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BRIEF RESEARCH REPORT

Good and Poor Readers' Use of Graphic Aids Cued in Texts and in Adjunct Study Materials

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Most school texts do not provide cues that explicitly direct readers to turn their attention to the graphic aids accompanying the prose. This study investigated the possibility of compensating for the absence of these cues with the use of adjunct study material. Specifically, the study attempted to determine the relative effects of explicit textual cues and adjunct study material on good and poor readers' comprehension of texts, attention to graphic aids, and recall of information displayed in graphic aids. These effects were investigated with two expository passages each accompanied by two graphic aids. One graphic aid displayed information that was redundant to the text; the other graphic aid displayed information that was nonredundant but related to the text. Good and poor eighth-grade readers studied these passages with or without explicit textual cueing and using adjunct study material. The findings confirmed the results of earlier research supporting the utility of explicit textual cues to graphic aids. The findings also indicated that in the absence of these cues adjunct study material can be used effectively with both good and poor readers to turn their attention to graphic aids in texts.

Textbooks and other instructional literature typically include a variety of graphic aids such as diagrams, graphs, tables, and pictures. Although the intended purpose of these aids is to facilitate comprehension of the prose they accompany, the placement of graphic aids in a text does not in itself assure that readers will make effective use of them. The helpfulness of graphic aids depends importantly on the way they are presented in texts and on the ability of readers to give due attention to them during reading. Previous research (Reinking, Hayes, & McEneaney, 1988) suggests that graphic aids are more likely to be used effectively when they are explicitly cued in the text.

Most school texts do not provide such cues, however. Given that the design of textbooks is based largely on market forces and the intuitions of publishing house editors and production managers, it is unlikely that the presentation of graphic aids will be much changed in the texts used by teachers. A practical remedy for this situation may be for teachers to look

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for cued graphic aids in texts and to direct students' attention to them with adjunct study material. Among the uses indicated for adjunct study material, none seems more appropriate than for directing attention to significant information in a text, including information in graphic aids. Indeed, research on adjunct study material has found that it owes its effectiveness largely to its role in stimulating readers to inspect specific aspects of material to be studied (Duell, 1984). Adjunct study material can do more than merely inform readers that the prose content of a text is illustrated in its graphic aids. Adjunct study material can be constructed so that readers are given tasks that direct their attention to the graphic aids of a text. In order to complete such tasks, readers in some way have to act on the information given in the graphic aids. Although it is often impractical to include study tasks involving every graphic aid in a text, turning readers' attention to some of the graphic aids may prompt inspection of others.

Such an application of adjunct study material may offer a way to serve students who lack skill in shifting attention between the prose of a text and its accompanying graphic aids. Research by Harber (1983) and others indicates that it is a lack of this very skill that largely accounts for poor readers' inability to take advantage of graphic aids in texts. Characteristically, poor readers do not allocate attention selectively when they process texts, as they must do if they are to make connections between the prose of a text and corresponding information in graphic aids. Poor readers dedicate attention to the processing of prose so intensively that they do not take notice of its accompanying graphic aids. Adjunct study material may help poor readers make crucial connections between prose and graphic aids, and, within graphic aids themselves, distinguish relevant information on which to focus attention.

The purpose of the study reported here was to investigate the effectiveness of adjunct study material for cueing readers to graphic aids in texts. How would the use of adjunct study material compare with explicit cues provided by a text itself to signal graphic aids? To address this question, an earlier study by Reinking *et al.* (1988) was replicated and extended. The earlier study was replicated insofar as the present study involved a sample of students from the same school population and provided an examination of good and poor readers' differential use of explicit cues provided by a text to inspect its graphic aids. And as in the earlier study, performance on measures of literal and inferential reading comprehension was examined, as well as performance on measures of memory of information in graphic aids. The earlier study was extended by providing for an examination of the effects of using adjunct study material to turn readers' attention to graphic aids in texts.

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METHOD

Subjects

Participants in the study were 277 eighth-grade boys and girls from 12 English classes in a rural, 7th through 12th grade high school. Across the 12 classes, students were blocked on reading ability and randomly assigned to one of four treatment conditions. Students scoring at or below the 35th percentile on the reading subtest of the *Metropolitan Achievement Test* (Balow, Farr, Hogan, & Prescott, 1978) were designated poor readers (n = 149). The remaining students were considered to be average or better readers and for the sake of convenience were designated good readers (n = 128).

Materials

Materials were assembled into packets so as to provide an examination of readers' use of graphic aids as they may be studied in four different ways, each corresponding to the four treatment conditions: in texts without explicit cues and without adjunct study material, in texts with explicit cues only, in texts without explicit cues but with adjunct study material, and in texts with both explicit cues and adjunct study material. Every packet contained two passages that had been used in previous research on cueing eighth-grade readers to graphic aids (Reinking, *et al.* 1988). Both passages were approximately 300 words long. One passage was about the eye, and one passage was about volcanoes. The order of the passages was counterbalanced in the packets of each treatment condition. Each passage in every set of materials was accompanied by two graphic aids, one which depicted information redundant to the prose and one which depicted information related to the passage's content but that was not explicitly discussed in the prose. The graphic aids were place on a page opposing the prose passage so that they would be readily available for inspection.

Two sets of passages included explicit cues to the reader to attend the graphic aids, but two sets left the graphic aids uncued. Explicit cues were inserted after one to two paragraphs. Each cue directed readers' attention to an aspect of the redundant graphic aid that was relevant to the content of the text immediately preceding the cue. Adjunct study materials were included in two sets of the materials, in one of the sets providing explicit cues to the graphic aids and in one of the sets not providing these cues. This adjunct study material was a worksheet loosely inserted between the pages of the passage for which it was intended to be used. The worksheet required readers to complete several tasks focused exclusively on the redundant graphic aid. A test of passage comprehension was placed behind each passage and its graphic aids. A test on information in the graphic aids was placed at the end of the packet.

Procedure

Students participated in the experiment during their regular 55-min English class period. Because assignment of students to treatment had been random irrespective of class, each class included students assigned to all four treatment conditions. The use of packets allowed administering all treatments in each class simultaneously and under conditions alike for all treatments, except for the treatment condition itself. The packets were distributed to students, who were instructed to study the first passage contained in the packet given them and to complete any worksheet that might be provided with that passage. Students were told that not all packets contained worksheets to be completed. They were directed to study the passage for the purpose of taking a test on it and to wait for further instructions before proceeding beyond the first passage. Students were told that they had up to 7 min to study

the passage, but to look toward the front of the room when they were satisfied that they had studied the passage sufficiently to learn its content.

Each student then studied the first passage under one of four treatment conditions, which varied as follows: Under one of the conditions, the student studied a passage without explicit cues to inspect the graphic aids and without adjunct study material. Under a second treatment condition, the student studied a passage with explicit cues that encouraged inspection of the graphic aids at appropriate junctures during reading, but without adjunct study material. Under a third condition, the student studied a worksheet to be completed in studying a passage without explicit cues to attend the graphic aids. Under a fourth condition, students studied a worksheet to be completed in studying a passage that contained explicit cues to inspect the graphic aids. In order to complete the worksheet, the student had to refer to the graphic aids redundant to the passage in order to answer questions about information depicted in them, provide information for a table that sorted the graphic aids' information, and draw and label information presented in the prose. No student took the full time allowed for this phase of the experiment.

After studying the first passage, students were directed to turn to the test placed behind the first passage in the packet. This was a multiple-choice test comprising five literal items and five inferential items on information presented in the passage. Students were given 5 min to complete this test. Once students completed the test, they were instructed to turn to the second passage in the packet and study it for the purpose of taking a test on it. Each student studied this passage under the same treatment conditions as the first passage had been studied. Again, no student took the full 7 min allowed. Following the study of this passage, students were again given 5 min to take a 10-item multiple-choice test of passage comprehension.

Finally, the students were directed to take the graphic aids information test placed at the end of the packet. This was a 20-item multiple-choice test, with 5 items on the redundant graphic aid and 5 items on the nonredundant graphic aid of each of the two passages. The test was designed to distinguish the recall of information in the redundant graphic aids from recall of information in the nonredundant graphic aids. Recall of the latter information was used as a measure of attention to graphic aids not signaled in the passage or by the adjunct study material. Students were allowed up to 10 min to complete this test.

RESULTS

Data from the passage comprehension test and the graphic aids test were analyzed separately using analysis of variance (ANOVA) procedures. Comprehension scores were analyzed using a 2 (Textual Cues) × 2 (Adjunct Material) × 2 (Ability) × 2 (Question Level) mixed-factorial ANOVA in which textual cues, adjunct materials, and ability were the between-subjects factors and question level was the within-subjects factor. Similarly, students' scores on the graphic aids test were analyzed using a 2 (Textual Cues) × 2 (Adjunct Material) × 2 (Ability) × 2 (Redundancy) mixed-factorial ANOVA in which textual cues, adjunct material, and ability were the between-subjects factors and redundancy was the within-subjects factor. Given the relatively large sample size and that the present study partially replicated previous research, the value of α was set at .01 for determining the significance of statistical tests conducted on these data.

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Passage Comprehension Test

After reading each of the two experimental passages either with or without textual cues and with or without adjunct study material, students responded to five literal and five inferential multiple-choice items covering the content of the passage. Means and standard deviations for students' passage comprehension scores on these items across both passages are shown by treatment condition, reading ability, and question level in Table 1.

The results of the statistical tests on these means indicated no significant interaction effects or main effects associated with treatment. Statistically significant main effects were obtained for reading ability and for question level. As expected, good readers outperformed poor readers, $F(1,269) = 55.411$, $MS_e = 6.87$. Both good and poor readers correctly answered more literal level questions than inferential level questions, $F(1,269) = 59.59$, $MS_e = 2.63$.

Graphic Aids Test

After completing the tasks associated with both experimental passages, students completed a graphic aids test designed to measure students' recall of graphical information accompanying the texts. This test comprised 10 items from each passage. Each set of 10 items included 5 items focusing on the redundant graphic aid and 5 items focusing on the nonredundant graphic aid. Means and standard deviations for students' scores

TABLE 1
MEANS AND STANDARD DEVIATIONS FOR SCORES ON THE COMPREHENSION TEST

	Treatment							
	Text only		Adjunct material		Textual cues		Textual cues and adjunct material	
	L	I	L	I	L	I	L	I
	Poor readers							
M	4.86	4.36	4.72	3.78	5.05	3.55	4.54	3.73
SM	2.10	2.32	2.08	2.27	2.50	2.01	1.98	2.05
	(n = 36)		(n = 32)		(n = 40)		(n = 41)	
	Good readers							
M	6.88	5.81	6.33	5.11	6.95	5.30	6.25	5.34
SD	2.06	1.97	1.71	1.91	2.17	2.38	2.59	2.47
	(n = 32)		(n = 27)		(n = 37)		(n = 32)	

Note. L, literal items; I, inferential items.

across both passages are shown by treatment condition, reading ability, and redundancy in Table 2.

The results of statistical tests on these means revealed no significant interaction effects. Significant main effects were found for textual cues, $F(1,269) = 7.43$, $MS_e = 4.05$, for adjunct study material, $F(1,269) = 40.78$, $MS_e = 4.05$, for ability, $F(1,269) = 15.76$, $MS_e = 4.05$, and for redundancy, $F(1,269)$, $MS_e = 2.38$. Because main effects for textual cues and for adjunct study material were significant, further analyses were carried out to compare the relative effects of the treatment conditions. For students' scores on the graphic aids test, effect sizes were calculated in order to determine the magnitude of differences between studying with neither textual cues nor adjunct study material and studying under each of the other treatment conditions. In standard deviation units, the effect sizes were .06 for textual cues, .38 for adjunct study material, and .76 for textual cues and adjunct study material.

These analyses indicate that textual cues and adjunct study material had a statistically significant effect on students' scores on the graphic aids test. However, the effect of adjunct study material was greater than the effect of textual cues. Furthermore, the combination of textual cues and adjunct study material together had a greater effect that adjunct study material alone.

DISCUSSION

The results of the experiment indicate that students' attention to and learning from graphic aids in texts can be increased with adjunct study

TABLE 2
MEANS AND STANDARD DEVIATIONS FOR SCORES ON THE GRAPHIC AIDS TEST

	Treatment							
	Text only		Adjunct material		Textual cues		Textual cues and adjunct material	
	R	NR	R	NR	R	NR	R	NR
	Poor readers							
M	3.94	2.39	4.28	1.72	4.98	2.68	6.41	3.27
SD	1.72	1.46	2.41	1.57	1.85	1.70	1.61	1.78
	(n = 36)		(n = 32)		(n = 40)		(n = 41)	
	Good readers							
M	5.19	2.22	5.37	2.89	5.78	3.35	6.84	3.50
SD	1.67	1.62	1.92	2.89	2.06	1.95	1.94	1.67
	(n = 32)		(n = 27)		(n = 37)		(n = 32)	

Note. R, redundant items; NR, nonredundant items.

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material. This effect was observed for both the good and the poor readers in the experiment. Students who completed adjunct study material scored higher on the postexperiment test of information contained in the graphic aids than did students who did not complete the adjunct study material. That students using adjunct study material recalled more information from the redundant graphic aids indicates that these readers attended to the graphic aids as a result of completing the adjunct study material. Although information in the redundant graphic aid overlapped information presented in the prose, it is unlikely that better recall of this information was the result of better comprehension of the prose. Students' performance on the passage comprehension test did not differ according to treatment condition, but their performance did differ according to treatment condition on the test of information in the nonredundant graphic aids. The nonredundant graphic aids displayed information not discussed in the prose, and unlike the redundant graphic aids, were neither signaled by textual cues nor included in tasks of completing the adjunct study material. Thus, the results indicate unambiguously that completing adjunct study material tends to heighten students' general awareness of graphic aids, even if they are not directly mentioned in the prose and even if they are not the focus of the adjunct study material.

The findings support the results of our earlier experiment which indicate that directing readers' attention to graphic aids through the use of explicit cues produces effects in the desired direction. The provision of explicit cueing of graphic aids in the prose they accompany increases both good and poor readers' general attention to graphic aids and therefore increases recall of the information they depict. The results of the present study indicate that this effect can be obtained with the use of adjunct study material that focuses on the graphic aids. This is an important finding in that many of the graphic aids of published material are unsignaled. It implies that the assignment of adjunct study material may compensate for the absence of explicit directions to readers to inspect graphic aids in texts. Given the strength of the effect associated with completing adjunct study material in the present experiment, assigning such adjunct study material may prove helpful even if explicit cues to the graphic aids are present in texts. Indeed, in the present experiment, the effect of providing adjunct study material for passages with explicit cues to the graphic aids produced the strongest of all treatment effects.

What remains unclear is the effect of increased attention to graphic aids upon readers' comprehension of the prose they are intended to clarify. Given the findings of previous research (Reinking *et al.* 1988), it was expected that increased attention to the graphic aids would not only increase readers' passage comprehension, but would differentially increase the passage comprehension of poor readers. In the present experiment,

however, greater attention to graphic information and recall of information they depicted were not shown to result in a concomitant increase in readers' comprehension of the passages. The present experiment was conducted with a sample taken from the same school population as the earlier study, and the sample was large enough to allow a strong likelihood that the effects observed in the earlier study would be replicated. Further research is needed to explain why increasing attention to graphic aids is sometimes effective and sometimes ineffective in increasing comprehension of the prose they accompany.

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