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ABSTRACT

An experiment was conducted to test the generalized response suppression hypothesis by comparing the amounts of retroactive inhibition for items whose retrieval cue was the same on both lists to the retroactive inhibition for items whose retrieval cues were different on the two lists. Subjects were 56 adults randomly assigned to experimental groups of 14. Groups were instructed to use either alphabetical or free recall, or alphabetic or clustering organization when learning successive lists of nouns. Alphabetic instructions produced faster learning than free recall instructions; alphabetic and clustering instructions did not differ. Groups that used the same organization on both lists recalled fewer items than groups that used different organizational strategies, which indicates that organizational overlap was the source of interference. In each experiment, the first letters of half the items were repeated on both lists; the first letters of the remaining items were unique. Groups that alphabetized both lists recalled fewer words with duplicated than non-duplicated initial letters, a fact suggesting item-specific interference rather than generalized suppression of first-list responses. (Author/EMH)

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Abstract

Groups were instructed to use either alphabetical (A) or free recall (F), or A or clustering (C) organization when learning two successive lists of nouns. A instructions produced faster learning than F instructions; A and C instructions did not differ. Groups that used the same organization on both lists recalled fewer items than groups that used different organizational strategies, which indicates that organizational overlap was the source of interference. In each experiment, the first letters of half the items were repeated on both lists; the first letters of the remaining items were unique. Groups that alphabetized both lists recalled fewer words with duplicated than nonduplicated initial letters, a fact suggesting item-specific interference rather than generalized suppression of first-list responses.

LIST ORGANIZATION AND RETROACTIVE INHIBITION IN FREE RECALL[1]

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In free recall more retroactive inhibition (RI) is found when Ss learn two lists composed of items from the same conceptual categories than when the items on the two lists are from different categories (Shuell, 1968; Watts & Anderson, 1969). Unfortunately, as Watts and Anderson noted, the paradigm employed in these studies does not permit one to separate the effects of organizational similarity and item similarity. Since the groups learned different lists of items, the marked RI for the same categories groups could be attributed to either item-by-item associative similarity or to the organizational overlap. Obviously items from the same categories would have a higher average similarity than items from different categories. One purpose of the present experiment was to demonstrate that organizational congruence could account for the increased RI.

Recent experiments by Wood (1970), Royer (1970), and Zavortink and Keppel (1968) bear on this issue. In these studies at least some groups learned identical lists, thus equating item-by-item associative similarity. However, some Ss were instructed to organize the two lists using the same organizational strategy, while others were instructed to employ a different organizational strategy. More RI was found for the same-organization than for the different-organization groups. The first two experiments reported herein employed a similar paradigm; Ss were given either alphabetical (A) or free recall (F) instructions on both lists or instructions to alphabetize one list and free recall instructions for the other. All four combinations of alphabetize and free recall instructions were used. It was predicted that less RI would be found for the differing organization groups than for the same organization groups.

A second issue raised by Watts and Anderson (1969) concerned the role of list differentiation in free recall RI. Watts and Anderson (1969) found considerably more RI than did Shuell (1968). They attributed this greater RI to failures of list differentiation. Shuell (1968) asked for recall of both lists, while Watts and Anderson required only first-list recall. Presumably, list differentiation has no effect in the former case but does play a role when only the first list is recalled (Keppel, 1968). The present experiments directly investigated this issue by comparing the performance of groups instructed to recall both lists with groups required to recall only the first list. Less RI was expected when both lists were recalled.

A third issue is the nature of the interference process. Traditionally, interference theory held that RI was produced by two components, unlearning and competition. Unlearning was assumed to be an extinction-like process that operated item-by-item. In the A-B, A-C paired associate paradigm the acquisition of A-C associations during List 2 learning is alledged to lead to unlearning or extinction of the A-B connection acquired during List 1.

Recently, Postman and his associates (Postman, Stark, & Fraser, 1968; Postman & Stark, 1969) have suggested an alternative explanation of the loss of List 1 response availability following List 2. According to them, during List 2 the subject learns to inhibit all List 1 responses and to select only List 2 responses. The mechanism through which the S accomplishes this is called the "response selector." When the S is then asked to recall responses from both lists, the inertia of this response selector prohibits him from recalling List 1 items. In other words, there is a generalized suppression of List 1 responses.

The present experiment tested the generalized response suppression hypothesis by comparing the amounts of RI for items whose retrieval cue was the same on both lists to the RI for items whose retrieval cues were different on the two lists. Some subjects in the following experiments were asked to recall the lists in alphabetical order. Eight of the first letters were duplicated in both List 1 and List 2, while the remaining eight initial letters appeared on only one of the lists. The generalized suppression hypothesis would predict equal amounts of RI for both items with duplicated first letters and items with different first letters while if interference is item specific there will be more RI for the duplicated-letter items.

Method

Experiment 1A

Design and lists. A four factor mixed design was employed. The three between-subject factors were: the type of organizational instructions given to Ss on List 1, alphabetical (A) or free recall (F); the type of organizational instructions given on List 2, A or F; and the type of instructions given for final recall, free recall of the first list only or free recall of both lists. Two additional control groups were run. One learned the first list under A instructions while the other received F instructions for the first list. The control groups did arithmetic problems in place of the second list, and then were asked to recall List 1.

Two lists of 16 nouns were formed from words occurring 1-10 times per million (Thorndike-Lorge, 1944). Within each list each noun began with a unique first letter; across the lists eight of the words had the same first letter and the remaining eight had different first letters. Letter duplication across lists constituted the within-subject factor. List order was counterbalanced within treatments.

Apparatus. The experiment was run on PLATO, a computer-based teaching system at the University of Illinois. A Control Data Corporation 1604 computer and 20 semi-enclosed student stations make up PLATO. Each station contains a television screen and a typewriter-like keyset.

Procedure. Subjects were randomly assigned to experimental groups as they appeared at the PLATO classroom. PLATO presented instructions appropriate for each condition, then presented a practice list of four proper names. The practice list insured that the Ss understood the directions.

After completing the practice list S was reminded of the instructions, then received alternate study-test trials on List 1. During study phases the words were presented at a one-word-per-second rate; during recall phases, Ss typed their responses on the keyset. PLATO erased each word from the screen after it was typed, thus only one item of an S's recall was visible at a time. The criterion was one perfect recall.

After the criterion trial on List 1, instructions for List 2 were given, then the Ss learned the second list to a criterion of one perfect trial. Subjects in the control groups performed arithmetic problems for 15 minutes. After an S reached criterion on the second task he was asked to recall either the first or both lists.

Subjects. One hundred twelve men and women taking an introductory psychology course at the University of Illinois took part in the experiment as a course requirement. Subjects participated in groups of up to 20, but of course, PLATO permitted individualized treatment of each S. All treatments were represented in most sessions.

Experiment 1B

During Experiment 1A some procedural faults associated with the use of a computer system became apparent. PLATO had not been programed to accept misspellings or typographical errors as correct responses. This meant that Ss sometimes received extra study-test trials after being able to recall, but type incorrectly, all the list items.

Some minor procedural changes were made in Experiment 1B to remedy this problem. New lists of nouns occurring between 50-100 times per million were constructed. The criterion was changed to 15 out of 16 instead of perfect recall. And, PLATO was reprogramed to accept misspellings or typographical errors.

Since only a limited number of Ss were available, the control groups of Experiment 1A were not included in Experiment 1B. In other respects Experiments 1A and 1B were identical.

Seventy-two male and female students from an introductory educational psychology course at the University of Illinois participated in Experiment 1B as a course requirement.

Results

First list trials to criterion. Analysis of variance indicated that instructions affected trials to criterion in both Experiment 1A, $F(1,82) = 8.95$, $p < .01$, and in Experiment 1B, $F(1,64) = 6.09$, $p < .05$. Groups receiving alphabetize instructions learned the first list more quickly than groups receiving free recall instructions. There was also a significant interaction between List 1 and List 2 instructions, $F(1,82) = 5.50$, $p < .05$, in Experiment 1A.

Second list trials to criterion. Instructions to alphabetize again caused significantly better performance than standard free recall instructions in both Experiment 1A, $F(1,82) = 20.14$, $p < .01$, and Experiment 1B, $F(1,64) = 5.49$, $p < .05$. Significant List 1 Instructions X List 2 Instructions and List 1 Instructions X List 2 Instructions X Recall Procedure interactions were also obtained in Experiment 1A, $F(1,82) = 8.24$, $p < .01$, and $F(1,82) = 4.13$, $p < .05$, respectively. Subjects in the AF group required more trials to reach criterion than Ss in the remaining conditions.

First and second list organization. The degree to which Ss followed instructions to alphabetize their recall was determined by computing an alphabetization index for the criterion trial on each list. The index was computed according to the following formula, $A = n/t-1$;

where n is the number of times the first letter of an item followed an item whose initial letter preceded it in the alphabet and t is the total number of items recalled. If recall is random with regard to alphabetization the expected value of this index is .50; whereas if alphabetization is perfect A will equal 1.00.

In every case in both experiments A averaged above .90 on lists Ss were instructed to alphabetize. With one exception A averaged near .50 when free recall instructions were given. The exception was the condition in Experiment 1A in which alphabetize instructions were given for List 1 and free recall instructions were given for List 2. The mean value of A on List 2 for this group was .62. Apparently some Ss persisted in alphabetizing on List 2.

Recall. The mean numbers of first-list items recalled appear in Tables 1 and 2. The Ss recalled significantly fewer words with duplicated

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Insert Tables 1 and 2 about here

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than nonduplicated first letters in both Experiment 1A and 1B, $F(1,82) = 36.67$, $p < .01$, and, $F(1,64) = 4.43$, $p \leq .05$, respectively. In Experiment 1A the Ss asked to recall only the first list recalled a mean of 6.88 words whereas the mean was 6.02 for Ss asked to recall both lists, $F(1,82) = 8.76$, $p < .01$. The trend was in the same direction, but not significant, in Experiment 1B.

The List 1 Instructions X Letter Duplication interaction was significant in Experiment 1A, $F(1,82) = 12.22$, $p < .01$, and nearly significant in Experiment 1B, $F(1,62) = 3.86$, $p < .054$. In both experiments, Ss who received alphabetize instructions on List 1 recalled more words with nonduplicated first letters than words with duplicated first letters. For Ss who received free recall instructions on the first list, approximately equal numbers of the two types of words were recalled.

The List 1 Instructions X List 2 Instructions interaction was significant in Experiment 1A, $F(1,82) = 6.72$, $p < .05$. Subjects who received the same instructions on List 1 and List 2 recalled fewer words than Ss who received different instructions. The same trend appeared in Experiment 1B but, once again, it was not significant.

Experiment 2

There are several difficulties in interpreting the results of Experiments 1A and 1B. One difficulty is that while alphabetical instructions prescribe the learning strategy that the Ss must employ; free recall instructions permit the Ss to use any recall strategy he wishes. Some Ss spontaneously employ alphabetical organization. A second problem is that alphabetical instructions produced a faster rate of learning. Finally, Ss in the AF groups tended to continue to use the alphabetical procedure during List 2 learning.

Experiment 2 was designed to eliminate these problems by providing an efficient, alternative recall strategy for Ss in the non-alphabetize conditions. The lists were composed of items from categories and the Ss were instructed to cluster their recall within these categories or to recall in alphabetical order. Since clustering provides an efficient learning strategy, and is commonly used when categories are present, it was hoped that this procedure would eliminate learning differences between the groups and control to a greater extent the Ss' strategies.

Method

Design. There were two between-subject factors, List 1 organization instructions, Alphabetize (A) or Cluster (C), and List 2 organization instructions, A or C. The within-subject factor again consisted of duplicated versus nonduplicated first letters. Four groups of Ss were involved: Group AA learned both lists under A instructions; group AC learned List 1 under A instructions and List 2 with C instructions; group CA received C organization instructions on List 1 and A instructions on List 2; while group CC received C instructions on both List 1 and List 2. During final recall all Ss were instructed to recall only List 1 items.

Lists. The two lists of 16 nouns consisted of four items each from the categories musical instruments, weapons, fruits, and four-legged animals found in the Battig and Montague (1969) tables. Within either list no first letter appeared more than once; across lists, the first letters of two items in each conceptual category were repeated.

Procedure. Experiment 2 was also conducted on the PLATO computer-based teaching system. Except for the changes in design and lists the procedure was identical with Experiment 1B.

Subjects. Fifty-six men and women taking an upper-level educational psychology course at the University of Illinois during the summer of 1970 participated in the experiment. Fourteen Ss were randomly assigned to each experimental group.

Results

First and second list trials to criterion. List 1 instructions failed to produce any reliable variation in the trials taken to reach criterion, $F(1,52) = 1.98$, $p > .05$. This finding supports the contention that alphabetical and category organization produce equally efficient learning. However, a significant effect for List 2 instructions was obtained, $F(1,52) = 4.19$, $p < .05$. Since the Ss had not yet received List 2 instructions, this result must have been a random occurrence or reflect ability differences between the groups. Group CA took approximately 1.5 trials longer to reach criterion than Ss in groups AA, AC, and CC. There were no significant differences between the groups in learning List 2.

List organization. Measures of the degree to which Ss alphabetized and clustered were computed from the last trials on the first and second lists. The pattern of results was similar to Experiments 1A and 1B. The Ss alphabetized when instructed to and categorized when so instructed.

Recall. Table 3 contains the mean numbers of words recalled. Analysis of the recall data indicated that the List 1 Instructions and

Insert Table 3 about here

Letter Duplication factors produced significant variation, $F(1,52) = 6.40$, $p < .02$, and $F(1,52) = 5.95$, $p < .02$ respectively. Subjects receiving alphabetical instructions during List 1 learning recalled more words than Ss receiving category instructions. More words with non-duplicated than duplicated initial letters were recalled, $F(1,52) = 5.94$, $p < .02$.

There was a strong List 1 Instructions X List 2 Instructions interaction, $F(1,52) = 33.99$, $p < .01$. Those who received different organization instructions on List 1 and List 2 recalled more items than Ss who received the same instructions on both lists.

The Letter Duplication X List 1 Instructions interaction was nearly significant, $F(1,52) = 3.96$, $p < .053$. The difference between words with duplicated and nonduplicated first letters was greater for Ss who had received A instructions on the first list than for Ss who received C instructions.

Discussion

The results of Experiment 1A and 1B and, especially, Experiment 2 support the contention that changing organization between first and second lists leads to a reduction in the amount of RI in free recall. Unlike the early studies (Shuell, 1968; Watts & Anderson, 1969), the reduction in RI cannot be attributed to a decrease in item-by-item similarity since the lists were the same; only the organization varied. The present findings confirm results reported by Wood (1970) and Royer (1970). Royer has suggested that the reduction in RI occurs because the Ss store differently organized lists in different "storage locations," while similarly organized lists are stored in overlapping locations. When the lists are stored in the same places, more forgetting of the items occurs than when the storage locations are different.

A more traditional explanation of the results is possible. If it is assumed that Ss in the A conditions used first letters and Ss in the C conditions used category names as covert retrieval cues, then the results are understandable in terms of the common paired-associate RI paradigms. In effect, the organization provides covert stimuli analogous to the stimulus terms in a paired-associate list. For Ss in the AC and CA conditions, the covert stimuli in the two lists are different and the situation is analogous to the A-B, C-D paired associate paradigm. The CC condition, on the other hand, is like the A-B, A-C paradigm, and so is the AA condition, at least for words in the two lists with duplicated initial letters.

One of the purposes of the present research was to test the hypothesis of Postman and his colleagues that RI is attributable to the action of a selector mechanism which suppresses the entire repertoire of first-list responses. According to this view there should be poor recall of all words, whether or not the initial letters are duplicated. In fact, recall of items with nonduplicated initial letters was significantly higher than recall of items with duplicated initial letters in the AA groups in both Experiment 1A, $t(44) = 5.77$, $p < .01$, and Experiment 1B, $t(34) = 3.14$, $p < .01$. Furthermore, in Experiment 1A, group AA recalled substantially fewer words with duplicated initial letters than the control group, $t(32) = 4.52$, $p < .01$, but only slightly fewer with nonduplicated initial letters, $t(32) = 1.50$.

These results are inconsistent with the generalized response suppression hypothesis. They suggest, instead, that interference is specific to items for which organization overlaps. If so, the AF groups in Experiments 1A and 1B would have been expected to do relatively well on items with duplicated initial letters. However, in both experiments recall of these items was depressed in the AF groups, though not so markedly as in the AA groups. Our explanation is that some Ss in the AF groups continued to alphabetize the second list. As noted before, the alphabetization index was above chance for the AF group in Experiment 1A.

Experiment 2 provided a stronger test of the generalized response suppression hypothesis. Clustering is an effective alternative to alphabetizing, and there is no indication that Ss in group AC continued to alphabetize the second list. The results were quite clear. Group AA recalled fewer duplicated-letter items than nonduplicated-letter items, $t(26) = 2.73$, $p < .02$, whereas there was little difference between the two types of items for group AC, $t(26) = 1.66$, $p > .05$, or for groups CA and CC for that matter. Group AA also recalled fewer duplicated-letter items than did group AC, $t(26) = 3.41$, $p < .01$. In sum, RI in free recall appears to be due to specific rather than generalized interference.

A surprising finding of Experiment 1A, weakly confirmed in 1B, was the poor recall of groups asked to recall both lists instead of only the first list. Apparently either list differentiation was not a factor in the present studies or its effect was masked by other, more potent variables.

Table 1

Mean Number of First List Words Recalled in Experiment 1A

	List 1 Instructions			
	Alphabetize		Free Recall	
List 2 Instructions	Duplicated First Letter	Nonduplicated First Letter	Duplicated First Letter	Nonduplicated First Letter
Alphabetize	4.89	7.02	7.04	7.46
Free Recall	5.68	7.14	5.92	6.46
Control	7.60	7.92	8.00	7.42

Table 2

Mean Number of First List Words Recalled in Experiment 1B

	List 1 Instructions			
	Alphabetize		Free Recall	
List 2 Instructions	Duplicated First Letter	Nonduplicated First Letter	Duplicated First Letter	Nonduplicated First Letter
Alphabetize	4.64	6.38	6.21	6.11
Free Recall	5.08	5.65	4.79	4.96

Table 3

Mean Number of First List Words Recalled in Experiment 2

	List 1 Instructions			
	Alphabetize		Categorize	
List 2 Instructions	Duplicated First Letter	Nonduplicated First Letter	Duplicated First Letter	Nonduplicated First Letter
Alphabetize	4.93	6.21	6.86	6.43
Categorize	6.86	7.64	4.21	4.86

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Footnote

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