

# Improving text memory by organizing interfering text at retrieval

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We provide evidence that information that organizes interfering text after learning improves recall of original text to which the organizing information does not pertain. Subjects learned two text passages. The second passage was difficult to understand without the aid of a picture that provided the necessary clarifying context. Using the picture as an organizing cue for the second passage (just before retrieval of the first passage) improved recall of the first passage. We address and rule out an alternate explanation that is based on the difficulty of the task immediately preceding recall. These results contradict several traditional hypotheses about interference, and they are difficult to explain with several current models of memory. Implications for learning are discussed.

Memory research has shown that people experience interference when learning two sets of material. In retroactive interference, for instance, the second set of material interferes with the first set, resulting in decreased recall of the first set. Bower and Mann (1992), extending a result from Zimmerman (1954), presented evidence that a postlearning organizing cue for *interfering* material can aid recall for the *original* material. Greater recall for a first list of items was found when subjects received an organizing cue for the second list of items directly prior to recall of the first list. This result is provocative because it appears to contradict a number of traditional memory findings, and it is difficult to explain by several popular memory models.

Postman and Underwood (1973) argued that interference is the result of response-set suppression, in which a subject learns to suppress items from an original list when learning a second list. Continuation of this suppression after learning is proposed to explain retroactive interference. According to this account, suppression of the first list occurs *during* learning of the second list, whereas Bower & Mann's (1992) finding concerns reorganization of the second list *after* learning. The response-set suppression account provides no reason to expect that later organization of interfering material would reduce suppression of the original material and thus does not explain the results of Bower and Mann (1992).

In addition, these results are at odds with findings of list-strength effects (Ratcliff, Clark, and Shiffrin, 1990; Tulving and Hastie, 1972). List-strength effects imply that strengthening some items in a learning set lowers the probability of recall of the other items in the set. Bower and Mann showed the opposite result; strengthening the second set with an organizing cue actually improved memory for the first set. Similarly, Bower and Mann's results are the opposite of what would be predicted by part-set cuing (Nickerson, 1984). In part-set cuing, subjects provided with a subset of the items to be remembered recalled fewer of the remaining items. In the context of Bower and Mann's study, the cue to reorganize interfering material would presumably enhance the availability of that material, which should, according to part-set cuing, impair recall of the original material. However, in Bower and Mann's study, subjects given the cue recalled more of the original material, rather than less.

In addition, many current associative models of memory (e.g., Search for Associative Memory [SAM], ACT, Minerva) cannot easily explain Bower and Mann's results. In these models, cues aid recall via their associations to the items to be recalled. The difficulty in using these models to explain Bower and Mann's findings is that in the Bower and Mann study, there is no direct association between the given cue and the items to be recalled. Instead, the cue refers to the interfering material, and not to the initially learned material, which is the material for which subjects showed improved performance.

Bower and Mann found a benefit of a postorganizing cue for interfering material in a number of different contexts and memory tasks. Material to be remembered included lists of letters and lists of cities. Memory tasks included paced and unpaced serial recall, free recall, and list reconstruction. The postlearning cue was in all cases a verbally delivered instruction that reorganized the interfering material.

In the present study, we seek to extend these findings to a more realistic learning situation. The material to be learned is meaningful text, rather than simple lists of letters or words. Furthermore, the organizing cue consists of a picture, rather than a verbal instruction. We are using Bransford and Johnson's (1972) technique of presenting an appropriate context, in the form of a picture, to clarify and enhance memory for ambiguous material. Finally, the organizing cue is presented *along with* the interfering material, which should, according to list-strength effect, part-set cuing, and response-set suppression explanations, cause *increased* interference. These changes provide a test of the generality and robustness of reducing interference with an organizing cue for interfering material at the time of recall.

## EXPERIMENT 1

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### METHOD

#### Subjects

Eighty-seven San Jose State University undergraduates participated for course credit in an introductory psychology class. Subjects were tested in three groups, and each group was randomly assigned to one of the three experimental conditions. All three groups were run in consecutive 30-min sessions. There were 24 subjects in the rest-control group, 31 subjects in the informed group, and 32 subjects in the uninformed group.

#### Materials

Text 1 was a slightly altered passage of five sentences from the book, *One Hundred Years of Solitude*, by Gabriel Garcia Marquez. Text 2 was Bransford and Johnson's (1972) passage about a balloon-powered serenade. Text 2 is difficult to understand unless one is supplied with a picture that provides the appropriate context. The texts are provided in Appendix A and the picture is provided in Appendix B.

#### Procedure

The subjects followed a standard, retroactive interference procedure. During learning, all subjects had 80 s to look at Text 1, projected on a screen by an overhead projector while the experimenter slowly read it out loud two times. Then subjects were given 3 min to write in their examination books as much of the passage as they could remember. Immediately after learning and recalling Text 1, subjects were instructed to turn their examination books to a blank page.

Subjects in the rest-control condition then engaged in a filler task while the subjects in the two experimental conditions proceeded to study and recall Text 2 using the same procedure as for Text 1. These subjects then worked on the same filler task, but for a shorter time than the rest-control subjects, so that the overall time between Text 1 learning and its final retention test was equated at 8 min for all groups.

The filler task consisted of reading "The Far Side" cartoons, presented using an overhead projector. Subjects rated each cartoon for degree of humor on a 10-point scale. Four cartoons were shown per overhead. Rest-control subjects were given 8 min to rate 32 cartoons, whereas informed and uninformed subjects were given 3 min to rate 12 cartoons.

After the informed and uninformed subjects finished the filler task, Text 2 was read to them again. At this reading, however, informed subjects were shown the picture providing appropriate context for the passage and were told to look at the picture as they listened to the passage. The uninformed subjects also were told to listen to the passage as it was read to them, but they were not shown the context-defining picture.

At this point, all subjects were given 5 min to recall as much as they could from Text 1 and to write it down in their booklets. Subjects in the informed and uninformed groups were reminded to write down only Text 1 (i.e., "the first passage that you learned"). After the 5 min were up, subjects were debriefed and dismissed.

## RESULTS

Recall was measured by the number of key words recalled from the text. Each passage had 65 key words, which included all important words from the passage except for articles, prepositions, conjunctions, and pronouns. Table 1 contains the mean number of recalled words for the three conditions.

Original learning for Text 1 was comparable for all three groups,  $F(2, 84) = .09$ ,  $p > .5$ . Original learning for Text 2 was also comparable for the two groups that learned Text 2,  $F(1, 61) = 1.43$ ,  $p > .2$ .

The difference between the original learning of Text 1 and the final recall of Text 1 was computed for each subject. The three groups significantly differed on the number of forgotten words between original learning and final recall,  $F(2, 84) = 9.03$ ,  $p < .001$ .

The uninformed subjects forgot significantly more words than did the informed subjects,  $t(60) = 3.16$ ,  $p < .003$ . In addition, the informed subjects did *not* forget significantly more words than the rest-control subjects, who were given no interfering material,  $t(48) = 1.04$ ,  $p > .25$ . The organizing cue for the interfering material, in effect, eliminated retroactive interference for the informed subjects.

## EXPERIMENT 2

One possible interpretation of the results of Experiment 1 is that the final recall of Text 1 is not affected by the reorganization of the interfering text provided by the picture, but rather by the difficulty of the task immediately preceding final recall. In Experiment 1, it is likely that when Text 2 was presented to the informed and uninformed subjects a second time, subjects expected that they would need to recall it later.

Table 1. Mean number of key text words recalled (and standard deviations) by group for Experiment 1

Condition	<i>n</i>	Original Text 1	Final Text 1	Difference
Rest-control	24	17.33 (5.35)	16.17 (7.12)	1.17 (3.56)
Informed	31	17.29 (6.34)	15.13 (8.09)	2.16 (3.46)
Uninformed	32	16.69 (7.63)	11.72 (7.42)	4.97 (3.59)

The informed group, however, likely had an easier task than the uninformed group; the informed group saw the organizing picture while hearing the passage, whereas the uninformed group merely heard the same confusing passage once again. Thus, an alternative explanation of our results need only invoke difficulty of the task immediately preceding final recall and need not consider the effect of reorganizing interfering material. In Experiment 2, subjects learn two texts, and then, immediately before recalling the first text, learn a third text, which is either easy or difficult. If the difficulty explanation is correct, then subjects who learn the easy third passage will recall more of Text 1 than subjects who learn the difficult third passage. Experiment 2 evaluates this alternative account of the results of Experiment 1 by isolating the effect of difficulty without reorganizing the interfering material.

## METHOD

### Subjects

Forty-seven Stanford University undergraduates participated for either course credit in a psychology class or for \$7. Subjects were tested in two groups, run in consecutive 30-min sessions. There were 20 subjects in the Hard Text condition and 27 subjects in the Easy Text condition.

### Materials

Each subject learned three texts: one initial target text and two subsequent interfering texts. All subjects learned Text 1 (Marquez) and Text 2 (Balloon Serenade), which were the same as those used in Experiment 1. All subjects also learned a third text immediately before final recall of Text 1. The third text was either easy or hard.

In the hard third text condition, the text was a passage from a Henry James short story. In the easy third text condition, the text was a passage from Roald Dahl's *James and the Giant Peach*. The Henry James passage was rather abstract and quite confusing, whereas the Dahl passage was more concrete and straightforward. Subjects' ratings of the two passages confirm these impressions (see below). Both texts appear in Appendix C.

### Procedure

The early procedure was similar to that of the informed and uninformed subjects in Experiment 1; subjects learned and initially recalled Text 1, then learned and recalled Text 2. They then engaged in the cartoon-rating filler task.

Instead of hearing Text 2 with or without the organizing picture (as the informed and uninformed subjects, respectively, did in Experiment 1), subjects then heard either the hard third text or the easy third text. Immediately afterwards, they recalled Text 1. In summary, the second exposure to Text 2 from Experiment 1 (which took place immediately before final recall of Text 1) was replaced here with exposure to either an easy or a difficult third text.

Finally, after recall of Text 1, subjects rated (on a 10-point scale) the difficulty of the three passages to which they had been exposed.

## RESULTS

As a check of our manipulation of text difficulty, we note that the hard third text subjects rated their third text as substantially more difficult ( $M = 9.7$ ) than did the easy third text subjects ( $M = 3.5$ ),  $t(28) = 14.9$ ,  $p < .0001$ .

Table 2 displays means and standard deviations of Text 1 initial and final recall. Original learning for Text 1 was comparable for both groups,  $t(41) = .82$ ,  $p > .4$ . The mean difference scores were also comparable between the two groups,  $t(37) = 1.80$ ,  $p > .05$ , with the hard third text group actually forgetting *fewer* words from Text 1 than did the easy third text group. Thus, recall of Text 1 in Experiment 2 was not consistent with the difficulty account discussed earlier, suggesting that the results of Experiment 1 are due to the *reorganization* of the interfering text.

## DISCUSSION

The present experiments extend the findings of Bower and Mann (1992) on the beneficial effects of organizing interfering material at the time of retrieval. Subjects, given a postlearning organizing picture for an ambiguous passage of text, better remembered a previously learned text. Memory of subjects who had the cue was comparable to memory of subjects who only learned a single passage. That is, the cue essentially eliminated retroactive interference altogether.

The results of Experiment 2 suggest that this central finding of Experiment 1 was *not* due to the difficulty of the task immediately preceding final recall of the first text. If the difficulty of the prerecall task did affect recall of Text 1, the easy third text subjects should have recalled Text 1 better than did the hard third text subjects. Our data showed a (nonsignificant) trend in the opposite direction.

One possible interpretation of the Experiment 1 results is that the uninformed subjects are confused by Text 2 and this distracts them in their recall of Text 1, inhibiting their performance. Informed subjects,

Table 2. Mean number of key text words recalled (and standard deviations) by group for Experiment 2

Condition	<i>n</i>	Original Text 1	Final Text 1	Difference
Easy Third Text	27	28.22 (8.62)	22.19 (7.71)	6.04 (3.71)
Hard Third Text	20	30.30 (8.61)	26.40 (9.59)	3.90 (4.25)

on the other hand, would not be distracted because the cue made sense out of the confusing Text 2. Whereas this explanation is similar to the difficulty explanation, the explanations are distinct. The difficulty explanation suggests that performing a difficult task weakens associations with Text 1 material and works as subjects read the interfering text. The distraction explanation suggests that dwelling on a confusing passage distracts subjects when they are trying to recall the original text. Both interpretations predict poor performance for hard third text subjects of Experiment 2 compared to easy third text subjects. We observed a trend in the opposite direction.

In their original study using the balloon text and disambiguating picture, Bransford and Johnson (1972) found that presenting the disambiguating picture to subjects *after* they had read the passage did not help them to comprehend or remember the passage. The picture only aided memory when presented simultaneously with the passage. In another version of our Experiment 1, after learning Texts 1 and 2, subjects were presented with the picture but were not read the associated passage again. Subjects then recalled Text 1 and performed no better than subjects who did not see the picture at all. This provides evidence that the cue must serve to reorganize the interfering material in order for it to improve memory of the initial material. Getting the cue in isolation, where it cannot reorganize the interfering material, is no help at all.

One possible explanation that Bower and Mann considered for their effect is a response-editing hypothesis. According to this hypothesis, the postorganizing cue works by allowing people to discriminate List 1 items from List 2 items, thereby preventing them from omitting recalled items from their List 1 responses because they erroneously believed that those items came from List 2. Bower and Mann dismissed this interpretation based on the results of one of their experiments (1992, Experiment 4) in which subjects were told to list all recalled words, either noting the word's list of origin or that they were unsure of the word's list of origin. In that study, informed subjects still recalled more List 1 items than uninformed subjects, subjects rarely confused which list contained a particular item, and subjects almost never used the "not sure" option.

Marsh, Landau, & Hicks (in press) argue, however, that Bower and Mann's Experiment 4 does not adequately assess the editing process, and that the editing hypothesis should not yet be discarded. They suggest that editing occurs covertly before subjects record their responses on paper. Even if subjects are reporting items from both lists, they still have to spend time discriminating the list of origin. When subjects are not given a cue that helps them to discriminate the two lists, the result is that more time is spent trying to discriminate, and less time is available for searching memory for further items.

In Experiment 1 of the present paper, it is possible that uninformed subjects are editing words out of their List 1 final recall because they erroneously think that those words came from List 2. Informed subjects might have an easier time distinguishing the balloon passage from the Marquez passage after seeing the context-providing picture for the balloon passage. However, this account is not fully convincing because the two text passages describe completely different situations, are written in different styles, and thus seem to be quite easy to discriminate. It would appear that a full explanation for this effect would require more than just response editing.

The present experiment has practical implications for learning. For instance, consider a student who studies two passages from a text in one sitting, finding the second one difficult to understand. In general, there will be interference between the two passages. If, however, the student goes to a lecture in which the second passage is explicated, interference with the first passage may be reduced, or even eliminated. Our results suggest that reorganizing information about one topic may improve memory for unrelated material learned at the same time.

It remains unclear why a cue that organizes interfering material would aid recall of original material, even if that cue is presented immediately before retrieval. More work needs to be done to determine under what conditions postlearning organizing cues will and will not prove beneficial. We present these experiments and explanations as a first step in this process.

## Appendix A

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### Text 1

Many years later, as he faced the firing squad, the colonel was to remember that distant afternoon when his father took him to discover ice. At that time the village consisted of twenty adobe houses, built on the bank of a river of clear water that ran along a bed of polished stones, which were white and enormous, like prehistoric eggs. The world was so recent that many things lacked names, and in order to indicate them it was necessary to point. Every year during the month of March a family of ragged gypsies would set up their tents near the village, and with a great uproar of pipes and kettledrums they would display new inventions. First they brought the magnet.

(Based on Marquez, 1970, p. 1)

### Text 2

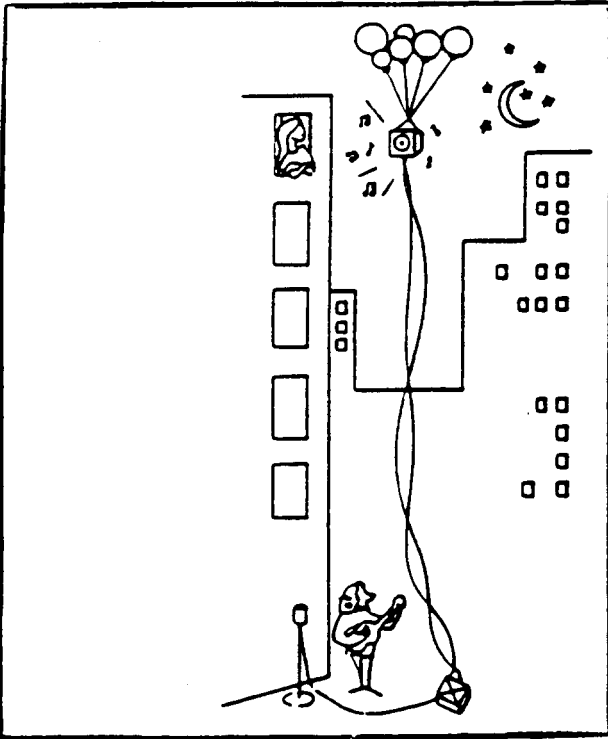
If the balloons popped, the sound would not be able to carry since everything would be too far away from the correct floor. A closed window would also prevent the sound from carrying since most buildings tend to be well insulat-



ed. Since the whole operation depends on a steady flow of electricity, a break in the middle of the wire would also cause problems. Of course the fellow could shout, but the human voice is not loud enough to carry that far. An additional problem is that a string could break on the instrument. Then there could be no accompaniment to the message. It is clear that the best situation would involve less distance. Then there would be fewer potential problems. With face to face contact, the least number of things could go wrong. (Bransford & Johnson, 1972, p. 719)

## Appendix B

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(From Bransford & Johnson, 1972, p. 718)

## Appendix C

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### Easy Third Text

At the end of the street it went crashing right through the wall of an enormous building and out the other side, leaving two gaping holes in the brick-

work. This building happened to be a famous factory where they made chocolate, and almost at once a great river of warm melted chocolate came pouring out of the holes in the factory wall. A minute later, this brown sticky mess was flowing through every street in the village, oozing under the doors of houses and into people's shops and gardens. Children were wading in it up to their knees, and some were even trying to swim in it, and all of them were sucking it into their mouths in great greedy gulps and shrieking with joy. (Dahl, 1961, p. 44–45)

### Hard Third Text

He was bringing it on, bringing it to perfection, by practice; in consequence of which it had grown so fine that he was now aware of impressions, attestations of his general postulate, that couldn't have broken upon him at once. This was the case more specifically with a phenomenon at last quite frequent for him in the upper rooms, the recognition—absolutely unmistakable, and by a turn dating from a particular hour, his resumption of his campaign after a diplomatic drop, a calculated absence of three nights—of his being definitely followed, tracked at a distance carefully taken and to the express end that he should the less confidently, less arrogantly, appear to himself merely to pursue. (James, 1909, p. 659)

### Notes

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