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SELECTIVE FACILITATION AND INTERFERENCE IN RETENTION OF PROSE[1]

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A prose passage may be described at the level of asserted relations among general semantic categories or at the level of predications about specific details (e.g., names, dates, places). This experiment used interpolated learning to facilitate retention of the *conceptual macrostructure* of an originally learned passage while simultaneously interfering with retention of the originally learned passage's *detailed microstructure*. The subjects originally learned a short biography; the experimental subjects then learned two more biographies of similar conceptual format which had one third of the details changed. Later, cued recall of changed details of the originally learned passage showed retroactive interference and many intrusion errors. Free recall of the originally learned passage showed depressed recall of changed details and enhanced recall of unchanged details, but equal facilitation in recall of the conceptual macrostructure.

This experiment investigates interference processes in retention of meaningful prose. Although earlier investigations of retroactive interference with prose materials typically found weak effects, strong effects have been obtained recently in experiments that have taken more care in arranging optimal interfering conditions and in analyzing appropriate aspects of recall in accordance with interference principles established in the typical "nonprose" experiments (e.g., Anderson & Myrow, 1971; Crouse, 1971; Myrow & Anderson, 1972). The present experiment extends this analytic approach to further interference phenomena in prose learning.

Previous investigations suggest that one can devise interpolated texts which when learned can produce either retroactive interference, retroactive facilitation, or "no effect" with respect to the retention of an originally learned passage. To illustrate, suppose that an originally learned passage is a short biography of a fictitious poet named John Payton and it contains the complex sentence, "Payton's father worked as a blacksmith but he died of diphtheria when John was only five years old." Consider a counterpart sentence that occurs in the interpolated passage, another biography about another fictitious poet, Robert Fowler: "Fowler's father worked as a blacksmith but he died of lung cancer when Robert was only three years old." Comparing these sentences, some details have remained the same whereas others have changed. Assuming initial learning of the first sentence, the second sentence should help the subject retain the original fact that the poet's father was a blacksmith, because that predicate construction is repeated for the main character. However, the disease that killed the father and the son's age when his father died are details that have been changed. For these, one expects response competition and retroactive interference when test questions explicitly probe for recall of their originally learned values. These two cases illustrate retroactive facilitation and retro-

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active interference, respectively. The neutral or noninterference condition would have, in the interpolated passage, a sentence that mentioned neither the subjects nor the predicates of the original passage. A given interpolated passage will have certain proportions of facilitating, ineffective, and interfering constructions with respect to an originally learned text, and its net effect upon originally learned retention should vary systematically with the proportions of the three constructions among the test items for originally learned retention. Our investigation attempts to validate this commonsense analysis.

A second issue we investigated is the recall of the *conceptual macrostructure* of the passage; this refers to the main conceptual categories and relations (or gist) of the passage without regard to the detail carried by names, dates, places, and numbers. Thus, the macrostructure of the two sentences above is that "the main character's father had *some* occupation but he died of *some* disease when the character was only *some* years old." The "somes" denote variables into which different instantiating details are inserted to produce a facilitating or interfering sentence for the interpolated passage. This formulation suggests that recall of the categories of an originally learned passage may be enhanced by an interpolated passage that alters and interferes with memory of many of the originally learned details. The following experiment attempts to create this pattern, that is, retroactive inhibition in recall of the detailed microstructure of the passage, while at the same time enhancing retention of its conceptual macrostructure.

We do this by use of unprompted or "free" recall, examining the conceptual relations recalled as well as the accuracy of the details instantiating those categories. Provided that the subject guesses when uncertain among competing answers, we should find retroactive facilitation in his recall of the conceptual macrostructure of the passage. In addition, facilitation or interference should be observed for recall of specific details of the originally learned passage, depending on whether these are repeated or changed in the interpolated text. These "detail-specific" effects should be as apparent in accuracy of cued-recall as in free-recall measures of originally learned retention. The following experiment tested these interlocking expectations.

Method

Two groups of undergraduates (13 in each group, approximately half male and half female) served as subjects and were paid $1.75 for one hour's service. Each subject learned three successive text passages and then received a final retention test over the initial two passages. All subjects originally learned the biography of a fictitious poet, John Payton. This passage, adapted from Crouse (1971), was arranged into 15 distinct sentences totaling 173 words. The first 4 sentences are illustrative:

> John Payton was one of the finest poets England has ever known. Payton was born in Northshire at the end of October, 1810. His father was a servant who worked in the nearby town of Blackrock. When Payton was only five years old, his father was killed by a robber.

These passages were shown to small groups of from 2 to 4 subjects by means of an overhead projector. The individual sentences were shown one every 5 seconds by sliding a cardboard "mask" down a translucent sheet exposing the sentences one by one. The subjects were told to memorize each sentence but also to relate it to the overall text. After one study trial and a 10-second pause, the same originally learned passage was studied again. Following the second study trial, subjects read aloud in unison a slide of random digits for 20 seconds (to minimize short-term memory), and then they were asked to free recall the 15 sentences of the passage studied. Recall instructions were somewhat vague: subjects were told that we were interested in how much they could recall verbatim (hence the 15 numbers down one side of the recall sheet for the corresponding sentences); but they were further urged to reproduce the gist or substance of any facts they could not recall verbatim and also to write any fact they could recall regardless of whether they knew its order of presentation. The subjects had 6 minutes to write their free recall, and all finished by that time. We will refer to this as the immediate free-recall test of original learning.

After collecting the free-recall sheets, the experimenter distributed the cued-recall sheet for the originally learned passage. This asked 20 questions (having one–three word answers) regarding specific details of the passage just studied. For example, for the Payton story, 1 question asked for the occupation of Payton's father, another asked for Payton's year of birth, another asked how old Payton was at the time his father died, etc. The subjects completed these cued-

recall sheets in 2.5 minutes. We will refer to this as the cued-recall test for the originally learned passage.

Upon arrival at the lab, subgroups of subjects had been assigned randomly to the experimental or control condition (subgroups of from two to four subjects in these two conditions were run in random alternation). The two treatment groups received different interpolated passages, each learning and recalling two separate interpolated passages (to enhance the hoped-for retroactive interference). The experimental subjects learned two more biographies which were very similar to the one for John Payton except that the main character had a different name (Robert Fowler, then Richard Hughes) and 22 specific details of the originally learned passage were changed. To illustrate the changes, the first four sentences of the "Robert Fowler" passage were identical to those for John Payton except for the details that Fowler was born in Hampstead in 1795 of a blacksmith who was killed by a wolf when Fowler was eight years old. The third, the "Richard Hughes" passage, changed the same factual details as did the second passage. So in comparing these passages to the originally learned passage, one can pinpoint which details have remained the same and which have changed. Control subjects learned two unrelated passages of similar length and difficulty, the first describing the collections of the fictitious King Library, the second describing the geography and inhabitants of the fictitious island of Karisoon. These passages were also adapted from Crouse (1971).

Learning of each interpolated passage followed the same procedure as the originally learned passage: two presentations of the single sentences of the passage, followed by 20-second digit reading, followed by a 6-minute written free recall, and then a 2.5-minute cued-recall test with 20 questions regarding details. For experimental subjects, the 20 questions on these interpolated tests were identical to those used for the originally learned passage except that the name of the poet was changed.

Following the cued-recall test on the last interpolated passage, retention of the originally learned passage was tested, yielding the data of primary interest. First, free recall was requested of "the first passage, the one about John Payton." After 6 minutes, the subjects then received the cued-recall test for the originally learned passage (for 2.5 minutes), asking the same questions again. Because of time limitations, we were unable to test retention in both ways for the interpolated passages. However, a final cued recall was obtained for the first interpolated passage, List 2.

Protocol Scoring

Each subject contributed four free-recall protocols and five cued-recall protocols. Cued recall was scored as correct or wrong and, if wrong, whether or not an intrusion error from an incorrect list occurred. A lenient criterion for gist recall was used. Free-recall scoring introduced several problems. We had to decide what were the parts of conceptualizations expressed in the text. These were basically of two types: (*a*) attributive or modificatory statements (e.g., "disease was cancer," "John's age was five years") or (*b*) nouns serving as case-relation arguments in relation to the main verb—either as agent, recipient, time or location of the action (verb). For instance, the sentence, "his father was killed by a robber," has the two argument–relation pairs stipulating "robber–killed" (agent–act) and "killed–father" (act–recipient). Although one might quibble over our exact segmentation of the sentences into "idea units," it is doubtful whether the overall pattern of the results would be much affected by these identifications (see Paul, 1959).

By this means, we identified 63 "idea units" in the originally learned passage; of these, 22 had been changed in detail in both of the interpolated passages (learned by the experimental subjects), whereas 41 had remained the same throughout the originally learned passage and both interpolated lists. Recalls of these two kinds of originally learned units were tabulated separately. Each idea unit of the originally learned list was scored according to whether it was recalled as a specific detail (e.g., that Payton's age was five years at the time his father was killed) and according to whether the right general kind of fact was recalled (e.g., mentioning Payton's age at the time his father was killed). We called this latter the subject's general fact recall and the former his specific fact recall. These are correlated measures, since correct recall of a specific fact entails recall of the corresponding general fact. However, the scoring scheme permits a general fact to be recalled without its specific detail being correct (due to intrusions or simple mistakes). Scoring was lenient with respect to paraphrases and synonyms but nonetheless was quite reliable for two judges (scoring was not "blind" for either judge).

Results

Original Learning

The degree of original learning for the three successive lists is shown by the immediate cued-recall proportions in Table 1. The experimentals and controls did not differ reliably in immediate recall on any list. This was true for free recall as well as for cued recall. There was a general practice effect from List 1. Although the experimentals are slightly inferior to the controls on Lists 2 and 3, a result possibly reflecting negative transfer, that inference is unwarranted due to a covarying (small) difference on List 1 performance and also to

TABLE 1

CUED-RECALL PROPORTIONS ON THE IMMEDIATE TEST FOR LISTS 1, 2, AND 3 AND CUED-RECALL PROPORTIONS AND INTRUSION PROPORTIONS ON THE DELAYED TEST FOR LISTS 1 AND 2

Condition/test	List 1		List 2		List 3	
	Experimental	Control	Experimental	Control	Experimental	Control
Cued recall						
Immediate	.54	.59	.71	.78	.68	.75
Delayed	.40	.59	.59	.75		
Intrusion						
Delayed	.10	—	.12	—		

the fact that the Lists 2 and 3 which were learned by the two groups differed, so there is no assurance that the lists were of comparable difficulty.

Forgetting: Cued Recall

The cued-recall loss scores for Lists 1 and 2 are calculated by subtracting the delayed from the immediate cued-recall proportions in Table 1 (time did not permit a delayed test on List 3). For List 1, the experimental subjects had a specific loss of about 13.9%, whereas the controls forgot .4%. An overall analysis of variance was carried out on transformed (arcsin) recall proportions with experimental–control interpolation as a between-subjects factor and immediate–delayed testing as a within-subjects factor (see Winer, 1962, p. 302 ff.). As expected, that analysis revealed significant forgetting ($F = 14.6$, $df = 1/24$, $p < .01$), with reliably more forgetting by the experimental than the control subjects (interaction, $F = 11.9$, $df = 1/24$, $p < .01$). Similar conclusions stem from comparing forgetting of List 2 items by the two groups ($p < .01$).

A revealing statistic in Table 1 is the proportion of intrusions of competing responses from interfering lists learned by the experimental subjects (e.g., recalling a birthdate from List 2 or 3 while trying to recall the one stated in List 1). These competitive intrusions were a major determinant of the differential loss in the originally learned passage for the experimental subjects.

Free Recall

Specific facts. Free recall of specific factual details was examined first. The proportions of specific originally learned facts recalled on the immediate and delayed tests are shown in Table 2, divided according to changed versus unchanged facts and according to experimental versus control treatments. For the controls, the changed versus unchanged set refers to those items in the originally learned passage that were changed or not changed in the interpolated passages learned by the experimental subjects. The total proportions for the changed and unchanged scores combined are shown for each cell, and the changes from the immediate- to the delayed-recall scores are easily computed.

These data allow several interesting comparisons whose discussion can begin with the total scores. Much as with earlier studies, these totals revealed no net retroactive interference. An overall analysis of variance on total free-recall proportions (arcsin total) yielded no effect due to treatment groups or to the interaction of treatment with retention interval ($F = 1.44$, $df = 1/24$, $p > .10$). Surprisingly, there was even a slight *increase* in the total facts recalled between the immediate and the delayed retention test.

However, the detailed story of what happened is told by separately considering recall of the changed versus the unchanged specific facts. Relative to the controls, the experimental subjects forgot changed details while increasing their recall of unchanged (repeated) details. An analysis of variance was performed on the transformed proportions (see Table 2) with experimental versus control as a between-subjects factor, and changed versus unchanged facts and immediate versus delayed tests as two

within-subjects factors (see Winer, 1962, p. 319 ff.). The effects of chief interest appear as interactions. First, the changed–unchanged factor interacts with immediate versus delayed testing ($F = 104$, $df = 1/24$, $p < .01$), reflecting an increase in the unchanged versus changed difference over the retention interval. Second, there was a significant triple interaction of the above two factors with the experimental versus control contrast ($F = 34$, $df = 1/24$, $p < .01$). As expected, then, the results show retroactive interference in recall of changed details and facilitation for unchanged (repeated) details, with the changes being greater for the experimental than for the control subjects. These specific contrasts were confirmed by significant t tests. One main effect was significant in the overall analysis—unchanged facts were recalled better than changed facts, even on the immediate test—but that is a *materials construction* artifact of no particular interest. No other effects were significant in the overall analysis on free recall of specific facts. Part of the loss in recall of changed details was due to intrusions of interpolated details while the subject was attempting recall of the originally learned detail (average of 1.77 per subject).

General facts. A *general fact* is said to be recalled if the subject recalls the correct general category of a thing or relation between things, though possibly with the wrong detail. Free-recall proportions for such general facts are shown in Table 3 for immediate and delayed tests, the general facts divided according to whether their details were changed or unchanged between the originally learned and the interpolated passages.

TABLE 2

FREE-RECALL PROPORTIONS FOR SPECIFIC FACTS ON IMMEDIATE AND DELAYED TESTS

Test/specific facts	Experimental	Control
Immediate		
Changed	.48	.53
Unchanged	.61	.68
Total	.55	.63
Delayed		
Changed	.34	.51
Unchanged	.76	.73
Total	.62	.66

TABLE 3

FREE-RECALL PROPORTIONS FOR GENERAL FACTS ON IMMEDIATE AND DELAYED TESTS

Test/general facts	Experimental	Control
Immediate		
Changed	.62	.67
Unchanged	.66	.72
Total	.64	.70
Delayed		
Changed	.76	.71
Unchanged	.80	.77
Total	.79	.75

These general-fact-recall proportions were used in an analysis of variance similar to that described above, with one between-subjects factor and two within-subjects factors. The chief effects of interest are the overall increase in recall scores from the immediate to the delayed test (for retention interval, $F = 21.68$, $df = 1/24$, $p < .01$) and the fact that this increase was larger for experimental than for control subjects (interaction, $F = 5.40$, $df = 1/24$, $p < .05$). The changed versus unchanged factor did not enter into any of these significant interactions, although it was associated with a significant main effect: unchanged items were recalled slightly better than changed items even initially ($F = 6.36$, $df = 1/24$, $p < .05$); this is the same materials construction artifact noted before. The difference scores (delayed minus immediate free-recall proportions) make transparent the pattern of significant outcomes: experimental subjects improved their free recall of general facts more than control subjects, and this improvement was as large for general facts with changed details as for those having unchanged details. We may therefore conclude that improvement in recall of the conceptual macrostructure is approximately the same whether the underlying details are changed or kept the same from the original to the interpolated texts.

DISCUSSION

The results accorded with commonsense expectations: retroactive interference was observed for changed details and retroac-

tive facilitation for unchanged details. Interpolated passages that were similar to the originally learned passage but which had altered details were nonetheless beneficial in facilitating retention of the conceptual macrostructure of the original passage. The interpolated passage boosted free recall of the appropriate *kinds* of facts, while lowering the accuracy of the details recalled. The effect here is similar to that encountered in free recall of categorized word lists: a taxonomic category that is repeated on an interpolated list but with different instances will be thereby enhanced in category recall of the original list but at the expense of a lower score on a conditionalized measure of "items per recalled category" (see Shuell, 1968).

Some discussion is needed regarding limitations on the generality of our result. First, the learning and retention intervals here were short, spanning 35 minutes at most, and similar experiments are required at longer intervals and with larger amounts of learning material. Second, a serious limitation is that the experiment used only one specific biography as the critical originally learned material. One should like to generalize the results to a larger population of materials—and not only to biographies but to other "fact-listing" passages and possibly even to less "fact-oriented" materials. Therefore, replication of the experiment with several different sets of materials would clearly enhance the generality of its principal conclusions.

An issue requiring discussion is whether our procedures oriented the subject far too much to word-for-word or verbatim memorization, stripping the text of its meaningfulness and only thereby creating conditions favorable for demonstrating interference effects in retention. We have serious doubts about the dichotomies implicit in such a remark. Nothing in interference theory restricts its applicability to meaningless material or to "factual details" such as names, dates, locations, and numbers. Simple sentences may be conceived of as being learned by associating concepts corresponding to the subject and predicate of the sentence (see Anderson & Bower, 1973). For example, using such simple sentences as "the uncle shouted an obscene remark," Anderson (1971) showed that following study of such sentences, later recall of the subject term (*uncle*) was cued almost as well by a *paraphrase* of the predicate ("——yelled some dirty words") as by the *verbatim* predicate that had been studied. Moreover, this close correlation in cueing effectiveness of the verbatim predicate and its paraphrased predicate was also found for subjects instructed to learn the original sentences by "rote, verbatim repetition." The implication is that even with instructions designed to promote "nonnormal," rote processing of sentences, the subject nonetheless and willy-nilly established associations between semantic concepts. In another relevant study, Anderson and Carter (1972) found that recall of a subject–predicate construction showed retroactive interference from interpolated learning of a paraphrased predicate paired with a different subject (the originally learned predicate was the recall cue for the originally learned retention test). Such interference must have been at a semantic level. Such evidence indicates that interference principles apply to retention of meaningful text passages.

A fourth issue requiring discussion concerns the clarity and utility of the distinction between the conceptual macrostructure of a passage and its detailed microstructure. This distinction currently rests on linguistic intuitions. Even formal systems for analyzing the semantical structure of text such as those of Crothers (1972) and Fredericksen (1972) only try to describe explicitly our intuitions regarding successive "levels of abstraction" from a specific text. Starting from a detailed statement (e.g., "Mary washed her pet cat"), we may generalize it by substituting a more general category for each content word or by deleting a qualifier (e.g., "a girl cleaned her pet"); alternatively, we may generate an interfering specific statement by replacing the original instances with others. If these substitutes are within the same category (e.g., "Mary brushed her pet dog"), then the same categorical relationships have been repeated and these connections should be strengthened in memory. If the substituted instances come from different categories

(e.g., "Mary cleaned her bedroom"), then interference or *unlearning* would be expected of the original conceptual (general) relation. Admittedly, assignment of particular statement pairs to different levels of abstraction is not always clear, nor is the decision as to what is the same versus a different conceptual relation. Nonetheless, the decisions are sharp in many comparisons (e.g., names, dates, places in biographies), and it is an important analysis to aim for. Why? Because, following Bartlett (1932), most of us believe that text recall is initially a matter of the person remembering the general gist or an "abstract outline" of a text, and then fleshing out the details of this abstract (partly by "reconstruction"). Our biography-recall data illustrate in a simple, transparent context how repetition of an abstract outline facilitates recall of at least the right general kinds of facts. Presumably, the same facilitation could be shown for materials other than listings of specific names, dates, numbers, and places. Presumably, also, one should be able to *interfere* with recall of the conceptual macrostructure by breaking the originally learned conceptual relations with the interpolated passage. These are matters for future research.

Finally, let us consider a practical matter, namely, interference potentialities in learning school materials. A critic might point out that in the present experiment, retroactive interference was produced only by highly similar passages, and even then the magnitude of the forgetting was not dramatic. Is such retroactive interference, then, a phenomenon likely to be restricted to only a small portion of what a student learns? The critic may ask, "After all, how often does a curriculum teach a student totally different answers to the same question?"

The answer, of course, is "practically never," but the critic's charge plays upon a deceptive indefiniteness in our notions of "the same question" and "different answers." Suppose that memory for a simple proposition depends upon associating the semantic concept underlying the subject (A) to that underlying the predicate (B) so that the associative structure is A–B. By such analyses, then, interference effects should arise whenever knowledge requires a "multiple listing" of predicates that apply to the same concept or similar concepts (see Anderson & Bower, 1973). One example would be a zoological classification in which a species is characterized by a list of salient attribute–value pairs (e.g., heart type, vertebrate–invertebrate, habitat, color, size, etc.) and different species are defined by a conjunction of different values on the same attributes. A second example would be temporal conjunctions defining historical or contemporaneous events. A schematic example would be, "When A was King and B was his General, War C was fought. But when A′ was King and D was the General, War E was fought." Confusion would surely reign when the student sorts out in memory which king went with which general and which pair got involved in which war. A third example where interference may be expected is when the same objects (e.g., different historical characters) are to be rank ordered along two independent dimensions, such as historical date and relative power or senatorial seniority and political influence. To the extent that objects occupy differing locations in the two linear orders, confusions and interference may be expected in learning and keeping separate the two orders.

These examples—and many more of this general type come readily to mind—suggest many opportunities for interference processes to exert a pervasive influence on learning and retention in the usual curriculum. Moreover, these interference effects would seem to apply just as formidably to the retention of "meaningful principles" or rules as it does to "straight facts." First, the distinction between *principles* and *facts* is none too clear anyway. Second, under proper analysis, *rules* would seem to be decomposable into atomic propositions connected by conditionals which, if the indicated analysis has merit, are just as vulnerable to retroactive interference when it is "aimed" at the proper level.

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