are primarily concerned with the effects of elaborative processing on performance in the same-context condition, which is sensitive to implicit memory for a newly acquired association. Nonetheless, it is important to include a different-context condition in our experiments to provide a benchmark against which we can compare performance in the same-context condition. If we fail to observe a difference between these two conditions, then there is no evidence of implicit memory for new associations. If we do observe a difference, then we can go on to examine how variations in elaborative processing of study materials affect implicit memory for newly acquired associations, as reflected by performance in the same-context condition. This same general logic applies to our analysis of the letter-cued recall test and the inferences that we make concerning explicit memory for newly acquired associations.

Experiment 1

In the Graf and Schacter (1985) study, evidence for implicit memory of new associations was observed when subjects performed a sentence-generation task that required considerable associative elaboration and was not observed when subjects performed a vowel-comparison task that did not require any associative elaboration. Though this finding indicates that the elaborative activities required by a sentence-generation task are sufficient to produce implicit memory of new associations, it does not reveal what aspects of these elaborative activities are necessary for this form of memory. It is possible that even a lesser degree or a different type of associative elaboration of study pairs would produce implicit memory for new associations. Although there is abundant evidence that explicit recall and recognition of new associations is facilitated by variation in degree and type of associative elaboration (e.g., Anderson & Reder, 1979; Fisher & Craik, 1980; Jacoby & Craik, 1979; Hasher & Johnson, 1975; Stein, Morris, & Bransford, 1978), we do not know whether implicit memory is affected similarly.

In Experiment 1, we examined the effects of different types of associative elaboration on implicit and explicit memory for new associations by instructing one group of subjects to perform the sentence-generation task that was used in our previous experiments and instructing a second group to generate only a single word to link the members of each pair. We hypothesized that this word-generation task would require less associative elaboration than the sentence-generation task, and hence, that explicit memory for new associations would be lower following word generation than following sentence generation. We did not know, however, whether the elaboration manipulation would have a comparable effect on implicit memory for new associations. To address this question, we compared performance on implicit and explicit tests in which the nominal cues were identical and only the test instructions differed: One group was told to write down the first word that came to mind (word completion), whereas a second group was told to try to remember study-list targets (letter-cued recall). In addition, we examined the effects of the elaboration manipulation on a standard paired-associate recall test that was administered after the completion test.

Method

Subjects. Ninety-six University of Toronto undergraduates participated in the experiment. Subjects either received course credits for participating or were paid $3.00.

Design and materials. The main experimental design consisted of two between-subjects factors and one within-subjects factor. The between-subjects factors were type of study task (sentence generation vs. word generation) and type of test (word completion vs. letter-cued recall); the within-subjects factor was type of test context (same vs. different).

The to-be-remembered materials were composed of 48 cue–target pairs consisting of common words that were selected from the Kučera and Francis (1967) norms. Three constraints were observed in the selection of target words. First, the initial three letters of each target word had to be unique in the set of all words that were included in the pairs (e.g., *bre, app*). Second, for each three-letter target stem a pocket English dictionary had to list at least 10 English words with the same stem (e.g., *bread, break, breakfast, breast*). Third, the target words had to be between 5 and 10 letters in length and of medium frequency. The selected targets averaged 6.3 letters and they had a mean Kučtera-Francis frequency of 26.2 occurrences per million. The cue words were between 3 and 11 letters long (M = 5.8), and their mean frequency was 100.2 occurrences per million.

We also constructed a set of 24 fillers that appeared only on the completion and letter-cued recall tests. Each of these fillers was comprised of a context or cue word and a three-letter word stem. The filler words and stems were drawn from the same pool as were the critical pairs; the three-letter filler stems were unique in the pool of all words included in the experiment. The purpose of including the filler pairs was to disguise the fact that the completion test included previously studied pairs, because once the memory testing aspects of the completion test become apparent to subjects, the test can be transformed into a cued-recall test. However, to make the completion and letter-cued recall tests identical except for instructions, we also included the filler items on the letter-cued recall tests.

For counterbalancing purposes, the critical 48 pairs were divided randomly into four sets of 12. For each subject, two sets (24 pairs) appeared in the study list and were later tested on either the completion or letter-cued recall test. In one of these sets, the target fragments appeared next to their study-list cue (same-context condition) on the test forms, whereas in the other set the target fragments appeared next to a randomly chosen study-list cue (different-context condition). The two other critical sets of word pairs were not presented on the study list. They

[1] When we use the phrases "same-context condition" and "different-context condition," we refer exclusively to the local context that is provided by a paired word on the completion test. This local context should be distinguished from the global context that is provided by the entire study list, the experimenter, the experimental room, and so forth (see Schacter, 1985a, for discussion). In a previous experiment, we found similar levels of performance when the different-context condition was defined by re-pairing target words with other study-list items, with non-study-list items, or by testing of the target item alone (Graf & Schacter, 1985).

Table 1
Word-Completion and Letter-Cued Recall Performance as a Function of Study Task and Test Context in Experiment 1

	Test context					
	Word completion			Letter-cued recall		
Study task	Same	Different	*M*	Same	Different	*M*
Sentence generation	.41	.25	.33	.72	.41	.57
Word generation	.42	.22	.32	.62	.37	.50
M	.41	.24	.33	.67	.39	.53

appeared only on the completion and letter-cued recall tests, one of them in the same-context condition and one of them in the different-context condition (the nonpresented sets for half the subjects appeared as presented sets for the other half). These nonpresented sets provided an estimate of baseline performance—the frequency with which subjects write the target word as a completion without a study-list presentation. The experiment was counterbalanced so that each set appeared equally often in each of the experimental conditions defined by the orthogonal combination of study task (sentence vs. word generation), test type (word completion vs. letter-cued recall), test context (same vs. different completion-test context), and presented versus nonpresented items. Two different forms of the completion and letter-cued recall tests were required for complete counterbalancing. Both test forms consisted of two pages, with 36 cue–target fragment pairs on each page. In addition, a standard paired-associate test was used. This test consisted of a single page that presented the cue words from the 24 previously studied pairs in a random order.

Procedure. Each subject was tested individually. Subjects in the sentence-generation condition were told that they would be shown some word pairs and would later be asked to remember them. They were instructed to generate a sentence for each pair that related the two words in a meaningful manner. Subjects in the word-generation condition were given similar instructions, except that they were told to think of a single word that meaningfully related the two words in each study pair. All subjects were given two practice pairs to illustrate the nature of the study task. The 24 critical pairs were then presented on 3" × 5" index cards, in a random order for each subject. Subjects were required to read each pair aloud and were given 6 s either to generate a sentence or think of a mediating word. At the end of 6 s, subjects were required to state aloud either the sentence or the mediating word.

After presentation of the study list, subjects were instructed that they would be required to complete some filler tasks before the initiation of memory testing. The first task was to generate names of cities; its purpose was to induce an appropriate set for word-completion testing. Subjects were told to start at the beginning of the alphabet and to write names of cities that begin with an *A* and then to proceed in order through the alphabet. They performed this task for 3 min.

The word-completion test was then presented as a second filler task to one half of the subjects. The completion-test instructions informed subjects that they had to "complete each word beginning on the [completion test] form with the first word that [came] to mind." Subjects were instructed that they could write any word except proper names, and when a proper name was given an alternative completion was requested. Because some of the completion cues were presented in the context of a word from the study list, the instructions emphasized that the task was to complete each cue with the first word that came to mind, that the context word would sometimes help to think of a completion, but that it was unimportant whether or not their completion was related to the context word. We encouraged subjects to finish the completion test as quickly as possible (it required about 3 min). After this test, subjects were given a paired-associate test with instructions that emphasized explicit remembering. Subjects were reminded of the word pairs that they had studied, they were informed that the test cues were the first words from the pairs that they had seen, and they were instructed to recall the target word that had been paired with each cue in the study list. This test required about 5 min.

The other half of the subjects were given the letter-cued recall test immediately after the city-generation task. The letter-cued recall form was the same as that used for word completion; the two tasks differed only with respect to the instructions given to subjects. On the letter-cued recall test, subjects were told that some of the word fragments on the test form were the beginnings of target items from the study list and that they should do their best to remember the study-list target that was represented by a word-fragment cue. They were further instructed that some of the fragment cues appeared next to the same words that they had been paired with on the study list (same context), whereas other fragment cues appeared next to stimulus words that had been paired with other targets on the study list (different context). In addition, subjects were told that some of the test items had not appeared on the study list and therefore would seem unfamiliar. However, they were required to complete each test fragment, even if they were just guessing.

Results

Word completion. The mean proportions of words completed with study-list targets in the main experimental conditions are displayed in Table 1. Baseline performance on the completion test averaged .09 for fragments in both the same- and different-context conditions.

The data in Table 1 indicate that the probability of completing fragments with target words increased substantially above baseline after exposure to them in the study list. In the sentence generation condition, subjects completed more fragments when they were paired with their list cues (same context) than when they were paired with other cues (different context). These data replicate our previous findings with the sentence-generation task. The critical new result is that completion rate was also higher in the same- than in the different-context condition following word generation, thereby demonstrating that this task, too, can produce an associative effect on completion performance. Moreover, performance in the same-context condition, which reflects this associative influence, did not differ in the word-generation (.42) and sentence-generation (.41) tasks. Analysis of variance supported this description of the data. There was a main effect of test context on completion performance, $F(1, 46) = 29.07$, $p < .05$, $MS_e = 3.88$, whereas there was neither an effect of study task, $F(1, 46) < 1$, nor a Study Task × Test Context interaction, $F(1, 46) < 1$.

Additional analyses revealed that following both study tasks, performance in the different-context condition significantly exceeded the baseline level, for both sentence generation, $t(23) = 4.39$, and for word generation, $t(23) = 4.26$, $ps < .05$. This result is consistent with earlier findings that presentation of a target word increases completion performance even when the word is tested in a different context from the one in which it was studied.

Letter-cued recall. Table 1 also presents the results of the letter-cued recall test. There are three important points to note about these data. First, performance in all conditions was higher than that observed on the word-completion test. An analysis of variance (ANOVA) that included type of test as a factor revealed a significant main effect of this variable, $F(1, 92) = 15.15$, $p < .05$, $MS_e = 32.61$. This finding replicates and extends previous reports that the proportion of study-list targets produced to letter-fragment cues is typically higher with recall instructions than with completion instructions. Second, more items were recalled in the same- than in the different-context condition. A separate (ANOVA) performed on the letter-cued recall data revealed a main effect of test context on recall performance, $F(1, 46) = 77.92$, $p < .05$, $MS_e = 3.68$. This result confirms, not surprisingly, that cued-recall performance was influenced by memory for newly acquired associations. Third, recall performance in the same-context condition, which reflects this associative influence, was higher following sentence generation (.72) than following word generation (.62). A planned comparison showed that the difference between these means was significant, $t(46) = 1.70$, $p < .05$. In the different-context condition, performance was also higher following sentence generation (.41) than word generation (.37), but the difference was not reliable, $t(46) = 1.16$.

The finding that recall performance in the same-context condition was significantly higher following sentence generation than word generation contrasts with the corresponding finding from the word-completion test, which showed no effect of study task. However, an overall ANOVA revealed a nonsignificant Study Task × Type of Test interaction, $F(1, 92) = 1.73$. The Study Task × Type of Test × Test Context interaction was also nonsignificant, $F(1, 92) < 1$.

Paired-associate recall. The pattern of results on the standard paired-associate test was similar to that observed in the same-context condition of the letter-cued recall test: Subjects remembered significantly more items in the sentence generation condition (.54) than in the word generation condition (.40), $t(46) = 2.49$, $p < .05$. In addition, subjects in the sentence-generation condition made significantly fewer intrusion errors (.05) than did subjects in the word-generation condition (.13), $t(46) = 3.02$, $p < .05$.

Discussion

Experiment 1 has demonstrated an associative effect on word-completion performance following both sentence generation and word generation tasks and has shown that the magnitude of the effect is about the same in the two study conditions. These findings indicate that the type of associative elaboration involved in the word-generation task is sufficient to produce implicit memory for new associations. By contrast, explicit remembering of new associations was higher following sentence than word generation on both the letter-cued recall and paired-associate tests. Thus, the overall pattern of results suggests that implicit and explicit memory for new associations may depend on different consequences of elaborative processing: Explicit remembering benefits from the type of elaboration that is required by sentence generation relative to word generation, whereas implicit memory does not. This finding must be viewed with caution, however, because (a) the Study Task × Type of Test interaction failed to achieve significance, and (b) the effect of the elaborative processing manipulation on explicit remembering of new associations was not particularly large. In the same-context condition of the letter-cued recall test, there was only a .10 advantage for sentence generation over word generation, and the corresponding advantage on the paired-associate test (.14) was not much larger. Thus, it is important to determine whether implicit memory for new associations would remain unaffected by degree or type of elaboration even when a more powerful manipulation is used, one that exerts large effects on explicit remembering of new associations. We examined this issue in Experiment 2.

Experiment 2

It is well known that more extensive elaboration often occurs when subjects generate elaborators than when they are simply provided with them and that explicit recall and recognition benefit substantially from active elaboration (e.g., Jacoby, 1978; Slamecka & Graf, 1978). We do not know, however, whether active elaboration has similar effects on implicit memory for new associations. Both study tasks in Experiment 1 required subjects to generate elaborators, and it is possible that this activity was necessary to observe an associative effect on word-completion performance. Alternatively, it is possible that the associative effect did not depend critically on active elaboration and would be observed even when subjects are provided with elaborators at the time of study.

To examine these issues, Experiment 2 compared word-completion and recall performance following two types of study. In one condition, the sentence-generation task from Experiment 1 was used to induce active elaboration of unrelated word pairs. In a second condition, subjects were shown sentences that included the same target pairs, and they were required to rate how well these sentences related the targets. For example, the cue–target pair *officer—flower* was shown in the sentence, "The injured OFFICER smelled the FLOWER," and subjects rated the degree to which the sentence related the two capitalized words. We expected that explicit memory for new associations, as indexed by performance on the letter-cued recall and paired-associate tasks, would be higher following sentence generation than following sentence rating. The critical question was whether this elaboration manipulation would have comparable effects on implicit memory for new associations.

Subjects in Experiment 2 were administered the same completion and recall tests that were used in Experiment 1. In Experiment 2, however, the tests were given either immediately after the study tasks or after a 24-hr delay. The delayed condition was included to permit assessment of the generality of our re-

Table 2
Word-Completion and Letter-Cued Recall Performance as a Function of Study Task, Time of Test, and Test Context in Experiment 2

	Test context					
	Word completion			Letter-cued recall		
Study task	Same	Different	*M*	Same	Different	*M*
			Immediate			
Generation	.35	.19	.27	.60	.35	.48
Rating	.31	.16	.24	.34	.32	.33
M	.33	.17	.25	.47	.34	.41
			Delayed			
Generation	.26	.15	.20	.48	.18	.33
Rating	.24	.12	.18	.27	.20	.24
M	.25	.13	.19	.38	.19	.29

sults and also to determine whether implicit memory for new associations persists over a 24-hr retention interval.

Method

Subjects. Sixty-four University of Toronto undergraduates either received course credits or were paid $6.00 for participating in the experiment.

Design and materials. The basic design had two between- and two within-subjects factors. The between-subjects factors were retention interval (immediate vs. delay) and type of test (word completion vs. letter-cued recall). The within-subjects factors were type of study task (sentence generation vs. sentence rating) and completion-test context (same vs. different). In addition, a standard paired-associate recall test was administered after the completion test at both delays.

The word pairs and tests were the same as those described in Experiment 1. For the sentence-rating condition, 48 sentences were constructed. Cues and targets appeared in uppercase letters, and other words in the sentences appeared in lowercase letters. All of these sentences were relatively meaningful ones, such as "the new RADIO was returned to the FACTORY," "the old SHACK collapsed in the STORM," and "the DOCUMENT was examined by the DEPUTY." In addition to these sentences, 12 anomalous sentences were interspersed among the critical ones, such as "the humid PAINTER ventilated the LEASE" and "the crisp STUDENT flew through the ADVICE." These sentences were not subsequently tested. Their purpose was to provide a contrast with the critical sentences so that subjects would be encouraged to think carefully when rating the meaningfulness of each study sentence and use the entire range of the scale when making their ratings. The anomalous sentences were similar in structure to the critical sentences.

To achieve counterbalancing of materials across conditions, the 48 critical word pairs were subdivided into eight sets of six. Each set appeared equally often in the individual experimental conditions defined by the orthogonal combination of study task (sentence generation vs. sentence rating), test type (word completion vs. letter-cued recall), test context (same vs. different), time of test (immediate vs. delayed), and presented versus nonpresented items.

Procedure. The procedure was similar to the one used in Experiment 1, except for changes dictated by the inclusion of the sentence-rating task as a within-subjects variable. Subjects were told that they would be shown some word pairs, and that they should study the pairs in two different ways. They were informed that for some pairs they would be required to generate a sentence that related the two words. Subjects were further instructed that some pairs would appear as capitalized words in sentences and that they would be required to rate how meaningfully the sentences related the two words. It was pointed out that some sentences would be highly meaningful, whereas others would be relatively meaningless, and that they should make their ratings on a 5-point scale ranging from *the sentence does not relate the words at all meaningfully* (1) to *the sentence relates the words quite meaningfully* (5). Subjects were encouraged to take account of even subtle differences in meaning when making their ratings. They were then given three practice pairs: One was in a meaningful sentence, one was in an anomalous sentence, and one was presented with instructions to generate a sentence. The critical pairs were then shown at a 6-s rate. Items from the sentence-generation and sentence-rating conditions were intermixed randomly. Subjects initially read aloud either the pair or the sentence, and after 6 s stated either their generated sentence or their rating.

After exposure to the entire study list, half of the subjects in the immediate condition were given the city-generation, word-completion, and paired-associate tests in the same manner as was described in Experiment 1. The other half of the subjects were given the city-generation and letter-cued recall tests, also as described in Experiment 1. Subjects in the delay condition were told to return to the laboratory the next day. They were then treated in the same manner as were subjects in the immediate condition.

Results

Word completion. As in Experiment 1, baseline probabilities of completing a fragment with a target did not differ significantly in the same-context condition (.13) and the different-context condition (.09), $t(31) = 1.25$, and thus they were averaged to yield a mean baseline completion rate of .11.

Table 2 displays the mean proportions of words completed in the main experimental conditions. The means indicate that after exposure to the study list, the percentage of fragments completed with target items was generally higher in the same-context condition than in the different-context condition. This difference was present in both the sentence-generation and sentence-rating conditions and was evident on both the immediate

and delayed tests, thereby indicating that newly acquired associations affected word-completion performance in all experimental conditions. Overall performance in the same-context condition, which reflects this associative influence, was comparable following sentence-generation and sentence-rating tasks. An ANOVA revealed a significant main effect of test context, $F(1, 30) = 12.84$, $p < .05$, $MS_e = 1.77$. In contrast, there was no main effect of study task, $F(1, 30) < 1$. The interaction between delay and text context was also nonsignificant, $F(1, 30) < 1$, as was the Delay × Study Task interaction, $F(1, 30) < 1$, and the three-way interaction of Delay × Study Task × Test Context, $F(1, 30) < 1$.

There was some evidence of a main effect of retention interval on word-completion performance, $F(1, 30) = 2.92$, $p = .094$. Performance declined across the retention interval in both the sentence-generation and sentence-rating tasks and in both the same- and different-context conditions. At the 24-hr delay, completion performance remained significantly above baseline levels in the same-context condition following both sentence generation, $t(15) = 2.19$, and sentence rating, $t(15) = 2.85$, $ps < .05$. In the different-context condition, however, delayed performance did not exceed baseline levels following either word or sentence generation ($t < 1$ for both tasks). The overall pattern of results indicates that the associative influence on completion performance persists across a 24-hr delay, albeit with some evidence of forgetting over time.

Letter-cued recall. Table 2 also displays the data from the letter-cued recall test. As in Experiment 1, performance on this test was generally higher than on the completion test. An ANOVA that included type of test as a factor revealed a significant main effect of this variable, $F(1, 60) = 13.70$, $p < .05$, $MS_e = 2.16$. Inspection of individual conditions revealed a consistent advantage for letter-cued recall, except for the same-context condition of the sentence-rating task, which showed only a slight and nonsignificant advantage at both immediate and delayed tests. (The advantage of letter-cued recall over completion was also nonsignificant in the delayed different-context condition, but this is probably attributable to a floor effect in completion performance.)

As in Experiment 1, more items were recalled in the same- versus different-context condition. A separate ANOVA performed on the letter-cued recall data revealed a significant main effect of test context, $F(1, 30) = 20.74$, $p < .05$, $MS_e = 1.40$. This effect was evident in each of the experimental conditions except for the immediate sentence-rating condition.

Comparison of the two study tasks revealed that type of elaborative processing had a large influence on explicit remembering of new associations: Recall in the same-context condition was nearly twice as high following sentence generation versus sentence rating at both test delays. Planned comparisons demonstrated that this advantage was significant on both the immediate test, $t(15) = 3.58$, and the delayed test, $t(15) = 2.40$, $ps < .05$. In addition, an ANOVA that included type of test as a factor revealed a significant Test Type × Study Task interaction, $F(1, 60) = 6.95$, $p < .05$, $MS_e = 1.14$. This analysis also revealed a marginally significant Test Type × Study Task × Test Context interaction, $F(1, 60) = 3.22$, $p = .074$, which reflects the fact that recall in the different-context condition was unaffected by type of study task.

Table 3
Paired-Associate Recall as a Function of Study Task and Time of Test in Experiment 2

Time of test/Study task	Type of response: Target words	Type of response: Intrusions
Immediate		
Generation	.61	.11
Rating	.30	.17
Delayed		
Generation	.21	.17
Rating	.10	.19

Paired-associate recall. Both the study task and delay variables had substantial effects on paired-associate performance (Table 3). Subjects recalled a higher percentage of items in the sentence-generation condition (.41) than in the sentence-rating condition (.20), and also recalled more items on the immediate test (.45) than on the delayed test (.15). An ANOVA performed on the number of correctly recalled items revealed significant main effects of study task, $F(1, 30) = 37.78$, $p < .05$, $MS_e = 2.85$, and retention interval, $F(1, 30) = 24.05$, $p < .05$, $MS_e = 8.89$. There was also a significant Study Task × Retention Interval interaction, $F(1, 30) = 7.51$, $p < .05$, $MS_e = 2.85$. The interaction is probably attributable to a floor effect in the sentence-rating condition at the long delay. Recall intrusions were distributed approximately equally across experimental conditions (Table 3). An ANOVA was performed on the intrusion data, and no effects approached significance.

Discussion

Taken together, the data from the word-completion test and the two recall tests extend the finding of Experiment 1 by showing that type of associative elaboration had dissociable effects on implicit and explicit memory for new associations. In Experiment 2, however, the evidence for this dissociation was more compelling: Although implicit memory for new associations was not significantly influenced by the elaboration manipulation, explicit remembering of new associations was nearly twice as high following sentence generation than sentence rating on both the immediate and delayed tests. This effect was observed both when subjects were provided with the stimulus word plus the target fragment on the letter-cued recall test and when they were given the stimulus alone on the paired-associate test.

These results also demonstrate that active generation of elaborators is not necessary to observe implicit memory of new associations and suggest that encoding even a small amount of information that relates or unites two randomly paired words is sufficient to produce implicit memory for new associations. It can be questioned, however, whether it is necessary to encode any meaningful relations between two words in order to observe implicit memory for new associations. The evidence reported thus far is equally consistent with the idea that implicit memory for new associations requires only that subjects process the meanings of the individual words in a pair. In the one experimental condition that has failed to provide evidence of implicit

Table 4
Word-Completion Performance as a Function of Study Sentence, Time of Test, and Test Context in Experiment 3

	Test context					
	Immediate			Delayed		
Study sentence	Same	Different	*M*	Same	Different	*M*
Meaningful	.33	.20	.27	.22	.12	.17
Anomalous	.21	.22	.22	.22	.15	.18
M	.27	.21	.24	.22	.13	.18

memory for new associations (Graf & Schacter, 1985, Experiment 1), subjects performed a vowel-comparison task that did not require processing of meanings of individual words. In Experiment 3, we examined whether implicit memory for new associations requires encoding of information that relates the two words of a study pair or whether it can be observed when the meanings of individual words are processed simultaneously but are not related meaningfully to one another.

Experiment 3

In Experiment 3, subjects rated the meaningful sentences that were used in the previous experiment, and were tested with both completion and recall tests. In addition, they rated and were tested on anomalous sentences that resembled the fillers that were used in Experiment 2. These sentences, though grammatically correct, do not provide a meaningful relation between the two critical words (e.g., "the new ROCK was returned to the CANDLE"). However, in order to rate the degree to which an anomalous sentence relates the two words, subjects must process the meaning of each word. Accordingly, if encoding of a meaningful relation is necessary to observe implicit memory of new associations, then performance should be comparable in the same- and different-context conditions following rating of anomalous sentences. If, however, encoding of a meaningful relation is not necessary, and encoding the meanings of the individual words is sufficient to support implicit memory for new associations, performance should also be higher in the same- than in the different-context condition following rating of anomalous sentences, just as it is with meaningful sentences.

Method

Subjects. Forty-eight University of Toronto undergraduates took part in the experiment. They were paid $5.00 for participating.

Design. The main experimental design consisted of one between-subjects factor and two within-subjects factors. The between-subjects factor was retention interval (immediate vs. delayed). It was included both to determine whether the persistence of implicit memory for new associations across a 24-hr delay could be replicated, and to assess the generality of the results in this experiment. The within-subjects factors were type of study sentence (meaningful vs. anomalous) and completion-test context (same vs. different). We did not include a separate letter-cued recall group in this experiment because the findings from Experiments 1 and 2 indicated that the overall pattern of results on letter-cued recall and standard paired-associate tests are similar. Explicit remembering was investigated with a paired-associate recall test that was administered after the completion test.

The 48 critical word pairs, the completion and paired-associate recall tests, and the meaningful sentences were the same as described in Experiment 2. A set of 48 anomalous sentences was also constructed. Each of the 48 critical pairs was included in one meaningful sentence and in one anomalous sentence. Wherever possible, the noncritical words that were used to construct meaningful sentences were also used to construct anomalous sentences. For example, the noncritical words in the meaningful sentence "the angry MOTHER returned the CALENDAR" were used to construct the anomalous sentence "the angry BLIZZARD returned the FOREST." We used this procedure to make the two types of sentences comparable with respect to all features other than meaning.

For purposes of counterbalancing, the 48 critical word pairs were divided into eight sets of six pairs. Each set appeared equally often in the individual conditions defined by the orthogonal combination of the main experimental variables (i.e., meaningful vs. anomalous study sentence, same vs. different completion-test context, immediate vs. delayed testing, and presented vs. nonpresented items).

Procedure. The study and test procedures were identical to the ones described for Experiment 2 except that half of the 24 critical sentences were anomalous ones. Meaningful and anomalous sentences were intermixed randomly throughout the list, and subjects were given the same instructions for making meaningfulness ratings as in Experiment 2. The filler sentences from Experiment 2 were not used.

Results and Discussion

Word completion. Table 4 displays the proportions of words completed in the main experimental conditions. Baseline probability of completion was .11 in both the same-context condition and different-context condition.

Table 4 indicates that after rating words in meaningful sentences, subjects completed more items in the same-context condition than in the different-context condition at both delays. As in Experiment 2, the associative influence on completion performance was present on both immediate and delayed tests, although there was an overall decline in completion performance across the retention interval. In contrast, there was only weak evidence of an associative effect on completion following rating of anomalous sentences. Collapsed across the two retention intervals, completion rate was .22 in the same-context condition and was .18 in the different-context condition. Performance in the same- and different-context conditions was virtually identical on the immediate test; the slight advantage for same-context items is entirely attributable to the delayed test.

An ANOVA revealed significant main effects for both comple-

tion test context, $F(1, 46) = 9.97$, $p < .05$, $MS_e = 1.88$, and delay, $F(1, 46) = 5.51$, $p < .05$, $MS_e = 2.18$. More important, there was a significant interaction between test context and sentence type, $F(1, 46) = 3.80$, $p = .054$, $MS_e = 1.24$. The interaction indicates that completion performance was higher in the same- than different-context condition for meaningful sentences but not for anomalous sentences. Although there is some evidence of an associative effect for anomalous sentences tested at the 24-hour delay, the three-way interaction of Delay × Test Context × Study Task was not significant, $F(1, 46) = 2.04$, $MS_e = 1.24$. In addition, an analysis of completion performance for anomalous sentences tested at the long delay revealed a nonsignificant difference between the same- and different-context condition, $t(23) = 1.53$. These analyses indicate that the associative effect on word completion, as revealed by performance in the same-context condition, was influenced by sentence type. In contrast, the magnitude of priming in the different-context condition was unaffected by sentence type. On the immediate test, when performance was significantly above baseline, completion rates on different-context items were similar across sentence types, $t(23) < 1$. This pattern of results is consistent with findings from Experiments 1 and 2 indicating that performance in the different-context condition is not influenced by type of study task.

Paired-associate recall. The data in Table 5 indicate that cued-recall performance was higher for meaningful sentences than for anomalous sentences and was also higher on the immediate test than on the delayed test. An ANOVA revealed significant main effects for both sentence type, $F(1, 46) = 46.17$, $MS_e = 1.13$, and delay, $F(1, 46) = 22.10$, $MS_e = 2.37$, as well as a significant interaction between these variables, $F(1, 46) = 9.77$, $MS_e = 1.13$, all $ps < .05$. The interaction is probably attributable to a floor effect in recall of anomalous sentences on the delayed test. Recall intrusions occurred relatively infrequently in each experimental condition (Table 5). Although there is a trend toward more intrusions on the immediate test than on the delayed test, an ANOVA indicated that no effects approached statistical significance.

Overall, the main finding of Experiment 3 is that studying word pairs in anomalous sentences did not produce a significant associative effect on the completion test, whereas studying the pairs in meaningful sentences did. The overall pattern of findings thus suggests that encoding of a meaningful relation between two words is necessary to produce implicit memory of new associations. Encoding the meanings of the individual words without a meaningful relation between them, as was done in the anomalous sentences, does not produce implicit memory of new associations. These observations are consistent with all of the data reported in the present experiments and in our previous article (Graf & Schacter, 1985). However, they should be treated with some degree of interpretive caution: Although the immediate test yielded no evidence of an associative effect on completion performance following study of anomalous sentences, the delayed test showed a hint of such an effect. Moreover, it is possible that the unusual character of the anomalous sentences in some way altered how subjects processed the meanings of the target words and thus prevented them from encoding the meanings of the critical words in a manner that would support implicit memory for new associations. For example, when

Table 5
Paired-Associate Recall as a Function of Study Sentence and Time of Test in Experiment 3

Time of test/Study sentence	Type of response: Target words	Type of response: Intrusions
Immediate		
Meaningful	.30	.11
Anomalous	.10	.10
Delayed		
Meaningful	.11	.07
Anomalous	.04	.05

studying a sentence such as "the dusky SPEECH multiplied the EMPLOYER," subjects may not encode the meanings of the targets in the same way that they would if the pairs were presented alone, without an anomalous sentence context. In view of these considerations, we explored further whether encoding the meanings of the individual words in a pair can support implicit memory of new associations or whether elaborative processing of the relation between two words is required for implicit memory.

Experiment 4

Experiment 4 examined whether rating the pleasantness of each word in an unrelated pair is sufficient to produce an associative influence on the word-completion test. A pleasantness-rating task was used for two reasons. First, previous research has shown that pleasantness ratings are an effective method for inducing semantic processing of words (e.g., Hyde & Jenkins, 1973; Klein & Saltz, 1976). Second, this task avoids the potentially confounding effects of an anomalous sentence context discussed above. Thus, if encoding of the meanings of individual words is sufficient to produce implicit memory of new associations, a significant associative influence on completion performance should be observed after subjects perform the pleasantness-rating task. For comparative purposes, the sentence-generation task from Experiments 1 and 2 was also used.

Method

Subjects. Thirty-two University of Toronto undergraduates either were paid $3.00 or received course credits for participating in the experiment.

Design and materials. The main experimental design consisted of one between-subjects factor and one within-subjects factor. The between-subjects factor was type of study task (pleasantness rating vs. sentence generation); the within-subjects factor was type of completion-test context (same vs. different). Explicit remembering was investigated with a paired-associate test that was administered after the completion test.

The experimental materials and counterbalancing of materials across conditions were the same as described for Experiment 1.

Procedure. Subjects in the sentence-generation condition were given the same instructions as in Experiment 1. The study and testing procedures in the sentence-generation condition were also identical to those in Experiment 1. Subjects in the pleasantness-rating condition were told that they would be shown a series of word pairs and that their memory

for the pairs would be tested. They were further instructed that they would be required to study the list items by rating the pleasantness of the individual words in each pair. Subjects were then instructed in the use of a 5-point scale indicating that the word was *extremely unpleasant* (1) to *extremely pleasant* (5). They were encouraged to discriminate among even subtle differences in pleasantness and were also told to make their ratings for each word in a pair independently of the other word. A practice pair was presented to illustrate the nature of the task. The 24 critical pairs were then presented at a rate of 6 s per pair. Subjects were required to read each pair aloud, and at the end of the 6 s, the experimenter asked for the pleasantness ratings of the cue and the target, respectively. After the conclusion of the study list, subjects were given the city-generation, word-completion, and cued-recall tests in the same manner as were subjects in the sentence-generation condition.

Results and Discussion

Word completion. Baseline probability of completing a fragment with a target was .10 in both the same- and different-context conditions.

Consistent with the results of the preceding experiments, there was evidence of an associative effect on completion performance following the sentence-generation task (Table 6): Probability of completion was higher in the same-context condition (.40) than in the different-context condition (.23). In contrast, there was much weaker evidence of an associative effect following pleasantness rating: Subjects completed .29 of fragments with list targets in the same-context condition and completed .25 with targets in the different-context condition. An ANOVA revealed a marginally significant Study Task × Completion Test Context interaction, $F(1, 30) = 2.84$, $p = .09$, $MS_e = 2.92$. Planned comparisons indicated that in the pleasantness-rating condition, probability of completion in the same versus different contexts did not differ, $t(15) = 1.19$, whereas in the sentence-generation condition completion probability in the same versus different contexts differed significantly, $t(15) = 2.60$, $p < .05$. This pattern of results indicates that encoding the meanings of the individual words in a pair is not sufficient to produce implicit memory of new associations. As in previous experiments, however, encoding a meaningful relation between two words is sufficient to produce implicit memory of new associations.

When fragments were tested in a different context, completion rate in the sentence-generation and pleasantness-rating conditions did not differ significantly, $t(30) < 1$. For both study tasks, however, the amount of priming in the different-context condition exceeded the baseline level, $t(15) = 4.04$ and 3.58, $ps < .05$, for the sentence-generation and pleasantness-rating tasks, respectively.

Cued recall. Type of study task had a large effect on paired-associate recall. Subjects in the sentence-generation condition recalled significantly more items (.63) than did subjects in the pleasantness-rating condition (.18), $t(30) = 8.25$, $p < .05$. Intrusion errors occurred infrequently and equally often in the two conditions (.05 for both sentence generation and pleasantness rating.)

Table 6
Word-Completion Performance as a Function of Study Task and Test Context in Experiment 4

	Test context		
Study task	Same	Different	*M*
Sentence generation	.40	.23	.32
Pleasantness rating	.29	.25	.27
M	.34	.24	

General Discussion

The results of the present experiments have revealed both similarities and differences between implicit and explicit memory for new associations. Experiments 1 and 2 demonstrated that type of associative elaboration had little effect on implicit memory for new associations and that even a small degree of elaboration of word pairs is sufficient to observe implicit memory for new associations. Experiments 3 and 4 extended this finding by showing that whereas encoding a meaningful relation between two words produced a large associative influence on word-completion performance, semantic processing of the individual members of a word pair, without encoding a meaningful relation between them, produced little or no evidence of an associative effect. These results suggest that the associative elaboration entailed in encoding a meaningful relation between two randomly paired words is critical for establishing implicit memory of new associations.

Explicit memory for new associations, like implicit memory, also depended on the encoding of a meaningful relation between two words; cued-recall performance was much lower when subjects did not encode meaningful relations than when they did (Experiments 3 and 4). In addition, both implicit and explicit memory for new associations declined across a 24-hr retention interval (Experiments 2 and 3). However, Experiments 1 and 2 also provided evidence of a dissociation between implicit and explicit memory: Type of associative elaboration affected explicit memory for newly acquired associations but had either little or no effect on implicit memory. This pattern of results was most striking in Experiment 2. On both letter-cued recall and paired-associate tests, and at both immediate and 24-hr delays, subjects recalled nearly twice as many target words following sentence generation as compared to sentence rating. Yet word-completion performance was not significantly affected by type of study task at either test delay.

In view of the finding of similarities between word-completion performance and letter-cued recall and paired-associate performance, it can be questioned whether the phrase "implicit memory for new associations" should be used to describe word-completion performance. That is, because associative effects on completion performance seem to depend on some of the same factors as recall performance, we must consider the possibility that subjects engaged in intentional or deliberate retrieval of study-list targets on the completion test and did not simply write down the first word that popped into their minds. It is possible, for example, that once subjects had completed a few items correctly, they caught on to the fact that study-list items were included on the completion test and then engaged in explicit retrieval activities. Such explicit retrieval processes would be particularly likely to occur in the same-context condition,

which provided extensive cue information that may have enabled subjects to readily think back to the study list. Thus, the associative effect on completion performance may have depended on explicit memory and not implicit memory.

Contrary to the foregoing suggestions, however, several lines of evidence converge to support the notion that the associative effect on completion performance represents an implicit expression of memory. First, if subjects were using explicit memory on the completion test, type of associative elaboration should have influenced performance significantly, as was observed on the letter-cued recall test, particularly in Experiment 2. However, we obtained no such evidence. Second, we found that performance on the letter-cued recall test was significantly higher than performance on the completion test (Experiments 2 and 3). Had subjects been engaging in explicit retrieval throughout the completion test, such a difference should not have been observed. Third, if subjects at some point caught on to the nature of the completion test, and then engaged in explicit remembering for the remainder of the test, there should be some evidence that completion rate was higher near the end of the test than near the beginning. We evaluated this possibility by analyzing completion performance on items that appeared early on the test (the first three critical items) or late on the test (the last three critical items). There was no systematic evidence of different levels of performance on these two subsets of items. For example, in the same-context condition of Experiment 1, completion rate for items that appeared early in the test was .42 in the sentence-generation group and .40 in the word-generation group. The corresponding values for items that appeared late in the test were .37 in both groups. In Experiment 2, on the immediate test, completion of items tested early was .33, whereas completion of items tested late was .31; the corresponding values from the delayed test were .19 and .21. Even when analysis was restricted to the first critical item that appeared on the completion test, there was no evidence of a systematic deviation from the overall mean level of performance for a particular condition.

Finally, relevant evidence concerning the implicit/explicit nature of the completion test was provided by informal postexperimental interviews with subjects. Subjects who participated in immediate tests stated that though they sometimes realized that they had completed items with study-list targets, they continued to write down the first word that came to mind, as they had been instructed to do. Subjects who participated in the 24-hr delay condition frequently indicated that they were not aware of any relation between the completion test and the study list. Yet they showed a comparable associative influence on completion performance.

The foregoing considerations converge on the idea that the associative effect on word-completion performance observed in the present experiments represents an implicit expression of memory. Thus, these data replicate and extend the results of our previous experiments (Graf & Schacter, 1985), as well as other observations of implicit memory for new associations that have been reported with reading, listening, and lexical decision tests (Carroll & Kirsner, 1982; Franks et al., 1982; McKoon & Ratcliff, 1979; Moscovitch, 1984).

The finding that both implicit and explicit memory for new associations required elaboration of meaningful relations, in conjunction with the observation that both show some decline over a retention interval, suggests that a common underlying representation may be involved in both types of memory (cf. Jacoby, 1983). However, we also observed that type of associative elaboration had quite different effects on the implicit and explicit expression of a newly acquired association. It is possible that these differences are attributable to the different retrieval processes required for implicit and explicit memory tests. In addition, however, we would also hypothesize that implicit and explicit memory for new associations depend on distinct and dissociable components of the representation established by elaborative processing. We cannot yet say very much about the exact nature of the representational components that are critical for implicit memory, nor can we specify how they are related to the components of a memory representation that support explicit remembering. The general idea, however, is consistent with several other findings concerning implicit memory for new associations. First, we have recently found that associative influences on word-completion performance are unaffected by retroactive and proactive interference manipulations that have a significantly detrimental effect on letter-cued recall (Graf & Schacter, in press). These findings suggest that the components of the memory representation that underlie implicit memory for new associations may not be susceptible to interference, whereas the components that support explicit remembering are susceptible to interference.

Second, as noted earlier, we found that amnesic patients showed an associative influence on word-completion performance despite their low level of explicit remembering. In more recent research, however, we have found that this associative influence does not seem to occur in patients with the most severe forms of amnesia, but is observed in patients with mild-to-moderate amnesia (Schacter & Graf, in press). This latter group of patients, though characterized by low levels of performance on paired-associate and letter-cued recall tests, may be able to establish the components of a new representation that support implicit memory for new associations, perhaps because they require only low degrees of elaboration. Severely amnesic patients, however, may be unable to establish even those components of a representation that are necessary for implicit memory of new associations.

The present experiments also provide further evidence that implicit memory effects cannot be attributed entirely to the activation of preexisting representations (e.g., Diamond & Rozin, 1984; Graf et al., 1984; Graf & Mandler, 1984; Mandler, 1980; Morton, 1969; Rozin, 1976), because newly acquired associations have no preexisting, unitized representations as pairs in long-term memory that can be activated during list presentation. However, in view of evidence that is consistent with an activation view (e.g., Cermak, Talbot, Chandler, & Wolbarst, 1985; Diamond & Rozin, 1984; Graf & Mandler, 1984; Mandler, 1980; Schacter, 1985a), it would probably be incorrect to exclude activation as a major factor in implicit memory. Instead, it seems reasonable to postulate two varieties or types of implicit memory effects. One type involves the automatic activation of preexisting representations; it occurs independently of elaborative activities, is preserved in even severely amnesic patients (cf. Schacter & Graf, in press), and may be relatively short-lived, lasting for perhaps several hours (cf. Diamond

& Rozin, 1984; Graf & Mandler, 1984). The second type involves the establishment of new memory representations; it requires at least some degree of elaborative processing, is preserved in only mild-to-moderately amnesic patients, and may be relatively long-lived, lasting for days or even weeks (cf. Experiments 2 and 3; Jacoby, 1983; Tulving et al., 1982). Associative effects on the performance of word-completion, lexical decision, and reading or listening tests represent an example of this latter type of implicit memory.

Our experiments and discussion have been largely concerned with the elaboration-dependent, associative effects on implicit memory that are observed in the same-context condition of the completion test. However, the results observed in the different-context condition of our experiments may also shed light on the activation component of implicit memory. Elsewhere we have presented evidence that priming in the different-context condition resembles priming or activation of familiar words (Graf & Schacter, 1985, Experiment 1). The present results indicate that completion performance in the different-context condition was not influenced significantly by any study-task manipulations. To the extent that performance in the different-context condition depends on activation of target words, these data extend previous observations that activation of preexisting representations does not depend on type of encoding activity (cf. Graf & Mandler, 1984). Note, however, that performance in the different-context condition of the letter-cued recall task was also not influenced by type of study task (Experiments 1 and 2). Thus, it is possible that type of associative elaboration does not affect either implicit or explicit memory when target words appear in a test context that differs from the study context.

In summary, the present research has revealed that elaboration of meaningful relations plays an important role in both implicit and explicit memory for new associations, whereas more extensive associative elaboration benefits explicit but not implicit memory. A major challenge for further research will be to characterize more precisely those consequences of elaborative processing that are common to both implicit and explicit expressions of memory and those that are uniquely involved in either type of memory.

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Received February 15, 1985
Revision received November 4, 1985 ■