Effect of Presentation Mode and Students' Prior Knowledge on Achievement (Visual/Verbal Testing) of Different Educational Objectives

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Abstract: The purposes of this study were to determine a) the effectiveness wlth which different types of rehearsal strategies complementing visualized instruction facilitates student achievement; b) the effect of different instructional treatment on students' possessing different prior knowledge levels; and c) whether verbal and visual tests are equally effective in retrieving information acquired from visualized instruction. One hundred twenty students enrolled at The Pennsylvania State University were randomly assigned to four treatment groups which determined both the method of instruction and testing mode they received. Students received their respective instructional presentations and criterion tests in one session. Analyses indicated that: a) students possessing different entry levels of prior knowledge profit differentially from the different treatments; b) differences in achievement potential among students with varying prior knowledge levels can be reduced, in terms of information acquisition, by providing instruction with elaborate rehearsal activity; c) Identical treatments are not equally effective in promoting student achievement for different types of educational objectives; and d) visual testing is a viable strategy for retrieving information acquired by students receiving visualized instruction.

Résumé: Les buts de cette étude est de déterminer: a) l'efficacité des différentes sortes de stratégies de répétition qui sont le complément de l'apprentissage visuel sur réussite des étduiants; b) l'effet d'un d'une stratégie différente sur les étudiants possédant d'autres niveaux de connaissances préalables: et c) si les analyses visuelles et verbales sont efficaces pour le rappel de l'information acquise d'une instruction visuelle. Cent-vingt étudiants inscrits au Pennsylvanla State Unlverslty étaient assignés au hasard à quatre groupes expérimentaux qui déterminaient leurs méthodes d'instruction et leurs façons d'analyse. Les analyses ont que: a) les étudiants possédant différents niveaux de connaissances préalables profitent des divers traitements par une action dlfférentielle; b) les étudiants ayant un niveau de connaissances préalables variable peuvent réduire les différences de performance, tout en fournissant un enseignement avec une répétition d'une activité complexe: c) des traitements identiques ne sont pas également effectifs pour promouvoir une réussite des étudiants dans différentes types d'objectifs pédagogiques: et d) le testing visuel est une stratégie viable pour la récupération de l'informaation acquise par les étudiants ayant reçu un enseignement visuel.

INTRODUCTION

Rehearsal

Considerable research (Paivio, 1971; Tulving, 1976; Dwyer, 1978; 1987) has indicated that merely using visual materials to complement oral or verbal instruction does not always optimize student learning. Gagne (1977) indicated that learning is a highly idiosyncratic event, and depends very much on the

nature of the learner- particularly on his prior learning. In order for learning to be effective at any level, the learners must be active (Bork, 1979; Bransford, 1979; Travers, 1970). In this regard, Murray and Mosberg (1982) have indicated that the longer an individual can be involved in rehearsal type activities (taking notes, summarizing, responding to question, etc.) where he/she is actively processing information related to the content material, the greater the possibility that this information will be moved from short term into long term memory and the greater the possibility that increased learning will occur and be retained. Mental activity on the part of learners is essential for learning to occur. This activity includes the selection and perception of stimuli; encoding of new stimuli, and the retrieval of prior knowledge for use in combination with the new stimuli for imaging, comparison, analysis, synthesis, and problem-solving. Varied forms of rehearsal, while focusing attention, allow time for incoming information to remain in short-term memory long enough to be elaborated upon and encoded for long-term memory (Anderson, 1980; Dushkin, 1970; Lindsay & Norman, 1972; Murray & Mosberg, 1982). Lindsay and Norman (1972) have argued that the longer an item is maintained in short-term memory by rehearsal, the greater the probability that it will be transmitted into long-term memory and be retained.

In general, rehearsal can be considered to be any mathemagenic activity that can serve the learner in several ways including motivating and promoting appropriate mental activity. Additionally, different rehearsal strategies differ in intensity of learner involvement and, thus, may have differential effects on specific learning outcomes. If this is the case, then it may also follow that optimum intensity of rehearsal activity (actual overt interaction with the content material) may be directly related to the level of learning to be achieved — the more complex learning requiring the most intense or involved type of rehearsal activity. For example, covert rehearsal generally requires minimal information processing activity on the part of the learner. Examples of covert rehearsal include reading prose passages, reading summary statements, reading questions and answering them mentally before checking with a given answer, and following mentally the completed solution of a problem. Researchers have found that reading correct statements or correct answers does not always provide for a level of mental processing that results in increased understanding (Anderson, Goldberg, & Hiddle, 1971; Bransford, 1979). Overt rehearsal, by providing physical activity in which the learner is required to interact with the content material, ensures that he/she attends to the information and spends more time interacting with and encoding the information. Using visualization to complement oral or verbal instruction is presumed to be a form of overt rehearsal since it provides the learner with the opportunity to observe the structure of the constructs being illustrated and also their relationship to other constructs in the illustration. For example, when using visualization to complement instruction on the structure of the human heart the student can quickly see what the structure of the mitral valve looks like and also by further inspection (interaction) its location between the left auricle and right ventricle.

Visual Testing

The transmission, acquisition and the subsequent retrieval of information are primary concerns in any instructional/training environment. In considering factors that might enhance this process, Tulving and Thomson (1973) have proposed the encoding specificity principle — that recognition memory is better if the cues used in the original instructions/acquisition environment are used in the testing retrieval environment. Similarly, Battig (1979) and Nitsch (1977), in adhering to the encoding specificity principle, have indicated that any change in the retrieval environment from that which occurred in the original learning environment produces marked decrements in learner performance.

Support for the use of visual test items that employ visuals of the same type as those employed in the instruction has surfaced regularly in the research literature in the form of hypotheses and theories; for example, the sign-similarity hypotheses (Carpenter, 1953), cue summation theory (Tulving & Thomson, 1973), and transfer-appropriate processing principle (Morris, Bransford, & Franks, 1977). Lindsay and Normal (1977, p. 337) have stated that in the teaching-learning environment, "the problem in learning new information is not getting the information into memory; it is making sure that it will be found later when it is needed. "Bransford (1979), Tulving (1979), and Tulving and Osler (1968) have indicated that the accuracy with which information is retrieved is related to the degree of elaborateness of the encoding which occurred during the rehearsal activity.

Consequently, information retention level is assumed to be a direct function of the encoding occurring at the presentation stage and the degree to which the retrieval environment recapitulates this encoding (Battig, 1979; Tulving, 1979). The implications of this position would imply that in instructional situations where visualization was utilized in the encoding process and was not used in the retrieval (decoding) process, learner performance measures would yield gross underestimates, if not distortions, with respect to what and how much information had been originally required. This conceptualization suggests that information retrieval is a very specific process, easily disrupted. Since the features of the original learning cues have processed during a test, any reduction in the individual distinctiveness of the cues themselves should produce concomitant reductions in recall (Nelson, 1979).

PROBLEM STATEMENT

The purpose of this study was to investigate the instructional effectiveness of integrating rehearsal activity intovisually complemented prose instruction. Within this context the instructional effectiveness of both overt and covert rehearsal activity was examined Additionally, the study examined the effect that students' level of prior knowledge had on learning and the effect of visual/verbal testing had on information retrieval. Specifically, the purpose of this

study was todetermine: a) whether students possessing different prior knowledge levels profit differentially from different instructional treatments; and b) whether visual testing is a viable strategy for retrieving information acquired by students receiving visualized instruction.

VERBAL AND VISUAL TESTS (CRITERION MEASURES)

Students in each instructional group participated in their respective treatments followed immediately by four criterion tests (drawing, identification, terminology, and comprehension). The identification, terminology and comprehension criterion tests were in multiple-choice formats in both the verbal and visual versions. Scores on these three tests were combined into a 60-item composite test score (each test will be described below).

The three multiple-choice tests (verbal format) used in this investigation were developed by Dwyer (1972). Additional revisions were made to selected multiple-choice questions to further eliminate the ambiguity of specific distracters and to attempt to prevent a specific question and its distracters from clueing another answer (Dwyer, 1985-1986). The format of each of the 60 multiple-choice items consisted of a typical verbal stem and verbal response options. The following description of the criterion tests, adapted from Dwyer (1978, pp. 45-47) illustrates the kinds ofeducational objectives assessed in this study.

Drawing Test. The objectives of the drawing test was to evaluate student ability to construct and/or reproduce items in their appropriate context. The drawing test (20 items) provided the students with a numbered list of terms corresponding to the parts of the heart discussed in the instructional presentation. The students were required to draw a representative diagram of the heart and place the numbers of the listed parts in their respective positions. For this test the emphasis was on the correct positioning of the verbal symbols with respect to one another and in respect to their concrete referents.

Identification Test. The objective of the identification test was to evaluate student ability to identify parts or positions of an object. This multiple-choice test (20 items) required students to identify the numbered parts on a detailed drawing of a heart. Each part of the heart, which had been discussed in the presentation was numbered on a drawing. The objective of this test was to measure the ability of the student to use visual cues to discriminate one structure of the heart from another and to associate specific parts of the heart with their proper names.

Terminology Test. This test consisted of 20 multiple-choice items designed to measure knowledge of specific facts, terms, and definitions. The objectives measured by this type of test are appropriate to all content areas that have an understanding of the basic elements as a prerequisite to the learning of concepts, rules, and principles.

Comprehensive Test. The comprehension test consisted of 20 multiple-

choice items. Given the location of certain parts of the heart at a particular moment of its functioning, the student was asked to determine the position of other specific parts of the heart at the same time. This test required that the students have a thorough understanding of the heart, its parts, its internal functioning, and the simultaneous processes occurring during the systolic and diastolic phases. The comprehension test was designed to measure a type of understanding in which the individual can use the information being received to explain some other phenomenon.

Composite Test Score. The items contained in three of the four individual criterion tests (identification, terminology, and comprehension) were combined into a 60-item composite test score. The purpose was to measure the total achievement of the varied levels of objectives presented in the instructional unit.

Visual Criterion Tests. In designing the visual test formats for the identification, terminology and comprehension tests, the visual tests developed by De Melo (1980) were used as a guide. The revised version of the visual form of the criterion tests utilized only one drawing with four or five letter labels in all items in which it was possible to do so while maintaining clarity and correspondence to the verbal test items (See Figure 1 on page 204). However, two items in the terminology test and all items in the comprehension test required four drawings. The item stems of both the verbal and visual test questions were verbal and asked the same question. In addition, the visual distracters in the visual tests corresponded to the verbal distracters in the verbal tests as closely as was reasonable. The description of the verbal tests given previously also describes the visual tests.

INSTRUCTIONAL TREATMENTS

Each of the four instructional treatments in this study contained the same instructional script, visuals, terminology labels, and arrows. The treatments differed only in the degree of rehearsal employed and the type of testing employed (verbal or visual). Figure 2, Plate 1 (page 205) illustrates a sample frame received by students in Treatments 1 (Reading Summaries — Verbal Test). Students receiving Treatment 2 received the same instruction as did students in Treatment 1 (Figure 2, Plate 1); however, instead of receiving the verbal tests the students in Treatment 2 received the multiple choice criterion tests in thevisual test format. The summary statements at the end of each page required a minimal amount of covert rehearsal on the part of thestudents and did not review all the information in the instructional script. the summary statements were designed to provide the students with the opportunity for mental review of the instructional content.

Figure 2 (Plate 2) illustrates a sample frame received by students in Treatment 3. This treatment required that students shade with colored pencils the specified parts and functions of the heart. Students receiving Treatment 4

Figure 1.
Sample Questions from the Tests in the Visual Format.

Plate 1: Sample questions from the identification test (visual format)

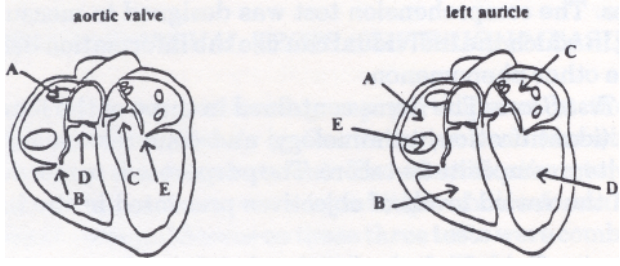
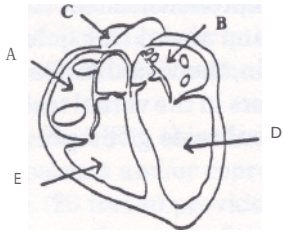


Plate 2: Sample questions from the terminology test (visual format)

The chamber of the heart that pumps oxygenated blood to all parts of the body:



The part(s) of the heart that control(s) its contraction and

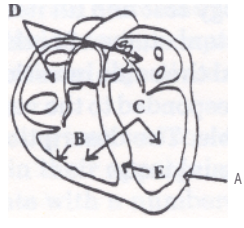


Plate 3: Sample questions from the comprehension test (visual format)

The parts of the heart though which blood is being forced during the second contraction of the systolic phase:

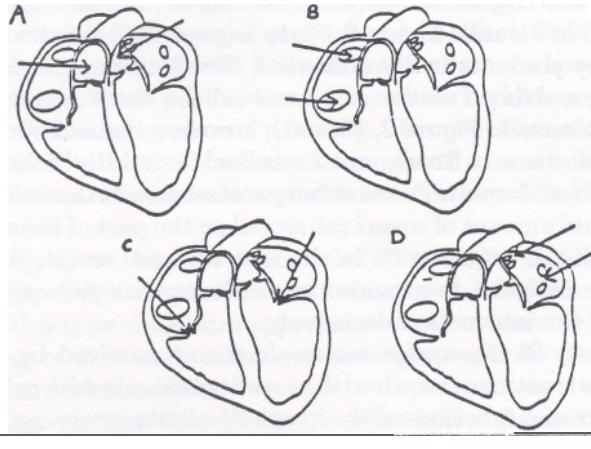
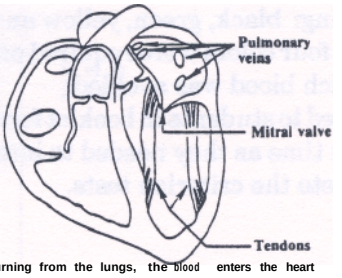


Figure 2.
Samples of the Rehearsal Strategies.

Plate 1: Sample page from Treatment 1 (Reading Summaries: covert rehearsal)

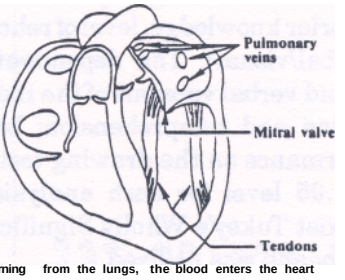


Returning from the lungs, the blood enters the heart through four pulmonary veins and collects in the left auricle: these vein openings, like the vena cava, have no valves. The left auricle contracts when it is full, squeezing blood through the mitral valve into the left ventricle.

The mitral valve, located between the left auricle and the left ventricle, is similar in construction to the tricuspid valve. As the left ventricle contracts simultaneously with its mate, the right ventricle, it forces blood behind the flaps of the valve. thereby closing the passageway back to the left auricle. Like the tricuspid valve, the ends of the mitral valve have naps that are anchored to the tloor of the left ventricle by slender tendons.

(10) As the blood returns to the heart from the lungs, it enters the heart through pulmonary veins and is deposited in the left auricle.
(11) The mural valve is locared bcrwcen the left auricle and the left ventricle.

Plate 2: Sample page from Treatment 3 (Shading on Drawing: overt rehearsal)



Returning from the lungs, the blood enters the heart through four pulmonary veins and collects in the left auricle; these vein openings, like the vena cava, have no valves. The left auricle contracts when it is full, squeezing blood through the mitral valve into the left ventricle.

The mitral valve, located between the left auricle and the left ventricle, is similar in construction to the rricuspld valve. As the left ventricle contracts simultaneously wth its mate. the right ventricle, it forces blood behind the flaps of the valve, thereby closing the passageway back to the left auricle. Like the tricuspid valve, the ends of the mitral valve have flaps that are anchored to the floor of the left ventricle by slender tendons.

(15) Color the pulmonary veins black
(16) Color the left auricle green
(17) Color the mitral valve yellow

received the same instruction as did students in Treatment 3 (Figure 2, Plate 2); however, instead of receiving the verbal tests the students in Treatment 4 received the multiple choice criterion tests in the visual test format. The parts and functions to be shaded corresponded to, as closely as possible, the information summarized in Treatments 1 and 2. The colors used were selected to avoid a sense of color coding: black, green, yellow and red. Red was used in two circumstances in which four colors were required on a page; association of the red color with oxygen-rich blood was avoided.

Instruction was presented to students in booklet format and students were permitted to spend as much time as they needed to interact with the instructional content and to complete the criterion tests

DESIGN AND ANALYSES

One hundred twenty undergraduate students enrolled at The Pennsylvania State University participated in this study. A pretest consisting of 36 items on general content in physiology (Dwyer, 1972) was utilized in this study. The pretest was used to determine students' prior knowledge level regarding human physiology. Scores on the pretest were arranged in descending order from highest to lowest. The top 40 scores represented high prior knowledge (M = 27.31, the next 40 medium prior knowledge (M = 21.8) and the bottom 40 low prior knowledge (M = 17.1). The Formula 21 reliability of the physiology pretest was .84 and its correlation with the total composite test was .56. Students in each of the three prior knowledge levels were then randomly assigned into one of the prior treatment groups. The independent variables manipulated were levels of prior knowledge, level of rehearsal strategy (covert/overt) and test mode (verbal/visual). The dependent variables were: a) performance on the visual and verbal versions of the individual criterion tests – terminology, identification and comprehension; b) performance on the composite test; and c) performance on the drawing test.

Alpha was set at the .05 level for each analysis of variance. Where significance was found to exist Tukey's Wholly Significant Difference (WSD) for comparison among the means was utilized.

RESULTS

Table 1 (see page 20'7) presents the means, variances and reliability coefficients on the criterion tests. Analyses of variance indicated that significance differences existed on the drawing ($F = 9.62$, $d_f = 3/108$, $p. < .05$), identification ($F = 19.86$, $d_f = 3/108$, $p. < ,05$), terminology ($F = 22.63$, $d/ = 3/108$, $p. > .05$), comprehension ($F = 34.15$, $d_f = 31108$, $p. < ,05$) and composite tests ($F = 31.06$, $d, = 3/108$, $p. < .05$). Figure 3 illustrates the comparison of mean achievement for each prior knowledge level on each of the criterion measures These

TABLE 2
Effect of Instructional Treatment on Prior Knowledge Level on Each Criterion Test

	INSTRUCTIONAL TREATMENTS			
CRITERION TESTS	Treatment 1: Reading Summaries (Covert Rehearsal): Verbal Test	Treatment 2: Reading Summaries (Covert Rehearsal): Visual Test	Treatment 3: Shading on Pictures (Overt Rehearsal): Verbal Test	Treatment 4: Shading on Pictures (Overt Rehearsal): Visual Test
Prestest	1>2 1≥3 2>3	1>2 1>3 2>3	1>2 1>3 2>3	1>2 1>3 2>3
Drawing Test	1>2 1>3	1>2 1>3	1>2 1>3	
Identification Test	1>2 1>3 2>3	1>2 1>3 2≥3	1>2	
Terminology Test	1>2 1>3	1>2 1>3	1>2	
Comprehension Test	1>2 1>3 2>3	1>2 1>3	1>2 1>3	1>2
Composite Test	1>2 1>3	1>2 1>3 2>3	1>2	

1 = High Prior knowledge level; 2 = Medium prior knowledge level; 3 = Low prior knowledge level

TABLE 1
Means, Variance estimates and Reliability Coefficients on the Criteria Tests

TREATMENTS	Items	CRITERION TESTS Drawing (20)	Terminology (20)	Identification (20)	Comprehension (20)	Composite (60)
Treatment 1 Reading Summons (Covert Rehearsal: Verbal Test)	Mean	13.97	13.40	14.30	10.60	38.30
	Variance	11.60	7.82	7.18	9.36	56.18
	K-R 21	.79	.71	.81	.74	.87
Treatment 2 Reading Summons (Covert Rehearsal: Visual Test)	Mean	14.47	12.20	14.63	12.30	39.13
	Variance	11.60	7.82	7.18	9.36	56.18
	K-R 21	.81	.63	.77	.67	.72
Treatment 3 Shading on Pictures (Overt Rehearsal: Verbal Test)	Mean	15.93	15.57	16.93	14.13	46.60
	Variance	11.60	7.82	7.18	9.36	56.18
	K-R 21	.77	.83	.73	.79	.83
Treatment 4 Shading on Pictures (Overt Rehearsal: Visual Test)	Mean	18.27	17.70	18.97	18.20	54.80
	Variance	11.60	7.82	7.18	9.36	56.18
	K-R 21	.83	.80	.79	.69	.78

comparisons generally indicate that Treatment 4, the shading on pictures (overt rehearsal): visual testing, was the most effective in facilitating information acquisition. Table 2 (see page 208) shows where significant differences occurred in achievement among students posessing different prior knowledge levels (High, Medium, Low) as the five criterion measures. The blank areas which exist where you would expect to find 2>3 on the different criterion tests indicate that significant differences in achievement did not occur between Treatments 2 and 3. These results would seem to indicate that the low prior knowledge group is the group which is most positively influenced by the different instructional strategies. Additionally, Treatment 4 would seem to be the instructional format which was most instrumental in reducing the effect of differences among students possessing different prior knowledge levels.

Table 3 (below) illustrates the results of comparing student performance receiving similar instruction but receiving tests in the different evaluation

TABLE 3
Comparison of Visual-verbal Testing on the Criterion Measures

TREATMENTS	Drawing Test	Terminology Test	Identification Test	Comprehension Test	Composite Test
	1=2	1=2	1=2	1=2	1=2
	4>3	4>3	4>3	4>3	4>3

.05 LEVEL

Treatment 1. Reading Summaries (Covert Rehearsal): Verbal Test
Treatment 2. Reading Summaries (Covert Rehearsal): Visual Test
Treatment 3. Shading on Drawings (Overt Rehearsal): Verbal Test
Treatment 4. Shading on Drawings (Overt Rehearsal): Visual Test

NOTE: The equal sign (=) does not mean that the means are equal, but that they fall in close approximation to one another "under the normal curve" so that achievement differences may considered insignificant.

modes. Insignificant differences were found to exist between students who received the reading summaries treatment which were evaluated by both visual and verbal tests. However, in evaluating the differences between Treatments 3 and 4, Treatment 4 the Shading on Drawing (Overt Rehearsal) Visual Test was found to be significantly more effective than Treatment 3 on all the criterion measures.

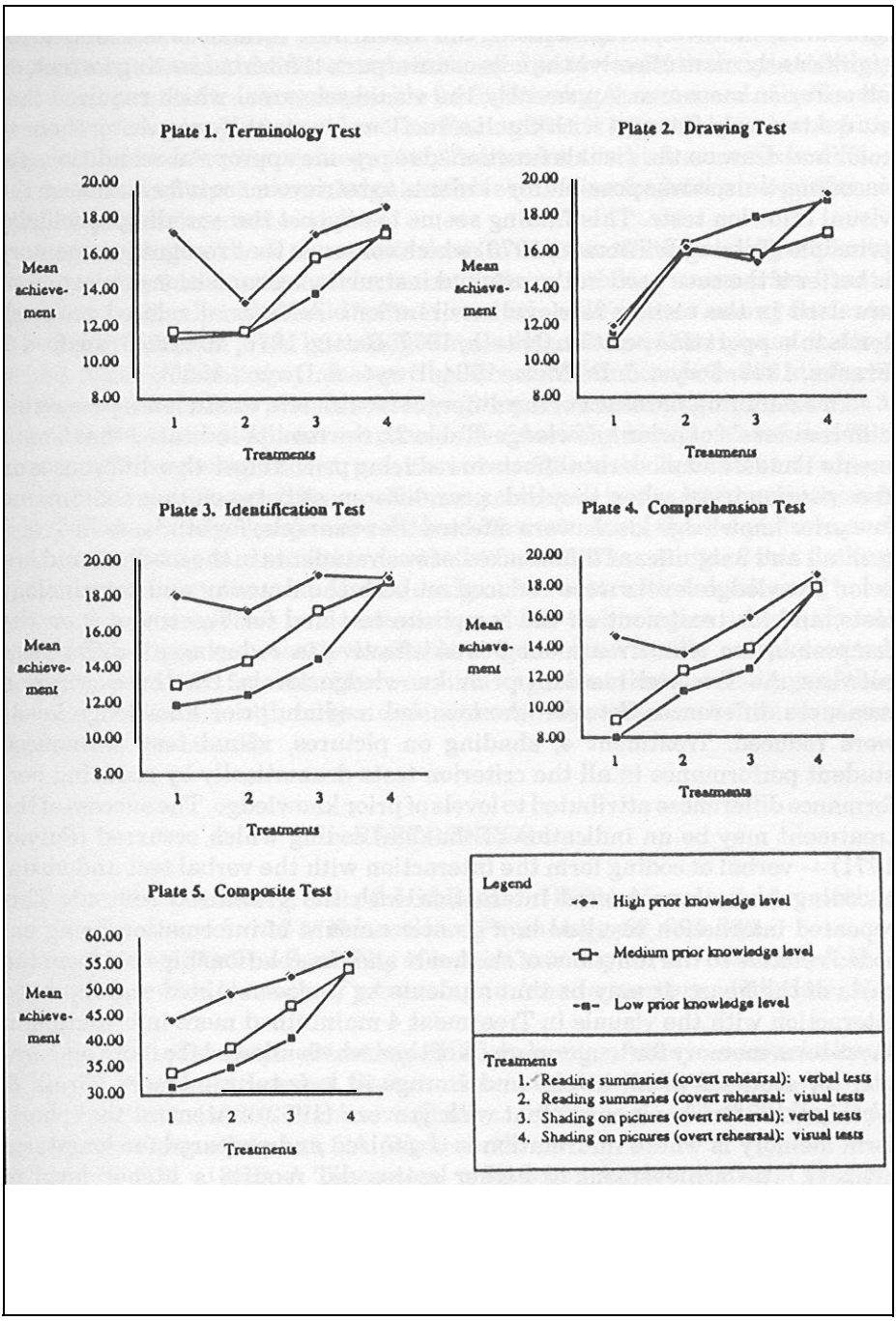
DISCUSSION

Considerable research on the design and use of visuals has shown that visualization can significantly improve students' learning from prose instruction (De Melo, 1980; Dwyer, 1978; Dwyer & Parkhurst, 1982; Levie & Levie, 19'75, 1971). The review of literature for this study indicated that rehearsal strategies and thevisual test mode are important instructional variables. The present study went one step beyond merely establishing the importance of visualization by attempting to determine: a) the effect of different rehearsal strategies used to complete visualized prose instruction; b) the effect of visual testing in retrieving information; and c) the effect that different instructional strategies have on students possessing different prior knowledge levels.

Results of this study indicate that all types of rehearsal strategies are not equally effective in facilitating student achievement of different educational objectives (Figure 3, page 211). The general trend also seems to indicate that overt rehearsal is more effective than covert rehearsal in facilitating student achievement. Additionally, it was found that within the overt rehearsal treatments, when significant differences were found to exist, students who received the visual test mode achieved significantly higher scores than did students who received the verbal tests The higher scores on the visual teats by students in Treatment 4 may be explained by the encoding specificity principle (Battig, 1979; Nitsch, 1977; Tulving, 1979) since the visual test situation in this study closely matched the learning situation; the visuals employed in the test situation provided the critical cues needed by students to retrieve the encoded information (Bransford, 1979). These results are also congruentwith the sign-similarity hypothesis (Carpenter, 1953), the stimulus-generalization hypothesis (Hartman, 1961), the cue summation theory (Severin, 1967), and the transfer-appropriate principle (Morris, Bransford, & Franks, 1977).

In comparing the results of the verbal-visual mode of testing on the different criterion measures (Table 3) insignificant differences were found to exist between students in Treatments 1 and 2. Two possible explanations may be proposed for this finding: a) the reading summaries treatments (covert rehearsal) apparently did not provide enough maintenance rehearsal to allow for additional elaborative rehearsal that would encode more information from short-term memory into long-term memory; and b) performance on the visual may have been influenced by the fact that visual tests are rather unfamiliar to most students and their performance on them suffered accordingly.

Figure 3.
Comparison of Mean Achievement on the Criterion Tests.



In examining the effect of the verbal-visual testing mode (Treatment 1 vs. Treatment 2 and Treatment 3 vs. Treatment 4: Table 3) insignificant differences were found to exist between Treatments 1 and 2 on all criterion measures; however, Treatment 4, the visual test format, was found to be significantly more effective than its counterpart, the verbal testing format, on all criterion measures. Apparently, the visual rehearsal which required that students overly interact with the instructional content by requiring them to color and draw on the visuals functioned to provide appropriate conditions for encoding; thus, it was possible for students to retrieve more information on the visual criterion tests. This finding seems to support the encoding specificity principle (Tulving & Thomas, 1973) which contends that recognition memory is better if the cues used in the original instructions/acquisition environment are used in the testing retrieval environment. Additional related research tends to support this position (Nitsch, 1977; Battig, 1979; Morris, Bransford & Franks, 1977; Dwyer & De Melo, 1984; Dwyer & Dwyer, 1985).

In examining the effect of the different treatments on students possessing different levels of prior knowledge (Table 2), the results indicated that Treatments 1 and 2 had moderate effects in reducing prior knowledge differences on the criterion tests; when they did occur differences between the medium and low prior knowledge levels were effected. For example, for students in Treatments 1 and 2 significant differences between students in the medium and low prior knowledge levels were reduced on both the drawing and terminology tests, and for treatment on the composite test and for Treatment 2 on the comprehension test. Treatment 3 was effective in reducing all differences between the low and medium prior knowledge levels. On three criterion measures differences between the low and medium prior knowledge levels were reduced. Treatment 4, shading on pictures, visual test, influenced student performance in all the criterion tests dramatically by reducing performance differences attributed to levels of prior knowledge. Thesuccess of the treatment may be an indication of the dual coding which occurred (Paivio, 1971) -verbal encoding form the interaction with the verbal test and visual encoding from the repeated interaction with the visualized content. This repeated interaction resulted in a greater amount of information being encoded relative to the functions of the heart and the relationships between the parts of the heart. It may be that students by their sustained and repeated interaction with the visuals in Treatment 4 maintained more information in short-term memory for longer periods of time which allowed for more elaboration (by students of all levels) and storage in long-term memory (Craik & Watkins, 1973). This is consistent with Travers' (1982) statement that term memory is where information is organized and prepared for long-term memory. The achievement of higher scores did require a higher level of processing, more elaborations, more “links,” more reflection, etc. In this regard, the data indicated that more information was encoded in the visual rehearsal situation as tested by the visual criterion tests.

SUMMARY

The results of this study reveal that all types of rehearsal strategies used to complement visualized instruction are not equally effective in facilitating student achievement of different educational objectives and that visual testing is an important instructional variable for facilitating the retrieval of optimum amounts of acquired information. The finding that it is possible to develop an instructional-evaluation strategy (i.e., Treatment 4) which can reduce differences attributed to prior knowledge levels is significant for future instructional design and development activities.

On the practical level the results seem to indicate that providing students with visualized instruction and a covert activity (reading summaries: Treatments 1 and 2) only has a "mild" effect in reducing differences among students possessing different prior knowledge levels regardless of the type of testing format (visual/verbal) they receive. Significant differences between students in the low and medium prior knowledge group were estimates in Treatment 3 where students shaded pictures and wereevaluated by means of theverbal test format. The most significant results were realized in Treatment 4 where virtually all significant differences among students in the low, medium, and high prior knowledge levels were reduced when students shaded pictures and were evaluated by means of the visual test format. The results of this finding has significant implications for the designers of instructional software to be delivered on computers and interactive video technologies where visual/graphic packages are readily available to generate visually complemented instruction and test formats. However, it is important that the findings of this study be replicated with larger and more varied audiences before they are generalized too broadly.

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