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Implicit memory: Effects of elaboration depend on unitization

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Previous research has demonstrated that performance on implicit memory tests such as word completion and identification does not require elaborative study processing, whereas performance on explicit memory tests such as recall and recognition is strongly dependent on elaborative study processing. We examined the effects of elaborative and nonelaborative study tasks on implicit memory for unitized and nonunitized word pairs. Unitized pairs were represented by common idioms (e.g., SOUR GRAPES) and highly related paired associates (e.g., TABLE-CHAIR). Nonunitized pairs were represented by British idioms (e.g., CURTAIN LECTURE) and unrelated paired associates (e.g., SALT-CHAIR). Implicit memory was assessed with a free-association test. Results of four experiments indicated that implicit memory for unitized pairs was independent of several, though not all, types of study processing that affected explicit recall. In contrast, implicit memory for nonunitized pairs was dependent on the same types of elaborative study processing that influenced explicit recall. The findings are discussed in the context of activation and episodic views of implicit memory.

Recent research has demonstrated that information acquired during a specific learning episode can facilitate performance on various tests that do not make explicit reference to the episode, such as word stem and fragment completion (e.g., Graf, Mandler, & Haden, 1982; Tulving, Schacter, & Stark, 1982), word identification (e.g., Feustal, Shiffrin, & Salasoo, 1983; Jacoby & Dallas, 1981), and lexical decision (e.g., Scarborough, Gerard, & Cortese, 1979). This facilitation of test performance, referred to as *repetition* or *direct* priming (cf. Cofer, 1967), occurs relatively automatically and does not require intentional or deliberate recollection of a prior learning episode. By contrast, performance on traditional recall and recognition tests typically entails deliberate recollection of a specific episode. The descriptive terms *implicit* and *explicit* have been used to describe the forms of memory involved in repetition priming and recall/recognition performance, respectively (Graf & Schacter, 1985; Schacter, 1987; Schacter & Graf, 1986a).

Considerable evidence now exists that implicit and explicit forms

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of memory can be dissociated experimentally (for review, see Richardson-Klavehn & Bjork, 1988; Schacter, 1987). Studies of normal subjects have shown that experimental variables such as level of processing, retention interval, study-test modality shifts, and word frequency have differential effects on implicit and explicit memory (Clarke & Morton, 1983; Graf & Mandler, 1984; Graf et al., 1982; Jacoby, 1983b; Jacoby & Dallas, 1981; Roediger & Blaxton, 1987; Schacter & Graf, 1986a, 1989; Winnick & Daniel, 1970). In addition, it has been demonstrated that amnesic patients, who have severe difficulties with explicit recall and recognition of recently studied materials, show normal or near-normal priming on various implicit memory tests (Cermak, Talbot, Chandler, & Wolbarst, 1985; Cohen & Squire, 1980; Diamond & Rozin, 1984; Graf, Shimamura, & Squire, 1985; Graf, Squire, & Mandler, 1984; Jacoby & Witherspoon, 1982; Moscovitch, 1982; Schacter, 1985b; Warrington & Weiskrantz, 1970, 1974).

One of the most impressive types of evidence for dissociation between implicit and explicit memory comes from studies that have manipulated level or type of study processing. It is well known that variations in level of processing exert a powerful influence on explicit remembering: Recall and recognition performance are generally higher following elaborative or semantic processing than following shallow or nonsemantic processing (e.g., Craik & Tulving, 1975; Hyde & Jenkins, 1973). By contrast, several studies have shown that similar manipulations have little or no effect on performance of implicit memory tests. For example, Jacoby and Dallas (1981) found that the amount of priming or facilitation on a word identification test was similar following semantic and nonsemantic encoding of familiar words, whereas recognition memory benefited from semantic relative to nonsemantic encoding. Graf and Mandler (1984) demonstrated that semantic versus nonsemantic encoding had little effect on the magnitude of priming on a word completion task in which subjects wrote the first word that came to mind in response to three-letter stems of recently presented words. However, this level of processing manipulation had large effects on explicit tests of memory, such as free recall, cued recall, and recognition (see also Graf et al., 1982; Graf et al., 1984). It has also been shown that variations in level or type of study processing can have opposite effects on implicit and explicit memory: Recall and recognition performance are higher when subjects generate to-be-remembered words than when they read them, whereas word identification performance is higher in read than in generate conditions (Jacoby, 1983b; Winnick & Daniel, 1970).

The observation that semantic or elaborative processing of study materials is critical for recall and recognition has led to the suggestion

that explicit remembering of recent events depends on the richness and distinctiveness of newly created episodic representations (e.g., Jacoby & Craik, 1979). By contrast, the finding that priming effects do not require semantic or elaborative processing has been used to support the idea that implicit memory is based on the automatic activation of preexisting memory representations, such as familiar words (e.g., Graf & Mandler, 1984). Such memory representations have been referred to as *unitized* structures (Hayes-Roth, 1977), because they function as discrete, integrated units that can be activated in an all-or-none manner. It has been argued that activation of these unitized representations occurs automatically as a result of presenting an item on the study list, independently of the type of processing carried out by the subject. When subjects are later instructed to write the first word that comes to mind in response to a particular cue, they tend to produce study-list words, because these words are the most accessible or highly activated (e.g., Diamond & Rozin, 1984; Graf & Mandler, 1984; Mandler, 1980).

An important implication of the activation hypothesis is that only items with highly integrated or unitized memory representations can be activated automatically and thus influence implicit memory performance. Three types of evidence bear on this point. First, several studies have examined whether exposure to nonwords during a study trial results in significant priming on a subsequent implicit memory test. Nonwords do not have unitized memory representations that can be activated automatically by the appearance of an item in a study list. Several studies of normal subjects have found that exposure to nonwords yields either no repetition priming or a smaller and less durable priming effect than is observed with words (e.g., Forbach, Stanners, & Hochhaus, 1974; Kirsner & Smith, 1974), although substantial priming of nonwords has been observed (Feustel et al., 1983; Whittlesea & Cantwell, 1987).

Second, several recent studies have examined whether newly acquired associations between normatively unrelated word pairs influence the magnitude of priming on a word completion test (Graf & Schacter, 1985, 1987, in press; Schacter & Graf, 1986a, 1986b, 1989). Unrelated word pairs (e.g., WINDOW-REASON), like nonwords, do not have unitized representations that can be activated automatically by study list presentation. Graf and Schacter found that word completion performance was higher when a test stem appeared together with its list cue (e.g., WINDOW-REA____) than with some other cue (e.g., OFFICER-REA____), thereby indicating that newly acquired associations influenced implicit memory (for similar results on other implicit memory tests, see McKoon & Ratcliff, 1979, 1986; Moscovitch, Winocur, &

McLachlan, 1986). However, this associative effect was observed only when subjects had processed the pairs elaboratively at the time of study, either by generating a sentence to link the two words or by reading the pair in a meaningful sentence. When study conditions prevented the elaboration of semantic links (i.e., comparing the number of vowels in two paired words, rating the pleasantness of each word), no associative influence on completion performance was observed (Graf & Schacter, 1985; Schacter & Graf, 1986a).

A third type of evidence that bears on the issue of unitization and activation is provided by studies that have examined priming of unitized representations other than familiar words. For example, Schacter (1985b) reported an experiment in which normal and amnesic subjects studied common linguistic idioms (e.g., SOUR GRAPES, SMALL POTATOES). It has been argued that such idioms have unitized memory representations (Horowitz & Manelis, 1972). Subjects in this experiment also studied nonunitized phrases that were formed by re-pairing the elements of the idioms (e.g., SOUR POTATOES, SMALL GRAPES). Schacter found that both amnesics and normals showed a substantial priming effect for the familiar idioms on a free-association test that presented the first word of the pair (e.g., SOUR-?). By contrast, there was virtually no priming of nonunitized pairs in either subject group. Similarly, Shimamura and Squire (1984) exposed amnesics and controls to highly related paired associates (e.g., TABLE-CHAIR) and found that they showed significant and comparable amounts of priming on a subsequent free-association test (e.g., TABLE-?).

The foregoing studies provide some support for the view that automatic activation of unitized representations plays a role in implicit memory. Nonwords frequently show reduced levels of priming relative to familiar words; newly acquired associations affect word completion performance only following elaborative encoding, whereas priming of familiar words is independent of type of encoding; and old, familiar associations show robust priming in amnesic patients. At the same time, however, the evidence indicates that an activation notion alone cannot accommodate all existing data (cf. Graf & Schacter, 1985; Jacoby, 1983a; Moscovitch et al., 1986; Schacter & Graf, 1986a, 1986b; see Schacter, 1987, for a discussion).

The present research explores further the relations among activation, unitization, and implicit memory. More specifically, the experiments compare the effects of variations in type of study processing on implicit memory for familiar, unitized word pairs and unfamiliar, nonunitized pairs. Previous studies that have demonstrated that implicit memory is relatively unaffected by type of study processing have used familiar words as target materials. In the present study, we

assessed the effect of various elaborative and nonelaborative study tasks on implicit memory for linguistic idioms (e.g., SOUR GRAPES) and highly related paired associates (e.g., TABLE-CHAIR). We assumed that these items have a *unitized* memory representation in the sense that they can be activated as a functional unit on a study trial, and that presentation of just one *component* of the unit on a priming test (e.g., SOUR-?) can automatically redintegrate the entire unit (cf. Hayes-Roth, 1977). We evaluated implicit memory with a free-association test in which the initial word of a pair was presented and the subject was required to respond with the first word that came to mind. It is known that subjects show significant priming effects for both idioms and highly related paired associates on a free-association test (Schacter, 1985b; Shimamura & Squire, 1984). It is not known, however, how such priming effects are related to type of study processing. If the activation view has any generality, implicit memory of both familiar idioms and primary associates should be observed following elaborative and nonelaborative study processing.

We also examined whether and to what extent nonunitized word pairs show priming effects on a free-association test. Graf and Schacter (1985; Schacter & Graf, 1986a) observed implicit memory for unrelated word pairs when the first word of a pair and the initial three letters of the second were present at the time of test (e.g., WINDOW-REA_____ for WINDOW-REASON). We wanted to ascertain whether unrelated or nonunitized pairs, like unitized pairs, can show priming when only the first word of the pair is present at test, and if so, to determine whether elaborative study processing is necessary for such priming to occur. As noted earlier, a key feature of the unitized representation is the ability of one component of a unit to redintegrate the entire unit (Hayes-Roth, 1977). The data reported by Graf and Schacter (1985; Schacter & Graf, 1986a) indicate that after a single exposure to an unrelated pair, presentation of part of *both* preexisting components of a new unit (e.g., WINDOW-REA____) is sufficient to redintegrate the entire unit. However, presentation of just *one* component of an unrelated pair following a single study episode does not appear to yield part-whole redintegration on an implicit memory test (Schacter, 1985b). In the present experiments, we varied type of study processing and number of study exposures in order to delineate the conditions under which unrelated or nonunitized word pairs come to show the property of part-whole redintegration on an implicit memory test that appears to be characteristic of items that have unitized memory representations. In Experiments 1 and 2, we used familiar and unfamiliar linguistic idioms to examine implicit memory for unitized and nonunitized information. In Experiments 3 and 4, we assessed

the generality of these results using related and unrelated pairs of common nouns.

EXPERIMENT 1

The major purpose of Experiment 1 was to examine implicit memory for unitized and nonunitized word pairs as a function of variations in type of study processing. Unitized pairs were represented by common idioms such as SOUR GRAPES, SMALL POTATOES and DOUBLE TALK. Nonunitized pairs were represented by British idioms such as CURTAIN LECTURE, FAIR HAND, and SOFT SOAP, which are generally unfamiliar to North American subjects. British idioms were used in this experiment because an earlier study (Schacter, 1985b) failed to find priming of nonunitized items that were formed by re-pairing components of common idioms (e.g., SOUR POTATOES). It is possible that failure to observe implicit memory of these nonunitized pairs was attributable to the fact that the cue presented on the priming test (e.g., SOUR) already had strong associations to an idiomatic response, which may have blocked or inhibited the emergence of any new association. The first words of the British idioms that we used are not part of an already familiar idiomatic unit, thereby reducing the possibility that implicit memory for nonunitized pairs might be concealed by some sort of inhibition effect.

To examine implicit memory for unitized and nonunitized information under a range of conditions, we used four different study tasks, two that encouraged associative elaboration of the pairs and two that discouraged associative elaboration. In the *definition* condition, subjects were presented with a sentence that defined the common and the British idiom (e.g., *Complaints about failure by an ungracious loser are known as SOUR GRAPES; When a husband is scolded privately by his wife, he receives a CURTAIN LECTURE*). In the *sentence frame* condition, subjects were shown a brief sentence with the word pair in it (e.g., *She is always full of SOUR GRAPES; The man thought about the CURTAIN LECTURE*). The definition and sentence frame conditions were intended to encourage subjects to elaborate on the meaning of each pair; the former by explicitly defining the word pairs and the latter by providing a context in which subjects could assign their own meanings to the pairs. By contrast, the *synonym generation* and *letter counting* conditions were constructed in order to reduce the level of associative elaboration. In the synonym generation condition, subjects were instructed to provide a synonym for each of the words in a pair. Thus, they engaged in elaborative processing of each word individually but

were not allowed to elaborate any semantic relations between the two words. In the letter counting condition, subjects were required to count the number of vowels and consonants in each word and to state whether or not they were equal. This task prevented semantic elaboration of either the individual words or the pair.

Following study-list presentation, implicit and explicit memory for the word pairs were tested with a free-association and a cued-recall test, respectively. On the free-association test, the initial word from a study-list pair was presented, and subjects were required to write down the first word that came to mind. On the cued-recall test, the same cue was presented, but subjects were instructed to try to remember explicitly the paired word from the study list. It was expected that explicit memory performance on the cued-recall test would be highest in the conditions that encourage associative elaboration (definition and sentence frame), lower in the condition that allowed only elaborative processing of single words (synonym generation), and lower still in the condition that prevented elaborative processing altogether (letter counting).

The critical question concerns the effect of the processing manipulation on priming of the unitized and nonunitized items. If preexisting representations can be activated independently of type of processing, as found in studies using familiar words, there should be significant priming of unitized idioms in all conditions and little or no effect of type of processing. Nonunitized phrases, by contrast, should exhibit little priming because there are no preexisting representations to activate, and whatever priming is observed should occur only following elaborative study processing.

METHOD

Subjects

Eighty University of Toronto undergraduates participated in the experiment. Subjects either received course credits for participating or were paid \$4.00.

Design and materials

The experimental design consisted of one between-subjects factor and two within-subjects factors. The between-subjects factor was type of study task (Definition \times Sentence Frame \times Synonym Generation \times Letter Counting). The within-subjects factors were type of test (Free Association \times Cued Recall) and type of word pair (Common Idiom \times British Idiom).

The critical items consisted of 16 two-word idioms taken from the materials of Horowitz and Manelis (1972) that are commonly used in North America (e.g., SOUR GRAPES, EARLY BIRD), and 16 two-word British idioms that were

presumably unfamiliar to our Canadian subjects (e.g., CURTAIN LECTURE, DEAD WALL). An attempt was made to choose common and British idioms that were comparable in terms of word frequency and word length. The frequencies of the individual words in each pair were determined from the Kucera and Francis (1967) norms. There was a nonsignificant difference in word frequency between the common idioms ($X = 125.19$) and British idioms ($X = 109.81$), $t(31) < 1$. Words constituting the British idioms ($X = 5.47$) were on average one letter longer than the common idioms ($X = 4.41$), $t(31) = 3.25$, but there was no reason to suspect that such a small difference would influence test performance in any systematic way. For counterbalancing purposes, the critical 16 common idioms and British idioms were divided randomly into two sets of 8. For each subject, two sets (8 common and 8 British) appeared in the study list, and were later tested on both the free-association and cued-recall tests. The two other critical sets of word pairs were not presented on the study list; they appeared only on the free-association test. These nonpresented sets provided an estimate of baseline performance—the frequency with which subjects write the target word on a free-association test without a study-list presentation. The experiment was counterbalanced so that each set appeared equally often in each of the experimental conditions. Two different forms of the free-association and cued-recall tests were also used for counterbalancing purposes, with the test cues appearing in opposite orders on each of the two forms.

The free-association test included 48 fillers as well as the 16 presented and 16 nonpresented critical items. The fillers were a random collection of common words. They were intended to disguise, at least partly, the fact that the free-association test included cue words from previously studied pairs and thereby encourage subjects to respond by providing the first word that came to mind, rather than by deliberately thinking back to the study list. The cued-recall test consisted of the initial words from the 16 previously studied pairs in random order.

Procedure

Each subject was tested individually. Subjects in all experimental conditions were told that they would be shown some word pairs and would later be asked to remember them. They were subsequently told that some of the word pairs are common idioms that would be familiar to them and that some are British idioms that would probably be unfamiliar.

Subjects in the *definition* condition were instructed to read the definition of each word pair presented to them (e.g., “Complaints about failure by an ungracious loser are SOUR GRAPES”; “When a husband is scolded by his wife in private, he receives a CURTAIN LECTURE”). Subjects in the *synonym generation* condition were instructed to provide a synonym for each word in the pair presented to them (e.g., DOUBLE TALK, two speak; SINKING FUND, falling money). Subjects in the *letter counting* condition were instructed to count the number of vowels in each word of the pair and report whether there were an equal number and then to count the number of consonants in each word and report whether there were an equal number (e.g., WHITE LIE—equal

vowels, unequal consonants; DOWN TRAIN—unequal vowels, equal consonants).

All subjects were given two practice pairs to illustrate the nature of the study task. The 16 critical pairs were then presented on 3" × 5" index cards, in a random order for each subject. In the definition and sentence frame conditions, the critical word pair was incorporated in the sentence on the index card. In the synonym generation and letter counting conditions, the word pair was presented by itself on the 3" × 5" card. In all conditions, the experimenter read each pair aloud, and subjects were given 6 s to respond according to the instructions they had been given. After presentation of the study list, subjects were informed that they would be required to complete some filler tasks before the memory test.

The first filler task involved generating names of cities. Subjects were told to start at the beginning of the alphabet and write names of cities that begin with an "A," and then to proceed in order through the alphabet. The subject was stopped after 3 min. The second filler task was a name completion task. Subjects were given a list of first names and were instructed to write the first surname that came to mind for each. The initial two filler tasks were intended to induce an appropriate set for the free-association test (cf. Graf & Schacter, 1985; Schacter & Graf, 1986a).

The free-association test was then presented as a third filler task to all subjects. This test contained the initial words of 8 previously studied common idioms and 8 previously studied British idioms, 8 common and 8 British idioms that had not appeared on the study list, and the 48 filler words. The subject was instructed to write the first word that came to mind for each cue on the list. It was emphasized that there was no "right" or "wrong" answer. Subjects were told that they could write any word except proper names. They were also instructed to work as quickly as possible. After this test, subjects were given a cued-recall test that consisted of the initial words of the 16 previously studied common and British idioms together with instructions that stressed explicit remembering. Subjects were reminded of the word pairs that they had studied, they were informed that the words on the test were the first words from the pairs that they had seen, and they were asked to recall the target word that had been paired with each cue in the study list.

RESULTS

Free association

The baseline probability of providing a common idiom on the free-association test without a prior exposure was .07. British idioms were never produced as free-association responses in the baseline condition.

The proportions of target responses for common and British idioms as a function of study condition are displayed Table 1. These data indicate that the probability of responding with the target word for common idioms increased substantially above baseline after one study-

Table 1. Free-association and cued-recall performance for common and British idioms as a function of study task in Experiment 1

Study task	Type of idiom		<i>M</i>
	Common	British	
	Free association		
Definition	.29	.06	.18
Sentence frame	.19	.03	.11
Synonym generation	.20	.02	.11
Letter counting	.14	.01	.08
<i>M</i>	.21	.03	.12
	Cued recall		
Definition	.59	.24	.42
Sentence frame	.66	.28	.47
Synonym generation	.41	.08	.25
Letter counting	.26	.02	.14
<i>M</i>	.48	.16	.32

list presentation in all study task conditions [all $t(19) > 2.04$, $p < .05$, for this and all other statistical tests]. Subjects in the definition condition completed a higher proportion of common idioms (.29) than did subjects in the sentence frame (.19), synonym generation (.20), and letter counting (.14) conditions. The proportion of correct responses for British idioms was low in all study conditions, but was slightly higher in the definition condition (.06) than in the sentence frame (.03), synonym generation (.02), and letter counting (.01) conditions. Performance was significantly above baseline only in the definition condition, $t(19) = 1.90$.

Analysis of variance (ANOVA) revealed a main effect of type of idiom on free-association performance, $F(1, 76) = 81.64$, $MS_e = .91$, confirming that common idioms showed significantly more priming than did British idioms. More important, there was also a main effect of study task, $F(3, 76) = 2.78$, $MS_e = 1.72$, together with a nonsignificant Study Task \times Type of Idiom interaction, $F(3, 76) = 1.51$, $MS_e = .91$. To determine the source of the main effect, one-tailed t tests were performed separately on the data from common and British idioms. For common idioms, there was no difference between any of the pairwise comparisons except definition versus letter counting, $t(19) = 2.50$; all other t s < 1.37 . Pairwise comparisons for British idioms also revealed no significant difference between any of the comparisons except definition versus letter counting, $t(19) = 1.82$; all other t s < 1.60 . Although this analysis suggests a similar pattern of priming across study task conditions for both common and British idioms, the

apparent similarity may be attributable to the fact that performance for British idioms is consistently at or close to the floor.

Cued recall

The results of the cued-recall test (Table 1) indicate that performance in all conditions was considerably higher than that observed on the free-association test. The proportion of common idioms recalled in the sentence frame condition (.66) was slightly higher than in the definition condition (.59). Recall in both of these conditions was greater than in the synonym generation condition (.41), which in turn was higher than in the letter counting condition (.26). Recall was substantially higher for common idioms than for British idioms in all study task conditions, although the same pattern of results was evident for both. Recall of British idioms in the definition condition (.24) was marginally lower than in the sentence frame condition (.28), with a large decline in recall performance for the synonym generation condition (.08) and virtually no recall in the letter counting condition (.20).

An ANOVA performed on the cued-recall data revealed a main effect of study task on recall performance $F(3, 76) = 19.07$, $MS_e = 3.03$, and a main effect of type of idiom, $F(1, 76) = 189.29$, $MS_e = 1.42$, but no significant interaction $F(3, 76) = 1.69$, $MS_e = 1.42$. This result is consistent with many previous findings that cued-recall performance is significantly affected by the degree of elaboration. Also, not surprisingly, more common than British idioms were recalled on this test. Planned pairwise comparisons between individual study task conditions revealed no difference in cued recall of common idioms in the definition and sentence frame conditions, $t(19) < 1$. However, recall of common idioms in both the sentence frame and the definition conditions was significantly higher than in the synonym generation condition, both $ts(19) > 4.35$, and performance in the synonym generation condition was significantly higher than in the letter counting condition, $t(19) = 2.60$, thereby indicating that cued-recall performance improved substantially with increasing degrees of elaboration. The same pattern was evident for British idioms: Performance in the definition and sentence frame conditions did not differ, $t(19) < 1$, whereas performance in both of these conditions was higher than in the synonym generation condition, both $ts(19) > 3.33$, and performance in the synonym generation condition was higher than in the letter counting condition, $t(19) = 2.50$.

Comparison of the free-association and cued-recall data reveals different patterns of results. Whereas free-association performance did not differ in sentence frame, synonym generation, and letter counting

conditions, cued-recall performance decreased substantially across these conditions. In addition, the trend for higher performance in the definition condition on the free-association task was not evident in cued recall. These differences were documented by a significant Study Task \times Type of Test interaction, $F(3, 152) = 21.16$, $MS_e = 1.04$, thereby confirming a dissociation between implicit and explicit memory. However, the three-way interaction of Study Task \times Type of Idiom \times Type of Test was nonsignificant, $F(3, 152) = 1.24$, $MS_e = 1.04$, thus suggesting that the observed differences between free-association and cued-recall performance held for both common and British idioms. However, this result may be because priming of British idioms was at near-zero levels. This floor effect would have masked any influence of type of study task on priming of British idioms. Therefore, Experiment 1 alone cannot address the issue of whether type of study task has differential effects on implicit memory for unitized and nonunitized items.

DISCUSSION

Experiment 1 demonstrated above-baseline levels of priming for common idioms following both elaborative and nonelaborative study tasks, whereas British idioms showed little or no priming, with performance significantly exceeding baseline only in the definition condition. More important, we found that the magnitude of priming effects for common idioms in letter counting, synonym generation, and sentence frame conditions did not differ from one another, even though cued recall increased systematically and substantially across these three conditions. These data extend previous findings (Graf & Mandler, 1984; Jacoby & Dallas, 1981) that implicit memory for familiar words can be independent of type of study processing and level of cued-recall performance, and are consistent with the view that common idioms function as unitized representations that can be activated automatically by study-list presentation.

Other aspects of our data, however, raise questions concerning the validity of this view. The finding that priming of common idioms in the definition condition was generally higher than in the other conditions and was significantly higher than priming in the letter counting condition appears to be inconsistent with the notion that implicit memory for the idioms occurs independently of study-trial elaborative processing. One possible explanation for this finding is that the elaborative information provided in the definition condition was richer and more distinctive than that provided in the other study conditions, thereby facilitating both free-association and cued-recall performance.

Such facilitation could have occurred because subjects intentionally engaged in explicit remembering strategies on the free-association test, strategies that were most effective in the definition condition. Alternatively, it is possible that subjects did write the first word that came to mind on the free-association test, as instructed, and that implicit memory for common idioms is in fact influenced by elaborative processing.

Several features of the data, however, cast doubt on these ideas. First, although it is possible that some subjects in the definition condition intentionally attempted to remember study-list items on the free-association test, the large performance difference between the free-association (.29) and cued-recall (.59) tests makes it highly unlikely that such a strategy was used frequently. If subjects had been treating the free-association test as a cued-recall test, performance on the two tests should have been identical or at least similar. Second, cued-recall performance in the definition condition (.59) was actually somewhat lower than in the sentence frame condition (.66), even though the opposite pattern of performance was observed on the free-association test. Third, performance in the sentence frame, synonym generation, and letter counting conditions did not differ on the free-association task, despite large differences on cued recall. If subjects had been treating the free-association test like a cued-recall test, such a pattern of results could not be observed (see Schacter, Bowers, & Booker, in press, for general discussion). In short, our data are inconsistent with the notions that subjects treated the free-association test like a cued-recall test, or that elaborative activities in the definition condition simply yielded "more memorable" encodings that facilitated both implicit and explicit memory.

An alternative explanation for the elevated priming observed in the definition condition is that some of the common idioms used in our experiment were only moderately familiar to some subjects and thus were not represented in memory in an entirely unitized manner. It is possible that complete activation of these "partially unitized" associations requires the presence of the idiom's definition during study-list presentation. Because the definition was not explicitly provided in the other three study conditions, some moderately familiar idioms may not have been activated, thus resulting in a trend for lower levels of priming in these conditions relative to the definition condition.

Whatever the validity of the foregoing ideas, the fact that free-association performance was higher in the definition condition than in the other encoding conditions means that the present data cannot be interpreted as indicating that implicit memory for unitized items

is entirely independent of type of study processing. What these data *do* indicate, however, is that implicit memory for unitized items can be invariant across several study processing tasks (i.e., sentence frame, synonym generation, letter counting) that produce significant differences in explicit memory performance. It is only in this latter sense, then, that Experiment 1 can be said to have produced a dissociation between implicit and explicit memory.

The fact that implicit memory of British idioms, like common idioms, was highest in the definition condition suggests a possible similarity between priming of unitized and nonunitized information. However, the data concerning the effect of the elaborative processing manipulation on the British idioms are difficult to interpret because of the floor effects noted earlier. Although the existence of the floor effect serves to emphasize that nonunitized pairs do not show robust priming effects in the free-association task following a single study exposure (cf. Schacter, 1985b), the question remains open as to how the processing manipulations would influence implicit memory for nonunitized pairs under conditions in which higher overall levels of performance were observed. We do not know whether implicit memory would remain relatively invariant across the letter counting, synonym generation, and sentence frame conditions, as was observed with common idioms.

In Experiment 2, we examined the effect of elaborative versus nonelaborative study processing on implicit memory for nonunitized word pairs by varying the number of repetitions of study-list pairs. Previous research using pseudowords has demonstrated that after only five or six repetitions, pseudowords show priming effects on a perceptual identification test that are similar to those observed with familiar words (Salasoo, Shiffrin, & Feustel, 1985). Because pseudowords do not have a unitized memory representation, this result implies that repetition of a nonunitized item eventually establishes a unitized representation of that item. Accordingly, we assumed that repetition of British idioms will result in the buildup of unitized representations of these items, just as Salasoo et al. observed with pseudowords. To the extent that such a unitization process occurs, we ought to observe robust priming of British idioms on the free-association test—presentation of just one part of the unit should reintegrate the entire unit. The critical question concerns the type of study processing that is necessary to support the buildup of unitization and consequent priming on the free-association test. On the one hand, it is possible that unitization proceeds automatically as a result of repetition, independently of type of study processing. If so, repetition of British idioms should result in similar levels of priming following both elab-

orative and nonelaborative study tasks. On the other hand, the building of a new unit may require elaboration at the time of study. If so, priming of British idioms following repetition should show strong dependence on type of study processing.

EXPERIMENT 2

METHOD

Subjects

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

Design and materials

The experimental design consisted of one between-subjects factor and two within-subjects factors. The between-subjects factor was type of study task (Definition \times Sentence Frame \times Synonym Generation \times Letter Counting). The within-subjects factors were number of item repetitions (Two \times Four \times Eight) and type of test (Free Association \times Cued Recall).

The study items consisted of the 16 British idioms used in Experiment 1 plus 2 additional British idioms, providing 18 cue-target pairs. The 18 idioms were divided into three sets of 6. For each subject, all three sets appeared in the study list and were later tested on both the free-association and cued-recall tests. One set of items was presented twice, one set four times, and one set eight times, yielding 84 items in the study list. The experiment was counterbalanced so that each set of items appeared equally often in each of the repetition conditions.

The free-association test included 65 distractor items, as well as the 18 cue words from the critical idiom pairs. The cued-recall test consisted of the cue words from the 18 previously studied idioms, arranged in a random order.

Procedure

Each subject was tested individually. Subjects in all experimental conditions were told that they would be shown some word pairs and later asked to remember them. They were also instructed that the pairs would consist of two word phrases that would probably be unfamiliar to them but were familiar idioms in Britain. They were further informed that each idiom would appear either two, four, or eight times in the study list. Subjects in each of the four conditions were instructed regarding the nature of their respective study tasks, as was described in Experiment 1.

The idioms were presented for 6 s each on a computer screen. The definition and sentence frame conditions were identical to those described in Experiment 1. Pilot work indicated that it was necessary to make small modifications in the synonym generation and letter counting tasks. Specif-

ically, we observed that with repetition, subjects did not require the allotted 6 s to perform the letter counting and sentence generation tasks, and were often able to make "snap judgments" after four or five repetitions of the same item. Thus, after frequent presentation of a pair, subjects sometimes had several seconds that could be used for associative elaboration. To prevent subjects from engaging in associative elaboration of a pair in the time remaining after they completed the target task, we required them to make further nonsemantic judgments in the letter counting task (i.e., to count how many letters in each word came from the first and second halves of the alphabet), and to produce additional synonyms for each word in the synonym generation task.

After exposure to the study list, subjects were given the city-generation, name-completion, free-association, and cued-recall tests in the same manner as was described in Experiment 1.

RESULTS

Free association

Because the design of Experiment 1 required presentation of all available British idioms, it was not possible to obtain a within-subjects measure of baseline performance. However, because no British idioms were produced by any subject in the baseline condition of Experiment 1, we felt safe in assuming a zero baseline for Experiment 2.

The data in Table 2 indicate that the repetition manipulation had the intended effect of raising performance above baseline levels in most experimental conditions. Performance was significantly above

Table 2. Free-association and cued-recall performance for British idioms as a function of number of repetitions and study task in Experiment 2

Study task	Number of repetitions			<i>M</i>
	2	4	8	
Free association				
Definition	.14	.16	.25	.18
Sentence frame	.21	.21	.25	.22
Synonym generation	.08	.10	.17	.11
Letter counting	.02	.04	.05	.04
<i>M</i>	.11	.13	.18	.14
Cued recall				
Definition	.45	.66	.79	.63
Sentence frame	.53	.62	.71	.62
Synonym generation	.22	.35	.56	.38
Letter counting	.09	.15	.19	.14
<i>M</i>	.32	.45	.56	.44

baseline at all levels of repetition in the definition, sentence frame, and synonym generation tasks, all $t_s(17) > 2.29$, and was significantly above baseline in the four- and eight-repetition conditions of the letter counting task, both $t_s(17) > 1.72$. In each study task condition, increasing numbers of repetitions were associated with higher levels of free-association performance. Overall levels of performance in the definition and sentence frame conditions were similar. However, performance in each of these conditions was higher than in the synonym generation condition, which in turn yielded higher levels of performance than in the letter counting conditions.

Statistical analysis confirmed this description of the data. An ANOVA revealed significant main effects of repetition, $F(3, 68) = 3.46$, $MS_e = 3.38$. The Repetition \times Type of Study Task interaction was non-significant, $F(6, 136) < 1$. Planned comparisons performed on the means in each study task condition indicated that performance in the sentence frame and definition conditions did not differ significantly, $t(34) = .52$. Overall performance in both of these conditions was significantly higher than in the synonym generation condition, both $t_s(34) > 1.66$, and performance in the synonym generation condition was significantly higher than in the letter counting condition, $t(34) = 2.09$.

Cued recall

As indicated by the data in Table 2, the pattern of cued-recall results was generally similar to that of the free-association data, except that overall level of performance was a good deal higher on the cued-recall test.

An ANOVA revealed significant main effects of number of repetitions, $F(2, 136) = 148.32$, $MS_e = 1.07$, and type of study task, $F(3, 68) = 26.94$, $MS_e = 3.78$, with a significant interaction between these variables $F(6, 136) = 5.36$, $MS_e = 1.07$. The interaction is attributable to the fact that performance in the sentence frame condition was higher than in the definition condition after two repetitions, whereas the opposite was true after four and eight repetitions. This unexpected finding is of no particular interest and will not be discussed further. Planned comparisons performed on the overall level of cued recall in the various study task conditions indicated that the definition and sentence frame conditions did not differ, $t(34) = .33$, whereas recall in each of these conditions was higher than recall in the synonym generation condition, both $t_s(34) > 1.72$. Recall in the sentence generation condition was significantly higher than in the letter counting condition, $t(34) = 5.86$.

DISCUSSION

Experiment 2 demonstrated implicit memory for British idioms following varying numbers of repetitions in all study task conditions. The results also revealed a marked dependence of implicit memory on type of study processing. The two study tasks that encouraged associative elaboration (definition and sentence frame) yielded similarly high levels of implicit memory; the task that permitted semantic elaboration of individual words (synonym generation) yielded an intermediate level of implicit memory; and the task that prevented semantic processing altogether (letter counting) yielded little or no implicit memory. The occurrence of significant priming implies that repetition of British idioms resulted in the development of unitized representations. The effects of the study task manipulation indicate that the buildup of unitization was strongly dependent on elaborative processing.

This pattern of results contrasts with the data from Experiment 1 concerning implicit memory for common idioms. With the exception of the definition versus letter counting comparison, implicit memory for common idioms was independent of type of study processing, whereas implicit memory for British idioms depended on type of study processing. Taken together, the data from Experiments 1 and 2 suggest that when target items consist of old, unitized representations, implicit memory can be influenced similarly following elaborative and nonelaborative study processing; the only exception to this was the definition condition of Experiment 1. By contrast, the building of a new, unitized representation that can support implicit memory on a free-association test requires some elaborative processing; mere repetition of a pair without any elaborative processing, as in the letter counting condition, does not appear to be sufficient. In fact, it appears that the building of a unitized representation that can influence implicit memory depends on elaborative study processes that are similar to those involved in explicit memory. The data on implicit memory for British idioms strongly resemble the data on explicit memory for both British and common idioms obtained in both Experiments 1 and 2: There were high levels of performance in the definition and sentence frame conditions, an intermediate level in the synonym generation condition, and a low level of performance in the letter counting condition.

To explore further the generality of the results from Experiments 1 and 2, in Experiments 3 and 4 we investigated the effects of elaborative and nonelaborative study tasks on implicit and explicit memory for highly related paired associates (e.g., TABLE-CHAIR) and non-

matively unrelated paired associates (e.g., SALT-CHAIR). We reasoned that highly related pairs, like common idioms, have unitized or integrated preexisting representations in memory, whereas unrelated pairs, like British idioms, do not. Accordingly, we expected that implicit memory for highly related paired associates should be observed following both elaborative and nonelaborative study processing. However, implicit memory for unrelated paired associates should be strongly dependent on type of study processing.

EXPERIMENT 3

This experiment examined implicit memory for highly related paired associates. To assess the effect of type of study processing on implicit memory for these pairs, we used the sentence frame and letter counting tasks from the previous experiments. These two tasks were chosen because they yielded similar amounts of implicit memory for common idioms, together with different levels of explicit memory. If highly related paired associates can be activated automatically by study-list presentation, significant and comparable amounts of implicit memory on the free-association test should be observed following both the sentence frame and letter counting tasks.

METHOD

Subjects

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

Design and materials

The experimental design consisted of one between-subjects factor and one within-subjects factor. The between-subjects factor was type of study task (Sentence Frame \times Letter Counting). The within-subjects factor was type of test (Free Association \times Cued Recall).

The critical study-list targets were 20 highly related paired associates taken from the Palermo and Jenkins (1964) norms. In all cases the targets were the most frequently provided responses to their respective cues (e.g., TABLE-CHAIR; SALT-PEPPER). In addition, 10 unrelated paired associates were included as filler pairs on the study list, interspersed among the target pairs. For counterbalancing purposes, the critical 20 related word pairs were randomly divided into two sets of 10 (Sets A and B). Each subject was shown 10 related word pairs (Set A or Set B), as well as the 10 unrelated filler pairs. The critical set of related word pairs presented in the study list were later tested on both the free-association and cued-recall tests. The nonpre-

sented set of related words appeared only on the free-association test. These items provided an estimate of baseline performance—the frequency with which subjects write the target word on the free-association test without a study-list presentation. The experiment was counterbalanced so that each set appeared equally often in each of the experimental conditions.

The free-association test included 45 fillers as well as cue words from the 10 presented and 10 nonpresented related word pairs. The cued-recall test consisted of the cue words from the 10 previously studied word pairs in random order. Two different forms for each test were constructed, with the cues appearing in opposite orders on the two forms. Administration of the two test forms was counterbalanced within each experimental condition.

Procedure

Each subject was tested individually. Subjects in both experimental conditions were told that they would be shown some word pairs and would later be asked to remember them. The sentence frame and letter counting tasks were the same as described in Experiment 2. After exposure to the study list, subjects were given the city-generation, name-completion, free-association, and cued-recall tests as described in the previous experiments.

RESULTS AND DISCUSSION

The baseline probability of providing a target word to its cue was .39 in the sentence frame condition and .44 in the letter counting condition. These two probabilities did not differ significantly from one another, $t(46) < 1$.

As indicated by the data in Table 3, exposure to a pair on the study list in both sentence frame and letter counting conditions significantly increased the probability of responding with the target on the free-association test relative to baseline [for sentence frame, $t(23) = 4.47$; for letter counting, $t(23) = 4.03$]. More important, the level of free-association performance was virtually identical in the sentence frame (.59) and letter counting conditions (.60). By contrast, cued-recall performance in the sentence frame condition (.71) was higher than in the letter counting condition (.60), although the difference was

Table 3. Free-association and cued-recall performance for highly related paired associates as a function of study task in Experiment 3

Study task	Type of test		<i>M</i>
	Free association	Cued recall	
Sentence frame	.59	.71	.66
Letter counting	.60	.60	.60
<i>M</i>	.60	.66	.63

only marginally significant, $t(46) = 1.63$. In the sentence frame condition, significantly more target items were produced on the cued-recall test than on the free-association test, $t(23) = 2.41$, whereas in the letter counting condition, free-association and cued-recall performance were identical. An ANOVA performed on the combined free-association and cued-recall data revealed a marginally significant Study Task \times Type of Test interaction, $F(1, 46) = 3.80$, $MS_e = 2.31$, $p = .06$.

These data demonstrate substantial implicit memory for a single exposure to a highly related paired associate in a nonelaborative study task. Moreover, the level of implicit memory for these pairs was entirely unaffected by the elaborative versus nonelaborative study task manipulation. These data thus complement the results obtained with common idioms in the sentence frame, synonym generation, and letter counting conditions of Experiment 1, and are consistent with the idea that automatic activation of preexisting representations plays some role in implicit memory.

EXPERIMENT 4

This experiment concerned the effect of elaborative and nonelaborative study tasks on implicit memory for unrelated word pairs (e.g., SALT-CHAIR). Unrelated word pairs, like British idioms, do not have unitized representations in memory that can be automatically activated and thus influence free-association performance. However, we expected that repetition of unrelated pairs would result in the buildup of a unitized representation of the pairs that could support implicit memory on the free-association test. The critical question is whether the buildup of unitization occurs automatically or is dependent on elaborative study processing, as was observed for repeated British idioms in Experiment 2. To examine this issue, we gave subjects either two, four, or eight exposures to unrelated word pairs under elaborative (sentence frame) and nonelaborative (letter counting) study conditions. Because Experiment 1 indicated that a single exposure to non-unitized word pairs (i.e., British idioms) yielded little or no evidence of implicit memory on the free-association task, we did not include a single presentation condition in this experiment.

METHOD

Subjects

Thirty-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 experimental design consisted of one between-subjects factor and two within-subjects factors. The between-subjects factor was type of study task (Sentence Frame \times Letter Counting). The within-subjects factors were number of item repetitions (Two \times Four \times Eight) and type of test (Free Association \times Cued Recall).

The study items consisted of 36 unrelated word pairs. Twenty of these pairs were constructed by randomly re-pairing the related pairs used in Experiment 3 (e.g., TABLE-KEY; BOX-PEPPER), with the constraint that the two words constituting the new pair were normatively unrelated to one another. The other 16 pairs were formed by selecting normatively unrelated common nouns from the Palermo and Jenkins (1964) norms. These 36 unrelated pairs were divided into two sets (Sets A and B) of 18. Each set of 18 pairs was in turn divided into three subsets of six (A1, A2, A3 and B1, B2, B3). Each subject was assigned either Set A or Set B and was shown all three subsets from the appropriate set on the study list. One subset of items was presented twice, one subset four times, and one subset eight times, yielding 84 study-list presentations. The first words of the pairs in the non-presented set appeared on the free-association test and were used to estimate baseline performance. The experiment was counterbalanced so that each subset of items appeared equally often in each of the repetition conditions.

The letter counting task was the same as described previously. For the sentence frame task, brief sentences were constructed that provided a meaningful link between the two target words (e.g., The man reached for the SALT near the CHAIR).

The free-association test included 53 distractor items as well as the 18 cue words from the critical study-list pairs and the 18 cue words from the nonpresented set of items. The cued-recall test consisted of the cue words from the 18 previously studied word pairs in a random order. Two different forms for each test were constructed, with the cues appearing in opposite orders on the two forms. Administration of test forms was counterbalanced within experimental conditions.

Procedure

Each subject was tested individually. Subjects in all experimental conditions were told that they would be shown some word pairs and would later be asked to remember them. The word pairs were presented at a rate of one per 6 s on a computer screen in random order.

The sentence frame and letter counting study tasks were given in the same manner as described in Experiments 2 and 3. After exposure to the study list, subjects were given the city-generation, name-completion, free-association, and cued-recall tests in the same manner as described in previous experiments.

RESULTS AND DISCUSSION

No target words were produced in the baseline condition by either group of subjects.

The results of the free-association test, presented in Table 4, indicate that there was virtually no evidence of implicit memory in the letter counting condition at all levels of repetition: Subjects produced only a single target item on the free-association test in each of the repetition conditions. By contrast, there were substantial amounts of implicit memory at all levels of repetition in the sentence frame condition, with small increments in performance associated with increasing levels of repetition. An ANOVA revealed a highly significant main effect of study task, $F(1, 34) = 25.60$, $MS_e = 2.99$. The main effect of repetition was nonsignificant, $F(2, 68) < 1$, as was the interaction between type of study task and number of repetitions, $F(2, 68) < 1$.

Performance on the cued-recall test was generally higher than on the free-association test. Level of cued recall was substantially higher in the sentence frame condition than in the letter counting condition, and performance in both conditions benefited from increasing numbers of repetitions. An ANOVA performed on the cued-recall data revealed significant main effects of study task, $F(1, 34) = 246.03$, and repetition, $F(2, 68) = 10.08$, and a nonsignificant interaction between these variables, $F(2, 68) < 1$.

Overall, the results of Experiment 4 are similar to those of Experiment 2: Implicit memory for unrelated word pairs, like British idioms, was highly dependent on elaborative study processing. Despite extensive repetition, virtually no implicit memory for unrelated pairs was observed following the letter counting task. One curious feature of the data from Experiment 4 concerns the high levels of free-association performance following just two study exposures in the sentence frame condition. This result contrasts with the data from

Table 4. Free-association and cued-recall performance for unrelated paired associates as a function of number of repetitions and study task in Experiment 4

Study task	Number of repetitions			<i>M</i>
	2	4	8	
Free association				
Sentence frame	.27	.29	.32	.29
Letter counting	.01	.01	.01	.01
<i>M</i>	.14	.15	.17	.15
Cued recall				
Sentence frame	.71	.82	.88	.80
Letter counting	.04	.08	.18	.10
<i>M</i>	.38	.45	.53	.45

the earlier experiments using British idioms, where one study exposure in the sentence frame condition (Experiment 1) failed to yield above-zero levels of priming and two exposures in the sentence frame condition (Experiment 2) yielded a substantial, though smaller, effect than was observed in Experiment 4. Because it is possible that the British idioms and unrelated pairs differed in some important way, we ran an additional subject group to examine priming of the unrelated pairs from Experiment 4 following a single study exposure. This group of 18 subjects was treated identically to the sentence frame group from Experiment 4, except that the two-repetition condition was changed to a one-repetition condition. In this group, level of free association for once-exposed unrelated pairs was .07, about what would be expected on the basis of the British idiom data. It is possible that the large jump in free-association performance from one exposure (.07) to two exposures (.27) with unrelated pairs represents a genuine discontinuity that reflects something important about the nature of the unitization process. Comparison across Experiments 1 and 2 yields some evidence of a similar discontinuity in free-association performance following one (.03) and two (.21) repetitions in the sentence frame condition, but there was no such evidence in other conditions. Accordingly, interpretive caution must be exercised regarding the significance, if any, of the apparent discontinuity.

GENERAL DISCUSSION

The present experiments have yielded three main results. First, implicit memory for unitized word pairs, as indexed by priming effects on a free-association test, was independent of several manipulations of study processing that significantly influenced explicit memory. This outcome was observed with both common idioms and highly related paired associates. In these experiments, the level of implicit memory for unitized pairs was about the same following sentence frame, synonym generation, and letter counting study tasks, despite significant variations in explicit recall across the same study tasks. The only condition in which elaboration appeared to facilitate implicit memory for unitized information was the definition condition of Experiment 1, and the possible reasons for this were discussed earlier. Second, there was little evidence of implicit memory for nonunitized pairs on the free-association test following a single study exposure, either with British idioms or unrelated paired associates; the implicit memory that was observed under these conditions occurred following elaborative processing. Third, repetition of nonunitized items produced significant levels of implicit memory on the free-association test, both with

British idioms and unrelated paired associates. However, implicit memory for nonunitized pairs systematically varied with type of study processing, in contrast to the pattern of performance observed with unitized items.

These results are consistent with and extend data that have been reported elsewhere in the literature. On the one hand, the finding that implicit memory for nonunitized pairs is strongly dependent on elaborative processing is consistent with previously reported elaboration-dependent effects of newly acquired associations on word-completion performance (Graf & Schacter, 1985; Schacter & Graf, 1986a). On the other hand, the finding that implicit memory for unitized word pairs was invariant across several study tasks that produce different levels of explicit memory extends previous demonstrations that implicit memory for familiar words is unaffected by elaborative versus nonelaborative study processing on word completion (Graf & Mandler, 1984; Graf et al., 1984), lexical decision (Carroll & Kirsner, 1982), and word identification (Jacoby & Dallas, 1981) tests. However, the finding in Experiment 1 that implicit memory for unitized items was higher in the definition condition than in other conditions suggests the need to qualify any general statement that implicit memory for unitized items is independent of *all* elaborative study tasks that affect the level of explicit memory performance. It would be interesting to determine whether studying a familiar word together with a definition of it produces a higher level of performance on an implicit test such as stem completion than does a nonelaborative study task, or whether the advantage for definitions is unique to familiar idioms, perhaps for reasons discussed earlier.

As implied by the foregoing suggestion, one possibly important qualification to the present observations concerns the range of implicit memory tests to which they apply. Although the finding that implicit memory for unitized items can be independent of some elaborative processing manipulations has been observed on several different tests (e.g., word completion, word identification, lexical decision, and free association), dependence of implicit memory for nonunitized items on elaborative processing has been observed only on word-completion and free-association tests. Yet implicit memory for nonunitized items (i.e., unrelated paired associates, nonwords) has been observed on various other tests, including lexical decision (e.g., McKoon & Ratcliff, 1979; 1986; Scarborough, Cortese, & Scarborough, 1977), word identification (e.g., Feustel et al., 1983; Jacoby & Witherspoon, 1982; Salasoo et al., 1985), and degraded reading (Moscovitch et al., 1986). We do not know whether implicit memory for nonunitized items on these tests is dependent on elaborative study processing.

A recent study by Gabel and Schacter (1988) indicates that implicit memory for new, nonunitized items (i.e., unrelated paired associates) can be observed following nonsemantic study processing when such processing is relevant to the demands of an implicit memory test. They required subjects to make judgments about the phonemic properties of unrelated paired associates, such as whether two words both possess a long vowel sound. They found that repeated judgments were made more quickly than initial judgments, but only when the specific pairing of the words remained intact between the first and second presentations; no facilitation was found when one of the pair members was changed. Gabel and Schacter argued that this associative effect occurred following nonsemantic study elaboration because the implicit memory test required nonsemantic processing. With respect to the present results, it is possible that implicit memory for nonunitized items depended on semantic study elaboration because the free-association test that we used elicits semantic processing. Similar considerations may apply to the observation that associative effects on the stem-completion task require semantic study elaboration (Graf & Schacter, 1985; Schacter & Graf, 1986a). However, this view does not readily account for the finding that semantic study elaboration is not necessary to observe implicit memory for unitized items on the free-association task (Experiments 1 and 3) or stem-completion task (e.g., Graf & Mandler, 1984). These considerations highlight the fact that an adequate theoretical account of implicit memory will have to accommodate differences between unitized and nonunitized items, differences of the kind documented here and elsewhere.

Although our data are to some extent consistent with the idea that automatic activation of preexisting representations plays a role in implicit memory (cf. Graf & Mandler, 1984; Mandler, 1980; Morton, 1969; Rozin, 1976), they also indicate that something more than mere activation is involved. Support for the activation view is provided by the finding that implicit memory for unitized word pairs was invariant across several elaborative and nonelaborative study tasks. However, the fact that some implicit memory for nonunitized word pairs was observed, and that it depended on elaborative processing, is clearly contrary to an activation view. If implicit memory were mediated solely by automatic activation of preexisting representations, we would not expect to observe elaboration-dependent effects of the kind that have been documented here and elsewhere (e.g., Schacter & Graf, 1986a). The fact that both implicit and explicit memory for nonunitized pairs required elaborative study processing suggests that a newly created episodic representation is involved in both forms of memory. A number of investigators have argued that priming effects

on implicit memory tests are entirely attributable to episodic factors (e.g., Jacoby, 1983a, 1983b; Roediger & Blaxton, 1987; Roediger & Weldon, 1987).

How can we reconcile those aspects of the present data that support an activation view and those that support an episodic view? One possibility has been suggested by Schacter and Graf (1986a, 1986b), who postulated that there are two different types of implicit memory effects—one mediated by activation of unitized representations, and another mediated by specific components of new episodic representations that are the product of elaborative processing. This view allows automatic activation some role in implicit memory, while at the same time acknowledging that many implicit memory phenomena cannot be accommodated by an activation notion alone (see also Schacter, 1985a, 1987). Alternatively, rather than postulate two distinct types of implicit memory, it may be simpler to argue that implicit memory depends on a single process—unintentional retrieval of a unitized representation. It may be that the difference between priming of related and unrelated pairs is that the necessary unitized representation has been established prior to the study trial for related items (e.g., SOUR GRAPES), whereas it must be created during the study trial for unrelated items (e.g., CURTAIN LECTURE). By this view, implicit memory always depends on access to a unitized representation, but the representation can be produced either by automatically activating a preexisting unit or by establishing a new unit through elaborative study processing.

Another important problem, one that the present experiments have only begun to address, concerns the process of building up new, unitized representations. Our data suggest that the building of a new unit that shows the property of part-whole redintegration on a free-association test does not proceed automatically as a result of repetition; elaborative study processing is also necessary. Although repetition clearly facilitates free-association performance, even after eight repetitions of British idioms and unrelated paired associates in the letter counting task, we observed little or no evidence of implicit memory. These results suggest that in the early stages of unitization, implicit memory depends on elaborative processes that are similar to those underlying explicit memory. It must be noted, however, that making inferences about degree of unitization solely on the basis of free-association performance entails some problems. For example, it is possible that free-association performance underestimates the degree to which a newly acquired pair has been unitized, because there may be a strong tendency for subjects to base their free association performance on old, well-learned associations. Perhaps one or two ex-

posures to a new association is insufficient to overcome this bias, even if a new unit has been formed.

As suggested by the foregoing, the generalizability of our suggestions regarding the building of unitized representations is uncertain. We do not know, for example, whether elaboration is a necessary or important component of the unitization process that occurs with repeated exposures of pseudowords (Salasoo et al., 1985). On the basis of the present research, what we do know is that combining familiar words into a larger associative unit does require elaboration, at least when implicit memory is assessed with a free-association test. It is quite possible that the role of elaboration in the unitization process depends on the kind of unit being built and the type of implicit memory test that is used.

Notes

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References

- Carroll, M., & Kirsner, K. (1982). Context and repetition effects in lexical decision and recognition memory. *Journal of Verbal Learning and Verbal Behavior*, *21*, 55–69.
- Cermak, L. S., Talbot, N., Chandler, K., & Wolbarst, L. R. (1985). The perceptual priming phenomenon in amnesia. *Neuropsychologia*, *23*, 615–622.
- Clarke, R. G. B., & Morton, J. (1983). Cross modality facilitation in tachistoscopic word recognition. *Quarterly Journal of Experimental Psychology*, *35A*, 79–96.
- Cofer, C. C. (1967). Conditions for the use of verbal associations. *Psychological Bulletin*, *68*, 1–12.
- Cohen, N. J., & Squire, L. R. (1980). Preserved learning and retention of pattern-analyzing skill in amnesia: Dissociation of “knowing how” and “knowing that.” *Science*, *210*, 207–209.
- Craik, F. I. M., & Tulving, E. (1975). Depth of processing and the retention

- of words in episodic memory. *Journal of Experimental Psychology: General*, *104*, 268–294.
- Diamond, R., & Rozin, P. (1984). Activation of existing memories in the amnesic syndrome. *Journal of Abnormal Psychology*, *93*, 98–105.
- Feustel, T. C., Shiffrin, R. M., & Salasoo, A. (1983). Episodic and lexical contributions to the repetition effect in word identification. *Journal of Experimental Psychology: General*, *112*, 309–346.
- Forbach, G. B., Stanners, R. F., & Hochhaus, L. (1974). Repetition and practice effects in a lexical decision task. *Memory & Cognition*, *2*, 337–339.
- Gabel, P., & Schacter, D. L. (1988). *Nonsemantic elaboration and implicit memory for new associations: Role of transfer-appropriate processing*. Manuscript submitted for publication.
- Graf, P., & Mandler, G. (1984). Activation makes words more accessible, but not necessarily more retrievable. *Journal of Verbal Learning and Verbal Behavior*, *23*, 553–568.
- Graf, P., Mandler, G., & Haden, P. (1982). Simulating amnesic symptoms in normal subjects. *Science*, *218*, 1243–1244.
- Graf, P., & Schacter, D. L. (1985). Implicit and explicit memory for new associations in normal and amnesic subjects. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *11*, 501–518.
- Graf, P., & Schacter, D. L. (1987). Selective effects of interference on implicit and explicit memory for new associations. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *13*, 45–53.
- Graf, P., & Schacter, D. L. (in press). Unitization and grouping mediate dissociations in memory for new associations. *Journal of Experimental Psychology: Learning, Memory, and Cognition*.
- Graf, P., Shimamura, A. P., & Squire, L. R. (1985). Priming across modalities and priming across category levels: Extending the domain of preserved function in amnesia. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *11*, 385–395.
- Graf, P., Squire, L. R., & Mandler, G. (1984). The information that amnesic patients do not forget. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *10*, 164–178.
- Hayes-Roth, B. (1977). Evolution of cognitive structures and processes. *Psychological Review*, *84*, 260–278.
- Horowitz, L. M., & Manelis, L. (1972). Toward a theory of redintegrative memory: Adjective-noun phrases. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 6, pp. 193–224). New York: Academic Press.
- Hyde, T. S., & Jenkins, J. J. (1973). Recall for words as a function of semantic, graphic, and syntactic orienting tasks. *Journal of Verbal Learning and Verbal Behavior*, *12*, 471–480.
- Jacoby, L. L. (1983a). Perceptual enhancement: Persistent effects of an experience. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *9*, 21–38.
- Jacoby, L. L. (1983b). Remembering the data: Analyzing interactive pro-

- cesses in reading. *Journal of Verbal Learning and Verbal Behavior*, 22, 485–508.
- Jacoby, L. L., & Craik, F. I. M. (1979). Effects of elaboration of processing at encoding and retrieval: Trace distinctiveness and recovery of initial context. In L. S. Cermak & F. I. M. Craik (Eds.), *Levels of processing in human memory* (pp. 1–21). Hillsdale, NJ: Erlbaum.
- Jacoby, L. L., & Dallas, M. (1981). On the relationship between autobiographical memory and perceptual learning. *Journal of Experimental Psychology: General*, 110, 306–340.
- Jacoby, L. L., & Witherspoon, D. (1982). Remembering without awareness. *Canadian Journal of Psychology*, 36, 300–324.
- Kirsner, K., & Smith, M. C. (1974). Modality effects in word identification. *Memory & Cognition*, 2, 637–640.
- Kucera, M., & Francis, W. (1967). *Computational analysis of present-day American English*. Providence, RI: Brown University Press.
- Mandler, G. (1980). Recognizing: The judgment of previous occurrence. *Psychological Review*, 87, 252–271.
- McKoon, G., & Ratcliff, R. (1979). Priming in episodic and semantic memory. *Journal of Verbal Learning and Verbal Behavior*, 18, 463–480.
- McKoon, G., & Ratcliff, R. (1986). Automatic activation of episodic information in a semantic memory task. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 12, 108–115.
- Morton, J. (1969). The interaction of information in word recognition. *Psychological Review*, 76, 165–178.
- Moscovitch, M. (1982). Multiple dissociations of function in amnesia. In L. S. Cermak (Ed.), *Human memory and amnesia* (pp. 337–370). Hillsdale, NJ: Erlbaum.
- Moscovitch, M., Winocur, G., & McLachlan, D. (1986). Memory as assessed by recognition and reading time in normal and memory-impaired people with Alzheimer's disease and other neurological disorders. *Journal of Experimental Psychology: General*, 5, 331–347.
- Palermo, S. S., & Jenkins, J. J. (1964). *Word association norms*. Minneapolis: University of Minnesota Press.
- Richardson-Klavehn, A., & Bjork, R. A. (1988). Measures of memory. *Annual Review of Psychology*, 39, 475–543.
- Roediger, H. L., III, & Blaxton, T. A. (1987). Retrieval modes produce dissociations in memory for surface information. In D. S. Gorfein & R. R. Hoffman (Eds.), *Memory and cognitive processes: The Ebbinghaus centennial conference* (pp. 349–377). Hillsdale, NJ: Erlbaum.
- Roediger, H. L., III, & Weldon, M. S. (1987). Reversing the picture superiority effect. In M. A. McDaniel & M. Pressley (Eds.), *Imagery and related mnemonic processes: Theories, individual differences, and applications* (pp. 151–174). New York: Springer-Verlag.
- Rozin, P. (1976). The psychobiological approach to human memory. In M. R. Rosenzweig & E. L. Bennett (Eds.), *Neural mechanisms of learning and memory* (pp. 1–48). Cambridge, MA: MIT Press.
- Salasoo, A., Shiffrin, R. M., & Feustel, T. (1985). Building permanent memory

- codes: Codification and repetition effects in word identification. *Journal of Experimental Psychology: General*, *114*, 50–77.
- Scarborough, D. L., Cortese, C., & Scarborough, H. S. (1977). Frequency and repetition effects in lexical memory. *Journal of Experimental Psychology: Human Perception and Performance*, *3*, 1–17.
- Scarborough, D. L., Gerard, L., & Cortese, C. (1979). Accessing lexical memory: The transfer of word repetition effects across task and modality. *Memory & Cognition*, *7*, 3–12.
- Schacter, D. L. (1985a). Multiple forms of memory in humans and animals. In N. Weinberger, J. McGaugh, & G. Lynch (Eds.), *Memory systems of the brain: Animal and human cognitive processes* (pp. 351–379). New York: Guilford Press.
- Schacter, D. L. (1985b). Priming of old and new knowledge in amnesic patients and normal subjects. *Annals of the New York Academy of Sciences*, *444*, 41–53.
- Schacter, D. L. (1987). Implicit memory: History and current status. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *13*, 501–518.
- Schacter, D. L., Bowers, J., & Booker, J. (in press). Intention, awareness, and implicit memory: The retrieval intentionality criterion. In S. Lewandowsky, K. Kirsner, & J. Dunn (Eds.), *Implicit memory: Theoretical issues*. Hillsdale, NJ: Erlbaum.
- Schacter, D. L., & Graf, P. (1986a). Effects of elaborative processing on implicit and explicit memory for new associations. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *12*, 432–444.
- Schacter, D. L., & Graf, P. (1986b). Preserved learning in amnesic patients: Perspectives from research on direct priming. *Journal of Clinical and Experimental Neuropsychology*, *8*, 727–743.
- Schacter, D. L., & Graf, P. (1989). Modality specificity of implicit memory for new associations. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *15*, 3–12.
- Shimamura, A. P., & Squire, L. R. (1984). Paired-associate learning and priming effects in amnesia: A neuropsychological study. *Journal of Experimental Psychology: General*, *113*, 556–570.
- Tulving, E., Schacter, D. L., & Stark, H. A. (1982). Priming effects in word-fragment completion are independent of recognition memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *8*, 336–342.
- Warrington, E. K., & Weiskrantz, L. (1970). Amnesia: Consolidation or retrieval? *Nature*, *228*, 628–630.
- Warrington, E. K., & Weiskrantz, L. (1974). The effect of prior learning on subsequent retention in amnesic patients. *Neuropsychologia*, *12*, 419–428.
- Whittlesea, B. W. A., & Cantwell, A. L. (1987). Enduring influence of the purpose of experiences: Encoding retrieval interactions in word and pseudoword perception. *Memory & Cognition*, *15*, 465–472.
- Winnick, W. A., & Daniel, S. A. (1970). Two kinds of response priming in tachistoscopic recognition. *Journal of Experimental Psychology*, *84*, 74–81.