The Effect of Proportion Overlap and Repeated Testing on Primed Word Fragment Completion

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Abstract Subjects studied a list of words (e.g., cheetah) and received an implicit word fragment completion test (complete -h–t-h). On the test, the ratio of studied to nonstudied items (proportion overlap) was 0, 25, 50, 75, or 100%. Subjects were administered the identical test twice. Proportion overlap did not affect priming in word fragment completion, on either the first or second test. Also, the completion of studied and nonstudied fragments increased over repeated tests, but priming (the studied – nonstudied rate) remained unchanged. The proportion overlap of items between study and test does not affect performance on primed word fragment completion.

Résumé Les sujets ont étudié une liste de mots (p. ex. cheetah) et ont été soumis à un test implicite où ils devaient compléter des mots (p. ex. -h – t-h). Pour le test, le rapport entre les mots étudiés et les mots non étudiés (rapport de recoupement) était de 0, 25, 50, 75 ou 100 %. Le même test a été administré une seconde fois. Le rapport de recoupement n'a pas influé sur l'amorçage relativement à la tâche, ni dans le premier test ni dans le second. Par ailleurs, davantage de mots étudiés et non étudiés ont été complétés lors de tests répétés, mais l'amorçage (taux de mots étudiés – non étudiés) est resté le même. Le rapport de recoupement des mots présentés durant l'étude et durant le test n'influence pas les résultats reliés à cette tâche précise.

In recent years considerable research has focussed on the comparison of implicit and explicit measures of retention. Although some variables have been reported to have parallel effects on these two types of tests, researchers have shown most interest in factors producing interactions, or dissociations, between implicit and explicit tests (see Roediger, 1990; Richardson-Klavehn & Bjork, 1988; and Schacter, 1987 for reviews).

The focus of this article is a variable reported to have a parallel effect on implicit and explicit memory tests. Jacoby (1983; Experiment 1) reported that the magnitude of priming in perceptual identification (identifying briefly

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presented words) was related to the ratio of studied to nonstudied words on the test, which he called *the proportion overlap*. The priming effect was larger when studied words constituted 90% of the items on the test than when studied words constituted 10% of the test items. Similar effects of list context have been found in recognition (e.g., Jacoby, 1972; Todres & Watkins, 1981), leading to the suggestion that reinstating list context has a parallel effect on implicit and explicit memory tests (e.g., Jacoby, 1983; Richardson-Klavehn & Bjork, 1988).

The presence of a proportion overlap effect on an implicit test has potentially important empirical implications. For instance, if proportion overlap affects the magnitude of priming, then comparisons of priming scores across conditions or experiments may be of limited value if proportion overlap differed across them. Furthermore, if the effect of proportion overlap interacts with a manipulated variable, statements concerning the effects of that independent variable on priming may have to be constrained. A survey of the literature revealed that proportion overlap has varied considerably in experiments involving implicit memory tests and that in many cases proportion overlap was not stated explicitly. For example, in experiments involving an implicit word fragment completion test (complete -l-ph--t as elephant), proportion overlap has included values of .00 (Smith, 1991, Experiment 1, control group), .33 (Greene, 1990, Experiment 2), .50 (Weldon, 1991, Experiment 1), .83 (Durgunoglu & Roediger, 1987), and 1.00 (Smith, 1991, Experiment 1, experimental group).

The occurrence of a proportion overlap effect on an implicit test such as perceptual identification has theoretical implications. Various contemporary accounts of implicit and explicit memory (e.g., Roediger, 1990; Roediger, Weldon, & Challis, 1989; Schacter, 1990; Tulving and Schacter, 1990) embrace the notion that perceptual processes underlie priming on implicit memory tests that provide isolated, data-limited displays, tests such as perceptual identification and word fragment completion. These implicit tests seem perceptual in nature, because they are greatly affected by study manipulations such as modality (visual or auditory) and symbolic form (word or picture, or language for bilinguals), whereas these tests are often little affected by manipulations of a semantic nature (e.g., organization of material and the like) (see the reviews listed in the first paragraph; also Roediger & Challis, 1992). A proportion overlap effect in an implicit perceptual test may be inconsistent with the foregoing view of performance on these tests, in that reinstating list context does not appear to be a manipulation of a perceptual nature (cf. Richardson-Klavehn & Bjork, 1988).

In spite of the empirical and theoretical implications of a proportion overlap effect on an implicit test, few researchers have examined this issue. Jacoby's (1983; Experiment 1) report of a proportion overlap effect in perceptual identification was replicated by Allen and Jacoby (1990), who argued that it was not mediated by intentional or explicit memory. This conclusion was based on the finding that generated words, which were better recognized than read words, did not benefit more from the proportion overlap manipulation in perceptual identification. The enhanced benefit from proportion overlap on perceptual identification implicated an effect of reinstating context that operated at an unconscious level. However, not all context manipulations reveal this effect in perceptual identification; Jacoby (1983; see also Jacoby & Witherspoon, 1982) examined the influence of match between environmental (room, computer, experimenter) contexts at study and test, but with generally null findings.

The experiment reported here sought to extend the finding of a proportion overlap effect in perceptual identification to another popular implicit memory test, word fragment completion (see Tulving, Schacter, & Stark, 1982; also Roediger & Blaxton, 1987a; 1987b). Researchers have shown that perceptual identification and word fragment completion behave similarly as a function of a variety of independent and subject variables (see Richardson-Klavehn & Bjork, 1988, for a review; also Weldon, 1991). Such similarities in perceptual identification and word fragment completion is consistent with current theory (e.g., Roediger, 1990; Tulving & Schacter, 1990) in that the stimulus presented at study occurs on both of these tests in a perceptually degraded form.

In the present experiment, subjects studied a list of words and received a word fragment completion test. The proportion of studied items on the test was .00, .25, .50, .75, or 1.00. Following Test 1, and after a short break, subjects were administered the identical fragment completion test a second time (Test 2). Subjects were given the same test twice for two main reasons, which were unrelated to each other.

1. The occurrence of a proportion overlap effect in a (putative) implicit test may reflect subjects' reliance on an explicit retrieval strategy. When completing a test with a high proportion of studied items, subjects may become aware that test items correspond to studied items and adopt an explicit retrieval strategy. In comparison, subjects completing a test with a low proportion overlap may not realize that test items correspond to studied items, or they may only become aware of this fact after completing most of the test, and therefore reliance on explicit retrieval would have limited benefit. In administering the same test twice, subjects who learned of the relation between study and test while completing Test 1 were provided with an opportunity to rely on an explicit retrieval strategy during all of Test 2. Therefore, if proportion overlap effects are the result of explicit retrieval strategies, they should occur more powerfully in Test 2 than Test 1.

2. In explicit memory tests, an overall improvement in performance (e.g., net recall) between repeated tests (in the absence of additional study opportunities) is referred to as *hypermnesia,* in contrast to more typical

forgetting or amnesia over time (Erdelyi & Becker, 1974). In explicit tests of recall and recognition, hypermnesia is a reliable phenomenon that is obtained with verbal and pictorial material, and is an issue with important practical and theoretical implications for our understanding of memory (see Payne, 1987; Roediger & Challis, 1989, for reviews). Whether hypermnesia occurs in implicit memory tests remains an open question. In the present experiment, subjects completed the same test twice, with no additional study between tests, to determine whether priming would increase between tests.

METHOD

Subject

Eighty Purdue University students participated in partial fulfillment of an introductory psychology requirement.

Materials and Design

The proportion of test fragments corresponding to studied words (.00, .25, .50, .75 and 1.00) was manipulated between subjects. Subjects completed the same word fragment completion test twice in succession.

A set of 160 words (e.g., UMBRELLA) with their corresponding word fragments (_ M _ R E _ L _) served as the critical target items. These items were drawn from a pool of materials developed for use in other experiments (e.g., Roediger & Challis, 1992; Weldon, Roediger, & Challis, 1989). The target words varied in length from 5 to 12 letters and were relatively low frequency nouns. The word fragments were constructed to have unique solutions, although a few did not. Twelve other words were selected to serve as buffer items in the study list. Slides of the target words and buffer items were constructed. Words and the test fragments were presented in upper-case letters. The 160 target items were divided into two sets of 80 items (A and B). Subjects studied the items in set A or B in one of two random orders. Six buffer items were included at the beginning and the end of a study list. Words were presented via a slide projector at 5 s per word.

Each of the two sets of items (A and B) were each randomly divided into four sets of 20 items. For the various proportion overlap conditions, different tests were constructed by integrating an appropriate number of items from set A and from set B. In the 1.00 and .00 condition, the test contained only items from set A or set B. Subjects who studied set A received a test containing all the items from set A (1.00 condition) or they received the test with all items from set B (.00 condition). In the .50 condition, half of the items on the test were selected from set A and half from set B. The same principle was used in constructing tests for the .75 and .25 conditions. Twenty different tests were constructed in order that the 160 target items were counterbalanced across the five proportion conditions and across studied and nonstudied conditions. The order of fragments on each of the 20 tests was random.

Sixteen subjects were assigned to each of the 5 proportion conditions, with 1280 observations (collapsed over studied and nonstudied items) in each of the proportion conditions.

Procedure

The subjects were tested in groups of 4 to 12. Following the introductory comments, study instructions were administered. Subjects were told to study the words for a later memory test.

Following the study phase, subjects completed a 5-min distractor task that required them to write the names of states and state capitals. After the distractor task, test materials were distributed and test instructions were administered. Subjects were instructed to complete each fragment so that it made an English word. No mention was made of the relation between the studied items and the fragments, and the test was presented as a filler task done for other purposes between study and test of the list. They were told to work on one fragment at a time, to use the cover sheet to conceal upcoming fragments and neither to work ahead nor return to any items. Example fragments and solutions were provided. Subjects were given 15 s to complete each fragment.

Upon completion of the first test, subjects were told to relax for a few minutes until the next task began. After a short break, subjects were given another word fragment completion test, along with a condensed version of the word fragment completion instructions administered on the first test. No mention was made about the relation between the second and first test, or about the relation between the test and study phases. In fact, Test 2 was exactly the same as Test 1 (the same fragments presented in the same order). Upon completion of the second test, subjects were debriefed. The experimental session lasted about 1 hr.

RESULTS

Presented in Table 1 are the proportions of studied and nonstudied fragments correctly completed, and priming scores, on Test 1 and Test 2 as a function of the proportion overlap.

There was no proportion overlap effect on Test 1 or Test 2. Several one-way analyses of variance that included proportion overlap as a between-subjects factor revealed that neither studied nor nonstudied completion rates varied as a function of proportion overlap on Test 1 or Test 2, Fs < 1.2. Similar analyses were performed on the Test 1 and Test 2 priming scores and again there was no significant effect of proportion overlap, $F(2,45) = 2.99$, $MS_e = .014$, and $F < 1$, respectively. There was significant priming on Test 1 and on Test 2, $F(1,45) = 168.07$, $MS_e = .007$, and $F(1,45) = 173.63$, $MS_e = .007$, respectively. (All effects reported as significant in this article had p values of less than .05.)

TABLE 1
Proportion of Fragments Correctly Completed on Test 1 and Test 2 as Function of Proportion Overlap

		Proportion overlap					
Test	Measure	.00	.25	.50	.75	1.00	Mean
Test 1	Studied	—	.48	.42	.46	.48	.46
	Nonstudied	.23	.20	.23	.25	—	.23
	Priming	—	.28	.18	.21	—	.22
Test 2	Studied	—	.55	.53	.56	.59	.56
	Nonstudied	.30	.30	.33	.32	—	.31
	Priming	—	.25	.20	.24	—	.23

Note. Proportion overlap refers to the proportion of studied items on the test.

The total proportion of studied and nonstudied items completed on Test 2 was greater than on Test 1. This was a robust phenomenon, with 60 of 64 subjects completing more studied items on Test 2 than Test 1 (3 ties), and 55 of 64 subjects completing more nonstudied items on Test 2 than Test 1 (7 ties)[1]. Averaging over the proportion overlap condition, studied rates increased from .46 to .56, and nonstudied rates increased from .23 to .31. Analyses of variance that included Test 1 or Test 2 as a within-subjects factor and proportion overlap as a between-subjects factor indicated that studied and nonstudied completion rates were greater on Test 2 than on Test 1, $F(1,60) = 170.97$, $MS_e = .002$, and $F(1,60) = 118.52$, $MS_e = .002$, respectively. In contrast, priming scores were similar on Test 1 (.22) and Test 2 (.23), $F < 1$, reflecting a similar increase in studied and nonstudied completion rates from Test 1 to Test 2. In all of these analyses, the main effect of proportion overlap and the interaction between proportion overlap and Test 1 versus Test 2 were not significant, greatest $F = 2.02$.

In the study of hypermnesia in explicit memory tests, the analyses has traditionally focussed on net or cumulative recall. However, Payne (1986; 1987) has pointed out that for a complete account of hypermnesia in the repeated test paradigm, one needs to examine both components of performance across Test 1 and Test 2, intertest recovery (items produced on Test 2 only) and intertest loss (items produced on Test 1 only). Despite the fact that more fragments were completed on Test 2 than on Test 1, reflecting intertest recovery, some items may have been produced on Test 1 but not on Test 2 (intertest loss.)

Presented in Table 2 are the intertest recovery and loss scores for studied

1 Note that 64, rather than 80, subjects are included because the 16 subjects in the .00 overlap condition were not tested on studied items, whereas 16 subjects in the 1.00 overlap condition were not tested on nonstudied items.

TABLE 2
Proportion of Fragments Completed on Test 2 Only (Intertest Recovery) and on Test 1 Only (Intertest Loss) as a Function of Proportion Overlap

	Proportion overlap					
Measure	.00	.25	.50	.75	1.00	Mean
Intertest recovery						
Studied	—	.09	.14	.13	.14	.13
Nonstudied	.09	.12	.11	.09	—	.10
Intertest loss						
Studied	—	.02	.03	.03	.03	.03
Nonstudied	.02	.02	.01	.02	—	.02

Note. Proportion overlap refers to the proportion of studied items on the test.

and nonstudied items in the various proportion overlap conditions. The levels of intertest loss and recovery were similar across the various proportion overlap conditions. Intertest recovery averaged 13% for studied items and 10% for nonstudied items, and was present in 61 of 64 subjects for studied and nonstudied items. Intertest losses were relatively low, averaging 3% for studied items and 2% for nonstudied items. Intertest loss occurred in 32 of 64 subjects for studied items and 40 of 64 subjects for nonstudied items.

GENERAL DISCUSSION

The main findings were straightforward. First, there was no effect of proportion overlap on priming in word fragment completion. Second, priming in word fragment completion did not increase over repeated tests, although overall completion rates did. These findings are considered in turn.

The experiment sought to extend Jacoby's (1983; Experiment 1) and Allen and Jacoby's (1990) report of a proportion overlap effect in perceptual identification to another popular implicit test, word fragment completion. However, in the present experiment there was no significant effect of proportion overlap. Apparently, primed word fragment completion is immune to the effects of proportion overlap, at least under conditions used in our experiment. With respect to this discrepancy over the effect of proportion overlap on implicit tests, there are several considerations.

First, memory tests differed across the studies. Jacoby (1983) and Allen and Jacoby (1990) used perceptual identification whereas word fragment completion was used in the present experiment. Although the difference in tests may account for the discrepancy across experiments, previous research indicates that perceptual identification and word fragment completion behave similarly as a function of a number of independent (and subject) variables (Weldon, 1991; see Richardson-Klavehn & Bjork, 1988, for a review). Furthermore, similar performance on perceptual identification and word fragment completion is consistent with some accounts of performance on implicit memory tests (see Roediger, 1990; Richardson-Klavehn & Bjork, 1988; Schacter, 1987).

A second difference between the experiments reported by Jacoby and Allen (Jacoby, 1983; Allen & Jacoby, 1990) and the present experiment concerns the nature of the test instructions. In the present experiment, all subjects were administered the same implicit test instructions in which no mention was made of the relation between study and test. In Jacoby's and Allen and Jacoby's experiments, the manipulation of proportion overlap was correlated with test instructions–subjects in the high proportion overlap condition were informed of the relation between study and test whereas subjects in the low proportion condition were not informed of the relation between study and test. Jacoby (1983, p. 26) acknowledged that in his experiment on the proportion effect, the manipulation of proportion overlap and the manipulation of test instructions was confounded, so that it was not possible to assess the relative contribution of the two variables on the obtained effect (cf. Bowers and Schacter, 1990). As well, the manipulation of proportion overlap was correlated with test order in Allen and Jacoby's (1990) second experiment, which raises problems for interpretation of the results.

A third issue concerns the reliability of the findings. Although the absence of a proportion overlap effect in the present experiment reflects a null finding, the experiment was relatively powerful[2] and there was no trend towards a proportion overlap effect. (Numerically, priming was actually greater in the low proportion overlap condition). As well, in an unpublished experiment, Donnelly (1988, Experiment 1) found that proportion overlap had a negligible effect on priming in word fragment completion under visual presentation conditions.

We can only speculate as to what underlies the discrepancy between the report of a proportion overlap effect in perceptual identification on the one hand (Allen & Jacoby, 1990; Jacoby, 1983), and the absence of a proportion overlap effect in word fragment completion in the presented experiment. However, given the results of the present experiment and the ambiguous nature of the reports of a proportion overlap effect in perceptual identification (e.g., the confound between proportion overlap and test instructions), any claim that proportion overlap affects priming in implicit memory tests lacks substantive empirical support. Further work on the effect of proportion overlap on implicit memory tests is clearly warranted.

We now turn to the issue of repeated testing and hypermnesia in an implicit memory test[3]. The results of the present experiment clearly demonstrated that

2 As a measure of the relative treatment magnitude of proportion overlap, omega squared values were computed for the studied, nonstudied and priming scores. The omega squared values of .03 to 0 reflected a very small effect.

3 A line of research concerned primarily with stochastic relations between successive tests

total completion rates for studied and nonstudied items increased from Test 1 to Test 2. A mundane interpretation for the increase in performance across tests is a total time hypothesis–the second test provided subjects with an additional 15 s to work on each fragment, and the additional time lead to an increase in the proportion of fragments completed (i.e., intertest recovery). In other words, if subjects were given 30 s to complete each fragment, the level of performance on the single test would be the same as performance after two tests that each allowed 15 s for fragment completion. (See Roediger & Thorpe, 1978, for a similar interpretation of improvements over tests in free recall.) In support of this reasoning, Srinivas and Roediger (1990, Experiment 3) recorded the time taken to solve fragments and plotted cumulative completion curves. These did not appear to have reached asymptotic levels after 15 s. Although 15 s seems to provide ample time for completing word fragments, further gains are possible when additional time is provided.

The fact that hypermnesia in priming did not occur in this experiment, whereas the phenomenon routinely occurs in free recall, probably should not be interpreted as a difference between implicit and explicit measures of retention. This is because hypermnesia does not occur on other explicit measures of retention, such as recognition (Payne & Roediger, 1987). The matter of possible hypermnesia in word fragment completion was worth a brief look, in our opinion, but can now be dropped from consideration unless further evidence warrants reopening the issue.

In conclusion, proportion overlap of studied to tested items appears to have no effect on completing word fragments over a wide manipulation of this variable. These results seem in accord with the notion that priming on these tests reflects operation of basic perceptual processes that may be relatively immune to higher cognitive factors (Roediger, 1990; Tulving & Schacter, 1990). However, as with all failures to reject the null hypothesis, the present data are consistent with this viewpoint, but hardly provide compelling evidence for it.

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involves repeated testing, although in many studies (e.g., Tulving et al., 1982) the successive tests were different (e.g., recognition and word fragment completion). In other experiments (e.g., Hayman & Tulving, 1989), successive implicit word fragment completion tests were administered but the two tests were not identical.

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