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Technical Report No. 399

BRIDGING THE COMPREHENSION GAP WITH PICTURES

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University of Illinois at Urbana-Champaign

December 1986

Center for the Study of Reading

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Abstract

Using a time series design, two special education students from a middle school were taught to interpret pictures that were topically related to reading passages. After 10 three-day sequences of pre-picture reading, picture study, and post-picture reading, their reading comprehension improved significantly on several measures. The authors attributed the gains to increases in amount and accessibility of the students' prior knowledge, produced by the systematic study of the pictures.

The research and line of reasoning described in this paper are based on the idea that pictures can be used as teaching devices to improve reading comprehension, especially for very poor readers. Most of the literature relating to pictures as aids to reading comprehension involves their use as illustrations. The effects of illustrations on the reader's ability to recall and comprehend verbal material has been a topic of controversy for at least the last 15 years. Samuels (1970) reviewed the literature on the effects of illustrations on young children's comprehension and concluded that pictures either detract from, or make no difference to, reading comprehension. These conclusions have been supported by both older studies (e.g., Koenke, 1969; Miller, 1938; Rankin & Culhane, 1970; Weintraub, 1960) and more recent studies (Harber, 1983; Rose & Robinson, 1984; Willows, 1978). In contrast, several recent studies have reported that pictures were successful in aiding word identification in sentences (Denburg, 1976-77), recognition and recall of functional relationships (Carr, Bacharach, & Mehner, 1977), retention of textual content (Peeck, 1974), and retention of incidental material in content area lessons (Goldberg, 1974).

A decade after the Samuels' review, Schallert (1980) commented that the conditions under which Samuels drew his conclusions presented pictures as adjunct aids; that is, the pictures were completely redundant to the text, adding no new information. Perhaps illustrations enhance comprehension and recall only when they contain or are used to elicit information

that is related, but ancillary, to the text. In the line of research described in this paper, the function of the picture is to elicit related information--not only to activate background knowledge, but also to build schemata by enhancing and enriching background knowledge. The primary hypothesis was that when pictures are thematically related to the story, and represent a multitude of enriching information, rather than simple recapitulations of text content, story comprehension is likely to be enhanced.

Two recent literature reviews have addressed the effects of ilustrations on prose learning (Levie & Lentz, 1982) and on reading comprehension (Readence & Moore, 1981). Levie and Lentz concluded that (a) learning of textual information is facilitated by pictures, (b) illustrations help readers comprehend and remember more of what they read, (c) illustrations are effective substitutes for words, (d) effective use of illustrations probably requires instruction, and (e) illustrations appear to be most useful to poor readers. Readence and Moore concurred with these conclusions via a meta-analysis of the effects of illustrations on comprehension.

In our line of research the facilitative effects of pictures on reading comprehension of learning-disabled children were originally demonstrated in a study by Croll (1983). University seniors in special education were randomly assigned to tutor poor readers from a learning disabilities class for grades four to six. One group of tutors delivered instruction in remedial reading to the control group, using word study, oral reading,

sentence construction, and questions about stories. During the same time period, another group of tutors instructed the experimental group, using only pictures, which the students interpreted with the help of guiding questions. The experimental group did not read stories, but merely interpreted and discussed picture content. This group gained significantly more than the control group on the reading comprehension subtest of the Iowa Test of Basic Skills. Croll concluded that reading comprehension can be facilitated without the use of printed text--and that the skills involved in interpreting pictures are possibly analogous to those involved in reading comprehension. Recent advances in explicating the relationship between schema theory and the comprehension process are particularly useful in understanding why the analogy between picture interpretation and reading comprehension may be a valid one.

Schema Theory

The importance of prior knowledge to the ability of a reader to comprehend text has long been acknowledged (Bartlett, 1932; Henderson, 1903). Cognitive psychologists have theorized about how prior knowledge and newly acquired information are organized in memory. One such theory is schema theory, which postulates that a schema represents an individual's accumulated knowledge associated with a person, object, event, or other entity (Anderson, 1977). Applied to the reading comprehension process, the reader's encounter with textual material prompts decisions about which schema "fits" the current information; such

instantiation causes the text to make sense to the reader and to become assimilated into memory (Anderson, Pichert, Goetz, Schallert, Stevens, & Trollip, 1976).

In addition, it is thought that each schema has a number of "variable slots" which can be filled by the reader as inferences are drawn between text and the reader's schemata. Such inferencing is accomplished automatically by mature readers who have sufficient prior knowledge about a particular entity and who are aware of its features. However, for readers whose prior knowledge is either inadequate or inaccessible, inferencing is more problematic (Spiro, 1980). This problem has been successfully addressed by a number of researchers, in the context of (1) building schemata increasing background knowledge (Beck, Omanson, & McKeown, 1982; Graves, Cooke, & LaBerge, 1983; Hartley & Davies, 1976; Langer, 1984; Stevens, 1982), and/or (2) activating schemata.

Building schemata. Instruction in background information prior to reading text has been a traditional method of improving comprehension of text. Its main purpose has been to provide new information in such a way that it interacts with existing schemata, thus broadening the reader's knowledge base. Recent studies have used such prereading strategies with enough success that the practice continues to have empirical support.

The schema-building studies illustrate the positive effects that the providing background information has on comprehension of readers at all grade levels. It does not seem to matter how the information is presented, as long as it is relevant to the text.

Tierney and Cunningham (1984) believe that before clear guidelines can be developed on how to build background knowledge, researchers must investigate the relationship between background knowledge components and specific instructional practices, e.g., direct versus symbolic experience, direct versus incidental instruction. In the present study, we tried to improve background knowledge by using direct instruction of theme-related concepts present in pictures, with the expectation that the subsequent engagement of that knowledge would improve story comprehension.

Activating schemata. Readers who have adequate prior knowledge about a topic may lack the disposition to activate that knowledge. Alternatively, their schemata may not have become sufficiently elaborated to provide "slots" into which new information can be integrated. Such situations can impede the extension of a reader's knowledge base.

Johnston and Pearson (1982) supported the expectation that students with greater prior knowledge of a subject show better reading comprehension on that topic, regardless of familiarity of story content. Furthermore, instructing students to relate what they know to what they read, facilitates reading comprehension scores, especially those of poor readers, and especially when comprehension is measured using inferential as opposed to literal questions (Gordon & Pearson, 1983; Hansen & Pearson, 1982).

Another class of schema activation processes that influence comprehension is non-text, of which one is visual imagery.

Apparent anomalies in the relative abilities of people to encode verbal and visual information led to Paivio's dual code theory.

> Dual code theory . . . is based on the assumption that memory and cognition are served by two separate symbolic systems, one specialized for dealing with verbal information and the other for nonverbal information. The two systems are presumed to be interconnected but capable of functioning independently. Interconnectedness means that representations in one system can activate those in the other, so that, for example, pictures can be named and images can occur to words. Independence implies, among other things, that nonverbal (imaginal) and verbal memory codes, aroused directly by pictures and words or indirectly by imagery and verbal encoding tasks, should have additive effects on recall (Paivio & Lambert, 1981, p. 532-533).

Reading comprehension is ordinarily facilitated by imagery, whether induced by pictures or by instructions to image. Arnold and Brooks (1976) found that a picture reduced children's ability to organize and recall information about a story. Bender and Levin (1978), Guttman, Levin, and Pressley (1977), and Ruch and Levin (1977) conducted similar studies with students in kindergarten to third grade, and educable mentally handicapped children aged 10 to 16 years, and found significant gains for those who had been shown a picture as they heard a narrative sentence.

However, not all children benefit from imagery interventions. After classifying fourth- and sixth-grade students as being predominantly verbal and/or visual, Levin, Divine-Hawkins, Kerst, and Guttman (1974) instructed half of the randomly-assigned students to image as they read two passages. They found that the highly visual learners who had been instructed to image scored significantly higher on the reading comprehension task than those who had not, and that both groups scored higher than low imagers. However, because the low imagers who had been instructed to image scored lower than their counterparts who had not, Levin et al. speculated that the instruction to image may have interfered with their usual comprehension strategies.

These results suported Paivio's (1975) conviction that while imagery influences memory, it does not consistently help it. As Levin et al. (1974) noted, individuals apparently differ in their use of imagery in learning and memory tasks.

Having reviewed the studies of imagery effects on comprehension, Levin (1981) has concluded that poor comprehenders who have adequate word recognition skills seem to benefit consistently from imagery instructions. Because of the possibility that the pictures used as the main intervention may induce imagery, subjects who fit this description were selected for the present study.

The purpose was to investigate the effects of using topic-related pictures to build and activate readers' schemata, as a

means of increasing background knowledge and, consequently, reading comprehension.

Method

Subjects and Setting

The subjects were two students in a middle school in a metropolitan area of approximately 100,000 people. Selection of the students was made on the basis of low scores on standardized reading comprehension and vocabulary tests, adequate decoding skills, and assignment to special education services.

The first student was a black male, aged 13 years 6 months, of low SES, with a WISC-R IQ of 52. He was labeled educably mentally handicapped and was assigned to a self-contained classroom for most of the school day. The second student was a black male, aged 12 years 11 months, with lower-middle class SES, with a WISC-R IQ of 89. He was labeled as learning-disabled and behavior-disordered and was assigned to a self-contained behavior disorders classroom for most of the school day. Instruction took place in an unused classroom in the school. Each student received individual instruction during a 40-minute class period; this was in addition to the reading instruction that was normally given in his classroom.

Teacher

The teacher was the principal investigator, enrolled in a Ph.D program at the University of Illinois, Department of Special Education. She had 15 years of experience teaching students of a variety of socioeconomic backgrounds, with seven years in grades seven through nine.

Materials

The Guided Reading Study Guide (Taylor & Heflin, 1972) series was used for both students, who were placed in the third- and fourth-grade levels based on their reading comprehension, pretest scores on the Nelson Reading Skills Test and the Iowa Test of Basic Skills. The first student read from Level 3, whose passages ranged in length from 1100 to 1400 words; the second student read from Level 4, whose passages ranged in length from 1200 to 1500 words. Both narrative and expository passages were used; passages were randomly assigned to sessions.

A colored picture that illustrated a complex view of the topic of each passage was selected for each lesson unit. All pictures were taken from magazines, calendars, and the like; they were at least five inches in width and length and were mounted on 8-1/2 by 11 inch manila tag board.

For each of the passages and pictures, eight questions were constructed, consisting of two prior knowledge (PK) questions that were text-independent, i.e., the answers were not contained in the applicable passage or picture; two textually explicit (TE) questions that were text-dependent, i.e., the answers were explicitly found in the passage or picture; two textually implicit (TI) questions, whose answers were based upon two or more non-explicitly connected details of the passage or picture; and two scriptally implicit (SI) questions, whose answers required integration of prior knowledge and one or more details of the passage or picture. Guidelines used for constructing

questions were derived from the writings of Johnston (1981), Pearson (1982), and Tuinman (1974).

Procedures

Design. The design was ABCA time series, across subjects, and multiple schedule across treatments (Herson & Barlow, 1976; Kazdin, 1982). The two students were randomly assigned to seven- and eight-day baselines.

Baseline conditions (A). For the first three to four days of baseline, two PK questions about story topic were orally posed by the teacher and answered orally by the student. After reading the story silently, the student read orally a 100-word timed passage to maintain a check on rate (correct words per minute; cwpm) and percentage accuracy. After the student finished reading the passage, he retold the story orally, from memory. The teacher then gave the student a worksheet on which two TE, two TI, and two SI questions were printed; the student wrote the answers to the questions on the worksheet.

On each of the next four consecutive days, two PK questions about the topic of a picture were posed by the teacher and answered orally by the student. The student was then given a mounted colored picture, which illustrated the topic, to examine for two minutes. When the picture was removed, the student was asked to tell the story contained in the picture, including as many pictured details as possible. Subsequently, two questions from each category of TE, TI, and SI were printed on a worksheet; these were answered in written form by the student.

The pictures, representing diverse topics that were unrelated to previously-read stories, were randomly assigned to one of two presentation sequences. Each student was then randomly assigned to one of the presentation sequences. All story retells during all experimental conditions were tape recorded for later transcription, coding, and analysis.

Teacher assisted intervention condition (B). Each three-lesson sequence was carried out during 40-minute periods on three consecutive days. The first session represented an assessment of comprehension ability and is referred to as the pre-picture session. Two PK questions about a topic were asked by the teacher and answered orally by the student. Then the student read (by self-preference, the first student orally, the second student silently) the first half of a story about that topic; the teacher corrected decoding errors where necessary. After the reading, the passage was removed, and the student retold the story. Two TE, two TI, and two SI questions were printed on a worksheet; the student answered each one orally, and then wrote the responses on the worksheet. No corrections were made by the teacher to any incorrect written response given by the student in session one of any experimental condition.

The second session represented schema building and was known as the picture session. A mounted colored picture, illustrating a complex view of the same topic as the story, was shown to the student; no PK questions were asked. The teacher and student discussed the content of the picture in terms of details, information about the topic and subtopics, cause and effect,

implications, and so on. An example of the format is given in Appendix A. With the picture removed, the student then gave a detailed account of the picture's contents. Two TE, two TI, and two SI questions were printed on a worksheet, for written response by the student. Incorrect responses were discussed orally, and the corrections explained by the teacher.

In the schema activation (third) session (post-picture), the student read orally the second half of the story begun in the first session, following the same procedures described for reading the first half of the story. An exception was that teacher feedback was provided for incorrect responses.

Student independent condition (C). When stability at or above criterion level of 67% correct responses to the six questions was reached by a student for two consecutive three-day sequences during the introductory intervention conditions (phase B), a second intervention phase (C) was instituted. Sessions one and three were conducted in the order described in phase B, except that both students read silently, and oral responses were omitted.

In the second session, the students were given a two-minute period to study the picture, before writing responses to the six questions. No teacher feedback was given for incorrect responses; as in phase B, no PK questions were asked.

Maintenance conditions (Mn). When a criterion level of 67% correct responses to the TE, TI, and SI questions was reached by the student for two consecutive sequences (six days) in phase C, all intervention procedures were stopped. Baseline (phase A)

procedures were again followed, to assess the degree of maintenance of comprehension, assessing the effects of using either pictures or stories as stimuli. The first maintenance phase (Mn1) was supervised by the classroom teacher within the students' special education classes. The second maintenance phase (Mn2) was conducted by the principal investigator, under phase A conditions.

Dependent Variables

The primary dependent variables were the percentage of correct responses to the daily comprehension questions (TE, TI, and SI, both separately and collectively), which were asked after each story had been read or picture studied. Performance on each of the categories of questions was analyzed for each of the experimental conditions (baseline, interventions, and maintenance) and across sessions (pre-picture, picture, and post-picture).

The fourth dependent variable was the percentage of correct responses to the prior knowledge (PK) questions asked before each picture was read during baseline and maintenance and before each story segment was read during all phases. Performance was analyzed on each of the experimental conditions.

The fifth dependent variable was a measure of the length of story retells. Each retell was measured with regard to number of clauses; a clause was defined as a group of words containing a verb or verb form.

The sixth through ninth dependent variables were performance on standardized tests of reading comprehension and vocabulary.

On the two days before baseline was instituted, the teacher administered the reading comprehension and the vocabulary subtests of the Iowa Tests of Basic Skills (ITBS; Hieronymus, Lindquist, & Hoover, 1979), and the Nelson Reading Skills Test (NRST; Hanna, Schell, & Schreiner, 1977). On the two days following the last day of maintenance phase, alternate forms of the same subtests were administered. Grade equivalents were calculated for the raw scores of both students.

The tenth dependent variable was performance on a general knowledge test. Prior to baseline conditions, the teacher administered the General Information subtest of the Peabody Individual Achievement Test (PIAT; Dunn & Markwardt, 1970). After maintenance conditions were completed, the test was readministered. Grade equivalents were calculated for the raw scores of both students.

Generalization. Generalization probes were taken during each of the baseline, intervention, and maintenance phases for all students. Each time, the student read orally a new story from the basal reader used in the classroom reading program. The first student read from the eighth-grade Scott Foresman reader (Aaron, Jackson, Riggs, Smith, & Tierney, 1981); the second student read from the third-grade Science Research Associates reading skill book (Engelmann, Meyers, Johnson, & Carnine, 1976). Before reading, the student responded to two PK stories about the story topic. After reading, the student responded to two TE, two TI, and two SI questions about the story

content. One month after the end of maintenance phase for each student, an additional generalization probe was taken.

Recording and Reliability Procedures

The principal investigator plotted all PK, TE, TI, and SI data on multi-band charts, transcribed the retells, and scored all test protocols. An independent observer checked all resultant data; in addition, she checked the standardized test data. She also independently coded 20% of the experimenter-designed questions, to ensure that they were accurately categorized as PK, TE, TI, or SI, and that the responses were accurately scored. Only 4 out of 360 items were discrepantly classified, representing a percentage reliability of 98.89%.

Results

Correct Responses to Comprehension Questions

The data for total correct comprehension responses by each student are displayed graphically in Figure 1. The mean response data for individual question type and total comprehension are displayed in Table 1.

Insert Figure 1 and Table 1 about here.

Pictures. In the first intervention (B), the first student's responses gradually rose to 100% by the fifth session, while the second student achieved 100% responses in the first session, falling below that rate only once in seven sessions. In the second intervention (C), the first student achieved a 100% response in 2 out of 3 sessions, while the second student

responded 100% correctly throughout the three sequences of this phase.

In the first maintenance phase (Mn1), the first student achieved 67% criterion during two sessions, but fell to 16.67% during a third. The second student responded above the 67% criterion twice and below criterion twice. Mean responses for both students were well above baseline, but considerably below levels of the intervention phases. In the second maintenance phase (Mn2), both students showed strong maintenance; the first student's reponses rose to the mean achieved in the second intervention condition, while the second student's mean responses fell only slightly from the 100% level he had achieved.

Stories. Data from the stories were divided into two parts during the intervention phases, to illustrate the performance contrast between the pre-picture and post-picture reading sessions in each three-day sequence. The contrast between pre-picture and post-picture reading sessions is evident from the visual display in Figure 1. The first student's comprehension showed improvement within every sequence in the first intervention condition, until both sessions were equal and high in the seventh sequence. In the second intervention condition, only the first sequence showed a comprehension decrease between pre- and post-picture sessions.

Except for two "bad mood" sessions, the second student showed immediate and dramatic increases in comprehension between pre- and post-picture sessions in intervention B. As general

comprehension above criterion increased, the vertical gap between data points closed.

In the first maintenance condition, only the second student was given the story assignments by his classroom teacher, as the first student has difficulty completing tasks independently. The student's comprehension was above criterion for 3 out of 4 stories. In the second maintenance condition, both students responded consistently above criterion level.

Questions. Between baseline and the second maintenance phase, both students made gains of 39 to 66% in the three categories of questions about stories and 54 to 81% about pictures. However, the first student barely maintained criterion level for SI questions about stories and just above criterion level for TI questions about stories. His lowest mean score for pictures was also in the SI questions. The second student maintained well on all categories of questions, although his lowest means (83.33%) were also in TI and SI questions about stories.

Correct Responses to Prior Knowledge Questions

The data for both students are displayed graphically in Figure 2 and in tabular form in Table 2. Both students improved responses to prior knowledge questions. These data are displayed graphically in Figure 2 and in tabular form in Table 2.

Insert Figure 2 and Table 2 about here.

Pictures. In order to ascertain prior knowledge about the topic of each picture, two questions were answered orally before the picture was presented during baseline and maintenance phases. Both students displayed variable responses with 0% comprehension 2 out of 4 days. The first student showed variable, but considerably higher, levels of comprehension during the maintenance phases. The second student developed to a level of perfect comprehension by the maintenance phases.

Before each story during baseline and maintenance, and before each story segment during the intervention conditions, two PK questions were answered orally by each student. Again, both students showed considerable gain from baseline to maintenance phases, although the first student failed to maintain the improvement in the last maintenance phase. Taking the average of both pre-story and pre-picture conditions overall, the first student showed an increase of 38.54% in PK questions answered correctly, while the second student showed an increase of 46.88%.

Retells of Stories and Pictures

The only consistent pattern in retell length was that retells for pictures were substantially shorter than those for stories throughout the study. The first student's retells ranged between 1 and 22 clauses for pictures and between 6 and 31 stories. The second student's retells ranged between 1 and 29 clauses for pictures and between 4 and 55 for stories.

Standardized Tests

Both students made substantial gains on at least one of the reading comprehension tests and at least one of the vocabulary tests. The data are summarized in Table 3.

Insert Table 3 about here.

All gain scores, except the first student's NRST Reading Comprehension score and the second student's Stanford Auditory Vocabulary score, were well above the level that would have been expected after two months of instruction.

General Knowledge

Both students made gains in general knowledge, as measured by the Peabody Individual Achievement Test. The data are displayed in Table 3.

Generalization Measures

Generalization data were gathered in each phase of the study, and are summarized in Table 3. Both students increased (to acceptable levels) their comprehension of material from the readers used in their classrooms.

Discussion

It seems reasonable to conclude that the intervention succeeded in improving the reading comprehension of two special education students. More specifically, teaching the students to examine details and interpret relationships inherent in topic-related pictures improved their ability to answer questions about

explicit and implicit information relevant to both pictures and stories.

Although it may be argued that individual teacher attention was the variable that accounted for the improvement, three features of the study's design tend to reduce the chance of such an effect. First, the baseline conditions established that no gradually improving trend was evident, regardless of baseline length; thus untutored experience with either pictures or stories did not succeed in systematic learning. Second, the pre-picture story segments formed a type of secondary baseline, which remained low and stable well into intervention for both students, before an effect began to appear. Third, the occurrence of repeated drops, from post-picture session of one sequence to pre-picture session of the next, suggests that any learning that took place in one sequence did not generalize to the next.

As an additional check on whether or not improvement was due to maturation, two control measures were used in this study: measures of oral reading accuracy (percentage) and rate (correct words per minute; cwpm) were taken daily. Accuracy and rate responses remained high and stable throughout the study.

Both students became proficient at answering questions based on information explicitly in the text or picture (TE). However, their performance for TI questions about stories was variable, even during teacher-assisted intervention sessions. This shows a general lack of improvement on questions that required synthesizing two or more details in the text. While Figure 1 shows that there was almost always improvement in the post-

picture sessions, the first student rarely answered the TI questions at the 100% accuracy level after reading text. In contrast, the second student scored below 100% only once in the last six intervention sessions. Similar patterns were evident in SI questions about stories, which required integrating personal prior knowledge with textual information.

The second student's higher performance in both TI and SI categories may suggest that intelligence plays an important part in a person's ability to synthesize and integrate information. However, the fact that both students did improve indicates that such skills can be taught through pictures. This relationship suggests that pictures and text have a common thread: both represent stimuli that permit the drawing of inferences; each is a blueprint for meaning, waiting to be fully constructed. An implication is that the concentration of effort should be on teaching students to draw inferences from pictures.

In the last two sequences of the second intervention condition, both students achieved excellent comprehension. This indicates that they were able to extract implicit and explicit information from the picture and synthesize it for the purpose of responding to the questions. It also indicates that what they learned from the picture was helpful to their comprehension of the story. This process follows the principle of schema building and activation. In the picture condition of the first intervention, the teacher modeled the process of asking numerous questions during a detailed and systematic examination of each picture. The questions always dealt with time, location, human

involvement, motives, important features, speculations, and so on. Thus, the students learned to build their background knowledge during the picture session and activate it during the post-picture story session. This was particularly evident in the case of the second student, who had very high percentage of correct prior knowledge responses from the fifth sequence on. In other words, the practice of searching out his prior knowledge may have stimulated schemata that he saw as relevant, thus making them more accessible in the reading comprehension process.

The same cannot be said for the first student, whose store of knowledge was much more limited; this may indicate a threshold effect--an individual must have some measure of knowledge to which to tie new information. Despite this possibility, however, his comprehension improved and remained above criterion level in one-to-one instruction, and his vicarious experiences through pictures appeared to help him overall.

The comprehension of both students declined in the first maintenance condition. During this time, the students were given their assignments in their regular classroom programs and received the type and amount of supervision that their teachers would normally give in a multi-student classroom. The first student completed only the picture assignments; his teacher had previously commented that he habitually had difficulty in working independently. This observation was reinforced when the second maintenance condition again placed him in an individual attention

situation; his comprehension improved and was maintained above criterion level.

The second student completed all his assignments in a classroom in which behavior problems were the norm; the activities within the classroom frequently distracted his attention from his work. However, when the second maintenance condition was instituted, his comprehension of both pictures and stories stabilized at a level above 83% correct.

Carnine and Silbert (1979) have noted that a majority of learning-disabled students experience difficulty in reading. In addition, the distractibility of learning-disabled students has been documented in many studies. Lloyd, Hallahan, and Kauffman (1980) have concluded that students with learning disabilities frequently have difficulties in ignoring extraneous stimuli and in concentrating their attention on a specific task. If such be the case for the students in this study, it adequately accounts for their performance decline during the first maintenance phase. However, it is quite possible that, had the other students in the classroom been engaged in the same task, the results for each student might have been more positive, since the distractibility factor would have been minimized.

What evidence is there to show that comprehending concepts present in a picture translates into comprehension of related concepts in a reading passage? Such a possibility is graphically demonstrated in the sequence of low comprehension of the first part of the passage, followed by high comprehension of the picture, followed by an increase in reading comprehension of

the second part of the passage. This pattern is the dominant and striking feature of the data. The phenomenon could be explained by the cumulative effect of the progression of the story itself, were it not for the fact that initial comprehension of similar complete stories during baseline was low. It might also be explained by the presence of considerable teacher input in the intervening (picture) session between story segments; however, during intervention C there was no teacher input, yet the comprehension rose and stabilized at a high rate for both students.

Another factor might have to do with a contrast between this strategy and traditional remedial reading instructional methods. When middle school-aged students have severe deficits in reading, they are typically taught specific subskills of reading comprehension (e.g., main idea, cause-effect) in the context of print materials that are very simple in syntax and semantics. However, it is often very difficult for them to generalize their discretely-gained skills to the more complex structures of grade-level classroom textbooks. In addition, the remedial instructional materials often contain short passages with limited explicit information and very little that trains the student to draw complex inferences.

Therein lies a strength of pictures: They contain large overarching visual statements, many details that must be actively sought, subtopics which may be interrelated, clues about past events, implications for future action, human motives, and many other concepts that can be extracted. Teaching students how to

look carefully at the concepts represented in pictures gives them practice in the higher level comprehension skills that they previously have been unable to understand in print form. In short, middle school students, with their wealth of world knowledge, can be taught to use that knowledge to comprehend concepts present in a printed passage, by using a relevant picture.

Current instructional practices tend to reserve the use of pictures for reading readiness and primary grade activities. In their meta-analysis of studies that used pictures as adjunct aids, Readence and Moore (1981) found that the ability to extract information from pictures appears to increase with age; i.e., middle school-aged students use pictures to greater advantage than elementary school-aged students, and college students make use of pictures to a greater extent than younger students. Such findings imply that teaching through pictures has benefits for older students, perhaps because their prior knowledge is more extensive than that of younger students. Further research is needed to investigate the effects of teaching specific skills to older students through the use of pictures.

The effectiveness of the picture strategy may lie in the ability of a complex picture to represent functional relationships among its constituents. This property has been demonstrated by Arnold and Brooks (1976) and Carr et al. (1977) to aid recall. Perhaps, as Spiro and Myers (1984) suggest, pictorial representation of a gestalt enables schema instantiation via the visual-perceptual system; perhaps the

process of recall of the gestalt facilitates a transfer from the visual-perceptual to the verbal system.

Possibly imagery was important in accounting for the improvement of comprehension, particularly of the pictures themselves. During a debriefing session at the end of the study, each student was asked how he remembered what was in the picture. The first student responded that he did not know; the second student stated that he tried to picture it in his mind and remember things about it that were not obvious. For example, having been taught how to estimate time or compass direction in a picture by examining sun, shadows, location of mountains, he tried to take special note of such details. Levin et al. (1974) concluded that there are high imagers and low imagers (and perhaps "non-imagers," as Tierney and Cunningham (1984) have speculated), and that high imagers who deliberately image tend to have higher reading comprehension than low imagers. If true, their conclusions would help to explain why the second student improved his comprehension of both text and pictures to a greater extent than the first student.

Alternatively, perhaps a picture strategy is more beneficial to high imagers than to low imagers. Levin and his colleagues found that low imagers who were instructed to image had lower comprehension of a text than low imagers who did not attempt to image. Thus a strategy that places high emphasis on remembering the features of a picture may effectively signal an "instruction to image," with deleterious results for comprehension of low imagers. The possibility merits further study.

There are several distinctions between previous research and the present study. First, in much of the literature about illustrations in reading research, illustrations have been used in conjunction with isolated words or word lists with beginning readers or poor decoders. The present study deliberately selected students who were good decoders, and required them to read long narrative or expository passages. Therefore, word recognition was not an issue.

Second, most of the studies of longer text addressed the effects of illustrations on reading comprehension merely by their presence or absence. In most cases, students were not instructed to study the illustrations (Readence & Moore, 1981). The present study deliberately introduced illustrative material as the primary instructional vehicle, for the purpose of extracting as much information as possible. The strategy conformed to Levie and Lentz's (1982) conclusion that effective use of illustrations probably requires instruction.

Finally, most of the studies used elementary school-aged subjects, the majority of whom were beginning readers. The present study deliberately used middle school-aged students with learning handicaps, to capitalize on their broader range of prior knowledge.

One artifact from the study suggests implications for research into other visual media: The ability of both students to extract information and draw inferences from pictures increased over time. Perhaps an extension could be made from

still pictures to moving pictures such as television, to encourage children to see more than the passing images.

One potent explanation for the results of this study will go unchallenged: the possibility of a Hawthorne effect. That the pictures were attractive and the sessions motivating was constantly affirmed by the students, who would exclaim as they arrived for that session, "Oh, boy! Picture day!" Perhaps that enthusiasm carried over to the final day of each sequence, then waned on the first day of the next sequence. Such evidence is present in the data, but only to the point when the pre-picture sessions rose near the level of the post-picture sessions. Then, the presence of the picture sessions had little influence on subsequent reading comprehension, perhaps because of a ceiling effect. One might suggest, then, that the transfer from conceptual learning from pictures to conceptual learning from print was complete; however, such an assertion cannot be reasonably inferred from these data.

To summarize, the results of this study have supported the hypothesis that building and activating schemata through intensive study of topic-related pictures can have a strong positive effect upon reading comprehension of poor comprehenders. Although possible reasons for its success have been suggested, a primary task for interested researchers is to ascertain the critical features of the current intervention that contribute to reading comprehension. This investigator has speculated that these have to do with reader-related variables, such as task focus, schema adequacy and accessibility, and ability to

integrate and synthesize information; and picture-related variables, such as imageability and gestalt features. The issue may be less which elements are integral and more how much of each element is essential.

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Table 1

Mean Percentage Correct Comprehension

First Student

TE	Phase A	B	C	Mn 1	Mn 2	Gain
Pre-Picture	33.33*	71.43	100.00	--	100.00*	66.67
Pictures	18.75	100.00	91.67	16.67	100.00	81.25
Post-Picture	33.33*	78.57	91.67	--	100.00*	66.67
Pre-Post Contrast		+7.14	-8.33			
TI						
Pre-Picture	25.00	35.71	75.00	--	75.00*	50.00
Pictures	31.25	82.14	100.00	66.67	91.67	60.42
Post-Picture	25.00*	71.43	83.33	--	75.00*	50.00
Pre-Post Contrast		+35.72	+8.33			
SI						
Pre-Picture	25.00*	50.00	91.67	--	66.67*	41.67
Pictures	12.50	78.57	75.00	83.33	75.00	62.50
Post-Picture	25.00*	64.29	83.33	--	66.67*	41.67
Pre-Post Contrast		+14.29	-8.34			
Total						
Pre-Picture	27.78*	52.38	88.89	--	80.05*	52.27
Pictures	20.83	86.90	88.89	55.56	88.89	68.06
Post-Picture	27.78*	71.43	86.11	--	80.05*	52.27
Pre-Post Contrast		+19.05	-2.78			

Table 1 (Continued)

Second Student

TE	Phase A	B	C	Mn 1	Mn 2	Gain
Pre-Picture	37.50*	71.43	66.67	75.00*	100.00*	62.50
Pictures	37.50	100.00	100.00	62.50	91.67	54.17
Post-Picture	37.50*	60.71	100.00	75.00*	100.00*	62.50
Pre-Post Contrast		-10.72	+33.33			
TI						
Pre-Picture	43.75*	46.43	58.33	68.75*	83.33*	39.58
Pictures	37.50	100.00	100.00	62.50	91.67	54.17
Post-Picture	43.75*	78.57	91.67	68.75*	83.33*	39.58
Pre-Post Contrast		+32.14	+33.34			
SI						
Pre-Picture	37.50*	39.29	66.67	87.50*	83.33*	45.83
Pictures	43.75	96.43	100.00	93.75	100.00	56.25
Post-Picture	37.50*	85.71	91.67	87.50*	83.33*	45.83
Pre-Post Contrast		+46.42	+25.00			
Total						
Pre-Picture	39.58*	52.38	61.11	79.17*	88.89*	49.31
Pictures	39.50	96.43	100.00	72.92	94.44	54.94
Post-Picture	39.58*	75.00	94.44	79.17*	88.89*	49.31
Pre-Post Contrast		+22.62	+33.33			

Table 2

Prior Knowledge - Mean Percentage Responses

	Phase A	B	C	Mn 1	Mn 2	Gain
First Student						
Pre-Picture	25.00*	28.57	91.67	--	66.67*	41.67
Pictures	31.25	--	--	75.00	58.33	27.08
Post-Picture	25.00*	57.14	58.33	--	66.67*	41.67
Pre-Post Contrast		+28.57	-33.34			
Overall total net gain:		+38.54%				
Second Student						
Pre-Picture	68.75*	60.71	75.00	75.00*	100.00*	31.25
Pictures	25.00	--	--	100.00	100.00	75.00
Post-Picture	68.75*	82.14	83.33	75.00*	100.00	31.25
Pre-Post Contrast		+21.43	+8.33			
Overall total net gain:		+46.88%				

*Complete story read

Table 3

Standardized Tests--Grade Equivalent Scores

	Pretest	Post-test	Change	Pretest	Post-test	Change
SDRT Vocab	3.6	5.7	+1.9	6.7	6.6	-0.1
NRST Vocab	1.2	3.1	+1.9	3.5	5.6	+2.1
NRST Comp	3.3	3.4	+0.1	4.6	5.5	+0.9
ITBS Comp	2.9	3.9	+1.0	4.6	8.2	+1.3
PIAT Gen Know	2.6	3.3	+0.7	4.3	5.6	+1.3

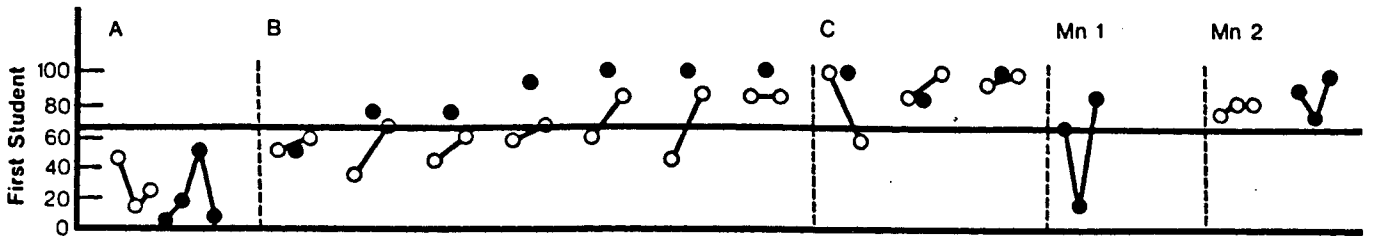
Generalization--Mean Percentage Comprehension

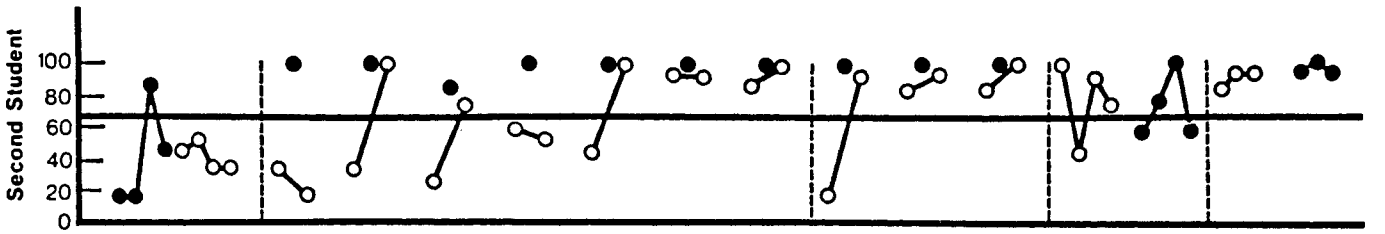
	Text	Phase A	B	C	Mn
First Student	SRA	33.33	46.83	66.67	79.17
Second Student	SF	41.67	62.50	75.00	87.50

Figure Captions

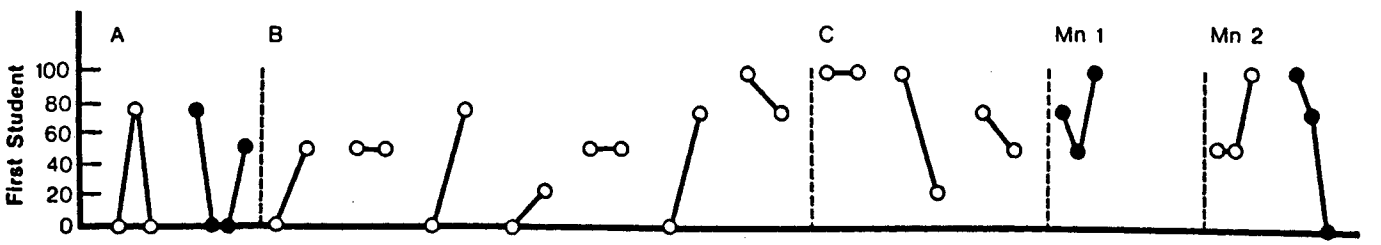
Figure 1: Total percentage of correct comprehension across phases.

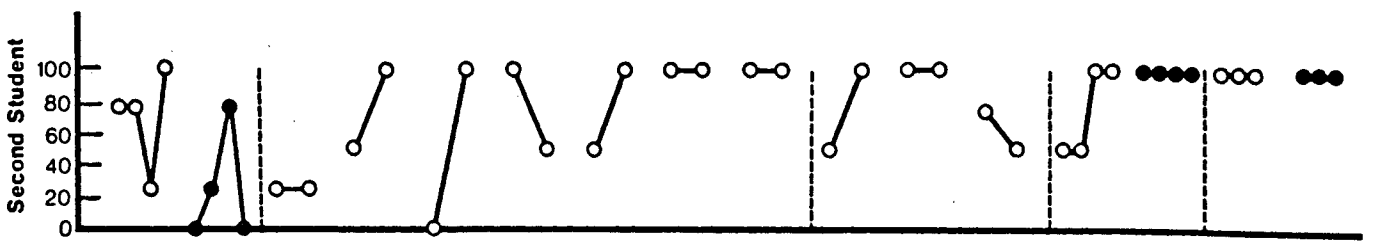
Figure 2: Percentage of prior knowledge questions answered correctly.





Key:
○ = Reading passages
● = Interpreting pictures





Key:
○ = Before passage segments
● = Before pictures

Appendix A

Sample Questions for Picture Study

Rocky Mountain Forest and Glacial Lake Scene

In what part of North American is this scene? What makes you think so?

What do you call this mountain range?

What time of year is it? How can you tell?

What direction is the sun coming from?

What time of day is it? How can you tell?

What direction is the photographer facing? What makes you think so?

What weather does this area have in summer? winter?

What do you call the thick snow and ice on the mountains?

What happens to the glaciers in spring and summer?

Do they melt completely? Why not?

What is the thin line in the middle of the picture?

Where did this lake come from?

What would happen if it were very warm all year round?

What's mixed up with the ice and snow on the underside of the glacier?

Where did the big rocks come from?

What is the light brown substance on the far shore of the lake?

What is the lake bottom made of?

Where did they come from?

As the glacier moves, what does it do to the ground beneath?

What kind of trees grow there?

What kind of soil is it? How do you know?

Why do you think there aren't any leafy trees?

What do leafy trees need that isn't there?

What animals might you see there?

Why aren't there any houses?

What does a national park protect?

What would happen if this stopped being a national park?

What do you think would happen if someone bought this land?