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ABSTRACT

Evaluated were three printed instructional formats (narrative textbook, individualized materials, and pictorial display) used with 146 hearing impaired college students in two experiments. Ss in both experiments were divided into three groups, each group receiving one of the three formats. Ss were given a pretest of information comprehension and retention followed by a session of reading and studying and instructional packages. A posttest was administered on the following day to Ss in the first experiment and after a delay of 13 days to Ss in the second experiment. The posttest scores were significantly higher for the pictorial format group than for the textbook group, with the individualized format scores falling at an intermediate level in both experiments. (Author/DB)

THE EFFECTIVENESS OF TEXTBOOK, INDIVIDUALIZED, AND PICTORIAL INSTRUCTIONAL FORMATS FOR HEARING IMPAIRED COLLEGE STUDENTS

Horace N. Reynolds, Ph. D.

Richard F. Rosen, Ph. D.

Gallaudet College

Washington, D. C.

Presented at the

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ABSTRACT

The purpose of this study was to compare three printed instructional formats (narrative textbook style, individualized, and pictorial) evaluated by student performance on tests of information comprehension and retention. Two experiments were conducted, with 52 hearing impaired college students in Experiment 1 and 94 similar students in Experiment 2. Subjects in both experiments were divided into three groups, each group receiving one of the three formats. Subjects were given a pretest followed by a session for reading and studying the instructional packages. A posttest to assess comprehension and retention was administered on the following day to subjects in Experiment 1, and after a delay of 13 days, to subjects in Experiment 2. Results for Experiment 1 showed that the posttest scores were significantly higher for the pictorial format group than for the textbook format group, with the individualized format scores falling at an intermediate level. A similar trend was observed in the results for Experiment 2. These results demonstrate an approach to designing printed instructional formats which can circumvent many of the language and reading difficulties of hearing impaired students.

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Horace N. Reynolds, Ph. D.†
Richard F. Rosen, Ph. D.†

Gallaudet College
Washington, D. C.

INTRODUCTION

The purpose of this study is to compare three, printed instructional formats in terms of information comprehension and retention for hearing impaired college students. This objective is important because textbooks and other printed materials prepared for hearing students are often written at a level of language complexity which the deaf or hearing impaired student has not achieved. Such materials do not provide an efficient or effective medium for presenting information to hearing impaired students with English language deficiencies. The assumption underlying this study is that printed instructional formats can be designed to at least partially circumvent this problem. Accordingly, this study provides empirical data on the relative effectiveness of three different instructional format designs--a narrative textbook format, a format incorporating some of the characteristics of individualized instruction, and a pictorial format.

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†Mailing address: Gallaudet College, Kendall Green, Washington, D. C. 20002

BACKGROUND

Most individuals who have suffered profound hearing impairment at birth or before initial language development remain linguistically handicapped by comparison with hearing persons (Furth, 1971; Ries, 1971). Linguistic deficiency in the hearing impaired may be revealed by relatively poor performance on tests of vocabulary and reading comprehension, slow reading speed, and difficulty with written expression and speech. For example, the Office of Demographic Studies at Gallaudet College reports that 18 to 20 year old hearing impaired students across the country achieve mean reading test scores comparable to the 4th grade level for hearing students (Ries, 1971).

In spite of the significance of this problem, there is almost no research comparing the comprehensibility of different methods of presenting information in a printed format to hearing impaired students. There is, however, research related to this question with hearing subjects. Dwyer (1972) has summarized his studies on the use of visuals or illustrations in enhancing the effectiveness of instructional presentations. His results show that illustrations can facilitate student achievement on tests of comprehension and retention for certain types of instructional objectives, but the effectiveness of illustrations is dependent on the type of information being presented. His findings also suggest that relatively simple line drawings can be more effective in enhancing student test performance than more realistic drawings or photographs, especially in externally paced (time limited) instructional formats. In comparing

instructional formats, which generally involved a description of the human heart and its functions, Dwyer found that programmed materials required more time for completion than textbook-like materials, although these formats did not produce significant differences in student performance on comprehension tests given immediately following the instructional session and after a two-week delay (Dwyer 1968, 1972).

In a related study, Haney (1969) compared a printed format presenting action-sequenced tabular instructions with a narrative, textbook-style format in terms of technician performance in completing a sequence of operational procedures. He found that the tabular presentation produced a substantially lower error rate than the narrative format. This result suggests the importance of organizing the instructional presentation in a way that is most consistent with the performance objectives set for the student.

Hartman (1961,b) has discussed the instructional effectiveness of various forms of "multiple channel communication", which includes materials presenting information simultaneously through pictorial imagery (the "pictorial channel") and printed words and sentences (the "print channel"). His review suggests that the pictorial channel alone may sometimes produce better comprehension of information than the print channel alone. However, multiple channel presentations are generally more effective than single channel presentations, provided that the tests of comprehension and retention use the same information channels employed in the presentations (Hartman, 1961,a,b). The effectiveness of multiple channel formats depends on the extent

to which the student's perceptual and cognitive characteristics enable him to receive and interpret the information conveyed through each of the channels (Mehrabian and Reed, 1968). Thus, in a multiple channel, print and pictorial format, the information in the print channel must employ a level of vocabulary and language complexity compatible with the student's reading achievement level and linguistic competence.

Booher (1973) has compared a number of single and multiple channel instructional formats employing different picture-word combinations, in terms of the subjects' performance in carrying out a set of operational procedures on a control-display panel. His results, with military technicians, showed that a multiple channel format with a high degree of pictorial information combined with related print information produced the best overall results in terms of task performance time and accuracy. His study reveals that in a concrete operational task situation, the use of pictorial information in presenting instructions can be an important factor in facilitating performance.

In contrast to the above studies which show some performance differences resulting from variations in instructional format, Grayson (1972) notes that comparative studies of college teaching methods (such as lecture, discussion, tutorial, and independent study) have revealed no differences between these methods when evaluated by student performance on final examinations (Dubin and Taveggio, 1968). Furthermore, studies on the effectiveness of computer-assisted instruction and the use of television vs. personal contact have generally yielded negative results (Chu and Schramm, 1968; Suppes and Morningstar, 1969).

In the context of these bewildering and conflicting results, the need for educational research intended to assist the designer of instructional materials has been expressed by Hoban (1960) and Schramm (1960), among others. A recent and increasingly popular trend in the design of instructional materials has been the development of individualized, self instructional units in programmatic sequence (Mechner, 1967), and the behavioristic emphasis on measurable, learning or performance objectives in combination with criterion-referenced tests for assessment of student performance (Commission on Science Education, 1965; Hambleton and Novick, 1972; Walbesser, 1970). In considering the effectiveness of individualized instruction, Rosen (1971) has compared rates of information acquisition and forgetting for different performance classes of behavioral objectives.

DEVELOPMENT OF HYPOTHESIS

These studies suggest that individualized instruction, with its attention to the programmatic organization of information in relation to measurable performance objectives, should offer significant educational advantages in comparison with the more traditional narrative textbook style of instructional format. Other research, cited earlier, suggests that pictorial information can be a significant factor in facilitating the learning process and enhancing student performance on tests of comprehension and retention. With hearing impaired students, who typically exhibit some deficiencies in English language related skills, a pictorial presentation format should facilitate the acquisition and retention of information because it relies less heavily on the verbal-print channel. Therefore, this study compares a textbook

style format, a format incorporating many of the characteristics of individualized instruction, and a pictorial format with less reliance on verbal information, in terms of student performance on a test of comprehension and retention of information contained in the instructional materials. It is hypothesized that the pictorial format will produce the best test performance, followed by the individualized and textbook formats in that order.

METHOD

Subjects

A total of 52 hearing impaired students served as subjects (Ss) in Experiment 1. Experiment 2 employed a total of 94 hearing impaired Ss. All Ss were enrolled at Gallaudet College in the Preparatory Program, which is a college preparatory curriculum preceding the freshman year. The language and reading deficiencies of students in the Preparatory Program are revealed by their scores on norm-referenced reading tests (ETS Cooperative Reading Tests) which on the average are equivalent to a seventh or eighth grade reading level for hearing students.

Materials

Three different printed instructional formats were compared for information comprehension and retention. The three instructional formats all presented essentially the same information, consisting of an introduction to neuroanatomy and physiological psychology. The three formats were:

1. Textbook. This presentation was written in a narrative form typical of many textbooks, using a vocabulary and grammatical structure which (by subjective judgment) were somewhat less complex than would usually be found in a college level text. Eight line drawings were incorporated into the presentation to portray the various parts of the central nervous system being described. The textbook format consisted of about 700 words, not including labels and titles on the illustrations. An example of the textbook format is provided by the paragraph and drawing shown in Figure 1.

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Figure 1 here

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2. Individualized. This format began with a list of six learning objectives which described the kinds of information the student would be expected to understand in answering the final comprehension test. The text of the individualized format was similar to the narrative used in the textbook format, although in some cases sentence structure was simplified. This format included nine line drawings with special instructions or self-test questions for the student preceding each drawing or figure. The answers to these questions were always immediately available in the accompanying text or drawings. Consequently, this instructional package contained many of the features of individualized instructional programs, such as learning objectives, active responding by the student, immediate confirmation or knowledge of results on questions in the text, and self-pacing by the student.* This format, including the learning

*Actually, all three formats allowed students to progress at their own pace, so this characteristic was not unique to the individualized format in this study.

objectives and self-test questions, was composed of about 1,100 words. Figure 2 provides a representative selection from the individualized format, including descriptive text, self-test questions, and illustrative drawing. This selection covers the same information as the textbook selection in Figure 1.

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Figure 2 here

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3. Pictorial. The pictorial format presented as much of the information as possible in the form of line drawings and figures. This instructional package consisted of 26 picture displays, each accompanied by labels and a brief descriptive phrase or sentence. The verbal material was simplified as much as possible without sacrificing informative content, so that the pictorial format presented essentially the same information as the other two instructional programs. The descriptive, verbal information in this presentation consisted of about 300 words, excluding labels and titles on illustrations. An example of the pictorial format is shown in Figure 3. This example consists of only one drawing from several in the pictorial format which were used to convey the same information as the textbook and individualized selections shown in Figures 1 and 2.

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Figure 3 here

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A posttest was prepared to assess subjects' comprehension and retention of information presented in the instructional materials.

This test included several different types of questions. The first three questions consisted of a total of 20 matching items, requiring the student to match the names of parts of the brain with numbered parts shown in a diagram. This type of test item will be referred to as "matching name with location." The second type of question consisted of 5 items requiring the student to match written descriptions of brain functions with numbered parts of the brain shown in a diagram. This kind of test item will be referred to as "matching function with location." The third type of test question included five items requiring the student to match names of brain parts with written descriptions of brain functions. These will be identified as "matching name with function items." Finally, the posttest included 14 multiple choice questions, each with 5 response options. These questions related to naming and describing parts of the brain and identifying their functions or effects on human behavior.

With this combination of questions, the posttest covered virtually all the substantive information presented in the three instructional formats.

A pretest was also prepared to estimate the students' initial comprehension (prior to reading the instructional materials) of the topics covered in the instructional formats. The pretest was composed of an 8-item matching name with location question, and 5 multiple choice questions, all drawn from the posttest.

Procedure

Experiment 1 was designed to compare the three instructional formats for information comprehension and retention within one day

after studying the instructional materials. A pretest-posttest experimental design was used, with three groups of subjects corresponding to the three instructional formats. The 52 hearing impaired students who served in this experiment were randomly assigned to the three format groups. Due to some subject attrition between study and posttest sessions, the three groups were unequal in size, with 15, 18, and 19 Ss for the Pictorial, Individualized, and Textbook formats respectively. Subjects were run in one-hour sessions on two consecutive days. In the first session, Ss were given the pretest followed by the appropriate instructional packages. Subjects were told to study these materials carefully because there would be a test on their comprehension of the material. No limit was placed on the amount of time students could spend studying the instructional packages, but all Ss finished within the one-hour period. In the second session, the posttest was distributed, with no stated time limit for completion. All Ss finished well before the end of the one-hour class period, however.

The purpose of Experiment 2 was to compare the three instructional formats for information comprehension and retention, with a 13-day period intervening between the study and posttest sessions. Thus, Experiment 2 is a study of retention, over a relatively long period, of information acquired from the three instructional formats. In other respects, the procedure was parallel to that followed in Experiment 1. The 92 hearing impaired students who participated in Experiment 2 were randomly assigned to the three

format groups, with 30, 32, and 32 Ss in the Pictorial, Individualized, and Textbook groups respectively. During the pretest-study session, the time spent studying each format was measured for about half the students in Experiment 2. The results showed that the Individualized format produced the longest study time, with a mean of about 16 minutes. The Pictorial and Textbook formats required less study time, with means of about 12 and 11 minutes respectively. The posttest session was administed after a 13-day interval. Subjects were not told in advance when the posttest would be given.

RESULTS

The pretest consisted of a total of 13 items: 8 matching items and 5 multiple choice questions. These were scored on a percent correct basis, and the results for Experiments 1 and 2 are shown in Figure 4.

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Figure 4 here

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Figure 4 shows that for Experiment 1, the median percent of questions correct on the pretest was identical for the Pictorial and Textbook groups (46%) and somewhat lower for the Individualized group (38.5%). However, this difference between groups is small and not statistically significant.*

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*Unless otherwise specified, the Mann Whitney non-parametric test was used for statistical comparisons. Since the experimental hypothesis predicted the direction of expected results, it was decided before conducting the experiment to accept the p=.05 level of significance for a one-tailed test.

The pretest results for Experiment 2 show somewhat lower scores than those achieved in Experiment 1 (although this difference is not significant). The Individualized and Textbook groups achieved the same median percent correct scores (38.5%), but the Pictorial group was somewhat lower (30.8%). Again, this discrepancy in pretest scores is not statistically significant. The pretest scores, then, support the assumption that before reading the instructional materials, the three format groups were comparable in their level of understanding of the subject matter.

The posttest, previously described, consisted of 44 items. The test was scored on a percent correct basis, and the results for Experiments 1 and 2 are shown in Figure 5, and Table 1.

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Figure 5 here

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Table 1 here

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For Experiment 1, the Pictorial group achieved a median score of nearly 80% of the questions correct, while the Individualized and Textbook groups achieved lower scores of about 68% and 66% respectively. The difference between scores of the Pictorial and Textbook groups is significant ($p < .05$), but other group differences are not statistically significant.

Median posttest scores for Experiment 2 are considerably lower for each format group than scores from Experiment 1. Group differences between Experiments 1 and 2 are all highly significant ($p<.001$) and most strongly reflect the decay in retention over the longer study - posttest interval in Experiment 2.

Nevertheless, the format differences within Experiment 2 show a trend similar to that produced in Experiment 1, with the Pictorial group achieving higher scores than the other two groups. None of the differences between groups in Experiment 2, however, reached the required significance level.

Since the purpose of the pretest was to provide a rapid check on the assumption that all groups started the experiment with the same comprehension of the subject matter, the pretest consisted of only a small sample of the posttest questions. Consequently, it is not appropriate to compare pretest and posttest scores directly. However, pretest scores can legitimately be compared with scores on the 13 posttest items which had been included in the pretest. Table 2 shows these gain scores in terms of the increase in percent of questions correctly answered from pretest to posttest. The degree of improvement for each format group is highly significant ($p<.0001$)* in both Experiments 1 and 2.

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Table 2 here

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Table 2 shows that for both experiments, posttest gain scores for the Pictorial group were higher than the gain scores for the

*Wilcoxon Matched-Pairs Signed-Ranks Test

other two groups. For Experiment 2, the difference in gain scores between the Pictorial and Textbook groups is significant ($p<.02$). These results are consistent with the finding that total posttest scores were higher for the Pictorial format than for the Individualized and Textbook formats.

Finally, it is interesting to examine the distribution of scores across the different kinds of questions composing the posttest. The questions, already described, were of four types: (1) matching name with location, (2) matching function with location, (3) matching name with function, and (4) multiple choice items (with 5 response options). Figure 6 displays the distribution of scores for each question type in Experiments 1 and 2.* The scores represent the number of correct responses as a percentage of the total number of responses within that question block, i.e., (number of question items) x (number of Ss).

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Figure 6 here

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Figure 6 shows that for all format groups in both experiments, the most difficult items were those that required matching written descriptions of brain functions with numbered parts of the brain shown in a diagram ("matching function with location"). Also apparent in Figure 6 are the generally lower posttest scores for Experiment 2, and the relatively poor performance of the Textbook group in Experiment 1 on matching

*A line graph is used for clarity of presentation, even though the variable on the abscissa is not continuous.

function with location and name with function items. In addition, Figure 6 reveals the relatively superior performance of the Pictorial group in Experiment 1 on multiple choice questions and matching name with location items.

DISCUSSION AND CONCLUSIONS

The results of this study provide some support for the experimental hypothesis by demonstrating the relative effectiveness of the pictorial channel in presenting information to hearing impaired students who are deficient in linguistic comprehension. The two experiments reported in this paper suggest that the use of a pictorial instructional format can facilitate both comprehension and retention of information by comparison with more linguistically dependent presentations, such as a narrative, textbook format. The conclusions derived from the results of this study are discussed in more detail below.

Information presented to hearing impaired students by a pictorial format with relatively brief verbal descriptions, can produce significantly better comprehension of information than a more verbal textbook style of presentation. When the posttest to assess comprehension and retention was administered within one day following presentation of instructional formats, the scores of the students who received the pictorial format were considerably higher than the scores of students receiving individualized and textbook presentations. Apparently, this trend in favor of the pictorial

mode persists over a period of at least two weeks between instructional presentation and posttest, as shown by the results of Experiment 2.

It is perhaps surprising that the individualized format did not compare more favorably with the textbook format, considering the presumed educational advantages of instructional objectives, active responding by the student, self-test questions in the instructional presentation, and immediate knowledge of results in answering these questions. However, for hearing impaired students with deficient language and reading skills, the heavy emphasis on the verbal, print channel for presenting information may have nullified any of the advantages that the organization of the individualized format might otherwise have had with hearing, linguistically proficient students. These results should not be construed to imply that the individualized format is not an effective instructional approach for hearing impaired and linguistically deficient students. Rather, the results suggest that the use of pictorials for information display can enhance the effectiveness of "individualized" and other narrative presentations.

The relatively long delay in Experiment 2 between presentation of instructional formats and posttest was intended to study the persistence of format group differences in posttest performance. Since some forgetting would be expected during this longer interval, it was anticipated that overall posttest scores for Experiment 2 would be

lower than those for Experiment 1. This result was obtained and primarily reflects the decay in retention over the longer posttest interval in Experiment 2. However, the pretest scores for Experiment 2 were also lower (although not significantly) than those in Experiment 1, which suggests that another factor may be a generally lower level of test performance for the Ss in Experiment 2. If such a factor is operating, the reasons for it are not clear. Further information on this question might have been obtained if Ss in Experiment 2 had been given two posttests (alternate forms) - one immediately following presentation of instructional materials, and the second after the two week delay. This was not done, because exposure to the first posttest would have served, in effect, as an additional instructional experience, by consolidating and reinforcing information acquisition and retention for all three format groups, thereby influencing performance on the second posttest and possibly dissolving any measurable performance differences between groups. In addition, truly equivalent alternate forms of the posttest would have been virtually impossible to devise because the posttest covered nearly all the points of information contained in the instructional materials.

Improvement in performance from pretest to posttest was determined by comparing scores on the 13 pretest items with scores on the same 13 items included in the posttest. The results show a significant level of improvement for all format groups in both experiments (Table 2). However, the

magnitude of the gain score for the Pictorial group is considerably higher than gain scores for the Individualized and Textbook groups, in both Experiments 1 and 2. This result supports the conclusion drawn from analysis of total posttest scores that the Pictorial presentation was the most effective instructional format for the students in this experiment.

The analysis of posttest scores across the different categories of questions (Figure 6) showed substantially lower scores for those items requiring students to match a list of descriptions of brain functions with numbered parts of the brain shown in a diagram ("matching function with location"). This type of question was probably more difficult than the others because it involved a higher level of abstraction and interpretation. That is, the instructional materials (formats) most often presented information by first naming a part of the brain, then indicating its location in a diagram, and finally describing its functional significance. In studying this material, a student would be expected to associate a name with a pictured location, with a stated function, in that order. The "matching function with location" questions on the posttest required the student to bypass the "naming" response and reverse the order of this chain of associations, by matching a stated function with a pictured location. This conceptual difficulty is probably the most important factor accounting for the lower scores on this type of question.

It is particularly interesting to note in Figure 6 that the Textbook group in Experiment 1 performed most poorly on the "matching function with location" items and also the "matching name with function" items. Both of these categories require comprehension of relatively difficult written description of brain functions, and the highly verbal presentation of the textbook format is apparently a rather ineffective medium for communicating this information to hearing impaired students. By comparison, the Pictorial format seems to produce superior test performance, even on highly verbal multiple choice test items.

This experiment, comparing the effectiveness of three printed instructional formats, demonstrates the importance of presenting information in a form that is compatible with the information processing capabilities of the student. The explicitness and clarity of a pictorial presentation can be especially effective with hearing-impaired and/or linguistically deficient students, but as Dwyer (1972) has shown, pictorial information can be effective with hearing students as well.

The ultimate challenge in the education of the hearing impaired is to overcome the language and reading deficiencies which frustrate all other educational objectives. Since this goal has not been achieved, the educator is continually faced with the problem of presenting information to hearing impaired students in a form which is both interesting and comprehensible. The extensive use of

pictorial information integrated into a printed text, not only can enhance student comprehension and motivation, but also can provide information which is supplementary and redundant to the printed, verbal material. This relationship between pictorial and verbal information can facilitate language learning as well as the acquisition of information in specific subject areas.

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FIGURES AND TABLES

Figure 1: Sample Paragraph and Diagram from the Textbook Format

Figure 2: Sample Paragraph and Diagram from the Individualized Format

Figure 3: Selection from the Pictorial Format

Figure 4: Pretest Results: Median Percent Correct

Figure 5: Posttest Results: Median Percent Correct

Figure 6: Percent Correct on Posttest for Different Types of Questions

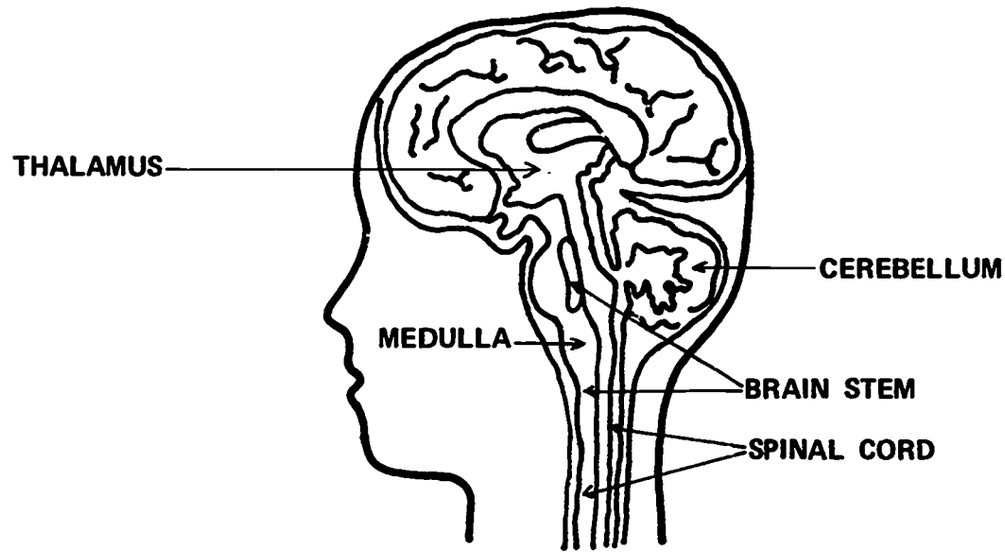
Table 1: Medians and Quartile Deviations for Posttest Scores

Table 2: Pretest - Posttest Gain Scores

FIGURE 1

Sample Paragraph and Diagram from the Textbook Format

Picture 4 (page 3) shows the inside parts of one of the cerebral hemispheres, including the spinal cord and the brain stem. One part of the brain stem is called the medulla. The medulla controls heart activity, breathing, and blood pressure. If the medulla is destroyed, the person will die, because the brain will not be able to control the heart beat and breathing.



Picture 4. Inside parts of the human brain.

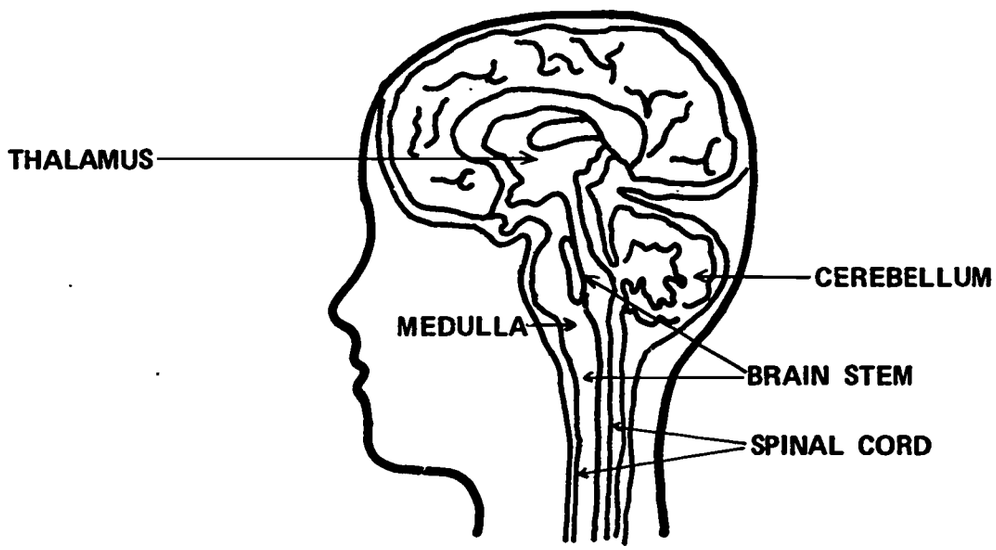
FIGURE 2

Sample Paragraph and Diagram from the Individualized Format

Picture 5 shows the inside parts of one of the cerebral hemispheres. Do you see the spinal cord and the brain stem in Picture 5? One part of the brain stem is called the medulla. The medulla controls heart activity, breathing, and blood pressure. If the medulla is destroyed, the person will die, because the brain will not be able to control the heart beat and breathing.

Mark the letter "M" next to the medulla in the drawing in Picture 5.

What is the job of the medulla? _____



Picture 5. Inside parts of the human brain.

FIGURE 3

Selection from the Pictorial Format

The medulla controls heart activity, breathing, and blood pressure.

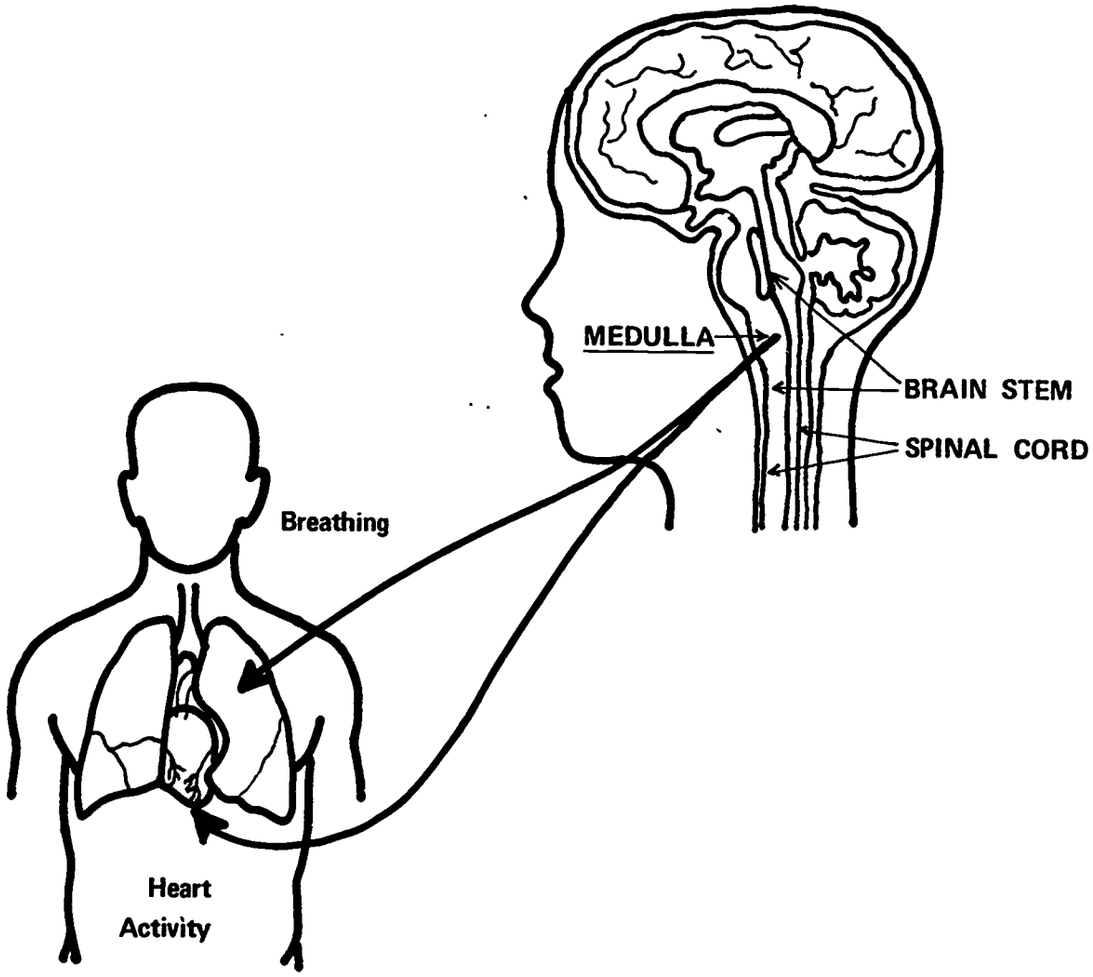


FIGURE 4

PRETEST RESULTS: MEDIAN PERCENT CORRECT

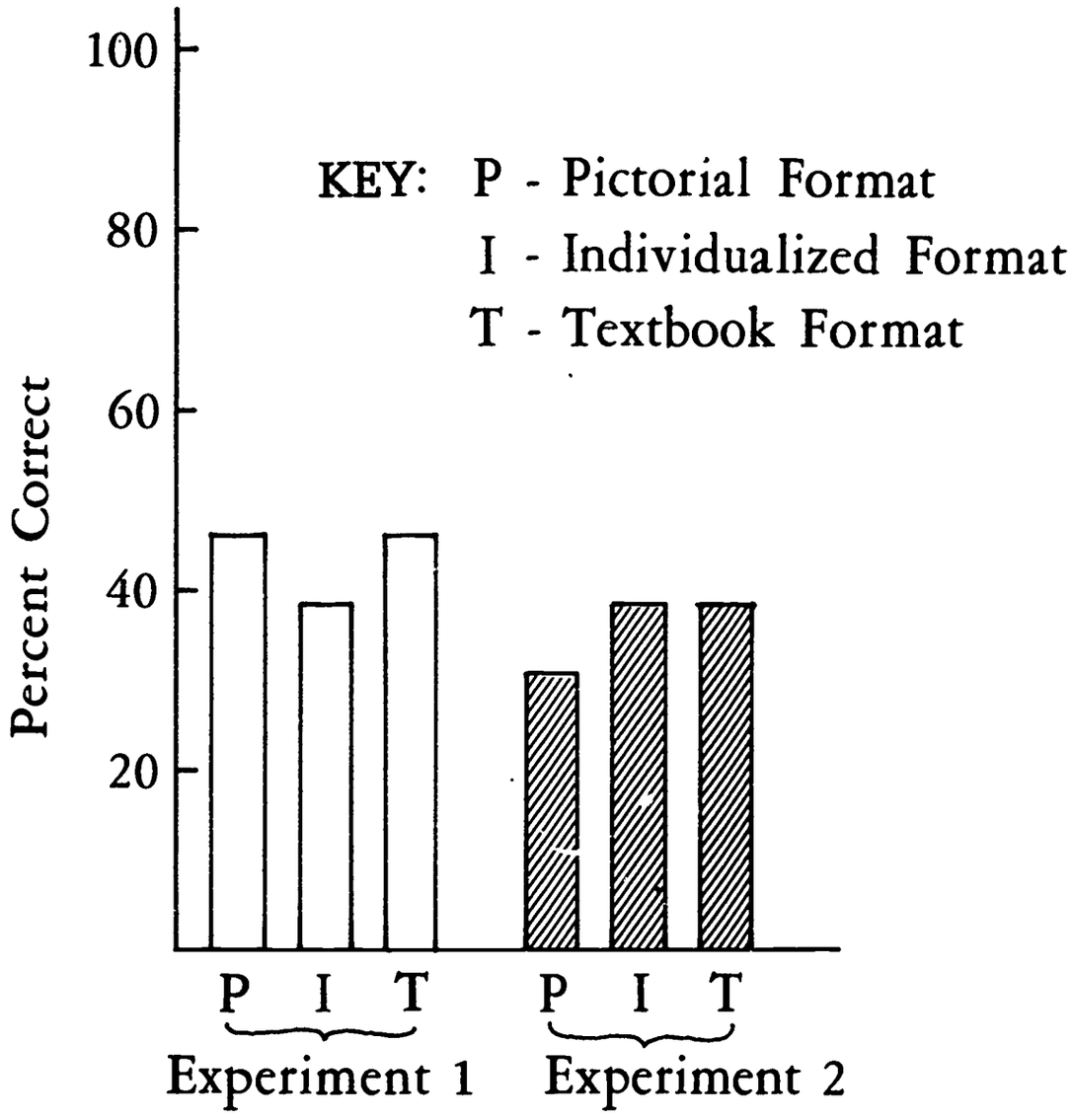


FIGURE 5

POSTTEST RESULTS:
MEDIAN PERCENT CORRECT

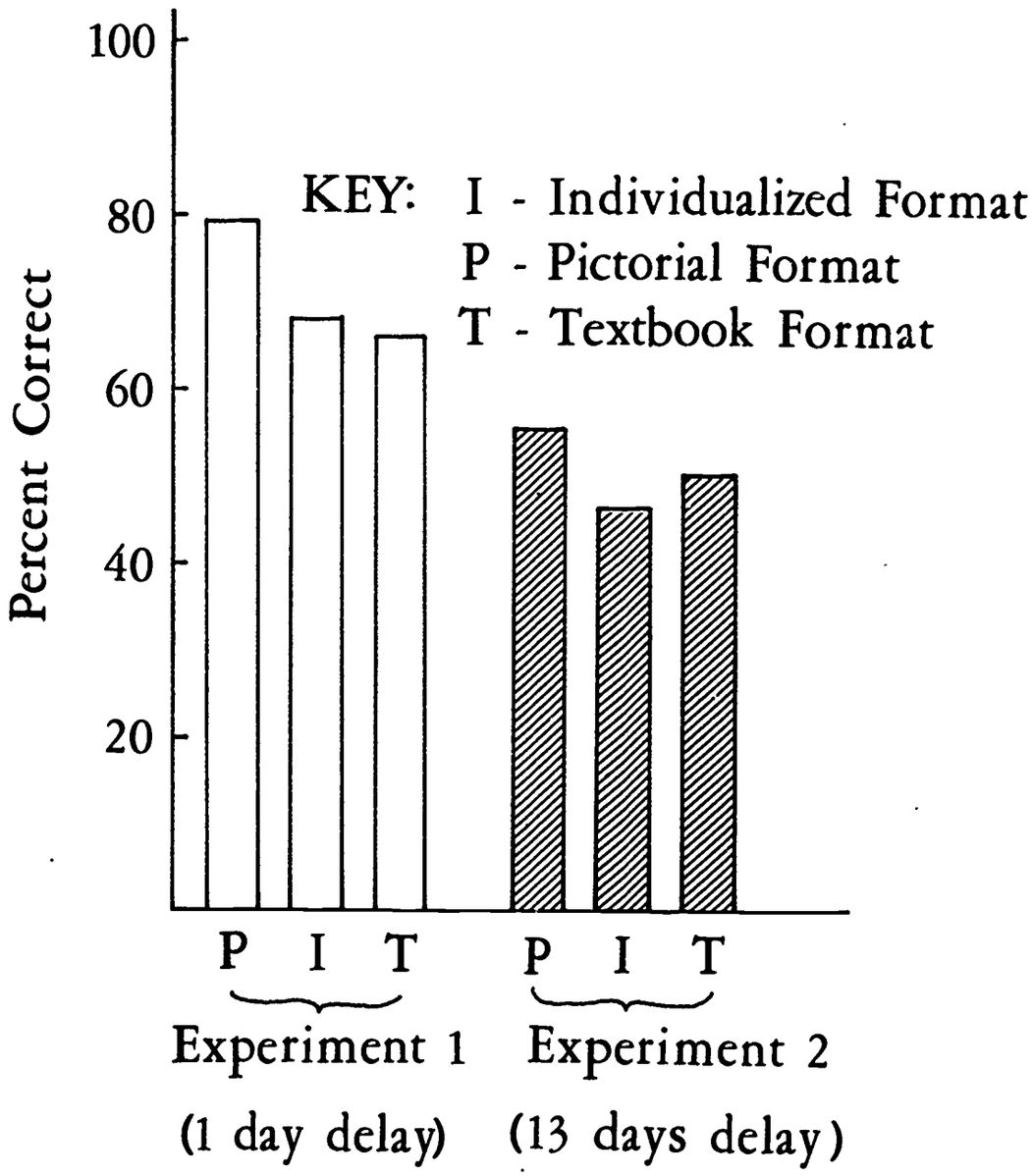
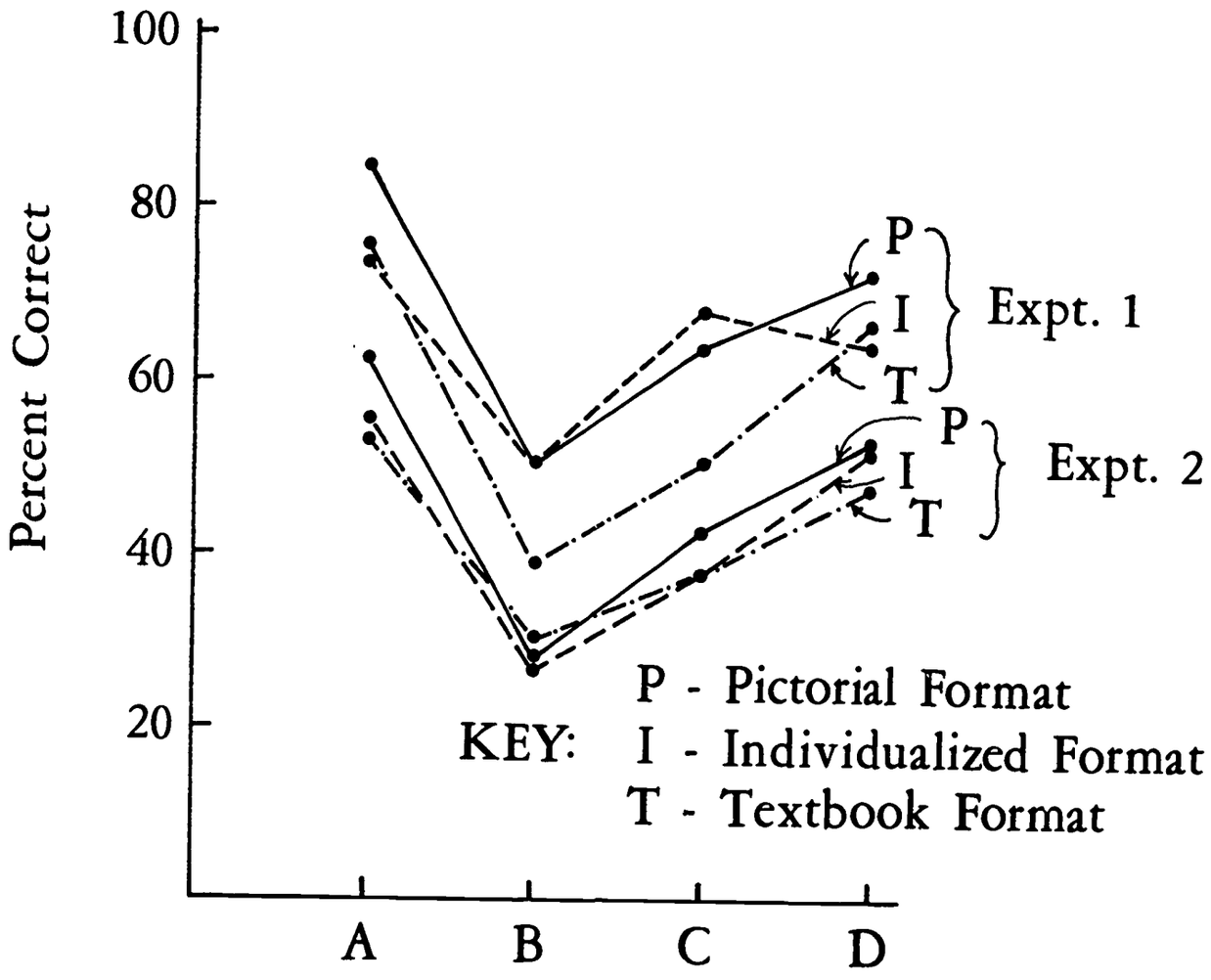


FIGURE 6

PERCENT CORRECT ON POSTTEST FOR DIFFERENT TYPES OF QUESTIONS



KEY:
A: Matching - Name/Location (20 items)
B: Matching - Function/Location (5 items)
C: Matching - Name/Function (5 items)
D: Multiple Choice (14 items)

TABLE 1

Medians and Quartile Deviations (Q)

for Posttest Scores

(Number of Items Correct)

	Instructional Format					
	Pictorial		Individualized		Textbook	
	Median	Q	Median	Q	Median	Q
Experiment 1	35.0	4.5	30.0	4.5	29.0	5.1
Experiment 2	24.5	6.0	20.5	4.5	22.0	5.0

TABLE 2

Pretest - Posttest Gain Scores

(Percent Correct)

	Instructional Format		
	Pictorial	Individualized	Textbook
Experiment 1	+46.1%	+38.4%	+38.4%
Experiment 2	+38.4%	+23.0%	+23.0%