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COMMENTARY

# Preserved Learning in Amnesic Patients: Perspectives from Research on Direct Priming*

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## ABSTRACT

An important source of evidence for preserved learning ability in amnesic patients is provided by the phenomenon of *repetition* or *direct priming:* the facilitative effect of an encounter with an item on subsequent processing of the same item. In this article we consider a series of experiments that have attempted to clarify the nature of priming in amnesic patients and normal subjects. The experiments indicate that there may be two varieties of priming, one dependent upon the activation of preexisting memory representations, the other dependent upon newly formed memory representations. We suggest that the former type of priming is preserved even in severely amnesic patients, whereas the latter may be preserved only in mildly-to-moderately amnesic patients. Implications of research on preserved learning for the development of remedial strategies are also discussed.

A defining characteristic of organic amnesia is an inability to recall and recognize recent events. Yet it has been known for many years that even densely amnesic patients possess some learning abilities. This observation was first reported in the early 20th century by clinical investigators who noted that amnesic patients are capable of learning new information, in spite of their inability to recollect the episode in which they acquired it (e.g., Claparède, 1911; MacCurdy, 1928). More recently, experimental studies have extended these

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clinical observations by demonstrating that some aspects of learning and memory are entirely normal in amnesic patients, thereby suggesting that certain memory processes or systems are spared in organic amnesia (e.g., Brooks & Baddeley, 1976; Cermak, Talbot, Chandler, & Wolbarst, 1985; Cohen & Squire, 1980; Graf, Squire, & Mandler, 1984; Kinsbourne & Wood, 1975; Milner, Corkin, & Teuber, 1968; Moscovitch, 1982; Rozin, 1976; Schacter, 1985a; Schacter & Tulving, 1982; Shimamura & Squire, 1984; Squire, Shimamura, & Graf, 1985; Warrington & Weiskrantz, 1974, 1982). This selective preservation of memory functions has important implications for the understanding of memory disorders, for theories of normal memory, and also for the development of effective remedial strategies (e.g., Cermak, 1984; Cohen, 1984; Jacoby, 1984; Moscovitch, 1984; Parkin, 1982; Schacter & Glisky, 1986; Squire & Cohen, 1984; Tulving, 1983; Wickelgren, 1979).

The present article is concerned with the phenomenon known as *repetition* or *direct priming* (cf. Cramer, 1966), which has provided some of the key evidence for preserved memory ability in amnesia. Direct priming refers to the facilitative effect of an exposure to an item on subsequent processing of the same item. Priming is observed on a class of memory tests that differs from standard memory tasks, such as free recall, cued recall, and recognition. On standard memory tasks, subjects are instructed explicitly to retrieve information that was acquired during a recent learning episode. In contrast, priming tests do not make explicit reference to any particular experience; memory is expressed by a performance facilitation that need not be accompanied by any recollection of a specific prior experience. We have used the descriptive terms *explicit* and *implicit* to distinguish between the two forms of memory that are tapped by recall and recognition tests on the one hand, and by priming tests on the other (Graf & Schacter, 1985). An example of the latter type of task is the *word-completion test.* This test presents subjects with letter fragments of recently exposed words and new words (e.g., CHA__ for CHAIR), and requires them simply to complete each fragment with the first word that comes to mind. Studies of college students have demonstrated that subjects show an enhanced tendency to complete test fragments with recently exposed words (e.g., Graf & Mandler, 1984; Tulving, Schacter, & Stark, 1982). More importantly, it has been found that the magnitude of this priming effect is comparable in normal subjects and amnesic patients, even though patients show a severe deficit on explicit recall and recognition tests (e.g., Diamond & Rozin, 1984; Graf et al., 1984; Rozin, 1976; Warrington & Weiskrantz, 1968, 1974). Amnesic patients have also demonstrated intact priming on various other tests that tap memory implicitly (e.g., Cermak et al., 1985; Jacoby & Witherspoon, 1982; Moscovitch, 1982; Schacter, 1985b; Shimamura & Squire, 1984).

The results of the foregoing studies have established that priming occurs normally in amnesic patients under a variety of conditions. Nevertheless, fundamental questions concerning the phenomenon remain unresolved: (1) Are all aspects of priming spared in amnesia? (2) What memory processes underlie

priming effects? (3) What is the relation between the memory processes involved in priming and those involved in explicit remembering? In this article, we will describe a series of experiments that were conducted in order to gain insight into these questions.

**Does Priming Reflect the Activation of Existing Memory Structures?**

The starting point for our series of experiments was an attempt to evaluate a widespread interpretation of priming effects that is known as the *activation* view. This view holds that priming is mediated by the temporary activation of preexisting memory representations (e.g., Graf et al., 1984; Mandler, 1980; Morton, 1969; Rozin, 1976). In most of the experiments on direct priming, subjects studied familiar items, such as individual words, that were represented in long-term memory prior to their appearance in a study list. It has been argued that presentation of an item activates its preexisting memory representation, and that this activation occurs independently of the processes that mediate explicit remembering. By this view, it is the process of activation that is spared in amnesics, and that underlies their intact performance on a test such as word-fragment completion (cf. Diamond & Rozin, 1984; Graf et al., 1984; Rozin, 1976; Warrington & Weiskrantz, 1982; Wickelgren, 1979).

Two types of evidence provide direct support for an activation interpretation of priming effects. First, after studying highly related paired associates (e.g., table – chair; Shimamura & Squire, 1984) or linguistic idioms (e.g., sour grapes; Schacter, 1985b), amnesic patients show intact priming when they are given the first word of the pair on a free-association test. This outcome is expected by an activation view, because highly related paired associates and linguistic idioms presumably have preexisting representations or associations in memory that can be activated by the appearance of these items in the study list. Second, patients show little or no priming on completion and identification tests after studying pseudowords (e.g., *numdy).* This outcome, too, is expected by an activation view, because pseudowords have no preexisting memory representation that can be activated (Cermak et al., 1985; Diamond & Rozin, 1984; Rozin, 1976).

In order to explore further an activation view of priming, we adopted a somewhat different strategy than that used in previous studies. Our approach was to examine whether priming effects on a word-completion task are influenced by newly acquired associations between normatively unrelated words. The reasoning behind this strategy is straightforward. Normatively unrelated words (e.g., WINDOW – REASON) do not have a preexisting long-term memory representation as pairs that can be activated; a new association between the two words must be constructed during a study trial. Consequently, an activation view would predict that priming effects on tasks such as word completion should not be influenced by such newly acquired associations; if priming were influenced by newly acquired associations, it would suggest that something more is involved in priming than activation of preexisting representations.

**Implicit Memory for New Associations**

In an attempt to evaluate the activation interpretation of priming effects, we conducted an experiment in which amnesic patients and normal subjects studied unrelated word pairs that had no preexisting association in memory (e.g., WINDOW - REASON). After studying the word pairs, subjects were given a word-completion test which presented the first three letters of the response word (e.g., REA__for REASON). Subjects were instructed to complete these fragments with the first word that came to mind. To determine whether newly acquired associations between the unrelated words affected completion performance, we compared completion of word fragments that appeared on the test together with the paired word from the study list (e.g., WINDOW-REA____; *same-context condition*) or with another word (e.g., RIPE - REA____; *different-context condition*). On the basis of previous research concerning priming of individual words, we expected that the appearance of a response word on the study list would produce some priming effects in both the same- and different-context conditions. The critical question, however, was whether there would be *more* priming in the same-context condition than in the different-context condition. If newly acquired associations contribute to priming, test fragments should be completed with words from the study list more often in the same-context than in the different-context condition. If, however, newly acquired associations do not contribute to priming, test fragments should be completed with study-list words equally often in the same- and different-context conditions. It is the latter of these two hypothetical outcomes that would be expected by an activation view of priming.

Twelve amnesic patients with mixed etiologies participated in the experiment, including closed-head injuries, ruptured anterior communicating artery aneurysms, encephalitis, and third ventricle tumor. Although the overall severity of patients' memory disorders varied, all of them had serious difficulties on standard tests of associative recall (see Graf & Schacter, 1985, for further details). Also participating in the experiment was a group of 12 control subjects who were matched to the amnesic patients for age, education, and IQ, and a group of 24 college students. All subjects were shown a list of 12 normatively unrelated word pairs and were required to generate a brief sentence that linked each word pair in a meaningful manner. After studying the list and engaging in a 2-minute distractor task, the word-completion test was given. This was followed by a standard test of explicit remembering in which the first word of the pair was provided (e.g., WINDOW - ____), and subjects were asked to try to remember the second word.

The relevant results of the word-completion test are depicted in Figure 1. There are three important points to note about these data. First, there is about a 10% chance or baseline probability of completing test fragments with target words even without a study list presentation. This baseline completion rate is represented by the broken line in Figure 1. Second, in the different-context condition, probability of completing a fragment with a study-list target in-

creased to about 20%, and performance of the three subject groups did not differ. This increase in completion performance relative to the baseline condition is attributable to repetition priming of the individual target words. Third, subjects completed significantly more test fragments in the same-context condition (about 30%-35%) than in the different-context condition, and the magnitude of this effect was comparable across the three subject groups. These data show that newly acquired associations affected the magnitude of priming on the word-completion test, and therefore are not consistent with the activation view.

In contrast to their intact performance on the word-completion task, amnesic patients were severely impaired on the cued-recall test in which explicit remembering was required. The contrast between word-completion and cued recall performance is depicted graphically in Figure 2, which displays the results from the same-context condition of the word-completion test together with the results of the cued-recall test. The figure highlights the similarity among the three groups on the completion test and the differences among groups on the recall test.



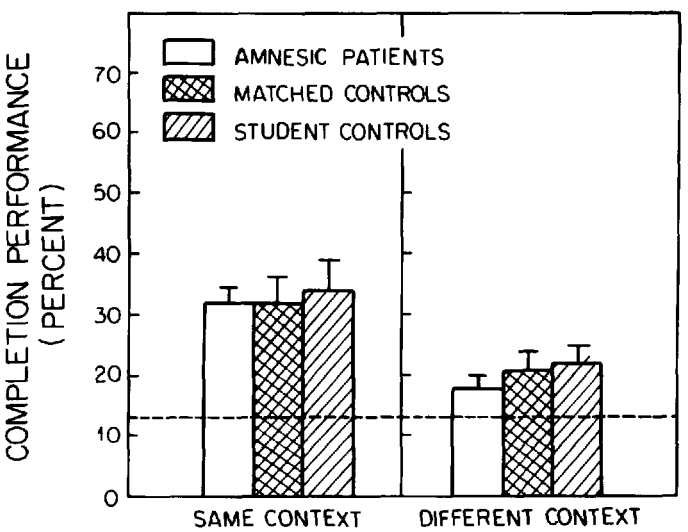


Figure 1. Mean word-completion performance for unrelated pairs in amnesic patients, matched controls, and student controls. The completion test presented the initial three letters of the response word from each study-list pair, either with the paired stimulus word from the study list (same context) or with another word (different context). A separate control group was used to obtain an estimate of baseline completion performance on the target response words, shown by the dashed lines. Vertical bars show the standard errors of the means.

The finding that amnesic patients showed implicit memory for new associations on the word-completion test is consistent with the results of other studies in which amnesics have exhibited some evidence of associative learning (e.g., Moscovitch, 1984; Schacter, Harbluk, & McLachlan, 1984; Weiskrantz & Warrington, 1979). However, in view of the fact that a severe deficit in the acquisition and retention of new associations has long been considered a hallmark of organic memory disorders (Rozin, 1976; Wechsler, 1917), our results are quite surprising. In order to gain a more detailed understanding of the processes underlying implicit memory for new associations, and thereby provide a firmer basis for interpreting the theoretical implications of the phenomenon in amnesic patients, we have explored the conditions under which implicit memory for new associations can be observed in normal subjects.

**Effects of Elaboration and Interference on Implicit Memory for New Associations**

One of the more striking demonstrations of a dissociation between priming and remembering is provided by studies of normal subjects that have examined the effects of elaborative processing on implicit and explicit memory tests. It is well known that explicit recall and recognition benefit substantially from elaborative processing during study (e.g., Cermak & Craik, 1979). For example, memory performance is considerably higher when subjects make semantic judgments about a word during study than when they simply count the number of vowels or consonants in it. In contrast, several studies have shown that the magnitude of priming effects on word-completion and other implicit memory tests is

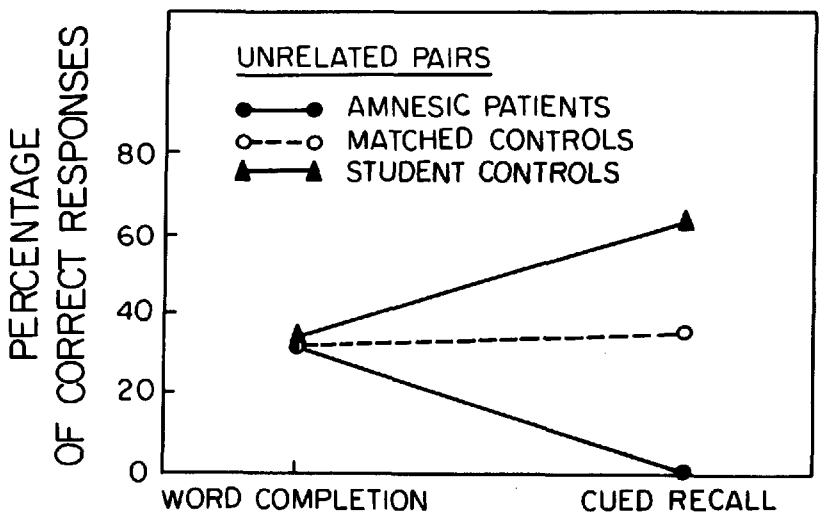


Figure 2.

Mean word-completion performance for unrelated pairs in the same-context condition, along with mean cued-recall performance, for the three subject groups.

largely unaffected by elaborative processing relative to nonelaborative processing (Graf & Mandler, 1984; Graf et al., 1984; Jacoby & Dallas, 1981; Schacter, 1985a).

The invariance of priming across study task manipulations has been interpreted by some investigators as evidence that performance on implicit memory tests depends upon a different memory representation than does performance on explicit tests (e.g., Graf et al., 1984). Note, however, that this invariance has been observed in experiments in which subjects studied familiar items that have preexisting memory representations, such as words and idioms. We have recently attempted to determine whether implicit memory for new associations, like implicit memory for items with preexisting representations, is also unaffected by elaborative vs. nonelaborative processing activities (Graf & Schacter, 1985). The relevant experiment was similar in most respects to the one described in the previous section, except that the type of study task was varied. In the elaborative condition, subjects were shown pairs of unrelated words and generated a sentence that linked each word pair in a meaningful manner. In the nonelaborative condition, subjects were required to compare the number of vowels in each word of the pair. Word-completion tests were then administered in which three-letter fragments of target words appeared either in the same- or different-context condition. The critical question was whether an associative influence on completion performance – more priming in the same- vs. the different-context condition – would be observed in both experimental conditions, or only in the elaborative condition. The results were clear-cut: Following the elaborative study task, performance in the same-context condition was significantly higher than in the different-context condition; following the nonelaborative task, there was no difference between the two conditions.

The dependence of implicit memory for new associations on elaborative processing contrasts with the aforementioned finding that implicit memory for items with a preexisting representation is largely independent of elaborative vs. nonelaborative processing activity. In view of the extensive evidence that elaborative processing is a powerful determinant of explicit remembering, our findings suggest that implicit memory for new associations may be mediated by some of the same processes that underlie explicit remembering.

The results of two further experiments with college students are consistent with this hypothesis. In one experiment (Schacter & Graf, 1986), subjects were exposed to unrelated word pairs, and they either performed the sentence-generation task used in the previously discussed experiments, or they rated the pleasantness of each word in a pair. This latter task was used in an attempt to determine whether semantic processing of the individual words in a pair would be sufficient to support implicit memory for new associations. The results, however, indicated a same/different effect in word-completion performance was observed only when subjects had engaged in the sentence-generation task at the time of study; there were similar amounts of priming in the same- and different-context conditions following the pleasantness-rating task. Explicit remember-

ing, too, depended on type of study task: Cued-recall performance in the sentence-generation condition was considerably higher than in the pleasantness-rating condition. In another experiment, subjects studied sentences that linked a normatively unrelated word pair in a meaningful manner (e.g., The thirsty COW drank from the BARREL) or an anomalous manner (e.g., The lazy COW invented a BARREL). On the subsequent word-completion task, performance was higher in the same-context condition (e.g., COW - BAR____) than in the different-context condition (e.g., MOTHER - BAR____) for pairs that had been studied in meaningful sentences, but there was no such same/different effect for pairs studied in anomalous sentences. Cued-recall performance was also higher following study of meaningful vs. anomalous sentences. In both of these experiments, then, implicit memory for new associations was observed only when subjects encoded a meaningful relation between the two critical words.

The foregoing results, taken together with the findings of the previously described experiment with amnesic patients, constitute something of an interpretive puzzle. On the one hand, implicit memory for new associations seems to depend upon the same kind of elaborative processing that underlies explicit remembering. Performance on both word-completion and cued-recall tests was higher when subjects encoded the paired words into a meaningful or coherent unit (i.e., sentence generation, rating of meaningful sentences) than when they did not (i.e., vowel comparison, pleasantness rating, rating of anomalous sentences), suggesting that newly formed representations underlie performance on both tests. On the other hand, amnesic patients, who have little capacity for explicit remembering of new associations, showed implicit memory for new associations. If both implicit and explicit memory for new associations depend upon a common episodic representation that is established by elaborative processing, what enables amnesic patients to show intact implicit memory despite their impaired explicit memory?

One possible explanation of this puzzle is that amnesic patients suffer from a selective inability to retrieve information acquired during recent episodes. That is, amnesics may store and retain information just as normal subjects do, but are unable to initiate deliberate or intentional retrieval processes that are necessary to gain access to stored information. When the requirement for intentional retrieval is bypassed, such as on the word-completion test, amnesics can express the information that they have encoded and stored (e.g., Jacoby, 1984). Although such an interpretation cannot be rejected out of hand, there are a number of serious problems with it that have been discussed elsewhere (e.g., Cohen, 1984; Schacter, 1985b; Squire & Cohen, 1984).

We cannot yet offer a resolution to this puzzle. However, the results of additional experiments concerning the effects of elaborative processing and interference on implicit and explicit memory have yielded several clues that may help us to do so. Consider first the findings of an experiment in which we compared the effects of the sentence-generation task and the rating of meaningful sentences task on word-completion and cued-recall performance. It is well

known that more extensive elaboration often occurs when subjects generate elaborators, as in the sentence-generation task, than when they are provided with them, as in the sentence-rating task; explicit recall and recognition benefit substantially from active elaboration during study (e.g., Slamecka & Graf, 1978). We therefore expected that cued-recall performance would be higher when subjects generated sentences for unrelated word pairs than when they rated sentences that linked the pairs in a meaningful manner. The results of the experiment were consistent with this expectation: Students remembered about twice as many items in the sentence-generation condition as in the sentence-rating condition. In contrast, there were similar amounts of priming on the word-completion test in the sentence-generation and sentence-rating conditions.

Further evidence that implicit and explicit memory can be dissociated is provided by experiments that examined the effects of interference on word-completion and cued-recall performance (Graf & Schacter, in press). In these experiments, subjects were first shown a list of unrelated word pairs and generated sentences for each pair. In the *interference* condition, the first word of the pair appeared on five subsequent lists together with different response terms (e.g., MAIL - FORMULA, MAIL - FATHER, MAIL - DINNER, MAIL - DRINK, MAIL - FRIEND, MAIL - POCKET). In the *control* condition, a critical pair appeared only on the first list, and did not appear again on subsequent lists. Memory was then tested by providing the first word of the pair together with the initial three letters of the second word, and requiring subjects to write down the first word that came to mind on the completion test, or to try to remember the appropriate study-list word on the cued-recall test. Not surprisingly, we found that cued-recall performance was significantly lower in the interference condition than in the control condition. This finding is consistent with a vast literature that has demonstrated interference effects on associative recall tests. More importantly, however, we found that priming effects on the word-completion test were largely unaffected by interference: Subjects completed significantly more target fragments with study-list words in the same-context than in the different-context condition, and the amount of priming was similar in the interference and control conditions.

The observation that manipulations of elaboration and interference have dissociable effects on implicit and explicit memory for new associations provides one clue regarding the interpretive puzzle that we posed earlier. Although, as discussed previously, both implicit and explicit memory for new associations seem to depend upon a new representation that is established by encoding of meaningful relations between two words, the observed dissociations suggest that they are supported by very different components of this representation. The components that support explicit remembering benefit from increasing degrees of elaborative processing and are susceptible to interference, whereas the components that support implicit memory for new associations are not susceptible to interference, and appear to be uninfluenced by elaborative pro-

cessing activity above and beyond that which is involved in the encoding of a meaningful relation between two words. It seems plausible to suggest that at least some amnesic patients are able to establish the components of a memory representation that are produced by relatively low degrees of elaboration, and that support implicit memory for new associations, even though they are unable to store those components of a representation that are produced by more extensive elaborative processing, and that support explicit remembering.

**Severity of Amnesia and Implicit Memory for New Associations**

Although the foregoing ideas are no more than suggestive hypotheses, they contain an interesting implication that we are just now beginning to pursue. If implicit memory for new associations depends upon a component of a representation that is involved in explicit remembering, then the phenomenon may be observed more readily in patients who are characterized by mild-to-moderate amnesia than in patients with severe amnesia. That is, patients with mild-to-moderate amnesia may be able to establish those components of a memory representation that support implicit memory for new associations, whereas even this ability may be compromised in patients with severe amnesia. We found some suggestive support for this hypothesis when we reanalyzed data from our initial study of implicit memory for new associations in amnesic patients. We performed a post-hoc classification in which the 12 patients who participated in the experiment were divided into two groups: those who showed more priming in the same- vs. different-context condition of the completion test (seven patients), and those who showed no difference between the two conditions or showed more priming in the different-context condition (five patients). To obtain a rough estimate of severity of amnesia in the two groups, we then examined the split between patients' IQ on the WAIS - R and their MQ on the WMS. Although the IQ-MQ split is at best a crude index of severity (Weiskrantz, 1985), there was a suggestive difference between the two groups: Patients who showed the same/different effect in word completion tended to have a smaller split (mean IQ = 89.4; mean MQ = 82.4) than did patients who failed to show a same/different effect (mean IQ = 99.6; mean MQ = 80.0). The magnitude of the IQ-MQ split in all of our patients is somewhat reduced because IQ on the WAIS—R, which we have used, is typically 7-8 points lower than on the WAIS (Prifitera & Barley, 1985; Wechsler, 1981). If we adjust for this difference, it can be seen that even our mildly impaired patients have substantial splits. Moreover, these patients performed poorly on standard paired-associate learning tests, averaging 0.8 items recalled on the hard associates of the WMS, and had memory problems that were serious enough to impair numerous aspects of everyday functioning. Nevertheless, these patients were not afflicted by the almost total inability to remember recent events that characterized the most severely impaired patients in this study.

In an attempt to explore more directly whether implicit memory for new associations depends upon severity of amnesia, we have conducted an experi-

ment that contrasts the performance of four mildly amnesic patients with that of four severely amnesic patients. Patient characteristics are displayed in Table 1. The mildly amnesic patients had relatively small IQ-MQ splits (note again that WAIS – R scores should be adjusted 7-8 points upward for comparison with traditional IQ-MQ splits), and also had some ability to recall and recognize recent events from everyday life. However, these patients performed poorly on the delayed tests of the WMS, recalling an average of 1.8 items on the logical memory subtest, 2.4 items on visual reproduction, and 0.5 items on hard associates. All of the mildly amnesic patients had intact linguistic functions, performing normally on the Token Test and the Benton Visual Naming Test. The patients whom we labelled severely amnesic had much larger IQ-MQ splits (Table 1), scored zero on all WMS delayed tests, and had little or no ability to recollect the events of daily life. These patients, for example, did not remember their many prior visits to the laboratory, whereas the patients with milder memory problems usually did. The severely impaired patients had IQs in the normal range, and performed within normal limits on the Token Test and the Benton Visual Naming Test, with the exception of an encephalitic patient who had problems on the Benton Test but was not characterized clinically as anomic (she scored 40 on the Benton Test, where 50 is the cut-off for normal performance).

The experiment was in most respects similar to our initial study: Patients were shown a short list of unrelated word pairs, generated sentences to link the words in each pair, and then were given a word-completion test in which half of the pairs appeared in the same context and half appeared in a different context. In this experiment, however, each patient was exposed to and tested on four different lists. This procedure was used in an attempt to generate reasonably stable data for individual patients. The experiment was counterbalanced such that all target

Table 1

Characteristics of Amnesic Patients

| | Diagnosis | | Age | IQ (WAIS – R)[a] | MQ (WMS)[b] |
|---|---|---|---|---|---|
| Mildly Amnesic | 1. | Head injury | 22 | 86 | 83.5 |
| | 2. | Head injury | 22 | 83 | 75 |
| | 3. | Head injury | 25 | 89 | 82 |
| | 4. | Aneurysm | 61 | 99 | 96 |
| | | M | 32.5 | 89.3 | 84.1 |
| Severely Amnesic | 1. | Head injury | 33 | 88 | 79.5 |
| | 2. | Head injury | 27 | 86 | 61.5 |
| | 3. | Encephalitis | 31 | 82 | 61 |
| | 4. | Anoxia | 56 | 99 | 85 |
| | | M | 36.8 | 88.8 | 71.8 |

*Note.* [a] Wechsler Adult Intelligence Scale—Revised; [b] Wechsler Memory Scale

words appeared equally often in the same- and different-context conditions for both patient groups. Patients studied and were tested on an initial list, engaged in various other tasks for 30-60 min, and then received the second list. This procedure was repeated for the third and fourth lists in a separate session that was usually conducted about a week after the first session.

The results for each of the patients in the two groups are displayed in Table 2. The first point to note is that the mildly amnesic patients showed a consistent trend for more priming in the same- vs. the different-context condition, whereas the severely amnesic patients did not. The amount of priming shown by the mildly amnesic patients in the same-context condition was comparable to that shown by normal subjects with similar materials and tests. (We did not include a normal control group in this study, because pilot work indicated that with repeated completion tests, normals "catch on" to the fact that study-list items appear on the completion test, and thus transform it into a cued-recall test. See Graf et al. (1984) and Schacter (1985b) for discussion of this point.) Thus, the general pattern of results is consistent with the idea that implicit memory for new associations is related to severity of amnesia. However, the overall level of priming in the mild and severe patients did not differ, largely because the former group of patients showed less priming in the different-context condition than did the latter. In light of this somewhat puzzling result, we must be cautious about the theoretical implications of these data. Perhaps it is most appropriate to state that the results provide suggestive, though not conclusive, evidence that implicit memory for new associations occurs in mildly amnesic but not severely amnesic patients. It is entirely conceivable that even severely amnesic patients would show normal implicit memory for new associations under some experimental conditions (cf. Moscovitch, 1984).

Table 2

Proportion of Fragments Completed with Study-List Targets by Mildly and Severely Amnesic Patients

| | | Completion-test context | |
|---|---|---|---|
| | | Same | Different |
| Mildly Amnesic | 1. | .38 | .17 |
| | 2. | .29 | .17 |
| | 3. | .42 | .29 |
| | 4. | .29 | .25 |
| | M | .34 | .22 |
| Severely Amnesic | 1. | .38 | .46 |
| | 2. | .29 | .17 |
| | 3. | .29 | .33 |
| | 4. | .21 | .21 |
| | M | .29 | .29 |

The finding that only mildly amnesic patients showed a same/different effect while the overall level of priming was similar in the two groups, though puzzling, does suggest an interesting hypothesis. As noted earlier, we assume that priming effects in the different-context condition are attributable to activation of preexisting representations of target words during study-list presentation, an assumption that is borne out by evidence presented elsewhere (Graf & Schacter, 1985). Since priming effects were equivalent in the same- and different-context conditions in the severely amnesic patients, it seems reasonable to postulate that priming in these patients was mediated largely or entirely by the activation of preexisting memory representations. Thus, the finding that severely amnesic patients showed more priming in the different-context condition than did mildly impaired patients, and similar amounts overall, suggests that activation of preexisting memory representations occurs independently of severity of amnesia. This idea, in conjunction with the observation that priming or implicit memory of new associations may depend upon severity of amnesia, leads us to hypothesize that there may be two distinct types or varieties of priming effects (cf. Feustel, Shiffrin, & Salasoo, 1983; Schacter, 1985b). One type of priming reflects the activation of preexisting structures and is preserved in both mildly and severely amnesic patients; the other type depends on representations that are constructed by elaborative processing and is preserved only in milder cases of amnesia.

Although we recognize that the empirical grounds for postulating two types of priming effects are less than firm, the hypothesis does have a number of attractive implications that seem well worth pursuing. First, this idea may provide a basis for integrating the views of those who have suggested that priming is entirely an activation phenomenon (e.g., Graf et al., 1984; Mandler, 1980; Morton, 1979), and those who have suggested that it is entirely an episodic phenomenon (e.g., Jacoby, 1983). Second, the notion that one type of priming is severity-dependent and the other is severity-independent may encourage us to examine whether other preserved memory phenomena depend upon severity of amnesia and, more generally, to define precisely what we mean by "severity of amnesia." Although most investigators recognize that there is a sense in which some amnesic patients are more impaired than others, these differences are frequently ignored in theoretical discussions (for elaboration of this point, see Weiskrantz, 1985 and Zola-Morgan & Squire, 1985). To the extent that we can formulate a clear and empirically based conception of "severity of amnesia," comparison of the performance of mildly impaired and severely impaired patients may turn out to be a useful tool that can aid the interpretation of the theoretical significance of preserved memory phenomena. Third, the hypothesis that there are two types of priming effects may help us to resolve what appear to be empirical inconsistencies in the literature. For example, some studies have found that priming effects in word completion decay to baseline in about 2 hours (Graf & Mandler, 1984; Graf et al., 1984), whereas others have found no decay between 1 hour and 1 week (Tulving et al., 1982). Without going into all

the relevant differences between these studies, we would suggest that priming effects attributable to the activation of preexisting structures may decay rapidly within an hour or two, whereas priming that is attributable to a newly created representation may, under some conditions, persist over relatively long temporal intervals.

## CONCLUDING COMMENTS

In this article we have delineated several features of direct priming in amnesic patients and normal subjects, and have contrasted various theoretical interpretations of the data. Although it seems safe to conclude that some basic facts about the phenomenon have now been established, it is also clear that our current understanding of the memory processes that underlie priming, and that are preserved in amnesia, is quite rudimentary. Since systematic experimental investigations of the problem have appeared only recently, it should not be surprising that the current level of understanding is not terribly sophisticated (for more extensive discussion of theoretical issues, see Cohen, 1984; Jacoby, 1984; Parkin, 1982; Schacter, 1985b; Squire & Cohen, 1984; Warrington & Weiskrantz, 1982; Weiskrantz, 1985).

In spite of the fact that comprehensive theories of priming and preserved learning in amnesia have not yet been developed, this research may have some practical implications that are of interest to investigators concerned with the remediation of memory disorders. Most studies of memory remediation have examined whether patients' memory abilities can be improved in some general sense, either by repetitive drilling or by teaching of mnemonic strategies. These approaches have thus far met with little success (e.g., Schacter & Glisky, 1986). However, patients' preserved capacity for some form of learning provides a basis for formulating a different approach, one that does not attempt to restore memory function. This approach focusses on the *acquisition of domain-specific knowlege*–learning of a particular body of facts and skills that are necessary to perform a task or function in everyday life (Schacter & Glisky, 1986). It seems reasonable to suggest that amnesic patients' preserved abilities could be exploited to teach them skills and knowledge that would reduce the impact of memory disorder on a particular sector or domain of everyday life; learning how to perform a new job, or acquiring and retaining knowledge in an educational context, are just two examples of potential target domains. In an attempt to evaluate this possibility, Glisky, Schacter, and Tulving (1986a, 1986b) used a priming technique to teach amnesic patients new knowledge pertaining to the operation of a microcomputer, reasoning that such knowledge might enable patients to use the computer as an external memory aid. An initial study (Glisky et al., 1986a) demonstrated that with extensive repetition, patients could acquire a small vocabulary of computer-related terms and retain it over a six-week delay. A subsequent study (Glisky et al., 1986b) that used a similar priming

technique has revealed that patients can learn to use computer commands, write and edit programs, and perform disk storage and retrieval operations. Although Glisky et al. found that the knowledge acquired by amnesic patients differed in important respects from that acquired by normal subjects, these data do suggest that amnesic patients can acquire fairly complex forms of knowledge. A critical task for both theoretical and applied research will be to determine the limits to the kinds of knowledge that amnesics can acquire through priming techniques, and to provide a detailed characterization of exactly what it is that amnesic patients do learn. The results of such studies could both clarify the nature of patients' preserved learning abilities, and also help to reduce the impact of memory disorder in patients' everyday lives.



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