A STUDY OF THE EFFECTIVENESS OF PICTORIAL ILLUSTRATIONS ON RECALLING FROM TEXTUAL AND ORAL PROSE

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ABSTRACT

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Black and white, shaded pictorial illustrations and the facilitative effect they may have on learning from textual and oral prose was investigated to determine if they promote long-term recall. The difference between pictorially-augmented and non pictorially-augmented paragraphs was also examined to see how illustrations interact with two types of verbal information. Subjects of the study were 80 undergraduates enrolled in introductory biology. They were randomly assigned to four groups: print alone, print plus picture, audio alone, and audio plus picture. Subjects were asked to complete the Nelson-Denny Reading Test, and to participate in the prose learning task in one of the four groups. An immediate post-test was administered followed by a delayed test a week later.

Regression analysis indicated that reading ability is a significant predictor of subject's performance on the multiple-choice and free recall tests at both immediate and delayed tests. Thus, the Nelson-Denny Test was used as a covariate in the subsequent analyses. Repeated measures analysis of variance disclosed a significant main effect for testing time and a marginal three-way interaction of time, presentation mode and picture condition. A comparison of the mean scores of the picture item group and the no picture item group on the delayed multiple-choice test indicated that subjects in the picture item group diminished by a lesser percentage on picture items, compared with the subjects in the no picture item group. The difference in scores suggested that pictures provide support for both prose types.

ACKNOWLEDGMENTS

In more ways than one, a research study resembles a symphony. A symphony evolves from a composer's disciplined mind. He fashions an agreeable succession of tones, serving to express a musical idea. The conductor injects meaning into the work. Relegated to the background, the musicians also figure prominently in the rendition of the musical composition. Each one plays a part. The cellists, the flutists, the harpists, the pianists, the clarinetists, and the drummers all contribute toward the elaborate instrumental work. The absence of one of these blemishes the desired effect.

The preparation of a thesis is also a cooperative venture, conceived by one, yet dependent on the efforts of others. I thank my thesis adviser Dr. Bob Bernard for being the able "composer" and "conductor." I am grateful to Lucy, my wife, to Aida, my sister, and to my parents for their encouragement and help. I acknowledge the assistance of Dr. Chris Petersen and Dr. Richard Schmid, whose comments and suggestions truly counted. I am grateful to Janice Picard and Mohamed Ally for their invaluable support, and to Concordia University for funding the study. To my other sisters and brothers, salamat din sa inyong tulong. These people are the kind "musicians" whose contributions led to the completion of this study.

DEDICATION

Para sa bunso ko'ng kapatid na si Josie...

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CHAPTER I

INTRODUCTION

A great deal of the formal knowledge that a person accumulates in his lifetime is acquired from reading or listening to verbal information (Ebel, 1965; Meyer, 1977). For this reason, finding optimal strategies through which to present classroom and individualized instruction continues to challenge educators involved in the design of instructional materials. This concern runs parallel to many a school's principal educational goal, which is to help students develop the effective ability to acquire information from their reading and listening. Because the visual and auditory (reading and listening) modes of information presentation are still prevalent forms of communication in the classroom (Gagne & Briggs, 1974) the search for preferred strategies continues to be a focus of research in instructional technology.

Before the middle part of the fifties, which marked the acceptance of what is now called audiovisual instruction as a regular and legitimate part of classroom instruction, it was common practice to present the material to students either in the visual format (i.e. in print form) or in an aural mode (i.e. in lecture form). The introduction and use of audiovisuals - pictures, films, audiotapes, slides, etc. - into the educational milieu resulted in the diversification of the modes of instructional presentation. It also brought about differing arguments among educators on the possibilities

of incorporating these media into the educational situation.

One of the major questions of interest to instructional designers and educational media researchers concerns the representation of information in various symbolic forms and its interaction with the modes of transmission previously mentioned (Salomon, 1979).

Two Forms of Symbolic Representation

Levie (1978) makes a clear distinction between two forms of symbolic representation (see Figure 1). Levie uses the terms digital and iconic to describe the categories of symbols which include words (verbal information) and pictures, respectively. Hereafter, the latter term will be used. Digital representation or digital symbol systems are those which contain individual elements which are arbitrarily conceived referents for realistic experience. Language falls into this category because words and the linguistic structures which bind them together (i.e. syntax) are agreed upon by convention and are thereby not isomorphically related to realistic experience. For this reason, a person must learn oral language first, with skilled reading usually requiring many years of formal instruction and practice. On the other hand, iconic signs are so designated because of their structural isomorphism with realistic experience. A picture, as an example, depicts what it represents. Therefore, for a person who has experience with the referent, pictures provide information in a form which is easier to assimilate than its verbal counterparts.

Verbal and pictorial communications are also different in terms of the way in which they convey information. According to Salomon (1979) verbal information describes what it represents, thereby pointing explicitly to the important features of the referent (Referent here

		SYMBOLIC MODALITIES		
		Digital Signs	Iconic Signs	Nonsign Stimuli
SENSORY MODALITIES	Visual	Printed words Numbers Semaphore, etc.	Pictures Statues Gesture, etc.	Natural Objects Man-made non-sign stimuli
	Auditory	Spoken Words Morse code Alarms, etc.	Sound effects Onomato-poeia Music (?)	Naturally occurring and man-made noise

Figure 1. Symbolic and Sensory modalities

Note. From "A Prospectus for Instructional Research on Visual Literacy" by W.H. Levie, ECTJ, 1978, 26, 25-36.

means anything which is being represented, not just a physical thing). Pictures, on the other hand, depict what they represent. In doing so they provide less information as to the specific and important features of the referent.

Verbal and Pictorial Information Forms

There are, of course, exceptions to this (e.g. a caricature which dramatizes important elements through exaggeration), but generally speaking, pictures leave interpretation and the extraction of meaning to the perceiver. From this analysis, it is not difficult to see why verbal and pictorial information forms are conceived by many to be a perfect complement to one another. The verbal form, through description, specifies pertinent elements in the content to be discriminated, while pictures provide a range of possible discriminations which may be easily assimilated. In instructional pictures (i.e. illustrations and diagrams) the specificity may be further enhanced by the use of verbal labels, arrows and other cuing devices.

As previously mentioned, verbal information can exist in two presentational forms; as print, which is perceived visually, and as spoken words which are perceived auditorily. There are differences in the way information received through these channels is perceived and processed (Hochberg, 1978). From an instructional point of view, the major difference appears to relate to the fixed nature of auditory perception and the variable nature of visual perception (Fleming & Levie, 1978).

In the case of many lectures, and most audiovisual treatments, aurally presented verbal information flows at a rate which is independent of the learner. That is, the listener does not control the rate

of presentation. By contrast, visually presented verbal information (i.e. textbooks) can be processed. The difference in learner control may partially account for the general sentiment that the lecture method is an ineffective means of transmitting information (Corey, 1934; Ross, Note 1).

The use of pictures and other visually presented iconic information during lectures has been suggested (Broadwell, 1980; Dwyer, 1968) as a way of producing increased learning and retention. In fact, this is the general sentiment underlying the use of audiovisual materials. Research tends to support this view. Levin and Lesgold (1978) report consistent learning and retention gains in studies with pictures where the prose information was presented aurally rather than visually. However, all of the studies cited by Levin and Lesgold used children as subjects who were presented with fictional narrative prose. As a result, the authors question whether these findings would generalize to adult subjects in instructional settings.

Similar agreement has not been reached regarding the use of pictures in textbooks and other instructional prose applications. Both Brody (1981) and Duchastel (1980) point to the lack of uniformity in terms of both purpose and findings in studies testing picture-textual variables. So many studies have reported such contradictory results that it is impossible to determine at this point in time whether pictures in textbooks enhance the learning process at all. A possible reason for this is that the typical study has tended to treat the text and the pictures as wholes, with little regard for the interaction of information within the text as the learner proceeds through it. For both design and theoretical purposes, it would be important to know how placing a picture in a particular place effects the verbal

information surrounding it. Duchastel (1981) performed an interesting study which represents a step toward this goal, but the findings were generally inconclusive. A similar methodology applied to aural presentation with and without pictures might shed light upon the discrepancies which seem so apparent in the literature.

In summary, an examination of related investigation discloses that there have been few serious attempts to investigate the relationship between pictures and learning from instructional texts and lectures for adults. Furthermore, although many separate modality studies (i.e. textual and auditory) have been performed, only a few have addressed the two concurrently. Research on audio presentation has generally focused on the learning of children. The outcome of this state of affairs is that instructional designers for university students refer to techniques and materials extracted from studies conducted on younger learners. Research has also shown that children and adults process textual or pictorial information differently (e.g Brown & Smiley, 1978; Levin & Lesgold, 1978; Haile, Note 2), and that there is still inconclusive support for generalizing picture studies involving children to include adults. It is therefore necessary for those involved in instructional design to focus on the way adults learn from prose and pictures, and from verbal information and pictures.

Statement of the Problem

The present study was organized to compare the differential performance of adult learners from two presentation modes, textual and auditory, both with and without pictorial accompaniments. Another major purpose of the study was to attempt to determine the relative effects of pictures on pictured and non-pictured segments of the prose

passage. Since it is unusual for an entire passage to be illustrated, as in the case of a comic book, it is useful to know how the placement of a picture at a particular point effects the other non-pictured prose around it. In this respect, the current study represents an initial attempt to analyze the organization aspects of textual and auditorially presented prose.

CHAPTER II

Review of the Literature

Functions of Pictures in Prose

A number of earlier reviews of studies on illustrations (Brody, 1981; Duchastel, 1980) have pointed to the confusing array of issues which complicate this research area and make generalization among studies very difficult. Duchastel believes this confusion is, in part, due to the failure to determine clearly what function the picture is designed to perfom. He states that there are three general functions; motivational, explicative and retentional.

Pictures included in text for motivational purposes are supposed to generate an interest in reading the text in the learner. Usually they are of a general nature (i.e. not related to specific textual elements), are relatively realistic, and are intended to present a striking contrast to the printed page. Often cartoons are used to spur interest in the prose materials. This function might also include images in written prose used to break up the visual monotony of the printed page.

Reiterative images are those used because they explain a concept or relationship pictorially which is difficult to explain verbally. Holliday (1976) found that the water cycle was best presented in pictorial form because the concepts had a decidedly spatial element to them. The prose decription of the same information was long and laborious.

Retentional images are included in prose material to make the prose more memorable. Presumably, if one can recall the picture, then

there is a better chance of recalling the constellation of prose associated with it. The next section in this review deals with types of retentional images in a deeper way.

In another effort to define the functional relationship of pictures used in textual material, Levin (Note 3) proposed a similar grouping of eight functions. To date, the categories remain hypothetical because little research has been done to warrant final statements about the additive and interactive effects. Four of the proposed hypothetical functions of pictures and prose constitute a more serious attempt to determine the instructional effectiveness of pictures and illustrations. They are the representation, organization, interpretation and the transformation functions. Levin, however, notes that a picture's function may not be easily classified according to certain categories. Instead, he chooses the view that it is the many aspects of the pictures that make for improved prose learning.

The current study was designed to test the retentional function of picture prose combinations in two transmission modes; written and auditory. According to Duchastel (1978) a retentional illustration should not present unique information, as is the case with an explicative image, but should in some way represent the semantic structure of the prose in pictorial terms.

The literature on textual (written) prose with pictures provides evidence of two distinctly different retentional strategies. The first is referred to as the contextual image strategy. The second is called the reiterative image strategy. Both are discussed in the next section.

Pictures and Written Prose

Contextual Retentional Pictures. There is some documentation

that pictures employed as organizational adjunct aids may supply the learner with a framework within which to understand written prose (Ausubel, 1963; Ruch & Levin, 1977). This interpretation is closely related to schema theory (Bartlett, 1932), which holds that the central meaning of a passage is stored in schematic form and that recall is achieved by a process of reconstruction on which rest the "basic building blocks of the human information system "(p. 111). This system is theorized to be a prerequisite to understanding verbal information, since comprehension depends on a reader's activation of a schema, or conceptual framework, to make the referents of the passage comprehensible (Reder, 1980). Thus Rumelhart and Ortony (1977) pointed out that a passage can be understood by "settling upon a configuration of schemata and their variable bindings, which appear to account for as aspects of it" (p. 115). The comprehension process creates a natural side effect, called memory, or the interpretation that was given to the input (passage read) as a result of the comprehension process (Rumelhart et. al., 1977). Bransford and Johnson, (1972) and Bransford and McCarrel (1975) reported that subjects provided with a picture or title in advance displayed superior comprehension of a textual passage they were asked to read. Minus the picture or the title, the passages were considered abstract and difficult to remember. Subjects failed to make the pertinent conceptual structure work, within which to embed new information. Consequently, the subjects did not grasp the passage content. It is notable that in the Bransford and Johnson study both picture conditions functioned differently. Samples supplied with appropriate information before they heard the passage, demonstrated increased comprehension ratings and recall scores as compared with subjects who received the same information subsequent to the passage.

The finding of this study suggests that difficult-to-understand passages containing few schema activating adjuncts were made more comprehensible and thus, more memorable by the addition of a picture placed before the passage.

Another study by Bernard, Petersen and Ally (1981) produced similar results. It was found that an image which provided an indication of the context of specific passage referents effectively enduced better long-term memory than a passage alone. However, neither of these situations represents the normal utilization of pictures in prose. Usually the passage contains sufficient referents to activate the learner's schema and provides the necessary context for the detailed information as well. More commonly, pictures serve as adjuncts to the prose information by providing a depiction of that which is verbally decribed. This type of retentional picture is dealt with next.

Reiterative Retentional Pictures. A number of attempts have been made to show that illustrations that are redundant with the prose content can have a facilitative retentional effect. However, it is much less clear why images of this sort are likely to have a retentive effect. The major difference between reiterative and contextual images is that in the former case the entire passage content is subsumed under a higher order or conceptual structure, while in the latter case selected bits of information are treated separately. Several studies have demonstrated the effectiveness of the reiterative strategy while several have failed to find differences. The positive results will be reported first.

Denburg (1976-77) tested the conception of a carefully chosen picture as a means of increasing the amount of information a learner

can use in identifying a new word. To examine this interpretation of picture use, she investigated the effect of increasing the amount of pictorial (line drawing) information on the word identification and word learning of first graders, as well as the nature of the interaction between the pictorial information and the operations associated with the reading task. The independent variable that was manipulated was the amount of pictorial information accompanying a simple declarative sentence. It had four levels: no picture, full picture, partial picture accompanied by a sentence, and full picture accompanied by a sentence. The findings of the study disclosed that the use of pictorial information is compatible with the operations involved in reading and, hence, helps bring about word identification and word learning. Thus the study indicated that the presence of pictures seems to encourage the subjects "to integrate their available graphemic skills with the available contextual information" (p. 187). For the present study this finding implies that reading and examining pictorial illustrations are two complimentary activities; and that if carefully designed, the picture-prose combination should produce a superior learning effect.

Haring and Fry (1979) wanted to find out if the level of pictorial detail is related to the level of verbal detail recalled from the prose. Haring and Fry asked fourth and sixth graders to read a 360-word written narrative and to examine simple pen and ink drawings. The dependent measures were free recall of the number of idea units in two levels of the story's content structure. The other variables were grades of subjects, picture details, and time of recall. The study reported that pictures do indeed help facilitate immediate and delayed recall of main ideas of written text, but that pictorial detail seems to make little difference. Additionally, there was no interaction

between grade level and time of recall (immediate or delayed) suggesting that children in these two treatments use illustrations in essentially the same way as an aid to story recall. The implication here is that while line drawings can have a facilitative effect on comprehension and recall of information by younger subjects, they may not necessarily be helpful to adult subjects. Although some studies have demonstrated the facilitative effect of pictures on learning, there are some that have not. Vernon (1953) performed a study to ascertain if pictures help or hinder the acquisition of information from text, and if pictures increase interest in the text. The first in a series of two experiments had 16 to 18-year-old boys and girls, assigned in two groups to study their respective versions of a short article of 700-800 words. Subjects were required to recall orally what was said in the passage. Subjects were also asked whether the picture seemed to make any difference. Findings indicated that the version with pictorial support was remembered no better than the non-illustrated one.

Duchastel (1981) hypothesized that an illustrated text will be better remembered than the same text without pictorial support. To test this, he developed a 1700-word passage divided into 12 topical paragraphs. The subjects were 15-year-old students who were asked to read the passage. Only six of the 12 paragraphs were assigned illustration, so that illustrations were found alternately in every other paragraph. Four treatment groups were included in the study. Two groups received an illustrated version of the passage; and the other two, a non-illustrated version. One of the groups with illustration, and one of the unillustrated groups took immediate recall tests. The other two took the recall test two weeks later.

An interesting element in the Duchastel study was his expectation that the pictures would help the subjects recall information only from the picture paragraphs and not from the other paragraphs. The findings of the study did not offer solid support for a retentional role for illustrations in text. However, it suggested an interesting methodology for exploring the relationship between pictured and non-pictured information.

Other studies have criticized pictures for interfering with children's learning how to read and, moreover, for not having any facilitative effect on reading. Samuels (1967) tested the hypothesis that when pictures and words are presented jointly, pictures tend to serve as a "distracting stimuli" and interfere with the acquisition of reading responses. In Experiment 1, 30 pre-first graders learned to read four words with no picture, a simple picture, or an elaborate picture present. During the acquisition trials, when pictures were present as cues for subjects in the picture group, the subjects in these conditions gave more correct responses than did subjects in the no picture group. On the critical test trials, however, when there were no picture cues, subjects in the no picture condition gave significantly more correct answers. Samuels forwarded the view that pictures caused subjects in the picture condition to use pictures rather than words as cues, suggesting that pictures drew the subjects' attention away from the printed words.

In summary, the literature on the use of reiterative pictures as aids to prose retention is far from conclusive. It appears that pictures can facilitate prose learning if they encourage the reader to interact with the verbal material to a greater extent. In this sense, reiterative pictures may perform in the same manner as inserted questions (Faw & Waller, 1976), cuing the learner as to the important

features within the text, and encouraging them to deal with it in greater depth.

Pictures in Oral Prose.

Taped narrations combined with pictures have been found to facilitate children's learning performance (Guttman, Levin & Pressley, 1977) and recall of orally presented passages by high school students, especially if the pictorial illustration of the verbal information was presented first (Bransford & Johnson, 1972). It has also been demonstrated that children (Lesgold, Levin, Shimron & Guttman, 1975) and adults (Clark, 1978) recall more details from an orally presented prose passage when the passage has been accompanied by pictures. Levin and Lesgold (1978) argue that pictures are most effective when used in conjunction with orally presented prose. This position receives support from studies that have reported positive effects for illustration.

Rohwer and Harris (1975) grouped their fourth-grade subjects into seven different treatment groups: Print only, picture only, oral only, print plus picture, print and oral, oral plus picture, and print plus picture plus oral. The learning material was a simple expository passage discussing the qualities of different types of monkeys and the illustrations showed each of the qualities discussed in the text. Comprehension was measured either by sentence verification or short answer question or free recall. An important finding was that the oral plus picture group performed significantly better than the oral plus print group. This replicated the findings of Rohwer and Matz (1975) who set out to test whether pictorial or printed augmentation affects performance in an activity necessitating the learning of orally presented prose. In the Rohwer and Matz study, fourth-grade children verified assertions related to the prose passages they had

heard. Within each sample an independent-groups design was employed to assess the effect of two presentation conditions under each of two conditions of testing. The oral versions of the passage were accompanied by either picture illustrations of text information or printed versions of the text. The study provided evidence that pictorial augmentation is more effective than print.

Finally, Levin, Bender and Lesgold (1976) selected first-grade children from two different communities and assigned them in equal numbers to four experimental conditions. Two single episode stories of 30-75 words were recorded on tape and presented in three different orders. For the picture condition, a colored picture depicting the events narrated in a sentence was presented together with the sentence as it was played. Four conditions were present in the study: In the Non-activity control condition, all three stories were played to the subject without interruption. In the Repetition condition the tape was stopped after each sentence and the subject was asked to repeat the sentence. The picture condition was produced in such a way that an appropriate picture was presented with each sentence as it was played twice consecutively before going on to the next sentence. The data from this study argued strongly in favor of a clear advantage of pictures over simple repetition. Levin et. al. (1976) speculated that the inclusion of pictures serves more than just a "second rehearsal" of the material to be learned. The functional components of the picture effect, then, involved more than just an increased quantity of what can also take place in a completely verbal situation.

At the same time, findings also exist that generally do not support the use of pictorial illustrations for orally presented information. Strang (1973) investigated the utility of several media

applications as self-instructional aids in a vocational school. The learners in this experiment were grade 11 and 12 boys with no prior knowledge of the topic to be learned. Subjects were randomly assigned to three groups: a print group that received pictorially oriented instructions plus a parallel printed explanation of what was going to be done, the oral group, whose learners received the textual units in oral form, and the print/oral group, where the members were allowed to use both print and/or oral modes to help them in acquiring the skill. Subjects in all groups were free to consult with an instructor standing nearby. Overall, under verbally augmented picture instructions, subjects needed only 20 percent of the instructor assistance needed with pictures only. The form of verbally-supported instruction that necessitated the least time and fewest episodes of instructor assistance was the print/oral group, which fared better than the oral, and then the print groups. Strang observes that the print/oral mode's instructive superiority can be seen as a function of its accommodation to the individual academic abilities of learners. This mode afforded good readers the chance to advance at a fast pace through the text augmented frames without having to listen to an orally presented passage.

In another study, Main and Griffiths (1977) classified their subjects into high and low reading ability groups, according to their vocabulary test scores, and assigned these adult subjects to four treatment conditions: control, print, print pictorial, and audio pictorial. The control group received only the 12 separate passages (learning material). All other groups received a supplementary presentation following completion of the learning activity. One treatment group received the print supplement, while another, the print/

pictorial supplement. A third experienced the audio/pictorial supplement. Total study time for each subject was recorded. Criterion tests were administered immediately after the subjects completed the instructional treatment. Findings showed that the print supplements required less study time than the print/pictorial or audio/pictorial supplements, but produced the same performance gains. This indicated an advantage for the print mode of presentation. Moreover, findings also indicated significant main effects for treatments and for verbal levels, with subjects in the high verbal group, requiring the shorter study time. When the performances of both groups were compared, a tendency for high verbal subjects to score higher with print supplements and for low verbal subjects to score higher with audio pictorial supplements was also noted.

Methodological Problems in Picture-Prose Research

Recently, two reviews have appeared (Brody, 1981; Duchastel, 1980) each of which point to methodological weaknesses in many of the picture-prose studies to date. Some relate to external validity of the procedures and methods utilized and others concern internal validity. The current study attempted to address as many of these as were feasible. Below is a listing of the major methodological criticisms and the way in which the current study was organized to address them:

1. Brody observed that "with few exceptions, the majority of the picture-text research has considered pictorial illustrations as discrete wholes...(which)... leads to the predominance of studies which compare learning from passages that include pictures to passages without, while

neglecting to isolate and compare different pictorial attributes" (p. 9). This is an important criticism but is of less relevance when one considers the massive contributions to the literature made by Dwyer (1978). His work on the realism continuum represents a major advance in our knowledge of pictorial attributes. The current study did, however, address the issue from a different angle. By examining the difference between pictorially supported and non-pictorially supported paragraphs across all conditions it was possible to judge how the pictures interacted with various kinds of verbal information.

2. Another difficulty with research on illustrated text is the issue of appropriateness and purpose (Duchastel, 1980). Pictures used as illustrations in most of the studies have their own varying purposes, so that little uniformity exists among these picture-prose investigations. The materials in the current study were designed to conform with Duchastel's own specifications for a retentional image. This specification, meager as it is, is discussed in an earlier section.

3. Prose materials used in many picture-text studies are fictional narratives unlike that typically found in most textbooks (Brody, 1981). This is not a criticism if one wants to generalize to fictional narrative, but it is if the intention is to generalize to textbooks. In the current study the materials were constructed to approximate an instructional text with pictures actually adapted from

various texts in the subject. The intention was to make the content as realistic as possible given the constraints of resources. Also, the materials were administered to classes of subjects studying in that field who had not yet covered the particular information treated. This was a further attempt to create a realistic setting.

4. Instructional texts utilized in many research efforts have been found to be extraordinarily short. Rankin and Culhane (1970) employed a 250-word passage as the learning material for college students. Thus, the college subjects were asked to read a passage of roughly one typewritten page in length, when a page in a collegiate textbook usually consists of a far greater number of words (Brody, 1981). The prose passage used in the current study was approximately 1,600 words in length. This probably does not conform to Brody's recommendation for chapter length selection, but was sufficiently long to tax the recall of the subjects.
5. Pictures used in experiments do not typify those ordinarily found in instructional text. An example is the use of line drawings for college students (e.g. Royer & Cable, 1976), which is an instance of utilizing inappropriate illustrations. Needless to say, the results of this and similar studies have no general applicability since simple, illustrations meant for elementary level students were used for college subjects. Rigney and Lutz (1976) used animated graphic illustrations produced by a computer, a visual form not commonly encountered in instructional texts. Rohwer and Harris (1975) employed printed versions of the text and

illustrations, presented by means of slides. The manner in which both pictures and passages are presented thus becomes questionable (Brody, 1981). In regard to the first criticism, as was earlier mentioned, the pictures used in the current study were adapted from recent textbooks on the subject and were therefore realistic. In terms of presentation of the pictures, however, the current study is clearly limited. Images had to be presented for both auditory and written treatments and therefore a compromise between internal and external validity had to be reached. It was decided that for both treatments a package of images would be provided. Students were then told (aurally or in written terms) when to look at the appropriate image. This way of presenting images is inconsistent with typical practice in either presentation mode, although it does not differ greatly from textual presentation.

Another limitation of the current study resulted from the necessity to fix reading time. Since the auditory mode, by necessity, had a fixed time, it was decided that the textual group should have the same fixed time. Again, this was a compromise between internal and external validity.

6. Duchastel (1981) argues that the beneficial effects of pictorial treatments can be best evidenced over time. Essentially, no difference between picture and no picture groups should appear on the immediate test, but pictures should benefit retention over a delayed testing interval. In the current study a delayed testing interval was used. All subjects were tested at both immediate and delayed times and the scores were treated as a within-group factor in the

design (Haring & Fry, 1979).

Subject aptitudes in prose learning

Although subject's performance on learning tasks may be affected by subject aptitudes, not many studies in prose processing have paid attention to aptitudes (Zimmer, Glover, Ronning & Petersen, (1979). Santiesteban and Koran (1977) and Winn and Holliday (Note 4) presented a strong argument showing that a relationship exists between verbal ability and learning from text. Reading ability was singled out as contributory to differences among subject populations (Bernard, et. al., 1981; Gellner, Note 5). The current study on the processing of textual passages included the subjects' reading ability. Toward this end, the Nelson-Denny Reading Test (Nelson & Denny, 1973) was used as part of a randomized block design.

Hypotheses of the Study

Given the limitations previously outlined the following hypotheses were formulated relative to the purpose of the study:

H_1 Verbal ability level (NDRT) will function as a significant positive predictor of performance on the immediate and delayed tests, in both picture conditions.

H_2 There will be no significant difference between the auditory and print presentation modes.

H_3 There will be a significant difference between those groups receiving pictures with their prose and those not receiving pictures, in favor of the picture conditions.

H_4 There will be a significant interaction between pre-

sentation mode and picture conditions and time of testing (the retention interval).

While no formal prediction as to the direction of the interaction is specified, based on Duchastel's (1981) argument it was expected that the retentional properties of images would emerge over time.

H_5 For picture items, it was expected that there would be a significant effect in favor of the pictorial treatment.

H_6 For non-picture items, it was predicted that there would be no significant difference in the four treatments.

Logical justification for the hypotheses can be drawn from a number of theoretical formulations. Paivio (1971) maintains that images, or words or both can serve as effective memory codes for the retrieval of item information. Atwood (1971), also supports the contention that two separate systems exist for the processing of visual information on the one hand, and verbal auditory on the other. Atwood, moreover, cites Bower (Note 6) who proposed a theoretical model which includes differentiated, but richly interconnected, visual and verbal processing systems.

The distinction between these two systems is supported by several indirect but converging lines of empirical study. Yuille and Paivio (1969) operationally distinguished between imaginal and verbal codes by experimentally changing stimulus attributes and mediational strategies in paired associate learning. Paivio (1968) and his colleagues have verified that pictures are less affected by interserial

interference than are words, and that pictures are more effectively stored in or retrieved from long-term memory and better retrieved from short-term memory, as evidenced by a higher recall for recent pictures than recent words.

CHAPTER III

METHOD

Sample

The experimental sample for the immediate posttest consisted of 80 university students enrolled in introductory biology at Concordia University, Montreal. The number, however, was reduced to 53 on the delayed posttest. This was due to subject mortality during the second testing session. The majority of the subjects were first year students, majoring in biology or commerce, or other liberal arts course. About ¼ of the entire subject population consisted of foreign students from the Middle East, Latin America, and Southeast Asia and thus did not have English as their first language. There were also several subjects whose first language was French. Majority of the subjects were female. Age of subjects ranged from 17 to 60, with a mean age of 25 years (see Table 2).

Experimental Design

The design of the study was a 2 X 2 X 2 factorial with repeated measures on the third factor. Picture condition, the first between group factor, had two levels; with picture and without picture. The second between-group variable, Presentation Mode, also had two levels; audio and textual presentation. Interval (immediate vs. delayed) was the within-group factor. The dependent measure consisted of a free recall and a multiple-choice test, to assess subject performance in terms

Table 1

Absolute and Relative Frequencies for Sex of Subjects

Sex	Absolute Frequency	Relative Frequency (%)
Male	38	47.5
Female	42	52.5

Table 2

Absolute and Relative Frequencies for Age Level of Subjects

Age Level (Years)	Scale	Absolute Frequency	Relative Frequency (%)
0-17	1	2	2.5
18-22	2	35	43.7
23-27	3	24	30.0
28-32	4	7	8.6
33-37	5	5	6.2
38-42	6	4	4.9
43-over	7	3	3.6

of recall and recognition. Figure 2 is a graphical representation of the design of the study.

Four different instructional strategies, used in four groups, were employed. The first was audio with pictures and second was an audio without pictures version. This was done by means of an audio taperecording of the passages and an examination of the copy of the pictures (Bransford & Johnson, 1972). The third was a printed version accompanied by a copy of the black and white shaded drawings (Peeck, 1974).

Both the audio and print versions provided definitions of terms and a discussion of how the human circulatory system functions. The audio plus picture and the print plus picture versions were different from the first two in that the subjects in these two treatments were instructed to refer to certain pictorial illustrations at certain points during the narration.

The four groups and the respective number of students in each follow:

Group 1 - Audiotaped version plus pictures: 12 subjects.

Group 2 - Audiotaped version alone: 10 subjects.

Group 3 - Print version plus pictures: 16 subjects.

Group 4 - Print version alone: 15 subjects.

The learning materials were prepared and randomly distributed to the subjects who participated in the study. The Level of significance for this experiment was set at .05.

Instrumentation

Measure of Reading Ability. All subjects in the study were given the Nelson-Denny Reading Test (Nelson & Denny, 1973) a week

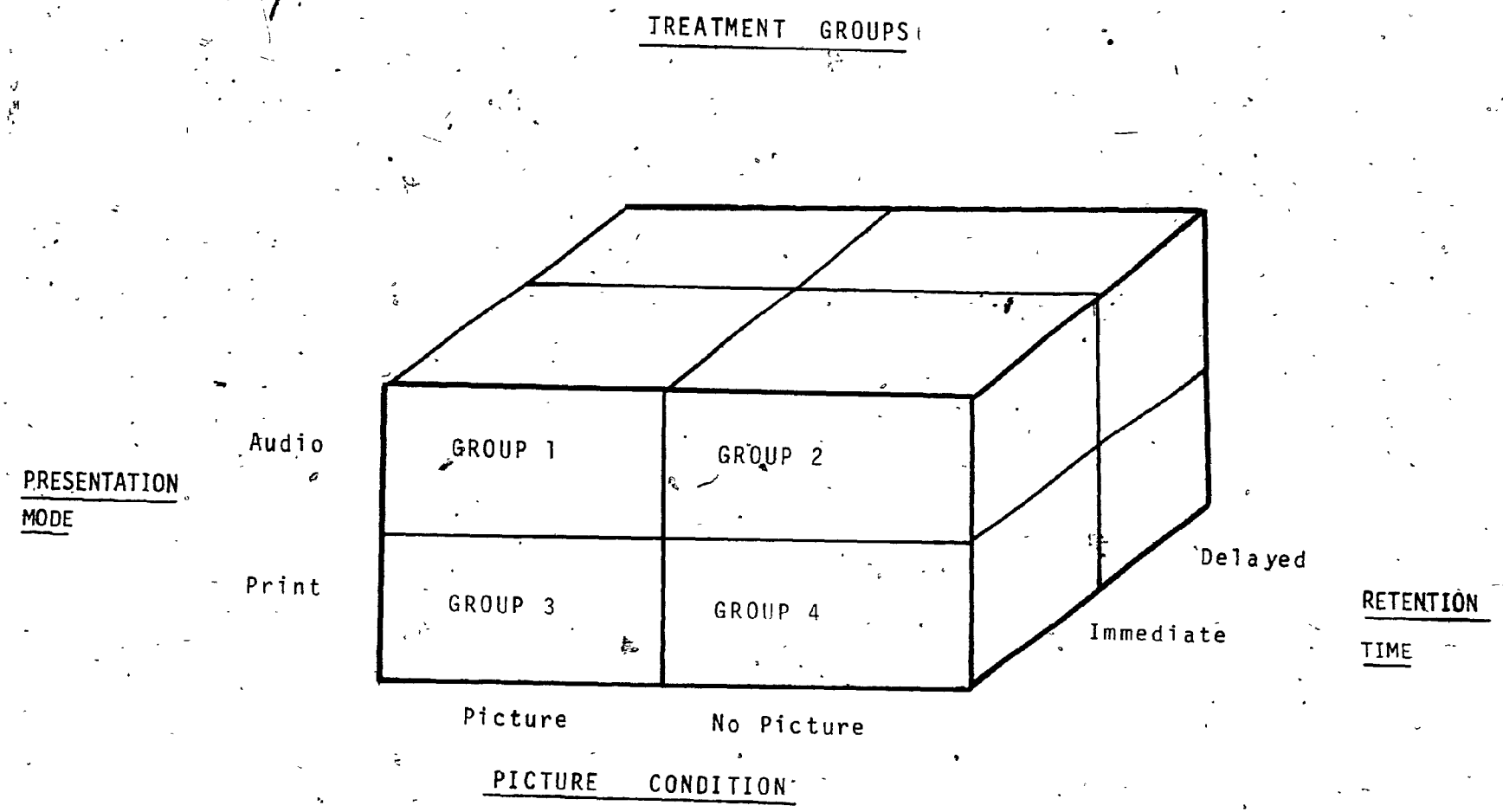

Figure 2. The experimental design

before the main experiment. This was done following Winn and Holliday (Note 4), who stressed that verbal ability and learning from text are related. The Nelson-Denny vocabulary test consisted of 100 items contained in a booklet and which was accompanied by a separate answer sheet. Subjects were instructed to mark the space lettered the same as the answer they thought was correct. Subjects were given 10 minutes to complete the test.

Recognition Test. The learning passage was evaluated by a multiple-choice recognition test in both the immediate and delayed conditions. The multiple-choice recognition test (Appendix D) was constructed by generating 47 questions that best evaluated the learning passage. From the 47-item pool, 40 were chosen by two subject matter experts, and used in this study. Twenty items, randomly selected, were used for the immediate posttest. The remaining 20 were used for the delayed posttest. Furthermore, a question was included to determine the subjects' familiarity with the topic before reading the passage. Subjects' responses were rated on a 7-point Likert scale on which they were directed to check the number which best represented their acquaintance with the topic (Appendix I).

Recall Test. The learning passage was similarly evaluated by a free recall protocol, in both immediate and delayed conditions. (Appendix C). In both instances subjects were directed to recall, as accurately as possible, the contents of the passage, and to write in complete sentences everything that they could recall about the passage. Subjects were given 10 minutes to complete the recall test. Scoring of the free recall test followed the Schallert and Ulerick prose analysis method (Note 7), which analyzes the textual passage

into different idea units, according to their relationship in the passage.

To be able to generate the experimental materials, and the recognition and recall materials, an appropriate instructional design process and a norming procedure had to be undertaken. Once the prototype materials were produced, the professor (handling the course from which the subjects came) was furnished a copy of the learning materials. She was asked her opinion on how to improve the learning materials, and later on, to approve the final version of the passage.

A layout was prepared in which the textual material and the pictorial illustrations were arranged as they would appear in the actual presentations. The suggestions of a media expert related to presentation modes and media combinations were also sought, considered and followed during the production stage of the materials.

Two subject matter experts (i.e. the biology professor and a biology graduate) were asked to point out what they thought were the idea units included in the print and pictorial versions of the topic. An idea unit here refers to a sentence, clause or phrase that contains a single complete idea, or a single block of information (Schmid, Note 8). A list of idea units handed in by both formed the master list for the evaluation of the subjects' idea unit recall, and for the generation of recognition test ideas. Seventy idea units were found to be represented in the passage.

Materials

Passage Selection. The print learning material was a 1, 665-word prose passage constructed by the researcher and drawn from the following

sources: Textbook of Modern Biology (Nason, 1965) and Biological Science (Keeton, 1972). The passage was entitled "The Human Circulatory System" and it discussed animals' metabolic activities, their specialized systems of food procurement, synthesis and elimination, and the operations of the human heart (Appendix G). The Dale and Chall (1948) readability indices for the passage yielded a ranking of college level.

The passage was constructed following the biology professor's suggestion that the topic was an unfamiliar one, relevant, and moreover, not yet studied by the students in the biology course. Another reason this topic was suggested by the professor is that it formed part of her course lecture plan. She provided some specific points that could be emphasized, pointing out that the topic would serve as an overview of the operation of the human heart and hence, would be supportive of the two succeeding lab sessions devoted to the dissection of an animal's heart. The professor also provided a list of reference materials, from which relevant information on the topic was drawn.

Print Presentation Mode. The print or textual version of the passage was a short, seven-page expository passage on the human circulatory system. It consisted of 12 paragraphs, or 1,665 words, and contained both concrete and abstract concepts. The print version was typewritten on sheets of paper stapled together.

Pictorial Illustrations. Pictorial illustrations used in the study were black and white shaded drawings (Dwyer, 1978) that were redundant with the content and gave no new information other than that included in both the print and audio versions. In all, five labeled pictorial illustrations were used in two treatment groups. These pictures were based on illustrations adapted from the biology

books consulted, and were executed by an artist with a background in biology. The pictures were designed to typify illustrations that appear in current university biology books.

The first pictorial illustration was a black and white shaded drawing, showing the connective body tissues through which systematic circulation takes place. It also contained enlarged inset illustrations of the artery, the capillary and the vein. Arrows were used to illustrate the path taken by the oxygen as it circulates through the body (Appendix H).

Illustration two was a cross section of the left side of the human heart, which showed the path of incoming blood as it enters the heart.

Illustration three was a cross section of the right side of the human heart which showed the various outlets taken by outgoing oxygenated blood.

Illustration four presented a diagram of a human torso (screened), showing the parts of the human circulatory system, and the main arteries and veins through which blood travels.

Illustration five displayed another inside view of the human heart, illustrating the location of the SA and the AV nodes. As with the other illustrations, parts of the heart discussed in the passage were labeled.

The learning materials were pilot tested with two groups: a similar group with high prior knowledge on the learning material, and a second group, a bit different with low prior knowledge. Both groups reviewed the learning materials. Later, an item analysis of the multiple-choice test based on the findings of the pilot study was done to determine item difficulty in the multiple-choice questionnaire.

Items were modified or deleted, and new ones generated, according to the item analysis findings. A coefficient alpha for the pilot test was .86. A true control group (placebo condition) was used in the pilot test to control picture and non-picture effects.

Audiotaped Learning Materials. A second set of learning materials was produced in the same way. This was made up of two audiotaped versions of the print passage. One contained cues and was used in combination with the pictorial illustrations. The other version had no pictorial support. The audio presentation mode was narrated by a female voice with no music. Except for the fact that it was presented aurally, the audio mode was exactly like the print version of the passage.

Assembling the Materials. Subjects in the main experiment (immediate posttest) received a set of learning materials consisting of three or four envelopes stapled together, with a general instruction (cover) sheet attached to the first envelope. Number and contents of the learning materials differed according to treatment.

The audio plus picture group received the following materials:

Envelope 1 - General instructions stapled to envelope 1 and pictorial illustrations inside envelope.

Envelope 2 - Interpolated task and a sheet of paper.

Envelope 3 - Free recall test plus a sheet of paper.

Envelope 4 - Multiple-choice test and answer sheet.

The audio alone group was provided with the following materials:

Envelope 1 - General instructions stapled to envelope 1 and interpolated task with a sheet of paper inside the envelope.

Envelope 2 - Free recall test and a sheet of paper.

Envelope 3 - Multiple-choice test and answer sheet.

The print plus picture group was given the following envelopes:

Envelope 1 - General instructions stapled to envelope 1, and print material and pictorial illustrations inside the envelope.

Envelope 2 - Interpolated task and a sheet of paper.

Envelope 3 - Free recall test and a sheet of paper.

Envelope 4 - Multiple-choice test with answer sheet.

The print alone group received the following envelopes:

Envelope 1 - General instructions stapled to envelope 1 and print material inside the envelope.

Envelope 2 - Interpolated task and a sheet of paper.

Envelope 3 - Free recall test and a sheet of paper.

Envelope 4 - Multiple-choice test and answer sheet.

Task instructions were enclosed in each envelope for the respective activities. A brief description of the task in each envelope was included as well as a note on the time alloted for studying the learning material.

Print material - This was a seven-page typewritten passage that discussed the human circulatory system, with emphasis on the operation of the human heart. There were two types of print material. These were the cued and uncued versions, which consisted of seven typewritten pages of 12 paragraphs. Pictorial accompaniment was designed so that paragraphs one and two had no pictorial support, while paragraph three had. Paragraph four did not, while five had pictorial support. This alternate arrangement (Duchastel, 1981) was followed throughout the pictorially-supported print version and audio version.

Interpolated Task - This was a math quiz which contained four problems each in simple addition, subtraction and multiplication, and two in division for a total of 14 items in all. Subjects were asked to answer as many items as they could within 2 minutes. This was designed to lessen the effects of short-term memory so that subjects' long-term verbal memory could be better measured.

Pictorial illustration - This consisted of five labeled, black and white shaded illustrations of some parts of the human circulatory system discussed in the passage and referred to by subjects in the print plus picture group and the audio plus picture group.

Free recall test - This was a 10-minute test that required the subjects to write down, in complete sentences and as accurately as possible, the important points contained in the passage heard or read.

Multiple-choice test - Two types of multiple-choice tests were constructed for purposes of determining how well the subjects recalled the passage they had heard or read. Multiple-choice questions consisted of a stem with one right answer and three distractors. For both the immediate and delayed posttests, all the multiple-choice questions were randomly arranged. The multiple-choice test was made up of knowledge questions and was constructed by generating 47 knowledge questions which had been reviewed by two subject matter experts to ascertain that the questions were easily understood, and that only one answer was correct.

The multiple-choice questions were of two types. Type A consisted of 20 randomly chosen questions. Among the 20 questions were 12 pictorially-supported questions which required 12 pictorially supported answers. Type B also consisted of 20 randomly chosen

questions. Among these were six questions that called for an equivalent number of six pictorially-supported answers. Both types of multiple-choice tests were to be answered in 15 minutes. To assess internal validity, the Cronbach α test was applied to both types of multiple-choice test. The results of this test will be reported in the next chapter.

Procedure

The experiment was carried out in the middle part of the fall term of 1981. The subjects in four different lab sessions were divided into four treatment groups. Thus, one lab session was assigned to the audio alone group and another was assigned to the audio plus picture group. The two other lab sessions, however, were each divided into print alone and print plus picture groups.

Subjects in all groups did not know that they were going to take part in an experiment until they were informed about the experiment just before the experimental session. When the researcher and his research adviser entered the room, they were introduced by a lab assistant to the students as people from the university's Education Department. The research adviser told the students that the study was being undertaken to enable educators to determine which modes of instruction are effective for teaching biology. He further asked for the students' full cooperation in the experiment. Subjects were asked to follow all instructions as closely as they could. A total of 89 subjects took part in the study, but nine were excluded for not following instructions during the experiment.

The randomized packages were distributed to the subjects following the researcher's instruction that they should not open the

packages until asked to do so. The researcher outlined the experimental procedure and the subjects were told to remove the general instruction sheet from the package and to read it carefully. All four groups were given 2 minutes to read the general instructions. At the end of 2 minutes, subjects were told to pull out the learning materials from envelope one, and start reading, or they were asked to listen to the learning materials according to group condition. After 15 minutes of reading or 12 minutes of listening, subjects were told to stop what they were doing, and to put the material back in its proper envelope. Then they were asked to take out the math quiz, and to begin solving the problems. After 2 minutes, subjects were told to stop answering the math quiz and to return the test question to its envelope. They were instructed to remove the contents of the third envelope, and directed to begin working on the recall test by writing down their answers on the enclosed sheet of paper. At the end of 10 minutes, subjects were again told to stop writing and to put away the recall test materials, and to start the multiple-choice test. At the end of the experiment, the envelopes were collected and the subjects were thanked for their cooperation and were told that they could obtain the results of their tests by contacting the researcher.

Exactly a week later an unannounced delayed test was given. The test was administered in the same manner as the immediate test. However, no learning materials (neither print nor audio) were included this time.

Instructions according to groups. Subjects in both print groups (with and without pictures) were instructed to study the passage, and to read it carefully since they would be asked to write

down as much as they could recall from the passage once they had finished. Subjects in the print plus picture group were instructed to refer to the illustrations when told to do so. Subjects in both print groups were also informed that a final task, a 20-item multiple-choice test, would be given to assess how well the subjects understood and recalled the information contained in the passage. Subjects in the two audio versions (i.e. with picture and without) were asked to listen carefully to the 12-minute narration. Those in the audio plus picture conditions were asked to examine the illustrations when instructed to do so. They were also informed that they would be asked to write down as much as they could recall from the narration once they had finished listening. They were also told of the multiple-choice test to determine how well they understood and remembered the information contained in the narration. In all four groups, the learning materials were arranged in such a way that the two types of multiple-choice tests (types A and B) were evenly distributed to each group.

Subjects in all four groups were encouraged to ask questions pertaining to the tests, by quietly raising their hand, and waiting for the researcher to assist them.

The four immediate posttests, which took 45 minutes each, were administered to the four groups during four separate lab sessions. The pretests were all done in a well-lit biology laboratory, which had four long dissecting tables, surrounded by chairs.

The delayed posttest was administered in the same laboratory. Although basically the same as the immediate posttest, the multiple-choice test used in the delayed posttest was different in the sense that subjects who received the type A multiple-choice test in the

immediate posttest were given the type B test in the delayed posttest, and vice versa.

CHAPTER IV

RESULTS

Introduction and Hypotheses

The purpose of this study was to determine the relative effectiveness of pictorial illustrations on learning from written prose, and the relative effectiveness of the same illustrations on learning from oral prose. The following hypotheses were tested in line with the purpose of the study:

H_1 - Verbal ability level (NDRT) will function as a significant predictor of performance on the tests (T_1, T_2) in both Picture conditions (picture, no picture).

H_2 - There will be no significant difference between Presentation Modes (oral, written).

H_3 - There will be a significant difference between those groups receiving pictures with their prose and those not receiving pictures, in favor of the picture conditions.

H_4 - There will be a significant interaction between presentation mode (oral, written) and Picture Conditions (picture, no picture), and time of testing (T_1, T_2).

H_5 - For picture items, it is expected that there would be a significant effect in favor of the pictorial treatment.

H_6 - For non-picture items, it was predicted that there would be no significant differences in the four treatment groups (oral, written, oral plus picture, written plus picture).

Covariate Predictor

Regression analysis was used to test the strength of the Nelson Denny Reading Test (NDRT) as a predictor of subject performance on the immediate multiple-choice (IMCT), and immediate free recall (IFRT) tests. The NDRT was a significant predictor of IMCT scores, $F(1,51) = 10.82$, $p < .01$, with eighteen percent of the variance accounted for (r^2) on the overall multiple-choice test. The NDRT was also a significant predictor of IFRT scores, $F(1,51) = 16.8$, $p < .01$, and accounted for twenty-four percent of the variance on the IFRT.

The NDRT was also a significant predictor of the delayed multiple-choice test (DMCT) scores, $F(1,51) = 14.1$, $p < .01$, with twenty-one percent of the variance accounted for, and similarly the NDRT proved to be a significant predictor of delayed free recall test (DFRT) scores, $F(1,51) = 12.7$, $p < .01$, with nineteen percent of the variance accounted for in the DFRT. These relatively high correlations indicated that reading ability appeared to be a significant predictor of subjects' performance on the two dependent measures at both points in time. Therefore, H_1 was accepted and the NDRT was used as a covariate in the subsequent analyses.

Analysis of Test Types (A,B) at T_1 and T_2

It was necessary to determine if the two forms of the multiple-choice test (MCT) (designated form A and form B) could be considered parallel forms of the same measure. Since these forms were counter-balanced in all treatment conditions across time, a direct test of the equivalence was conducted separately at Time 1 and Time 2. Equivalence would indicate that the test types could be pooled within treatment and time conditions.

A t - test was conducted between forms at T_1 and T_2 summed across treatment conditions. The results of this analysis indicated that at T_1, no differences existed between the forms ($t = 1.01$, $df = 46.62$, $p > .05$). A similar result was observed at T_2 ($t = -.84$, $df = 51$, $p > .05$). Based on these findings, form A and form B of the M C T were considered to be equivalent instruments.

An item analysis program (ITMANAL) was used to assess the reliability of form A and form B of the MCT at T_1. Form A yielded a coefficient alpha of .73 and the alpha for form B was .78. These results indicated that both forms were moderately reliable.

Analysis of Multiple-Choice Data

Since the regression analysis indicated that the NDRT significantly predicted scores on the MCT in both the immediate and delayed conditions, the NDRT was considered a viable covariate. As such, it would help explain otherwise unexplained variance due to differences in reading ability among subjects on the dependent measure, thus reducing the between group error term. However, the assumption of homogeneity of regression must be met before the results of Analysis of Covariance (ANCOVA) are interpretable (Huitema, 1980). Essentially, homogeneity of regression is the assumption that the regression lines of the predictor variable on the dependent measure are parallel across levels of the independent factors. It can be assessed by testing the interaction of the covariate and the treatments.

This was performed independently at Time One (T_1) and at Time Two (T_2). Results of the three-way interaction of NDRT with Presentation Mode (print and audio) and Picture Conditions (picture and no picture) at T_1 were not significant, $F(1,45) = .08$, $p > .50$. Similarly,

the results at T_2 were not significant, $F(1,45) = .05$, $p > .50$. It was determined from this analysis that the NDRT met the assumption of homogeneity of regression and was therefore an appropriate covariate.

The multiple-choice data was analyzed within a 2 X 2 X 2 factorial design with repeated measures on the third factor. The two between-group factors were Presentation Mode (audio vs. print) and Picture Condition (picture vs. no picture) and the within-group factor was Time of Testing (T_1 vs. T_2). The analysis of covariance showed no interesting findings in this portion of the analysis. The complete ANCOVA summary table is shown in Table 3, and Table 4 presents the unadjusted means in all conditions and the corresponding standard deviations.

Even though the findings of this portion of the analysis revealed no interesting effects, it is interesting to note the position of the means relative to one another (see Figure 3). There was an unexpected result. The audio with picture produced results at T_1 that were considerably below the other conditions. However, at T_2, all groups were essentially the same. The generally stable results for the audio with picture condition may be the result of a floor effect although it may also be interpreted as results favoring the pictorial adjuncts. Decline over time was less in this condition than in any of the others. It is certainly true that such an interpretation would not be tenable had the other groups remained high on the retention test.

Analysis of Free Recall Data

The free recall data was analyzed within a design similar to

Table 3

Summary of the Analysis of Covariance for the Multiple-Choice Test

Between-Group Effects	df	MS	F	P
Presentation Mode (A)	1	6.67	.39	.53
Picture Condition (B)	1	18.72	1.10	.29
A X B	1	3.70	.22	.64
Covariate	1	249.52	14.65	.0004
Error	48	17.02		
Within-Group Effects				
Time (T)	1	36.56	11.15	.0016
T X A	1	.69	.21	.6471
T X B	1	2.61	.80	.38
T X A X B	1	10.11	3.08	.08
Error	49	3.28		

Table 4

Adjusted and Unadjusted Means and Standard Deviations for the Multiple-Choice on Immediate and Delayed Tests

	Immediate Test				Delayed Test			
Groups	n	$\bar{X}$[1]	$\bar{X}_{adj.}$[2]	SD	n	$\bar{X}$[1]	$\bar{X}_{adj.}$[2]	SD
Audio with Picture	12	10.08	10.53	4.44	12	10.00	10.45	3.78
Audio Alone	10	13.00	12.76	2.87	10	11.00	10.76	4.12
Print with Picture	16	12.93	12.25	3.53	16	11.25	10.56	2.14
Print Alone	15	11.93	12.41	3.21	15	10.87	11.34	3.99

[1]Means

[2]Adjusted as a result of ANCOVA calculation.

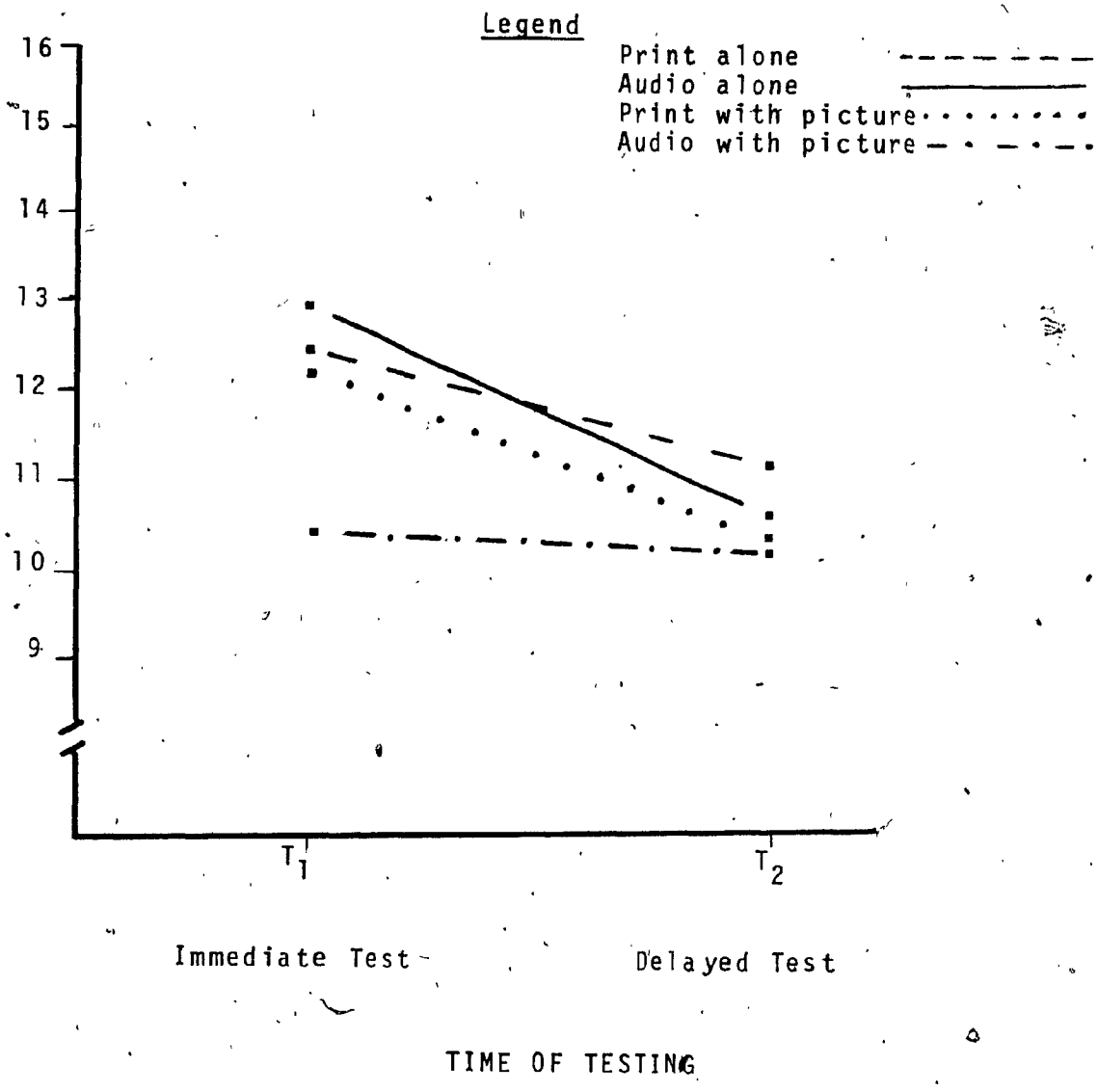

Figure 3. Interaction of time by treatment from overall multiple-choice test data

Table 5

Summary of the Analysis of Covariance for the Free Recall Test

Between-Group Effects	df	MS	F	p
Presentation Mode (A)	1	34.75	1.28	.26
Picture Condition (B)	1	125.17	4.62	.04
A X B	1	17.01	.63	.43
Covariate	1	579.10	21.38	.01
Error	48	27.09		
Within-Group Effects				
Time (T)	1	167.5	27.00	.01
T X A	1	20.25	3.26	.07
T X B	1	1.74	.28	.59
T X A X B	1	.48	.08	.78
Error	49	6.20		

that employed in the previous section. Idea units extracted from the subject's written transcripts served as the dependent measure. Results of this analysis (see Table 5) yielded a main effect for the Picture Condition, $F(1,48) = 4.62$, $p < .05$, a main effect for time, $F(1,49) = 27.0$, $p < .01$, and a marginal two-way interaction of Time and Presentation Mode, $F(1,49) = 3.26$, $p < .10$. An inspection of Table 6 reveals that the significant effect for Picture Conditions is due to the relatively higher number of idea units recalled by subjects in the no picture condition. When Picture Conditions (picture and no picture) are averaged across presentation Mode, the mean for picture condition is 10.5 as compared with a mean of 12.5 for the no picture condition accounting for the observed main effect. Since the higher order interaction previously noted does not include the Picture Condition term, it is difficult to clarify this seemingly anomalous effect.

Condition Specific Effects

As was mentioned in Chapter 3, the passage was constructed to contain 12 paragraphs. Beginning with the third paragraph, pictures were then designed for every other paragraph to the end of the passage. Paragraphs 3,5, 7, 9, and 11 had picture accompaniments (in only the picture conditions) while paragraphs 1, 2, 4, 6, 8, 10, and 12 did not. Paragraphs 1 and 12 did not contain substantive information so that, essentially, five paragraphs had additional picture support while five paragraphs did not.

Concomitantly, the multiple-choice test was so constructed as to include items from both picture and non-picture paragraphs making possible a separate analysis of these subtests. Separate reliability co-

Table 6

Adjusted and Unadjusted Means and Standard Deviations for the Free Recall Test on Immediate and Delayed Tests

	Immediate Test				Delayed Test			
Groups	n	$\bar{X}$[1]	$\bar{X}_{adj.}$[2]	SD	n	$\bar{X}$[1]	$\bar{X}_{adj.}$[2]	SD
Audio with Picture	12	11.66	12.35	7.73	12	8.58	9.25	5.19
Audio Alone	10	16.22	15.86	7.66	10	12.33	11.97	4.41
Print with Picture	16	12.31	11.27	3.23	16	10.75	9.71	2.62
Print Alone	15	12.06	12.78	3.62	15	10.25	10.97	3.10

[1]Means

[2]Adjusted as a result of ANCOVA calcultation

efficients were calculated for each subtest. Since different subjects received forms A and B, these coefficients were by necessity calculated for each form. On form A the alphas were .41 for the Non-Picture Item Subscale (item = 8) and .71 for the Picture Item Subscale (items = 12). For form B, the alpha were .72 for the Non-Picture Item Subscale (item = 14) and .55 for the Picture Item Subscale. While these reliabilities seemed a bit low, they were considered acceptable because in subsequent analyses the subscales (picture and non-picture) were pooled across forms. Unfortunately, the design counterbalancing precluded a direct reliability check of the pooled subscales.

Before the analyses were conducted the scores were linearly transformed to percentages. This was done in anticipation of the possibility of directly comparing the Picture and Non-Picture subscales. Conversion to percentages, since it is a linear transformation, preserves the characteristic distribution of the responses while avoiding the problem of item non-equivalence (22 non-picture items and 18 picture items). However, before the ANCOVA was run, the separate subscales were subjected to multivariate analysis of variance (MANOVA) to determine if it was appropriate to directly compare them. The result of the Multivariate F-test, $F(4,44) = 7.39$, $p < .01$ indicated that the subscales were sufficiently different to preclude a direct comparison. This finding necessitated separated analyses of the two subscales within the ANCOVA repeated measures design described in previous sections.

An analysis of the picture items was conducted using the percentage data mentioned above. The design consisted of two between-group factors, Presentation Mode and Picture Condition, and one within-group factor, Time. The results presented in Table 7 indicate only one significant main effect. Picture Condition was significant, $F(1,47) = 4.18$,

Table 7

Summary Table for Repeated Measures with Covariance for Picture Items

Between-Group Effects	df	MS	F	p
Presentation Mode (A)	1	.02	.40	.53
Picture Condition (B)	1	.25	4.18	.05
A X B	1	.13	2.29	.14
Covariate	1	.13	2.20	.14
Error	47	.06		
Within-Group Effects				
Time (T)	1	.07	2.50	.12
T X A	1	.02	.53	.47
T X B	1	.02	.75	.38
T X A X B	1	.00002	.00	.97
Error	48	.03		

$p < .05$ and an inspection of the means (See Table 8) reveals that the difference resides in the relatively higher performance of the picture level as compared with the no picture level. This indicates that pictures provide additional support for the prose for which they are designed. Two other items in Table 8 are also of interest. The covariate used successfully in all previous analyses was not significant. While there is no direct evidence to explain this unexpected finding, it is possible that the memory strategy used for these items by subjects in the Picture conditions was sufficiently non-verbal to reduce the correlation between the dependent measure and the Nelson-Denny Reading Test. Of additional note was the unexpected lack of differences over time. Again there is no direct explanation for this finding. However, by inspecting the means in Table 8 a suggestion is provided. Even though the Time by Picture Condition interaction was not significant, it is interesting to compare the relative difference of picture and non-picture groups over the delayed period. Picture condition subjects diminished 4% on picture items over the delayed testing period while no-picture condition subjects diminished 16% over the same period. Although there was no significant interaction between Picture Condition and Time, the difference in these scores over time suggests that pictures provide facilitative support for the prose once more.

Results of the analysis of the non-picture items was not as clear-cut. There was a significant three-way interaction of Time X Presentation Mode X Picture Condition, $F(1,48) = 4.11$, $p < .05$. Since this interaction subsumes all other interactions and main effects, the other significant main effects (see Table 10) were confounded. The relationship of the means are shown graphically in Figure 4 . When a significant higher-order interaction is found the appropriate post hoc comparisons are

Table 8

Adjusted and Unadjusted Means and Standard Deviations for Picture Items

	Immediate Test				Delayed Test			
Groups	n	$\bar{X}$[1]	$\bar{X}_{adj.}$[2]	SD	n	$\bar{X}$[1]	$\bar{X}_{adj.}$[2]	SD
Audio with Picture	12	.59	.60	.27	12	.59	.60	.20
Audio Alone	10	.62	.61	.19	10	.56	.55	.24
Print with Picture	16	.69	.67	.15	16	.64	.62	.15
Print Alone	15	.52	.53	.18	15	.41	.42	.26

[1]Means

[2]Adjusted as a result of ANCOVA calculation.

Table 9

Summary Table for Repeated Measures with Covariance for No Picture Items

Between-Group Effects	df	MS	F	p
Presentation Mode (A)	1	.15	3.01	.01
Picture Condition (B)	1	.40	3.19	.006
A X B	1	.001	.03	.37
Covariate	1	1.18	24.01	.01
Error	47	.05		
Within-Group Effects				
Time (T)	1	.22	12.10	.001
T X A	1	.00000	.00	.99
T X B	1	.00002	.00	.974
T X A X B	1	.07	4.11	.0433
Error	48	.02		

Table 10

Adjusted and Unadjusted
Means and Standard Deviations for
No Picture Items

	Immediate Test				Delayed Test			
Groups	n	$\bar{X}$[1]	$\bar{X}_{adj.}$[2]	SD	n	$\bar{X}$[1]	$\bar{X}_{adj.}$[2]	SD
Audio with Picture	12	.46	.49	.21	12	.43	.45	.13
Audio Alone	10	.69	.68	.25	.10	.55	.53	.21
Print with Picture	16	.68	.63	.21	.16	.53	.48	.18
Print Alone	15	.67	.69	.21	.15	.63	.65	.22

[1]Means reported here are based on percentage of correct response for non-picture items.

[2]Adjusted as a result of ANCOVA calculation.

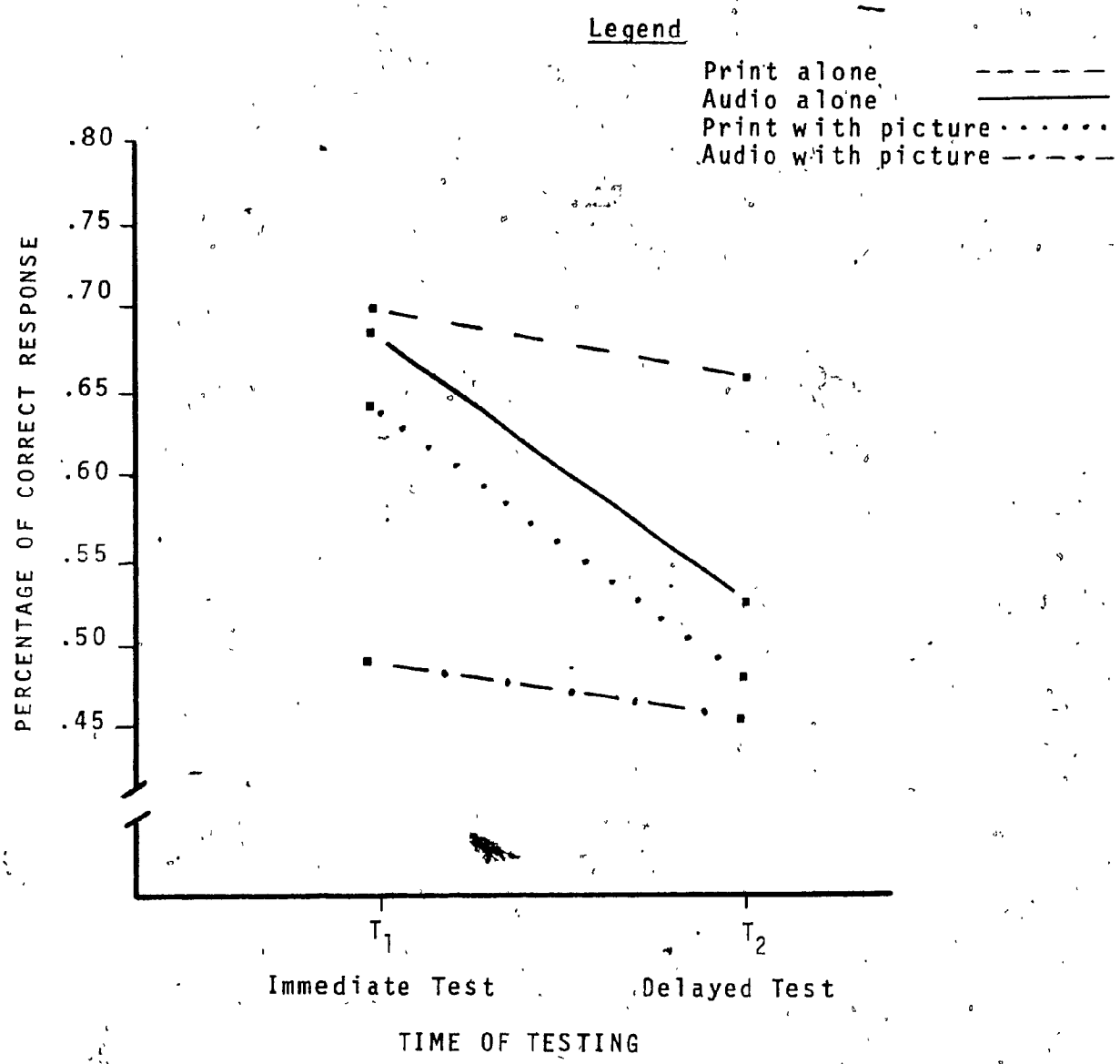

Figure 4. Three-way interaction of time of testing, presentation mode, and picture condition on non-picture items

based upon all means. Tukey's test of paired means was used to analyze the three-way interaction. At Time One, two differences were apparent. Audio without pictures was different from Audio with pictures ($p < .05$) and Print without pictures was different from Audio with pictures ($p < .05$). On the immediate test Print with pictures and Print alone (or Print without pictures) performed similarly.

At Time Two, the results were quite different. Print without pictures was different from Print with pictures and Audio with pictures ($p < .05$). However, it was not different from Audio without pictures.

Chapter V

Discussion

This study had two major purposes: (1) to determine if prose presented orally and in written form is made more memorable by the addition of pictures, and (2) to determine what effect, if any, pictures have on pictured and non-pictured segments of the passage. It was predicted that pictures would have a positive effect upon the prose material they were designed to support, but would have no effect (e.g. neither positive nor negative) on the other paragraphs that were not pictured.

Presentation Mode and Picture Condition

According to Duchastel (1978), the use of illustrations can facilitate later retrieval from memory by providing a conceptual plan of the information for the learner. Based on this interpretation, it was hypothesized that by providing pictorial illustrations that the learners can consult while listening to or reading their prose passage, performance on immediate and delayed tests would be better. For the overall multiple-choice test, this was not the case.

The overall multiple-choice test analysis yielded no significant effect, although a marginal interaction ($p < .08$) of time, treatment and presentation mode, and a significant effect for testing time was found. Result of the ANCOVA showed that at immediate testing, the audio with picture group did not perform as well as the other conditions, but on the delayed test, the same group scored as well as the other

treatment groups. Decline over time was less in the audio plus picture treatment group. This intriguing result on the immediate test may have occurred because subjects in the audio plus picture group concentrated primarily on the pictures, thus failing to pick up substantial parts of the narrative.

When students know that they are subjects of an experiment and that the test they are writing has no effect whatsoever on their grades, they tend not to take it seriously and instead follow the line of least resistance. Proceeding from this argument, then, examining a picture involves less attention than concentrating upon the taped narration. This might explain the subjects' propensity to consult the pictorial illustrations instead of utilizing them as a complementary tool used in combination with the taped passage. Additional partial explanation may be given, suggested by Brooks (1967).

Brooks reported that visual imagery occurs more readily in listening tasks than in reading tasks. When listening alone, especially when a complex description of the heart's function is presented, the learner has to visualize the intricate descriptions being presented. This, he can easily do since generating visual imagery while listening involves no conflicting perceptual activities. The addition of illustrations to the taped narration, however, might have caused a conflict brought about by two competing inputs occurring simultaneously. Examining the illustrations while the narration was played might have prevented the subjects in this group from processing all of the verbal content available in the passage. Listening to the tape, examining the illustration, and trying to visualize simultaneously might have become difficult so that subjects resorted to other processing strategies, which affected their performance on the immediate test.

The outcome of the delayed overall multiple-choice test, however, tended to show that examining the illustrations did have beneficial effects, since the illustrations might have helped the subjects recall and organize the data from the pictures they examined, and portions of the narration they had heard.

Picture Condition and Time

Paivio (1975), in his dual-coding theory of memory, assumes that information being learned can be coded in either a verbal or in an imaginal memory code or both. Empirical studies (e.g. Paivio, 1968) have verified that pictures are more effectively stored in or retained from long term memory and better retrieved from short-term memory. This current study extends Paivio's notion to learning and recalling pictorially-supported texts (Duchastel, 1981).

Picture Items from the Multiple-Choice Test

Earlier in Chapter Three, it was mentioned that the prose passage was designed so that starting with the third paragraph, pictorial illustrations were produced for every other paragraph. From a total of 12 paragraphs, five had picture support, while the other seven did not. Paragraphs one and twelve contained no important information, so that no pictures were assigned to them. In line with this, the multiple-choice tests were constructed such that items from paragraphs with pictorial supplements and paragraphs without pictorial supplements were included in the multiple-choice test. This made it possible to test each of the four treatment groups relative to their performance on picture and non-picture items (corresponding to pictured and non-pictured aspects of the passage).

An analysis of the picture paragraphs (or picture item group) disclosed a significant main effect ($p < .05$) in favor of the treatments which contained pictures. According to this effect it seems apparent that pictures do have a positive effect on the information they are designed to support.

No Picture Items from the Multiple-Choice Test

The result of the analysis of the non-picture items turned out to be a three-way interaction of Time X Presentation Mode X Picture Condition ($p < .05$). (see Figure 4). At the immediate test, the audio alone group was different from the audio with pictures ($p < .05$) and the print alone group was different from audio with pictures ($p < .05$). It was observed that on the immediate test, the print plus pictures and print alone groups performed similarly. At the delayed test, the results were quite different. Print alone was different from print with pictures and audio with pictures. It was, however, not different from audio without pictures.

The three-way interaction of time of testing, presentation mode and picture condition may indicate the following: On immediate testing, subjects in the print alone group (who received no pictorial illustrations) might have found it easier to recall the information they read. Subjects in the audio alone group (who also received no picture support) also recalled a substantial amount of information, since they must have concentrated on listening to the verbal narration, which is the only activity they were asked to do. On the delayed test, however, the print alone group forgot less information than the audio alone group. A possible reason for this is that subjects in the print alone group had the chance to reread the printed information

they were asked to study. Rereading may have provided the necessary link with long-term memory. Subjects in the audio alone group -- although they recalled substantial amount of information on the immediate test -- did not recall much of the information at Time Two. This could be due to the nature of verbally presented information, which is very temporary and thus, cannot be reviewed. Inability to rehearse the passage might have resulted in eventual forgetting.

Subjects in the print plus picture group scored better than the audio plus picture group at the immediate testing, but diminished by a greater amount than the audio plus picture group on the delayed testing. Subjects in both treatment groups -- it must be mentioned here -- received multiple-choice test with items that were not supported by pictorial illustrations. In this case, subjects in the print plus picture group -- since they were asked to answer some questions extracted from the non-pictorially supported paragraphs- might have been confused because they did not find questions related to the pictures they examined. The absence of the anticipated questions (i.e. those questions lifted from the paragraphs with pictorial support) could have caused the low score of subjects. At the delayed test, the scores went down some more. This might imply that, the absence of pictorial illustrations which help in the reconstruction of past information left the subjects with no memory aids. The result was that no significant recall took place.

Subjects in the audio plus picture group, too, might have been thrown off balance by the introduction of questions obtained from the non-pictorially supported paragraphs. As with the print plus picture group, they might also have been expecting questions lifted from the pictorially-supported paragraphs they were instructed

to examine. They scored low on the immediate test when they found no such pictorially-supported questions based on the picture paragraphs. At Time Two, this group's performance declined further.

The results of this analysis suggest that pictures, designed as they were for this study have a very localized effect on learning. They support and facilitate retention of the content for which they are designed. It appears that their effect on the non-pictured paragraphs depends upon the modality or the mode of presentation. They appear to interfere with audio presentation on both immediate and delayed testing and have little effect when presented with text. This suggests that the design of pictorial adjuncts is an important consideration since they appear to direct the learner to concentrate on pictured information.

Free Recall Test Analysis

An anomalous effect was observed following the analysis of the free recall data. Reminiscent of the Samuels (1967) and Main and Griffiths (1977) studies, analysis of data drawn from the current research showed that subjects in the no picture condition (i.e. audio and print alone) recalled a relatively higher number of idea units, compared with subjects in the picture condition. Why did the no picture group have this advantage? The interpretation suggested is that a trade off between the two groups took place. Subjects in the no picture group did not expect picture assistance or questions generated from the illustrations which subjects in the picture group were asked to study. The information was recalled well by the no picture group due to the absence of an interference. Subjects in the picture condition, however, scored low because they did not get the picture

assistance they thought would be offered by the picture illustrations they were asked to study.

An indirect but related further explanation of this result, based on the notion given earlier follows. Subjects in the groups provided with the pictorial illustrations did not outperform those in the no picture groups because subjects in the picture group might have directed their attention to specific segments of the passage (i.e. the pictorially augmented segments). This might have resulted in "dysfunctional focussing and incomplete cuing (Holliday, 1981), thus, diminishing student comprehension of important information in the no picture segments of the passage. On the other hand, the absence of illustrations directly related to certain sections of the same information might have encouraged subjects to develop and apply their own learning strategies without study aids. Or this absence might have provided them with a complete instructional system support (Anderson, 1972; Wittrock & Lumsdaine, 1977).

Consistent with the implications of this selective attentional model the performance of subjects in the treatment groups required to study the pictorial illustration, (although they did not get any pictorial support during the test) suffered.

An aspect of the study that remains to be explained is why the picture items in the free recall test depressed the performance of the subjects, while picture items in the multiple-choice test helped facilitate recall. A possible explanation is presented by Levie and Levie (1975), who pointed out that pictures, compared to words, can cause notable differences when employed as stimuli in experimental learning tasks. The multiple-choice test is a recognition test and, following Levie and Levie, may not have any need for the retrieval

stage of memory. This stage, however, is necessary in recall tests. It is possible that recognizing a picture does not entail any verbal transactions. In the recollection of information from the picture paragraphs, however, a verbal response becomes necessarily involved.

It will be recalled that information from the pictorially supported paragraphs contained pictorial illustration. There is the possibility that the subjects encoded the picture-based information in image form. Consequently, on the recall test, part of the information was stored in image forms. The problem might have occurred when subjects encountered difficulty while trying to translate the picture-backed information in verbal form during the free recall posttests.

The nature of the task the subjects were required to perform, or the learner's awareness that a recall task was the task they will be asked to undertake might also have caused the subjects to interpret the pictorially-supported information (in image form) into verbal terms during the free recall test. Thus the possibility exists that when the subjects tried to encode image forms verbally during testing, an interaction was prevented from taking place. Subject expectation of a written verbal answer could have discouraged or prevented them from using the nonverbal system for encoding pictorial as well as word stimuli. As a result, extensive loss of picture information occurred when the learner who expected testing by verbal reporting, was in fact tested by verbal reporting.

Educational Implication

In most learning milieux students are obliged to learn new and novel information which are not accompanied by suitable and per-

tinent memory aids that can help them to retrieve the important points studied more easily. In view of this, instructional designers should supply the necessary retentional aids to help facilitate retention. One promising aid is the pictorial illustration which could assist in information recall.

Data derived from this investigation suggested that the introduction of a simple shaded black and white line drawing into a prose test it is related to, should help in the retrieval of important points the pictures typify. This does not mean to say, however, that a pictorial illustration for a select group of collegemen may also apply to a group of high school students. Rather, the construction of pictorial illustrations should take into account the traits of the learners the illustrations will be designed for.

In the construction of retentional illustration, instructional designers should exploit the retentional qualities of illustrations similar to those employed in this study. These illustrations function as a conceptual map of the subject matter and help recall. In effect, this study is an amplification of Paivio's (1968) dual-coding hypothesis and Duchastel's (1978) illustrative strategy that pictures can help make important points in an instructional text retrievable.

As applied to learning situations, pictorial illustrations could be so employed that learners will not have a sad experience with difficult-to-remember materials. In this particular instance, pictures will serve to diminish forgetting.

Conclusion

The findings of this study suggest that retentional illustrations can be applicable in certain situations. At the outset, it

must be ascertained if the text is unfamiliar and if the learners do indeed need the illustrations. If a pictorial illustration is needed, it must be employed so that the illustrations, used together with an expository text, really represent important points in the text. This investigation used retentional illustrations, since the expository text was something the students were not familiar with. This was determined by consulting with the course professor and confirmed from the answers on the test questionnaire. Moreover, the instructional designer must see to it that the pictorial illustrations represent major concepts or points in the text. Otherwise they lose their effect. Furthermore, the pictorial illustrations should not represent additional information other than that also discussed in the prose text. Taking this into consideration will help avoid differences caused by new information not included in the text. Finally, the prose text (learning material) must be unfamiliar, so that the students do not rely on pertinent information they already know prior to studying the learning material.

Based on the findings from this study, it is suggested that pictorial illustrations do facilitate recall if properly designed. However, future studies could look into a related area by investigating the matter of dysfunctional selective attention, which can be caused by the assignment of pictorial illustrations to certain paragraphs in a prose passage. Future investigations could also study pictorial illustrations used as memory aids in a field other than biology.

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APPENDICES

APPENDIX A

Instructions

DIRECTIONS

This study is undertaken for the purpose of improving upon the quality of instructional textbooks. Hence, your participation is needed so that guidelines can be developed that will be useful to writers of instructional materials.

This package is made up of four (4) separate envelopes of material. You will be guided through these envelopes by the researchers in timed steps.

Please follow the researchers' directions closely . They will advise you when to start each task and when the time allotted for study of the material has ended.

Once the task has been completed, put the materials back into the proper envelope and wait quietly for the others to finish. Please do not look through subsequent envelopes until the researcher in charge of the study gives the go-ahead.

Please note that other students in the room will be working on slightly different materials, so we ask that you ignore them and attend to your task only.

DO YOU HAVE ANY QUESTIONS REGARDING THESE INSTRUCTIONS?

Thank you for your assistance and cooperation.

APPENDIX B

Interpolated Task

Math Quiz

Please perform the following mathematical calculations without using a calculator:

1. Add:

17	58	354	2287
8	14	465	1981

2. Subtract:

(a) 17 from 30 ? _____

(b) 20 from 221 ? _____

(c) 68 from 162 ? _____

(d) 12 from 9 ? _____

3. Multiply:

(a) 12 by 10 ? _____

(b) 13 by 13 ? _____

(c) 118 by 20 ? _____

(d) 146 by 54 ? _____

4. Divide:

(a) 46 by 6 ? _____ (b) 2346 by 32 ? _____

APPENDIX C

Free Recall Test

TEST - Part 1

Let us say that listening to "The Human Circulatory System" was assigned by your course professor. Let us also say that before this class, a friend told you that he cannot come and asked you to tell him next meeting all about the Human Circulatory System, so he will be able to catch up with the others.

Please write down (on the accompanying sheet of paper) in complete sentences, all that you can recall from "The Human Circulatory System," so that you would be able to give your friend a thorough account of its contents when you see him.

TEST - Part 1

Let us say that the reading of "The Human Circulatory System" was assigned by your course professor. Let us also say that before this class, a friend told you that he cannot come and asked you to tell him next meeting all about the Human Circulatory System, so he will be able to catch up with the others.

Please write down (on the accompanying sheet of paper) in complete sentences, all that you can recall from "The Human Circulatory System," so that you would be able to give your friend a thorough account of its contents when you see him.

APPENDIX D

Multiple-Choice Test A

TEST DIRECTIONS

This test is made up of twenty (20) multiple-choice questions which were drawn from the passage you read or listened to.

You will find an answer sheet included in the envelope. You are requested to use this answer sheet to respond to the questions. If you do not know or are not sure which of the given answers is the correct one, you are asked to choose the one that you believe is most likely to be correct

EXAMPLE:

Question No. 1 The capital of Canada is:

a. Regina

b. Montreal

c. Ottawa

d. Toronto

Of course the correct answer is (c) and you would indicate this by encircling (c) beside the appropriate question on your answer sheet:

1. A B (C) D

If you commit a mistake and want to change your answer, just cross out your first selection with an "X" and then encircle your new choice: <u>You have fifteen minutes for the task</u>.

1. (A) B ~~(C)~~ D

1. Where does most of the exchange of materials between the blood and the other tissues take place?

   a. across the thin walls of the vein

   b. across the thin walls of the capillaries

   c. in all of the body's vessels

   d. between the mass of tissues separating the left ventricle from the right ventricle

2. According to the "Human Circulatory System," how do the two nodal tissues mentioned operate to produce contractions?

   a. the SA node fires first and stimulates the AV node

   b. the AV node fires first and stimulates the SA node

   c. they fire simultaneously

   d. they fire independently

3. Alveoli are found:

   a. at the point of gas exchange in the bodily tissues

   b. at the point of gas exchange in both bodily tissues and lungs

   c. only in the lungs

   d. only in the ventricular musculature

4. Living cells seek the essential raw materials that they need. Similarly, they must rid themselves of wastes or used raw materials. This activity is called:

   a. synthesis

   b. metabolism

   c. osmosis

   d. symbiosis

5. Blood leaving the right ventricle may best be characterized as containing:

   a. less oxygen, more carbon dioxide

   b. less carbon dioxide, more oxygen

   c. an abundance of nutrients

   d. much oxygen

6. The left ventricle of a heart contains which of the following?

   a. blood that has just come from the body

   b. blood that will go next to the lung

   c. blood that is not yet oxygenated

   d. blood that is recently oxygenated

7. The four pulmonary veins empty into the _____ chamber of the heart, called the _____.

   a. upper left, left atrium

   b. upper right, right atrium

   c. lower left, left ventricle

   d. upper right, right ventricle

8. The post and pre vena cava _____ carry blood _____ heart.

   a. veins, towards the

   b. artery, away from

   c. veins, away from

   d. artery, towards the

9. The dorsal aorta is a _____ carrying blood _____ heart.

   a. artery, towards the

   b. artery, away from the

   c. vein, away from the

   d. vein, towards the

10. When it contracts, the right ventricle sends the blood through a valve into the pulmonary artery, which then divides into:

   a. four chambers going to each lung

   b. two branches going to each lung

   c. two branches going to the brain

   d. the pulmonary vein

11. Where is the Sino-atrial node located?

   a. near the Atrio-ventricular node

   b. near the interventricular septum

   c. near the anterior vena cava

   d. on the outside of the aortic arch

12. What will happen if the nerve connections to the heart are cut?

   a. the heart will stop beating

   b. the rate of beat may change slightly

   c. the rate of heartbeat will fluctuate erratically

   d. the heartbeat will remain unchanged

13. Which among the following best describes the function of the human circulatory system?

    a. delivery system

    b. thermostat

    c. heat exchanger

    d. pumping system

14. From the capillaries, blood enters into small veins which soon join to form large _____ veins running back toward the heart from the lungs.

    a. portal

    b. hepatic

    c. pulmonary

    d. cardinal

15. What substances might you expect to find in blood flowing in the pulmonary vein?

    a. carbon dioxide and nitrogenous wastes

    b. oxygen and nutrients

    c. oxygen alone

    d. carbon dioxide alone

16. The area where beds of capillaries in the walls of the alveoli connect with the small arteries is where _____ takes place.

    a. deoxygenation

    b. waste exchange

    c. gas exchange

    d. aeration

17. Which of the following sets correctly represents the flow of blood within the heart?

    a. right auricle, right ventricle, left auricle, left ventricle.

    b. right ventricle, left ventricle, right auricle, left auricle.

    c. right ventricle, right auricle, left ventricle, left auricle.

    d. left ventricle, left auricle, right ventricle, right auricle.

18. How is the heart nourished with blood?

    a. it extracts nutrients through its inner walls.

    b. the coronary artery feeds it.

    c. blood is sent to it directly from the lungs by one branch of the pulmonary vein.

    d. the heart does not need nourishment.

19. What is the first branch of the aorta?

    a. carotid artery.

    b. coronary artery.

    c. pulmonary artery.

    d. subclavian artery.

20. According to the "Human Circulatory System," William Harvey is credited with:

    a. discovering the existence of capillaries.

    b. defining the science now known as physiotheraphy.

    c. outlining the basic components of the circulatory system.

    d. writing a book on the respiratory system.

APPENDIX E

Multiple-Choice Test B

TEST DIRECTIONS

This test is made up of twenty (20) multiple-choice questions which were drawn from the passage you read or listened to.

You will find an answer sheet included in the envelope. You are requested to use this answer sheet to respond to the questions. If you do not know or are not sure which of the given answers is the correct one, you are asked to choose the one that you believe is most likely to be correct

EXAMPLE:

Question No. 1 The capital of Canada is:

a. Regina

b. Montreal

c. Ottawa

d. Toronto

Of course the correct answer is (c) and you would indicate this by encircling (c) beside the appropriate question on your answer sheet:

1. A B (C) D

If you commit a mistake and want to change your answer, just cross out your first selection with an "X" and then encircle your new choice: You have fifteen minutes for the task.

1. (A) B ~~(C)~~ D

1. Which statement best describes the pumping device known as the heart?

   a. a two-way action with one-way valves.

   b. a one-way action with two-way valves.

   c. a one-way action with one-way valves.

   d. a two-way action with two-way valves.

2. What substances might you expect to find in blood flowing in the pulmonary artery?

   a. carbon dioxide and other waste products.

   b. oxygen and other cellular nutrients.

   c. oxygen alone.

   d. a mixture of carbon dioxide and oxygen.

3. Which of these statements most accurately defines the term Physiology?

   a. explanations of bodily functions in terms of the physical sciences.

   b. the comparative study of higher and lower forms of animals.

   c. ~~the science~~ which studies the circulatory system.

   d. a science which studies the interaction of the neurons system and the circulatory system.

4. In the "Human Circulatory System," "warm blooded" refers to animals which:

   a. have four-chambered hearts.

   b. can resist fluctuations of environmental temperature.

   c. have precise control mechanisms over their circulatory system.

   d. can vary their metabolic rate depending on climatic conditions.

5. It is more important for the ventricles to contract as a unit because:

   a. they must force blood through a long chamber of veins which in turn, would transmit impulses like nerve to the AV node.

   b. they must force blood through a bundle of branching fibers and then let the blood flow at regular intervals.

   c. they must force blood to flow sequentially through a long system of capillaries, then to the arteries and then to the veins, wave-like.

   d. they must force blood through a long system of arteries, capillaries and veins, thus producing simultaneous contraction of all the parts.

6. The beating of the two halves of the human heart is inherent in the heart itself and not dependent on stimulation from the:

   a. digestive system

   b. nervous system

   c. lymphatic system

   d. systemic circulation

7. Identify the very large artery which carries blood from the left ventricle, to the tissues of the body.

   a. pulmonary artery

   b. coronary artery

   c. aorta

   d. subclavian artery

8. Which of these best describes the circulatory system as indicated in "The Human Circulatory System?"

   a. a very elaborate transportation system.

   b. a necessary structure in all living things

   c. required only in "warm-blooded" animals.

   d. two systems in one.

9. The work of William Harvey set the stage for:

   a. the current science known as physics and chemistry.

   b. the continuing study of respiratory disease.

   c. the modern study of physiology.

   d. recent findings regarding pulmonary resuscitation.

10. If the nerve connections to the heart are cut, which among the following is most likely to happen?

   a. the heart will stop beating.

   b. the heart will keep on beating.

   c. the rate of heartbeat will rise and fall irregularly.

   d. the rate of beat may change slightly.

11. Where would you expect to find arteries leading to the head and upper body?

   a. extending out of the heart itself.

   b. branching in the region of the aortic arch.

   c. branching from the pulmonary vein.

   d. arising from the pulmonary artery.

12. The two sides of the heart:

    a. beat separately, producing the characteristic "lub-dub" sound.

    b. beat essentially in unison.

    c. produce heartbeats which differ by less than a second.

    d. produce heartbeats as a result of entirely separate mechanisms.

13. How many pulmonary veins are there?

    a. two, one for each lung.

    b. one, from the combined right and left lung.

    c. four, two from each lung.

    d. three, counting the superior vena cava which enters at the same place.

14. What is the name of the intermediate size vessels which feed the capillaries, in both the lungs and in other body tissues?

    a. auricles.

    b. septae.

    c. arterioles.

    d. veins.

15. Which statement is true of the AV node?

    a. contracts like muscle and transmits impulses like nerve.

    b. located near the anterior vena cava.

    c. prevents the blood from flowing backwards in the heart.

    d. is stimulated by the central nervous system.

16. What forces the blood through a valve into the left ventricle, which is the lower chamber of the heart?

    a. contraction of the left atrium.

    b. steady flow of blood from the ventricle.

    c. the elastic recoil of blood from the ventricle.

    d. the pericardium, which minimizes friction on the outer surface of the beating heart.

17. In the "Human Circulatory System," the term <u>closed circulatory system</u> means:

    a. that blood passes through the heart twice during each cycle.

    b. that blood always travels in the same direction.

    c. blood travels on a rigidly circumscribed path.

    d. circulation provides two major functions for the body.

18. What is the primary function of the alveoli?

    a. to control blood flow through a series of check valves.

    b. to activate and control heartbeat and heart rate.

    c. to allow for the free exchange of oxygen and carbon dioxide in the muscles and bodily organs.

    d. to aid in the exchange of oxygen and carbon dioxide in the lungs.

19. Which of the following completely separates the two atrium and the two ventricles from each other?

    a. left internal lilac artery.

    b. partial septae.

    c. inferior vena cava.

    d. interventricular septum.

20. According to "The Human Circulatory System," why does the heart have two sets of chambers?

    a. to increase the pressure needed to keep the blood flowing.

    b. to prevent blood from reversing its direction in the vessels.

    c. to maintain the separation of oxygenated and deoxygenated blood.

    d. to provide blood to the heart muscle as well as the rest of the body.

APPENDIX F

Prose Passage with cues

DIRECTIONS

You will have fifteen (15) minutes in which to study this passage, entitled "The Human Circulatory System," The passage is seven (7) typewritten pages long.

Pay close attention to the set of illustrations that accompany this passage, and refer to the illustrations when instructed to do so.

Please attend to the passage very carefully. You will be asked to write down as much as you can recall from the passage once you have finished. The final task is a twenty (20) item multiple-choice test which will assess how well you understood and recalled the information contained in the illustration and in the passage.

If you have any questions, please raise your hand and you will be assisted.

PLEASE DO NOT TURN THE PAGE UNTIL INSTRUCTED TO DO SO.

Every living cell, whether it exists alone as a single-celled organism or as a component of a multicellular one, must perform its own metabolic activities. It follows, then, that every cell must obtain the necessary raw materials to support its metabolism. It must obtain nutrients and oxygen. Likewise, it must rid itself of metabolic wastes such as carbon dioxide. In fact, every cell must be exposed to a medium from which it can extract raw materials and into which it can dispel wastes. In larger and structurally more complex multicellular plants and animals, the more internal cells are far from the body surface and from the general environmental medium. Thus, some mechanism is needed for transporting substances between the specialized systems of procurement, synthesis, or elimination and the individual living cells throughout the body. The transport system necessary is provided by the circulatory system.

Most higher animals have a true circulatory system. Blood is moved round and round through the body along a fairly definite path. This circulatory system usually has some sort of pumping device called a heart. The heart follows a one-way pumping action usually combined with a system of one-way valves. This pumping action carries the blood in a regular fashion through the circuit. For higher animals, this circuit is one which is rigidly encompassed in well-defined vessels. We call this a closed circulatory system.

Man, like all vertebrates has a closed circulatory system, which consists basically of a heart and numerous arteries, capillaries and veins (Refer to figure 1). An artery is a blood vessel carrying blood away from the heart (for example, the dorsal aorta), while the vein is a vessel carrying blood back toward the heart (for example, the post and pre caval veins). Capillaries, meanwhile, are tiny blood vessels that interconnect the arteries with the veins. Note that it is across the thin walls of the capillaries that most of the exchange of materials between the blood and the other tissues takes place.

Since the continious beating of the heart is one of the most observable aspects of the body's operation, and since blood vessels can readily be seen through your skin on the wrist, it may seem to you that the basic idea of blood circulation via the heart, arteries and veins is pretty obvious. Yet it took a while before the idea of the heart as a pump was understood and accepted. Our understanding of how our body functions started in 1628 when William Harvey, an English biologist published a book entitled Anatomical Dissertation Concerning the Motion of the Heart and Blood. Here, Harvey clearly enunciated the idea of circulation of blood and outlined the basic components of the circulatory system as we know them today. His work not only improved knowledge of the

circulatory system, but also marked the beginning of the modern science of physiology, the attempt to understand bodily processes in terms of physics and chemistry.

Let us trace the movement of blood through the human circulatory system, beginning with that returning to the heart from the legs or arms (Refer to figure 2). Returning blood enters the upper right chamber of the heart called the right atrium or auricle. This chamber then contracts, forcing the blood through a valve into the right ventricle, the lower right chamber of the heart. Now, this blood, having just returned to the heart from its circulation through tissues, contains little oxygen and much carbon dioxide. It would be of little value to the body simply to pump this deoxygenated blood back out to the general body tissues. Instead, contraction of the right ventricle sends the blood through a valve into the pulmonary artery, which soon divides into two branches, one going to each lung.

In the lungs, the pulmonary arteries branch into many small arteries called arterioles, which connect the dense beds of capillaries lying in the walls of the alveoli. Here, gas exchange takes place, carbon dioxide being discharged from the blood into the air in the alveoli and oxygen being picked up by the hemoglobin in the red cells of the blood. From the capillaries, the blood passes into small veins, which soon join to form pulmonary veins running back

toward the heart from the lungs.

The movement of the blood through the circulatory system further continues with the pulmonary vein (Refer to figure 3). The four pulmonary veins - two from each lung - empty into the upper left chamber of the heart, called the left atrium of auricle. When the left atrium contracts, it forces the blood through a valve into the left ventricle, which is the lower chamber of the heart. The left ventricle, then, is a pump for recently oxygenated blood. When it contracts, it pushes the blood through a valve into a very large artery called the aorta, which carries blood to the tissues of the body.

As you can see, the pumping device just described is, in effect, two hearts in one, since the blood in the left side of a normal heart is completely separated from blood in the right side. This type of heart is known as a four chambered heart, as it consists of two atrium and two ventricles, which are completely separated from their counterparts by an interventricular septum. This is characteristic of mammals and birds, the two groups of vertebrates commonly termed "warm-blooded." These animals maintain relatively constant high body temperatures, regardless of fluctuations in the environmental temperature. They also have high metabolic rates and very precise internal control mechanisms. Constant perfusion of the tissues with blood rich in oxygen is clearly essential to them. It would be highly disadvan-

tageous to such animals if the oxygen-rich blood returning to the heart from the pulmonary circulation were mixed with the oxygen-poor blood returning from the systemic circulation. Now let us examine the route that oxygen-rich blood takes after it leaves the heart.

Numerous branch arteries arise from the aorta (the largest artery) along its length, and these arteries carry blood to all parts of the body (Refer to figure 4). For example, the first branch of the aorta is the coronary artery, which carries blood to the muscular wall of the heart itself. Other early branches of the aorta, which arise in the region of the aortic arch are the arteries that supply the head, neck, and arms. As the aorta runs posteriorly, arteries to the body wall, stomach, intestines, liver, pancreas, spleen, kidneys, and the legs arise from it. Each of these arteries, in turn, branches into smaller arteries, until eventually the smallest arterioles connect with the numerous tiny capillaries embedded in the tissues. Here, oxygen, nutrients, hormones, and other substances move out of the blood into the tissues. Such waste products as carbon dioxide and nitrogenous wastes are picked up by the blood, and substances to be transported, such as hormones secreted by the tissues, are also picked up. The blood then runs from the capillary bed into tiny veins, which fuse to form larger and larger veins, until eventually one or more large veins exit

from the organ in question and proceed on their way back to the heart. These veins, in turn, empty into the right atrium of the heart.

Even though the human heart is double, the two halves beat essentially in unison. The beating is inherent in the heart itself and not dependent on stimulation from the central nervous system. If all the nerve connections to the heart are cut, the heart will continue to beat in a normal manner, although the rate of beat may change slightly. As you probably know, the heart of a frog or turtle can continue to beat after its complete removal from the animal's body, if it is placed in a solution with proper osmotic concentration. Clearly, the initiation of the beat and the beat itself are intrinsic properties of the heart, but the rate of beat is partly regulated by stimulation from two sets of nerves.

The initiation of the heartbeat normally comes from a small mass of tissues on the wall of the right atrium near the point where the anterior vena cava empties into it (Refer to figure 5). This mass of tissue, called the sino-atrial, or SA node, is very important. A second mass of nodal tissues called atrio-ventricular or AV node, is located in the lower part of the partition between the two atria. A bundle of nodal tissue fibers runs from the AV node into the walls of the two ventricles, branching to penetrate into all parts of the ventricular musculature. The nodal tissue can contract like

muscle and it can transmit impulses like nerve. At regular intervals, a wave of contraction spreads from the SA node across the walls of the atria. When this wave of contraction reaches the AV node, the node is stumulated and excitatory impulses are rapidly transmitted from it to all parts of the ventricles via the bundle of branching fibers. These impulses stimulate the ventricles to contract as a unit.

It is easy to see why it should be adaptively more important for the ventricles to contract as a unit. After all, the ventricles must force blood through a long system of arteries, capillaries, and veins, and hence must exert great pressure on the blood. They can exert a greater force more efficiently if contraction occurs in all parts at once instead of moving across the chamber as a wave.

APPENDIX G

Prose Passage without cues

DIRECTIONS

You will have fifteen minutes (15) to study the following passage entitled "The Human Circulatory System." The passage is seven (7) typewritten pages long.

Please read the passage very carefully, because you will be asked to write down as much as you can remember from the passage once you have finished. The final task is a twenty (20) item multiple choice test which will assess how well you understood and remembered the information contained in the passage.

If you want to ask any questions, please raise your hand and you will be assisted.

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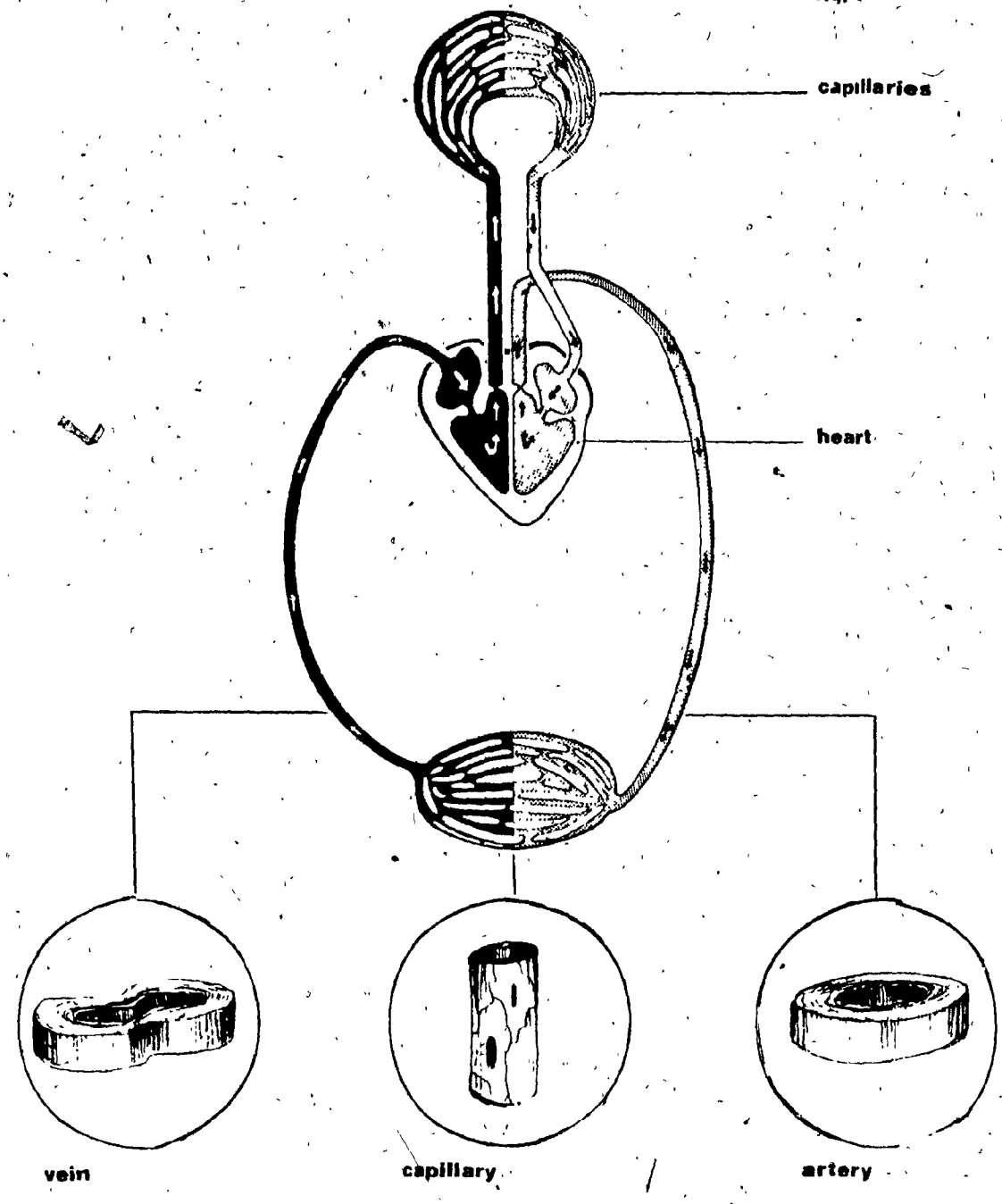
APPENDIX H

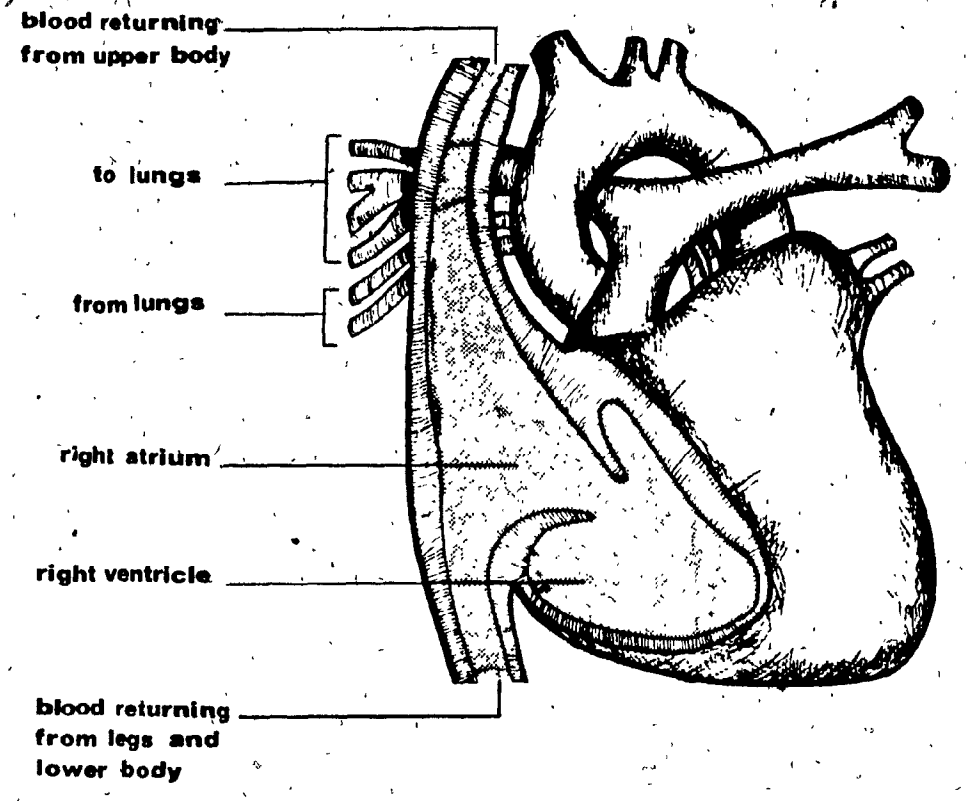
Pictorial Illustrations

fig. 1



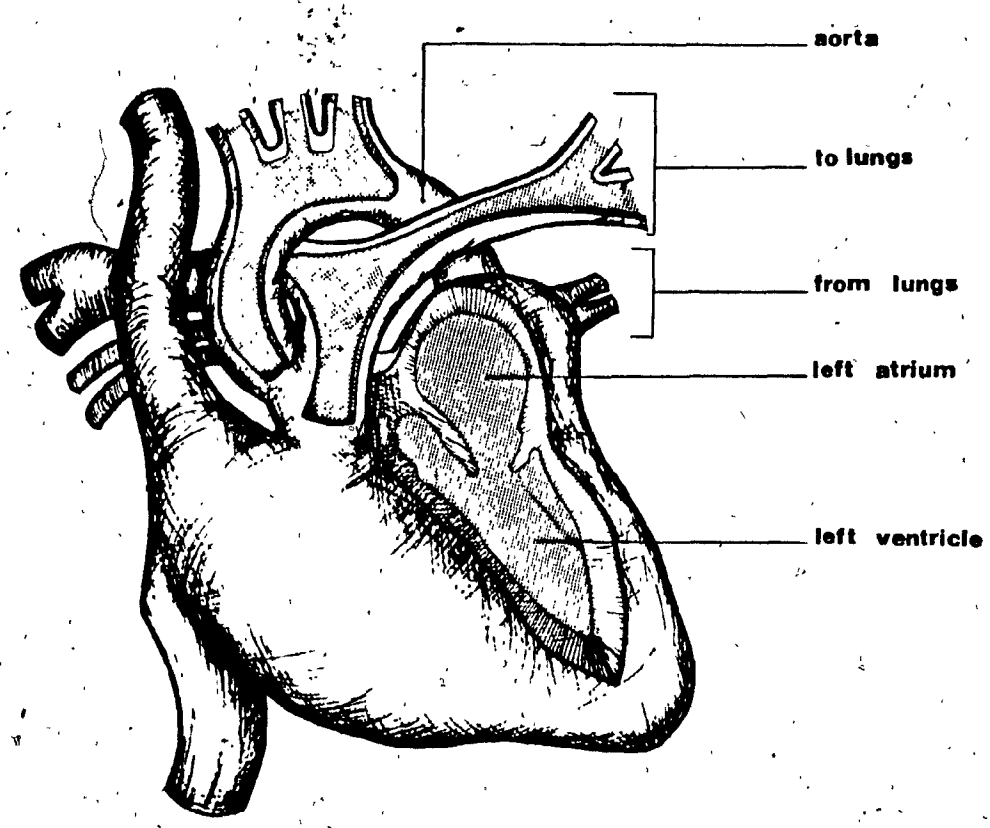
Note: 75% of the original size

fig. 2



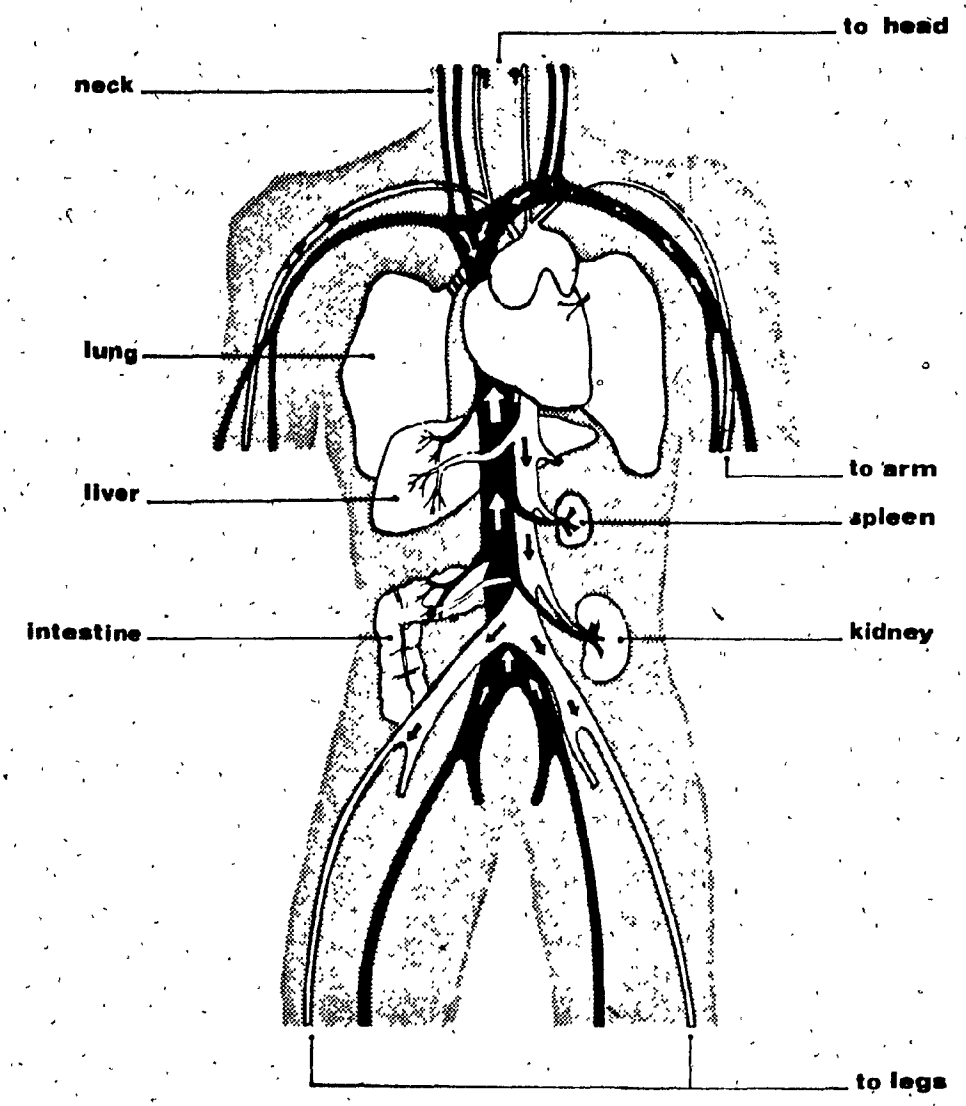
Note: 75% of the original size

fig. 3



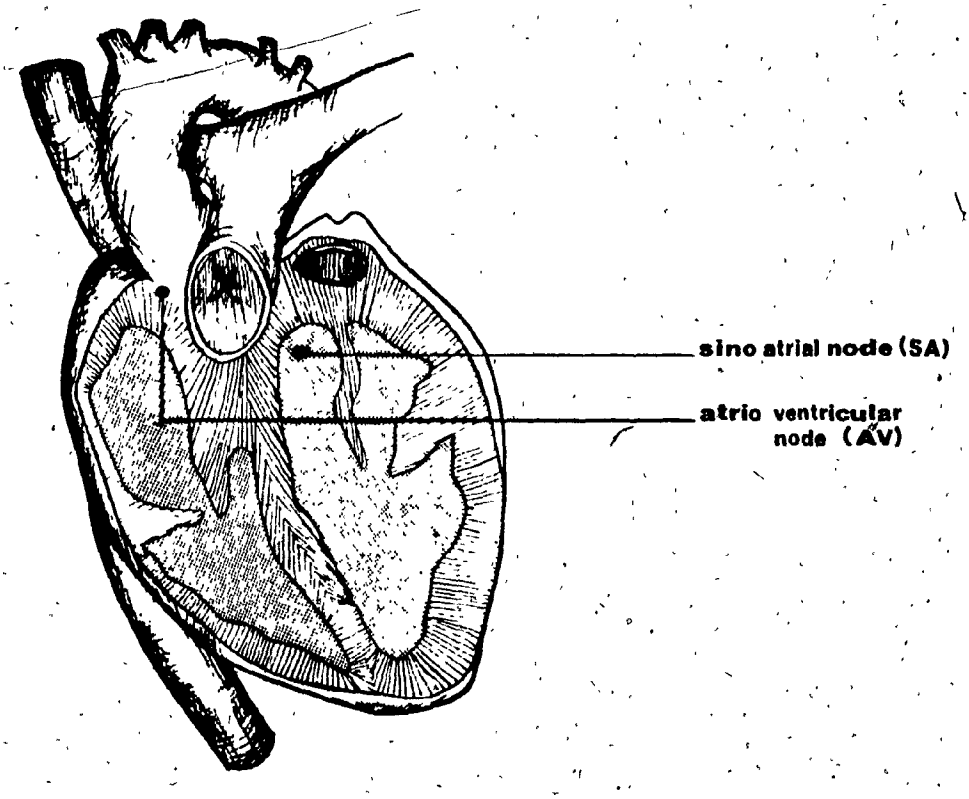
Note: 75% of the original size

fig. 4



Note: 75% of the original size

fig. 5



Note: 75% of the original size

APPENDIX I

Answer Sheet

ANSWER SHEET

STUDENT NO. _____

DATE _____ AGE _____

QUESTION No.

1.	A	B	C	D	11.	A	B	C	D
2.	A	B	C	D	12.	A	B	C	D
3.	A	B	C	D	13.	A	B	C	D
4.	A	B	C	D	14.	A	B	C	D
5.	A	B	C	D	15.	A	B	C	D
6.	A	B	C	D	16.	A	B	C	D
7.	A	B	C	D	17.	A	B	C	D
8.	A	B	C	D	18.	A	B	C	D
9.	A	B	C	D	19.	A	B	C	D
10.	A	B	C	D	20.	A	B	C	D

Please indicate with a check mark (✓) how well you knew the contents of the passage <u>before</u> you read it.

1	2	3	4	5	6	7
Not at all			Fairly well			Very well

APPENDIX J

Explanatory Notes

Dear Fellow Student:

The research study you are participating in is part of a series of four experiments undertaken to answer these following questions:

a) What relationship exists between visually read information and pictorial illustrations?

b) What relationship exists between verbally heard information and pictorial illustrations?

c) Under what conditions do pictures have a facilitative effect on learning?

d) Do picture/prose conditions have differential effectiveness for readers of different abilities?

Your group was assigned to one of the four learning conditions, with the two reading ability groups (i.e. high and low) equally represented in each.

The four learning conditions are:

1. The verbal information condition only (audiotaped version
2. The verbal information plus picture condition (audiotaped version plus pictures) of the "Human Circulatory System,"
3. The printed version only of the "Human Circulatory..."
4. The printed version of the "Human..." plus pictorial illustrations.

Both an immediate and a delayed posttest are being administered to determine how the treatments affect longer-term recall and understanding. The study can be meaningful only if you participate all throughout the experimental session, especially in todays delayed posttest. Incidentally, another purpose of the study is to design instructional materials that will be useful especially to lab courses at the university level. This means that eventually, you will benefit from this study. Once again, thank you for your cooperation and for bearing with us.

Purpose of the Study

The general purpose of the study you participated in was to attempt to find out if the inclusion of pictures in a relatively complex subject matter would enhance memory and comprehension.

Interpretation of tests

Nelson-Denny Vocabulary Test This test measures your verbal ability and also provides an indication of how well you learn from reading. It also provides the researcher with a tool to control for the differences in reading ability so that if the pictures have an effect on learning, then it can be assumed that the pictures account for the effect, and not some other influence.

Math Quiz The short math quiz you received was not designed to assess your arithmetical skills. Rather, its purpose was to reduce the effects of short-term memory so that we could better measure your long-term verbal memory.

Free Recall This test is used to collect both quantitative and qualitative information stored in your long-term memory.

THANK YOU ONCE AGAIN FOR YOUR HELP AND COOPERATION!