Journal of Literacy Research
http://jlr.sagepub.com/

Good and Poor Readers' Use of Explicitly Cued Graphic Aids

David Reinking, David A. Hayes and John E. McEneaney

Journal of Literacy Research 1988 20: 229
DOI: 10.1080/10862968809547641

Journal of Reading Behavior
1988, Volume XX, No. 3

GOOD AND POOR READERS' USE OF EXPLICITLY CUED GRAPHIC AIDS

David Reinking, David A. Hayes, and John E. McEneaney
University of Georgia

ABSTRACT

This study investigated the effects of explicitly cuing graphic aids in accompanying text. Specifically, the study attempted to determine if various cuing conditions would affect differently good and poor readers' comprehension of the text, attention to graphic aids, and recall of information displayed in graphic aids. Three expository passages each accompanied by two graphic aids were developed. One graphic aid displayed information that was redundant to the text; a second graphic aid displayed information that was non-redundant but related to the text. Good and poor seventh- and eighth-grade readers read these passages under five different conditions. Under one condition no graphic aids accompanied the text. Graphic aids accompanied the text in the remaining conditions that represented four levels of cuing: no cuing, general cuing, specific cuing, and combined cuing. Results of comprehension tests for each passage and a post-experiment graphics test were analyzed using analysis of variance procedures. Major conclusions were that explicit cuing increases attention to graphic aids and recall of information displayed in graphic aids that are redundant to the text. In addition, poor readers' comprehension of illustrated text is improved by explicit cuing of graphic aids.

Textbooks and other school materials contain a rich variety of graphic aids such as diagrams, maps, and pictures. Among their intended purposes, most important for instruction are those of augmenting the written text with additional information and clarifying the text content. Teachers and researchers find, however, that these purposes are not equally served for all readers. Due to differences in background and personal predilection some readers may look at graphic aids with little or no awareness of their significance, while others may fail to inspect graphic aids at the moment during reading when they would be most helpful. Still others may not look at them at all. Surely the usefulness of graphic aids varies from reader to reader, but previous research suggests that they may be less useful for poor readers than for

other readers (Braun, 1969; Harber, 1980, 1983; Koenke & Otto, 1969; Rose & Furr, 1984; Rose & Robinson, 1984; Willows, 1978). The research reported here investigated one possibility for improving poor readers' use of graphic aids in text, namely supplying them with explicit instructions in the text to attend to the graphic aids available.

Poor readers' failure to put illustrative materials to good use has been generally attributed to attentional deficits characteristic of students who have persistent learning difficulties. These students are unable to allocate attention selectively and to distinguish extraneous material from relevant material (Hallahan, 1975; Keogh & Margolis, 1976; Ross, 1976). Attempting to account for these deficits, a number of researchers (Ceci, Lea, & Ringstrom, 1980; Perfetti & Lesgold, 1979; Torgeson, 1978) have suggested that the limited word knowledge of poor readers restricts the verbal coding required to activate appropriate semantic networks during reading. This restriction on verbal coding may similarly result in poor readers' failure to establish effective connections between the verbal and visual systems in cognition (Swanson, 1984, 1986, 1987). A simpler explanation holds that the attentional resources of poor readers may be so much devoted to processing prose that they are depleted for relating graphic aids to the prose (Harber, 1980, 1983). In either case, it is possible that poor readers do not know *when* during reading to shift attention to the graphic aids in texts. It would seem that attending to graphic aids at critical junctures during reading would make an important difference in whether readers make appropriate connection between the prose and its accompanying graphic aids and thereby avail themselves to graphic aids' complementary informativeness (Brody, 1982).

Poor readers' use of graphic aids may differ from that of good readers who appear not to be affected by explicit cuing to graphic aids. In an experiment involving eighth-grade average and better readers, Hayes and Readence (1982) found that although providing illustrations improved students' comprehension of science texts, no additional advantage was gained by orally cuing students to attend to the illustrations. However, because they included only average and good readers in their study, their results cannot be generalized to poor readers. Unlike average and good readers, poor readers may benefit from explicit cuing to attend to graphic aids. Also, the effects of cuing attention to graphic aids by including written cues embedded in the text is unknown.

It is well known that the effectiveness of graphic aids for enhancing prose comprehension depends importantly on the way they are presented in texts (for extensive reviews of research on graphic aids see A. A. Lumsdaine, 1963; Levie & Lentz, 1982; and Levie, 1987). Relevant to the present investigation, research on textbooks' presentation of graphic aids has found that textbooks rarely include an explicit message to readers that it would be advantageous to examine a map or diagram or picture that elaborates the content being discussed. In an examination of middle-grade social studies textbooks, Friedman and Tinzmann (1985) observed no

signals for illustrations and few signals for maps and other ancillary graphic aids. Extending this research to science textbooks, Tinzmann, Friedman, Jones, and Walker (1986) found the graphic aids to be somewhat better signalled in those materials, though not so much by explicit directions to attend to the graphics as by the necessary interrelatedness of graphic and prose information in the presentation of scientific concepts and procedures. The consequence of omitting explicit references to the graphic aids may be more dire for poor readers than for proficient readers who may be more adept at choosing the appropriate time to examine a graphic aid. Thus, the provision of explicit cues may well increase poor readers' attention to graphic aids, and this in turn may improve their comprehension of the text and memory of information presented in the graphic aids.

The experiment reported here appraised the value that texts' explicit cuing of graphic aids holds for poor versus more proficient readers. The research questions were: Would such cuing result in increased awareness of graphic aids? Would it result in improved recall of information contained in texts' graphic aids? And, perhaps most importantly, would it result in improved prose comprehension? In the experiment seventh- and eighth-grade boys and girls representing a wide range of reading ability read and responded to three passages under five different conditions. Under one condition no graphic aids accompanied the text. Under the other four conditions graphic aids were present, each representing one of four levels of cuing: no cuing, general introductory cuing, specific cuing, and a combination of general as well as specific cuing. Given the findings of previous research, the following outcomes were expected: (1) Without cuing, poor readers would be less aware than other readers of the content of texts' graphic aids; with cuing, poor readers' awareness of graphic aids would be heightened. (2) With cuing, poor readers' recall of graphic aids' content would improve with specificity and amount of cuing available; other readers' recall of graphic aids' content would be unaffected by the presence of cuing. (3) With cuing, poor readers' passage comprehension would improve with increased specificity and amount of cuing available; other readers' passage comprehension would be unaffected by the presence of cuing.

METHOD

Subjects

Subjects were 167 seventh- and eighth-grade boys and girls in a rural, 7th- through 12th-grade high school. The sample was racially heterogeneous. Each subject's score on the reading subtest of the *Metropolitan Achievement Test* (Balow, Farr, Hogan, & Prescott, 1978) was obtained from school records. Scores ranged from the 1st to the 90th percentile based on national norms and indicated a normal distribution of reading achievement between these extremes. Subjects scoring at, or

below the 35th percentile were designated poor readers ($n=70$). It was reasoned that these subjects represented a population of students who experience consistent difficulties in comprehending texts employed in content area classrooms. The remaining subjects ($n=97$) were those scoring above the 35th percentile and represented students of average and above average reading ability whose problems in comprehending school texts are less serious and less pervasive. Comparing subjects who are clearly below average in their reading ability and other subjects who are average or above average in their reading ability was reasoned to be a stronger test of our research questions than to compare only readers at the lowest and the highest levels of reading achievement. Therefore, subjects obtaining average or above average reading scores on the standardized test constituted one comparison group and for convenience were referred to as good readers.

Materials

Stimulus materials in this experiment were three 250–300 word passages adapted from research conducted by Hayes and Readence (1983). The topics of the passages were as follows: parts of the eye, volcanoes, and topographic maps. A computer program (*Teacher Utilities: Volume 2*, Minnesota Educational Computer Consortium) was employed to compute the mean readability of each passage on the basis of six widely used readability formulas. The mean readability estimates for the passages were 11.1, 7.9, and 8.2, respectively. It was reasoned that readability estimates at or above the subjects' assigned grade level would increase the likelihood that readers would seek assistance from graphic aids to understand the passages' content. Five versions of each passage corresponding to the five treatment conditions were developed. Passages had either no graphic aids, graphic aids, or graphic aids plus one of the three cuing conditions.

In those passages containing cues the cues were printed in boldface type, boxed, and inserted in the text (see Appendix for the combined cuing version of the volcanoes passage). The general cue appeared at the top of the page before the main body of text and read as follows, "Look at the pictures to help yourself better understand and remember the information in this passage." Specific cues directed the reader to examine a specific aspect of an accompanying graphic aid. These cues were inserted at the end of a paragraph and the content of each cue was linked directly to the content of the text immediately preceding the cue. The three passages had three, four, and five specific cues respectively. The content and number of paragraphs varied across the three passages and this accounts for the different number of specific cues that were inserted. The different number of cues was considered to be representative of variations in content area texts. This difference was not addressed in the analysis of data since each subject read each of the passages and data were based on performance across all three passages.

The graphic aids that accompanied the passages were carefully developed for the purpose of this study. Each passage in the four conditions having graphic aids was accompanied by a pair of graphic aids. Each pair consisted of two types of graphic aids, redundant and non-redundant. The redundant graphic aid was a diagram, illustration, or map that displayed information redundant to the text (i.e., a pictorial representation of content presented in the accompanying text). The non-redundant graphic aid displayed new information related to the topic of the text but not discussed explicitly in the text. The presence of these two types of graphic aids permitted an analysis that compared recall of information presented in the text *and* in the graphic aids versus information presented only in the graphic aids.

Another important distinction between the redundant and non-redundant graphic aids was that only the redundant graphic aids were referenced by the specific cues when these were used in the text. Thus, for the specific cuing condition, recall of information in the non-redundant graphic aid would indicate that subjects had attended to graphic aids other than those specifically cued in the text.

The three passages were assembled by treatment condition into booklets. The order of passages in the booklets was counterbalanced in each treatment. Each booklet consisted of six pages: a cover sheet displaying the subject's name, followed by separate pages for each passage separated by a blank page. On the back side of each page displaying a passage was the 10-item comprehension test for that passage. Pages were legal size sheets (35.5 cm × 21.6 cm) with the text displayed parallel to the long edge. Text was centered on the left half of the sheet. When the passage was accompanied by a pair of graphic aids (redundant and the non-redundant), these were centered on the right half of the sheet adjacent to the prose.

Dependent Measures

Two multiple-choice tests were dependent measures used to investigate the effects of cuing in this study. A comprehension test that measured comprehension of explicit and implicit information was administered to subjects. In addition, subjects completed a post-experiment graphics test that measured recall of information displayed in the graphic aids that were either redundant or non-redundant to the text.

Comprehension tests. A 10-item, multiple-choice test was constructed for each passage to measure comprehension of information presented in the passage (see Appendix for the comprehension test for the volcano passage). Five of the items on each test were textually explicit and five were textually implicit (Pearson & Johnson, 1978). The content of each item focused on information found primarily in the text. That is, an attempt was made to avoid items that could be answered correctly by examining the graphic aids without reading the text.

Post-experiment graphics test. A 30-item, multiple-choice test was constructed to measure subjects' recall of information displayed in the graphic aids that accompanied passages. The test comprised 3 sets of 10 items that corresponded to the graphic aids associated with each of the three passages. Each set of 10 items included 5 items related to the redundant graphic aid and 5 items related to the non-redundant graphic aid (see Appendix for the 10-item set from the volcano passage). The items on the test required that subjects identify features of the graphic aid or, in a few instances, solve a simple problem to demonstrate an understanding of the graphic aid.

Procedure

Subjects participated in the experiment during their regular 55 minute English class period. Since assignment of subjects to treatment had been random irrespective of class, each class included subjects assigned to all five treatment conditions. One of the experimenters distributed booklets to the subjects, telling them to keep the booklets face up and then read general directions to the class. These directions introduced the activity to the subjects and encouraged them to read and study the passages as they would their school assignments. They were also informed that they would be asked to answer some questions about what they had read. The subjects were then directed to read the first passage and told to wait to go on until directed to do so. Based on an earlier pilot study of the materials, it was determined that 5 minutes was adequate time to read and study each passage. Therefore, subjects were allowed 5 minutes to read and study the passage. After 5 minutes, the experimenter told the subjects to turn the passage face down and answer the 10 multiple-choice questions on the back of the page. This procedure was repeated two more times to complete the second and third passages.

After the comprehension test following the third passage, the booklets were collected. The experimenter then passed out the post-experiment graphics test and directed the subjects to answer as many items as possible on this test. Subjects were allowed 15 minutes to complete this test, after which the tests were collected and subjects were thanked for their participation in the experiment.

The graphics test was administered separately after the comprehension tests for two reasons. First, if a graphics test had been administered after each passage, subjects may have altered their attention to graphic aids based on their awareness that they were to be tested specifically on this information. That is, when discovering that information in the graphic aids was tested after reading the first passage, subjects would be more likely to attend to the graphic aids in the second and third passages. Second, administering a graphics test and a comprehension test together after each passage presents the possibility that responding to items on one test might influence performance on the other test.

RESULTS

Treatment means were compared with analysis of variance procedures. Mean performance on the post-experiment graphics test was compared with an ANOVA for a 5 (Treatment) × 2 (Reading Ability) × 2 (Graphic Type) repeated measures design in which treatment and reading ability were between-subjects factors and graphic type was a within-subjects factor. Mean performance across the three comprehension tests was also compared with an ANOVA for a 5 (Treatment) × 2 (Reading Ability) × 2 (Questions Type) repeated measures design in which treatment and reading ability again were between-subjects factors and question type the within-subjects factor.

Post-Experiment Graphics Test

Means and standard deviations of scores on the graphics test by treatment group, reading ability, and graphic type are given in Table 1. Means on the graphics test were analyzed using a three-way (Treatment × Reading Ability × Graphic Type), mixed-factorial ANOVA. There were no significant interaction effects. Main effects for treatment, $F(4, 157) = 20.20$, $p < .001$, reading ability, $F(1, 157) = 11.37$, $p = .001$, and graphic type, $F(1, 157) = 155.93$, $p < .001$ were statistically significant. Because there were no significant interaction effects, pairwise comparisons of treatment means were then made across ability and graphic type. The Newman-Keuls procedure was used for these analyses. These analyses revealed statistically significant differences between the no-graphics condition ($M = 4.23$) and the general-cuing ($M = 6.57$), specific-cuing ($M = 8.19$), and combined-cuing ($M = 7.93$) conditions. The difference between the no-graphics condition ($M = 4.23$) and the graphics-only condition ($M = 5.49$) was not statistically significant. Statistically significant differences were also found between the graphics-only condition ($M = 5.49$) and both the specific-cuing and combined-cuing conditions. In addition, Scheffè's comparison procedure was used to compare the mean for the graphics-only condition to the mean of the three cuing conditions (general, specific, and combined cuing). This comparison was statistically significant.

These results indicate that subjects in each of the three cuing conditions outperformed subjects in the no-graphics condition on the recall of graphic information that was redundant and non-redundant to the accompanying text. In addition, subjects in the specific- and combined-cuing conditions outperformed subjects in the graphics-only condition. A comparison of the graphics-only condition to the combined performance of the three cuing conditions revealed that subjects having cues outperformed those who had only the graphics. Across all treatment conditions good readers outperformed poor readers, and scores on the items pertaining to the redundant graphic were higher than scores on the non-redundant items.

Table 1

Means and Standard Deviations for Graphics Test Scores

	Treatment									
	No Graphics		Graphics Only		General Cuing		Specific Cuing		Combined Cuing	
Graphic Type	Redundant	Non-Redundant	Redundant	Non-Redundant	Redundant	Non-Redundant	Redundant	Non-Redundant	Redundant	Non-Redundant
Good Readers	(n = 19)		(n = 20)		(n = 21)		(n = 19)		(n = 18)	
M	6.5	3.2	7.2	3.9	8.6	6.1	10.2	6.9	10.7	7.2
SD	2.3	1.5	2.8	2.7	2.8	3.3	3.0	2.5	2.7	3.1
Poor Readers	(n = 13)		(n = 11)		(n = 16)		(n = 15)		(n = 15)	
M	4.3	2.9	6.6	4.3	7.1	4.5	8.9	6.8	8.9	4.9
SD	2.1	1.5	1.9	2.4	2.7	2.2	2.6	2.5	2.5	1.9

Note. Maximum Score = 15.

Comprehension Test

Means and standard deviations of comprehension scores by treatment, reading ability, and question type are given in Table 2. Means on the comprehension test were compared using a three-way (Treatment × Ability × Question Type), repeated measures ANOVA. Main effects for ability, $F(1, 157) = 27.98$, $p < .001$, and question type, $F(1, 157) = 99.80$, $p < .001$, were statistically significant, as was the treatment by ability interaction, $F(4, 157) = 2.48$, $p < .05$. The interaction is presented in Figure 1. Main effects for treatment were not statistically significant; neither were the remaining three interactions.

Figure 1 suggests that the interaction involved poor readers' higher mean scores in the cuing conditions when compared to good readers whose mean scores remained relatively constant across treatments. Several analyses were conducted to investigate this possibility. First, good readers' treatment means on the comprehension test were compared using a one-way ANOVA. This comparison was not statistically significant, $F(4, 92) < 1.00$. Although the same comparison for poor readers was not statistically significant, it approached significance, $F(4, 64) = 2.01$, $p = .10$. Second, since the interaction was consistent with one of the hypothesized effects of explicit cuing, the interaction was investigated using an F ratio for *a priori* orthogonal comparisons (Kirk, 1968). The comparison of interest was the mean difference between good and poor readers in the two conditions without explicit cuing versus the mean difference between good and poor readers in the three conditions with explicit cuing. This comparison yielded a significant difference, $F(4, 157) = 2.84$, $p < .05$. In addition, two t-tests were employed to compare good and poor readers. One test compared good and poor readers across the two treatment conditions having no cues. This comparison was statistically significant, $t(156) = 3.61$, $p < .001$. The second test compared good and poor readers across the three cuing conditions. This comparison was not statistically significant, $t(156) = 1.81$, $p > .05$. Finally, the effect size was computed for the latter two comparisons (Glass & Hopkins, 1984). The difference between good and poor readers in standard deviation units was .94 across the two treatments without cues and .36 across the three treatments with cues.

These results were in the direction expected. Performance on literal items was better than on inferential items and good readers' comprehension was better than poor readers. However, statistical analyses of the interaction effect indicated that the difference between good and poor readers' comprehension was less when graphic aids were explicitly cued.

DISCUSSION

This study investigated the effects of augmenting prose with explicit cues to its accompanying graphic aids. It was expected that provision of explicit cues would

Table 2

Means and Standard Deviations for Comprehension Test Scores

	Treatment									
	No Graphics		Graphics Only		General Cuing		Specific Cuing		Combined Cuing	
Question Type	Literal	Inferential	Literal	Inferential	Literal	Inferential	Literal	Inferential	Literal	Inferential
Good Readers	(n=19)		(n=20)		(n=21)		(n=19)		(n=18)	
M	10.6	8.5	10.0	7.5	8.9	7.3	9.4	8.5	10.2	7.7
SD	3.0	2.9	3.2	2.6	2.8	2.9	3.1	2.7	2.2	2.6
Poor Readers	(n=13)		(n=11)		(n=16)		(n=15)		(n=15)	
M	6.4	4.5	7.2	5.8	8.8	6.8	8.5	6.0	8.5	5.8
SD	2.7	1.9	2.7	1.7	3.6	2.9	2.5	3.6	2.8	1.3

Note. Maximum Score = 15.

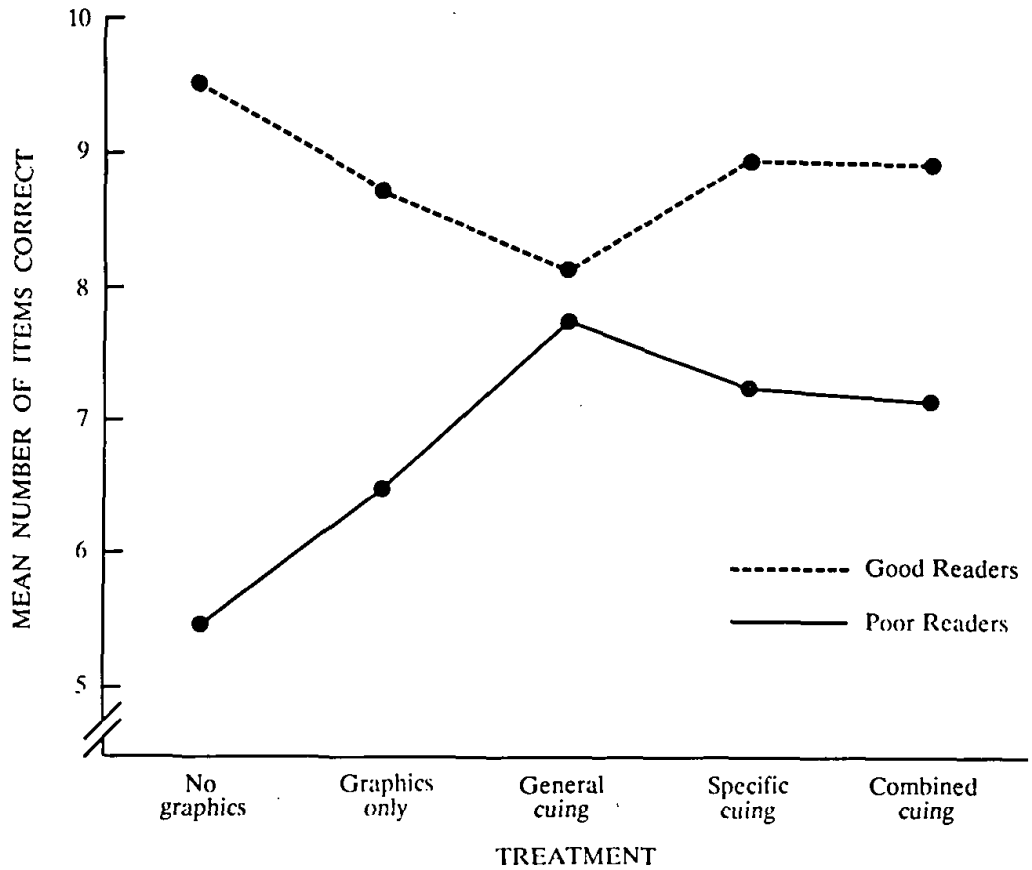


Figure 1. Treatment by ability interaction on comprehension test scores.

increase poor readers' attention to graphic aids, which would improve their comprehension of the text and their recall of the information presented in graphic aids. The data confirm that when given explicit cues, poor readers increase their attention to graphic aids and improve their comprehension of prose. Also expected was that good readers' performance would be unaffected by explicit cuing. This was not the case. Apparently, explicit cuing benefits good readers as well as poor readers by increasing their attention to graphic aids to the extent that they are able to recall more information presented in graphic aids. There was, however, a treatment by ability interaction for the comprehension test. The post hoc analysis of this interaction indicates that the difference between good and poor readers' comprehension of information in the passages was less under the cuing conditions.

These results are discussed in the remainder of the report. Observed differences in performance across levels of treatment and reading ability are addressed in separate sections for each dependent measure. The final section presents our overall conclusions about the significance of the results and suggestions for further research.

Post-Experiment Graphics Test

The results of the post-experiment graphics test indicate that explicit cuing increases attention to graphic aids and increases recall of graphic information cued in the text. Subjects who read texts in which graphic aids were explicitly cued recalled more information than did subjects reading the same text without cues. That subjects in the cuing conditions recalled more information from the redundant graphic may indicate that these readers attended to the redundant graphic in response to the cues embedded in the text. However, since information in the redundant graphic overlapped information presented in the text, better recall of that information might have been the result of better comprehension of the text. That subjects in the cuing conditions recalled more information in the non-redundant graphic indicates unambiguously, however, that explicit cuing resulted in greater attention to graphic aids. The non-redundant graphic displayed information not discussed in the passage, and unlike the redundant graphic, it was not cued in the specific-cuing condition. Thus, greater recall of information in the non-redundant graphic indicates that subjects in this condition attended to graphic aids other than those cued in the text. Apparently with specific cues readers increased attention not only to the graphic aids that were cued, but also to other graphic aids that accompanied the text.

The data also suggest that greater recall may be dependent on the type of cue employed. Cues that are interspersed within the text and that relate specific text content to the graphic aids may be more effective than a general cue that directs the reader to attend to graphic aids. (Post hoc analyses indicate that subjects in the specific- and combined-cuing conditions outperformed those in the graphics-only condition.) Subjects given only a general cue to attend to the graphic aids did not perform significantly better than subjects in the graphics-only condition. Readers in this study seemed to have allocated more attention to graphic aids when they were given guidance by specific, as opposed to general cues. This conclusion must be qualified, however, by the finding that the performance of subjects in the specific- and combined-cuing conditions did not differ significantly from the performance of subjects in the general-cuing condition.

The increased attention to graphic aids in the cuing conditions gains added significance when the no-graphics and graphics-only conditions are compared. Subjects' recall of graphic aids after reading passages without cues appears to have been no better than that of subjects who read passages that were not accompanied by graphic aids. Apparently, subjects reading passages without explicit cues allocated little attention to the graphic aids accompanying the passages.

Comprehension Test

Explicit cues also appear to have a positive effect on poor readers' comprehension of information presented in the text. Post hoc analyses of the treatment by

ability interaction on the comprehension test indicated that the difference between good and poor readers' performance was greater in the non-cuing conditions than in the cuing conditions. The presence of cues, be they general, specific or combined, resulted in significantly higher levels of comprehension for poor readers, but the presence of these cues did not significantly affect the comprehension of good readers. Improved comprehension for poor readers in the cuing conditions may have resulted from increased attention to the graphic aids, which, when processed as directed by the prose, aided comprehension of the prose. Additionally, the presence of cues may have stimulated more intensive processing of the text independent of the increased attention to graphic aids. Further research is needed to explore these possibilities.

Good and poor readers in this study attended more to graphic aids when graphic aids were specifically cued in the text, as is evidenced by their greater recall of information displayed in the graphic aids. The data suggest, however, that explicit cuing of graphic aids benefited poor readers' comprehension more than good readers' comprehension. One explanation for this finding is that good readers depend less on information displayed in graphic aids. On the other hand, poor readers may benefit from examining a graphic representation of information discussed in the prose and being advised when to do so. This interpretation is consistent with previous research on the value of graphic aids for poor readers (e.g., Harber, 1983). It is also consistent with research indicating that poor readers are less likely than good readers to direct their own learning from text (Baker & Brown, 1984).

CONCLUSIONS

A comparison of the results of the post-experimental graphics test and the comprehension test suggests that explicit cuing of graphic aids may assist poor readers in comprehending texts by increasing their attention to these aids. Before this conclusion can be established, however, the effects of several factors not investigated in this study need to be studied. For example, one relevant factor not specifically controlled or manipulated in the present study was the degree to which passage comprehension was dependent on information in the graphic aids. Schallert (1980) has argued that illustrations may be more important for comprehension when they portray spatial information that is central to the text's content. The effects of explicit cuing on attention and comprehension may be different when the text's dependence on graphic aids is manipulated. Explicit cuing may have also affected the time readers devoted to reading and studying the text. Further research is needed to determine whether this factor may contribute to poor readers' increased comprehension in the cuing conditions. The role of readers' background knowledge is another variable that might qualify the conclusions of the present study. The effects

of explicit cuing may be different when readers vary in their knowledge about or interest in the topics of texts accompanied by graphic aids.

Results of this study have implications for the design and classroom use of textbooks. Explicit cuing of graphic aids in textbooks may increase good and poor readers' attention to graphic aids and may be valuable for improving text comprehension among poor readers. Teachers may wish to consider adding glosses to texts or providing supplemental study guides that help poor readers focus on the graphic aids accompanying a text. Further research is needed, however, to determine whether these adaptations would produce the same results as found in this study. Explicit cues embedded in texts might also be compared to oral cues provided by a teacher. Hayes and Readence (1982) found that giving good readers oral cues to attend to graphic aids had no statistically significant effect on learning from text. The results of the present study suggest, however, that oral cuing of graphic aids might benefit poor readers.

The present study suggests that explicit cuing is a variable of some importance in increasing attention to graphic aids and may be helpful in increasing comprehension among poor readers reading texts accompanied by graphic aids. Further research is needed to examine the effects of explicit cuing and how it may interact with other reader, text, and instructional variables.

REFERENCES

Baker, L., & Brown, A. L. (1984). Metacognitive skills and reading. In P. D. Pearson (Ed.), *Handbook of reading research* (pp. 353–394). New York: Longman.

Balow, I. H., Farr, R., Hogan, T. P., & Prescott, G. A. (1978). *Metropolitan achievement test.* New York: The Psychological Corporation.

Braun, C. (1969). Interest loading and modality effects on textual response acquisition. *Reading Research Quarterly, 4,* 428–444.

Brody, P. J. (1982). Affecting instructional textbooks through pictures. In D. H. Jonassen (Ed.), *The technology of text* (pp. 301–316). Englewood Cliffs, NJ: Educational Technology Publications.

Cecis, L. S., & Ringstrom, M. (1980). Coding process in normal and learning disabled children. *Journal of Experimental Psychology: Human Learning and Memory, 6,* 785–795.

Duchastel, P. C., & Waller, R. (1979). Pictorial illustration in instructional texts. *Educational Technology, 19,* 20–25.

Friedman, L. B., & Tinzmann, M. B. (1985). Graphics in middle-grade U.S. history textbooks. In J. A. Niles & R. V. Lalik (Eds.), *Issues in literacy: A research perspective* (pp. 151–167). Rochester, NY: The National Reading Conference.

Glass, C. V., & Hopkins, K. D. (1984). *Statistical methods in education and psychology* (2nd ed.). Englewood Cliffs, NJ: Prentice-Hall.

Hallahan, D. P. (1975). Distractibility in the learning disabled child. In W. M. Cruickshank & D. P. Hallahan (Eds.), *Perceptual and learning disabilities in children: Research and theory* (Vol. 2, pp. 195–218). Syracuse, NY: Syracuse University Press.

Harber, J. R. (1980). Effects of illustrations on reading performance: Implications for further LD research. *Learning Disability Quarterly, 3,* 60–70.

Harber, J. R. (1983). The effects of illustrations on the reading performance of learning disabled and normal children. *Learning Disabilities Quarterly, 6,* 55–60.

Hayes, D. A., & Readence, J. E. (1982). Effects of cued attention to illustrations in texts. In J. A. Niles & L. A. Harris (Eds.), *New inquiries in reading research and instruction* (pp. 60–63). Rochester, NY: The National Reading Conference.

Hayes, D. A., & Readence, J. E. (1983). Transfer of learning from illustration-dependent text. *Journal of Educational Research, 76,* 245–248.

Keogh, B. K., & Margolis, J. (1976). Learn to labor and to wait: Attentional problems of children with learning disorders. *Journal of Learning Disabilities, 9,* 276–286.

Kirk, R. E. (1968). *Experimental design procedures for the behavioral sciences.* Belmont, CA: Wadsworth.

Koenke, K., & Otto, W. (1969). Contributions of pictures to children's comprehension of the main idea in reading. *Psychology in the Schools, 6,* 298–302.

Levie, W. H. (1987). Research on pictures: A guide to the literature. In D. M. Willows & H. A. Houghton (Eds.), *The psychology of illustration* (Vol. 1, pp. 1–50). New York: Springer-Verlag.

Levie, W. H., & Lentz, R. (1982). The effects of text illustration. *Educational Communications and Technology Journal, 30,* 195–232.

Lumsdaine, A. A. (1963). Instruments and media of instruction. In N. L. Gage (Ed.), *Handbook of research on teaching* (pp. 583–682). Chicago: Rand McNally.

Pearson, P. D., & Johnson, D. D. (1974). *Teaching reading comprehension.* New York: Holt, Rinehart, and Winston.

Perfetti, C. A., & Lesgold, A. M. (1979). Coding and comprehension in skilled reading and implications for instruction. In L. B. Resuck & P. A. Weaver (Eds.), *Theory and practice of earlier reading.* (Vol. 1). Hillsdale, NJ: Erlbaum.

Rose, T. L., & Furr, P. M. (1984). Negative effects of illustrations as word cues. *Journal of Learning Disabilities, 17,* 334–337.

Rose, T. L., & Robinson, H. H. (1984). Effects of illustrations on learning disabled students' reading performance. *Learning Disability Quarterly, 7,* 165–171.

Ross, A. O. (1976). *Psychological aspects of learning disabilities and reading disorders.* New York: McGraw-Hill.

Schallert, D. L. (1980). The role of illustrations in reading comprehension. In R. J. Spiro, B. C. Bruce, & W. F. Brewer (Eds.), *Theoretical issues in comprehension instruction* (pp. 503–525). Hillsdale, NJ: Lawrence Erlbaum.

Swanson, H. L. (1984). Semantic and visual memory codes in learning disabled readers. *Journal of Experimental Child Psychology, 37,* 124–140.

Swanson, H. L. (1986). Do semantic memory deficiencies underlie learning disabled readers' encoding processes? *Journal of Experimental Child Psychology, 41,* 461–488.

Swanson, H. L. (1987). Verbal-coding deficits in the recall of pictorial information by learning disabled readers: The influence of a lexical system. *American Educational Research Journal, 24,* 143–170.

Tinzmann, M. B., Friedman, L. B., Jones, B. F., & Walker, B. J. (1986, April). *Graphics in eighth-grade science textbooks.* Paper presented at the meeting of the International Reading Association, Philadelphia, PA.

Torgesen, J. K. (1978). Performance of learning-disabled children on serial memory tasks: A selective review of recent research. *Reading Research Quarterly, 14,* 57–87.

Willows, D. M. (1978). A picture is not always worth a thousand words: Pictures as distractors in reading. *Journal of Educational Psychology, 70,* 255–262.

APPENDIX

WHAT ARE VOLCANOES?

Directions: Study this passage carefully. You will be asked to answer some questions when you are fnished.

Long ago, the Romans named a mountain "Vulcano," because they thought that inside this steaming crater was the home of the god, Vulcan. They thought it was the place where he stirred his underground fires to run his blacksmith's forge.

From this one volcanic peak on an island off the coast of Italy, we have taken the name volcano to use for all peaks which steam or erupt lava. These volcanoes are mountains that have built themselves. They are made of cinders, ash, and hot molten material that comes out of their own centers.

Note in Figure 1A the layers of cinders, ash, and lava that make up this volcano.

At the very top of some volcanoes are large, bowl-shaped depressions called calderas. Calderas are caused by a collapse of the top of a volcano when the material inside it has erupted and left an empty chamber. Calderas can be more than a mile across and over a thousand feet deep.

Note in Figure 1B that the top of the volcano has collapsed to form a caldera.

A crater is a round depression with steep sides and volcanic eruptions often come through it. Craters can be at the top of a volcano, within the caldera, or along the volcano's sides. They are not as deep or as wide as calderas.

Note in Figure 1A that craters can be found at the top or on the sides of a volcano.

Why does a volcano erupt? We know that the temperature inside the earth increases as we go deeper and deeper within. The temperature becomes so high below the crust of the earth that rock at these depths should melt. But, it does not melt because the great pressure from the surface of the earth downward keeps it solid.

However, the crust is not the same thickness all over the earth, so the pressure varies. In some place where it is thinner, there are cracks, or fissures, which extend down into the earth. There, the pressure is not as strong, and the rock can move as a liquid. This liquid rock is called magma.

Note in Figure 1A that magma, or liquid rock, is below the volcano.

As the magma comes to the surface, it is called lava. Lava builds up around the opening in the shape of a cone. Cones can grow into mountains of various shapes. As the magma explodes into the air, it becomes hard and falls to earth as lava rocks or "bombs." Some volcanoes grow to be large mountains over a period of hundreds, maybe thousands of years and countless eruptions. Others grow in just a few years.

REDUNDANT GRAPHIC AID FOR THE VOLCANO PASSAGE

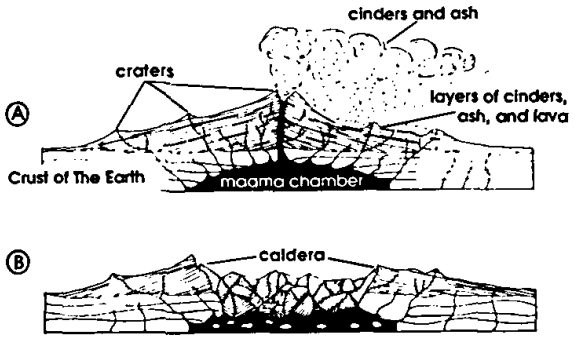


Figure 1. Cross section showing a volcano before (part A), and after (part B) the collapse of its top

NON-REDUNDANT GRAPHIC AID FOR THE VOLCANO PASSAGE

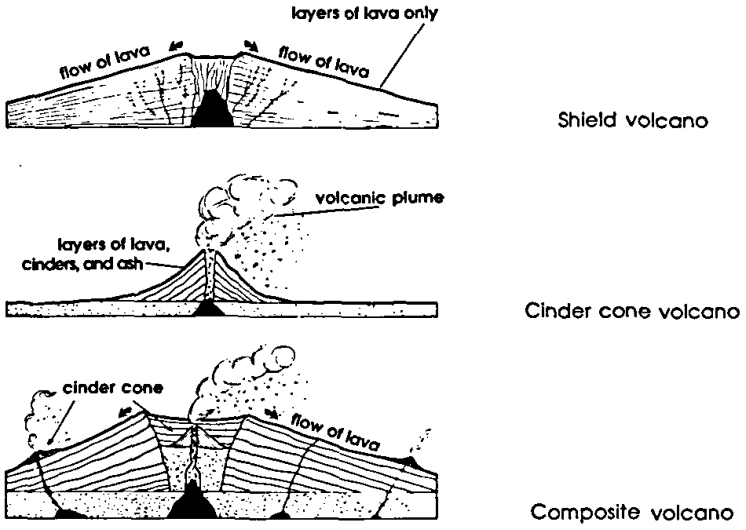


Figure 2. Three different types of volcanoes

THE TEXT OF THE VOLCANO PASSAGE

1. The large bowl-shaped depressions at the very top of some volca noes are called:

   a. craters.
   b. magmas.
   c. calderas.
   d. lava bombs.

2. Rocks inside the earth will not melt because:

   a. the temperature never becomes hot enough.
   b. magma and lava can not flow together.
   c. calderas block the flow of liquid rock.
   d. of great pressure from the earth's surface.

3. According to this passage, bombs that come from volcanoes are:

   a. lava rocks.
   b. fissures.
   c. magma.
   d. calderic matter.

4. According to this passage, what happens as we go deeper inside the earth?

   a. Magma changes to lava.
   b. Solid rock changes to liquid.
   c. The temperature rises.
   d. There are more cracks and fissures.

5. What causes a caldera to form?

   a. Lava builds up after an eruption.
   b. The top of a volcano caves in.
   c. Lava cools and hardens.
   d. Pressure from deep inside the earth turns rock into liquid.

6. The term "volcano" comes from:

   a. a high mountain in Italy.
   b. A Roman god.
   c. the Roman name for blacksmith.
   d. blending the Latin words for cinder, hot, and ash.

7. What causes a volcano to erupt?

   a. Lava explodes close to the earth's surface.
   b. Magma from deep in the earth moves upward through a crack in earth's crust.
   c. The temperature deep in the earth's crust rises past the boiling point of magma.
   d. Magma changes to lava and raises the pressure of the earth's crust.

8. Liquid rock in the earth is called:

   a. lava.
   b. caldera.
   c. magma.
   d. fissure.

9. What part of the earth probably has few volcanoes?

   a. where the earth's crust is cooler
   b. where the earth's crust is thin and rock can move as liquid
   c. where the earth's crust has shifted
   d. where the earth's crust is thick with few fissures

10. How long does it take a volcano to grow into a large mountain?

   a. anywhere from a few years to thousands of years
   b. usually about 100 years
   c. the time it takes for one major eruption
   d. millions of years, after countless eruptions

ITEMS PERTAINING TO THE VOLCANO PASSAGE ON THE POST-EXPERIMENT GRAPHICS TEST

1. What part of the volcano is at point A?

   a. the caldera
   b. a volcanic vent
   c. a crater
   d. the volcanic core
   e. a lava chute

2. What is at point B?

   a. rock sediment
   b. volcanic fissures
   c. the volcanic base
   d. the crust of the earth
   e. layers of lava

3. What is at point C?

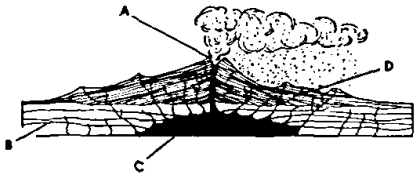
   a. the magma chamber
   b. the lava reservoir
   c. the interior core
   d. hardened lava
   e. hardened magma

4. What is at point D?

   a. the crust of the earth
   b. layers of cinder, ash, and lava
   c. fissures from deep within the earth
   d. an old crater
   e. lava bombs

5. What is shown by the arrows from point E?

   a. a large crater
   b. a caldera
   c. two lava domes
   d. twin volcanoes
   e. a dead volcano



Directions: Use the pictures above to answer the questions. Circle the best answer.

1. What kind of volcano is volcano Number 1?

   a. a shallow volcano
   b. a base volcano
   c. a field volcano
   d. a shield volcano
   e. a cinder volcano

2. What kind of volcano is volcano Number 2?

   a. a cinder cone volcano
   b. a shield volcano
   c. a base volcano
   d. a lava dome
   e. a smoke-filled volcano

3. What kind of volcano is volcano Number 3?

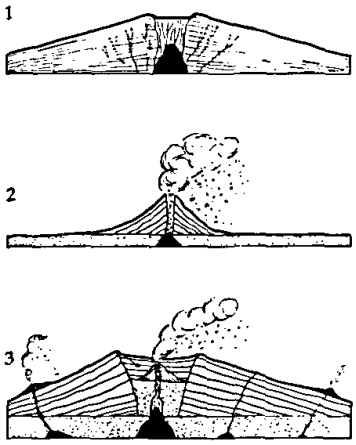
   a. a shield volcano
   b. a multi-layered volcano
   c. a field volcano
   d. an inverted volcano
   e. a composite volcano

4. Which volcano is made from layers of lava only?

   a. volcano Number 1
   b. volcano Number 2
   c. volcano Number 3
   d. all three are made from lava only

5. What is the arrow pointing at in volcano Number 2?

   a. calderic matter
   b. exploding lava
   c. the volcanic plume
   d. volcanic smoke



Directions: Use the pictures above to answer the questions. Circle the best answer.