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ABSTRACT

This study had as its purpose the investigation of visual-verbal presentation modes when used for instruction in different types of learning tasks with learners of differing mental abilities. Five parallel experiments were conducted, each for a different learning objective or task (identification, comparison, classification, generalization, application), and replicated with seven social studies and science content areas. Seven stimulus sequences were designed for each content area conforming to seven visual-verbal modes of presentation. Subjects were 617 fifth and sixth grade students. Performance was tested immediately after exposure to the experimental treatment and about two weeks later by specially constructed verbal objective tests. The results and conclusions include: (1) the Motion Picture Sound and Still Picture Sound treatments were generally superior to all other treatment modes for the Identification, Comparison, Classification, and Generalization learning objectives; and (2) there was little evidence that a hierarchical pattern existed between higher order and lower order tasks for the learning of cognitive information. (Author/SK)

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SUMMARY

This study had as its purpose the investigation of visual-verbal presentation modes when used for instruction in different types of learning tasks with learners of differing mental abilities.

Objectives

The general objectives of the study were:

1. To determine the immediate and delayed effects of visual-verbal presentation modes on learning of cognitive information for different ordered learning objectives or for learners of different mental ability levels.

2. To determine these effects for single-channel vs. multi-channel, motion vs. still, and pictorial vs. verbal presentations.

3. To determine the interrelationships among different learning objectives and the mode of visual-verbal presentation.

4. To determine if a hierarchical relationship exists in the learning for the different learning objectives.

Procedure

Five parallel experiments were conducted, each for a different learning objective or task (identification, comparison, classification, generalization, application), and replicated with seven social studies and science content areas. Seven stimulus sequences were designed for each content area conforming to seven visual-verbal modes of presentation: sound motion picture, silent motion picture, sound still picture, silent still picture, sound print, print alone, and sound alone. Subjects were 617 fifth and sixth grade students, assigned at random to the experimental treatments. A 3 x 7 experimental design was employed, the main variables being three levels of mental ability and the seven visual-verbal presentation modes. Performance was tested immediately after exposure to the experimental treatment and about two weeks later by means of specially constructed verbal objective tests. Analysis was by analysis of variance and multiple comparisons tests.

Results and Conclusions

The results and conclusions are summarized for the major comparisons, the learner characteristics, and the hierarchical analysis:

1. The Motion Picture Sound and Still Picture Sound treatments were generally superior to all other treatment modes for the Identification, Comparison, Classification, and Generalization learning objectives.

2. The High Mental Ability subjects achieved at a higher level than the Medium and Low Mental Ability subjects, but there was little difference in achievement between the Medium and Low Mental Ability subjects.

3. There was an overall tendency for the pictorial (motion picture and still picture) multi-channel sound treatments to show superiority over the single-channel treatments, but this superiority did not hold for the multi-channel verbal Print Sound over the single-channel Print alone treatment.

4. There was trend toward decreased influence of the mode of visual-verbal presentation as higher order skills were tested, more differences appearing for the Identification, Comparison, and Classification objectives than for the Generalization and Application objectives.

5. There was little evidence that a hierarchical pattern existed between higher order and lower order tasks for the learning of cognitive information.

CHAPTER I

INTRODUCTION

This exploratory study was directed toward the investigation of the effectiveness of different types of visual-verbal presentation modes when used for instruction in different types of learning tasks and with learners of different mental abilities. It systematically investigated specific instructional media design factors in order to discover how such factors and the unique characteristics of the different types of media might be most efficiently utilized in the design and selection of instructional materials. The study thus became a part of a broader research effort currently being made on many fronts to develop paradigms of instructional message design as related to an emerging science of instruction.

The Problem

The main objective of this study was to investigate the comparative effectiveness of seven different visual-verbal presentation modes when used for teaching five different learning tasks or objectives to learners at three mental ability levels. To accomplish this purpose, stimulus presentations were designed to present the content as sound motion pictures, silent motion pictures, sound still pictures, silent still pictures, combined print and sound, print only, and sound only. Each of these stimulus modes was presented to fifth and sixth grade subjects of high, medium and low mental ability, and the subjects were tested for their learning of identification, comparison, classification, generalization, and application learning tasks.

Specifically, five parallel experiments were conducted, one for each of the learning tasks or objectives. The stimulus material used in each of the experiments was identical, consisting of content from seven different subject matter areas, four from the general curriculum area of social studies and three from the area of science. Thus, it might be said that each experiment was replicated seven times with different subject matter content.

Learner performance was measured by specially prepared objective verbal tests of cognitive learning, the tests being separately administered and analyzed for each of the five learning tasks and each of the seven subject matter areas. Retention effects were measured about two weeks later by a re-administration of the performance posttests.

In addition, separate analyses were conducted to determine the differences in single vs. multiple channel modes, the insights into media design that might be gained from a study of performance on single test items relating to discrete segments of the stimulus treatments, and the possibility that a hierarchical structure existed among the five learning tasks.

Objectives of the Study

The main objective of the study was to investigate the comparative effectiveness of seven visual-verbal presentation modes with high, medium, and low mental ability upper elementary students in performing five different learning objectives or tasks. The specific objectives investigated were:

1. To determine the immediate posttest effects of the seven visual-verbal presentation modes for each of seven content areas in each learning objective or task.

2. To determine the immediate posttest effects of mental ability for each of the content areas in each learning objective or task.

3. To determine the immediate posttest interaction effects of presentation mode and mental ability for each content area in each learning task.

4. To determine the retention test effects for the above three objectives.

5. To compare the effects of single-channel (silent treatments) with multi-channel (sound treatments) presentation modes.

6. To determine the comparative effectiveness of different presentation modes (motion picture, still picture, print) within each of the two channel configurations (sound and silent).

7. To determine the comparative effects of motion and still presentation.

8. To determine the comparative effects of pictorial and verbal modes of presentation.

9. To determine the interrelationships among different learning objectives or tasks and the mode of visual-verbal presentation.

10. To determine if a hierarchical relationship exists in the learning of the content for the five learning objectives or tasks.

Procedurally, the problem was to produce and test under controlled conditions a number of stimulus treatments that would furnish evidence concerning the relationships of common forms of message struc-

ture to the learning tasks being taught and the mental ability of the learners. The acquisition of such information might lead to a more precise design of instructional materials and to the development of guidelines for their selection to meet specific teaching objectives.

Review of Related Literature

The research related to the objectives of this study will be reviewed under five general categories: comparison of media presentation forms, relationship of media presentation modes to learning tasks or instructional objectives, relationship of media presentation modes to the mental ability level of learners, comparison of multi-channel and single-channel effects, and hierarchies of learning.

Comparison of Media Presentation Forms

Although a great deal of broad and undifferentiated research has been conducted on the effectiveness of various media types--such as motion pictures, programed instruction, television--in which one media type is compared with another or with some other kind of material presentation, little research attention has been given to the effectiveness of different stimulus presentation forms, that is, to the encoding dimensions of media that comprise a more general class of characteristics than do the specific media types. Tosti and Ball (1969) listed four stimulus encoding forms: environmental structure (the real object), pictorial, symbolic, and verbal. The crucial point in the classifications of media presentation forms is that the stimulus materials have different physical attributes, depending upon the form of presentation employed, and that these attributes in themselves may contribute to different learning effects under different learning conditions. For example, the pictorial presentation form characterizes both motion and still pictures, whereas the verbal form characterizes print and spoken audio. It was the main purpose of this series of experiments to determine whether such effects did in fact occur and, if so, under what conditions of learning and with what kinds of learners. The research related to the various dimensions of the presentation form question will be reviewed: pictorial vs. verbal presentation, motion pictures vs. still pictures, and auditory vs. printed verbal modes.

Pictorial vs. Verbal Presentation. Little specific direct study has been made of the characteristics or the effects of the different pictorial or verbal stimulus encoding forms as such, although a great deal of attention has been given to the different media types of which they are elements. Several investigators, however, have developed classification schemes that subdivide the stimuli into different classes. The two classes we are considering here--pictorial and verbal--have been given different labels, but could be characterized generally as being either nonverbal or verbal forms of presentation.

Conway (1967, 1968), utilizing Knowlton's (1966) theoretical structure, distinguished two types of sign vehicles--iconic and digital--

and illustrated their relationships to auditory and visual sensory modalities. He classified a picture of an object as "iconic" and the printed word of the same object as "digital." Ruesch and Kees (1956) suggested a similar categorization. Langer (1942) characterized the two stimulus classes as presentational and discursive. The "presentational" form, or pictures, presented their constituents "simultaneously" so that that "relations determining a visual structure are grasped in one act of vision. The "discursive" form of stimuli presented their constitutents "successively" and was represented by words. Pryluck and Snow (1967) also categorized stimuli into two classes: "digital" information consisted of letters, words, numbers and other familiar symbols of an abstract nature occurring in serial form; "analogic" information consisted of pictures, gestures, intonations, etc., occurring simultaneously. Tosti and Ball (1969) described the "pictorial" encoding form as "a reproduction of either real or imagined visual aspects of objects" and words and verbal syntax the stimuli of the "verbal" encoding form. Gibson (1954), in explicating a theory of pictorial perception, characterized pictures and words by their "fidelity," or faithfulness to the physical and observable attributes of the original, pictures possessing this quality and words not possessing it. It would appear, therefore, that the distinguishing features of pictorial and verbal stimulus encoding forms are "realism" and "simultaneity" (nonlinearity) for the pictorial form and "abstraction" and "successiveness" (linearity) for the verbal form.

May (1965), in a paper on word-picture relationships in audiovisual presentations, explained the role of visuals and verbals in motivating, cueing, and reinforcing acquisitions of responses for productive-constructive learning tasks--that is, tasks that require evidence that the substance of the materials was comprehended. He explained that visuals can facilitate such learning by directing attention to key features or a combination of features so that relationships may be formulated to produce a rule or concept.

Gropper (1963, 1966) also contended that visual examples and cues facilitated acquisition, retention, and transfer of concepts. He concluded, for instance, that "due to everyday experience with shapes, colors, sizes, etc., responses to attributes of physical objects and events are generally at high strength. On the other hand, responses to verbal symbols for the same phenomena, or for abstract referents, are not likely to be at equally high strength." He found, in another study (Gropper, 1965), a superiority of the visual/verbal order of presentation of a concept to be learned over the verbal/visual order. There is also evidence on paired-associate learning research (Kopstein and Roshal, 1961; Lumsdaine, 1958) that an optimum learning condition is obtained when visuals are in the stimulus position and words are in the response position. Kale and Grosslight (1955) also found that presentations with pictures (motion pictures for verbs and still pictures for nouns in teaching the Russian language) were more effective than presentations without pictures.

In a study in which verbal printed programed instructional materials were supplemented or substituted for by motion pictures or still

pictures, Allen, Filep and Cooney (1967) found that the learning of materials having concrete referents that were describable and picturable was significantly enhanced by the pictorial presentation modes over the verbal print mode.

Motion Pictures vs. Still Pictures. Little analytical research has been conducted in which the effectiveness of motion picture presentation has been compared with still pictorial presentation. The largest number of studies have been evaluative in the sense that they compared the overall effectiveness of motion pictures and still filmstrips or slides. These evaluative studies were reported in detail in Allen (1960) and showed, in general, that still presentations were about as effective as motion pictures in teaching factual information.

In a directly related study, Roshal (1961) compared knot-tying performance by Naval trainees when instructions were presented by motion pictures and by sequences of still pictures. The results significantly favored the motion picture mode, suggesting the importance of motion in portraying actions possessing continuous changes in cues. In a study of moving ("animated") versus static transparencies in verbal instruction on weapons, Silverman (1958) found no significant differences between the two methods when measured by verbal tests, but a significant superiority for the motion mode when measured by performance tests.

Hovland, Lumsdaine and Sheffield (1949) compared the effectiveness of a motion picture and a filmstrip teaching map reading to Army trainees and found no overall differences in achievement. However, when they measured the effectiveness of the two presentation modes in showing the measuring of contour interval, in which the motion picture used a "moving viewpoint (from horizontal to vertical) to show how differences in elevation of terrain are projected onto a map in the form of contour lines," the film was significantly more effective than the still filmstrip. The researchers hypothesized that "the large effect of the motion picture appears to be due to the fact that in a movie the object being photographed can remain still while the angle from which it is viewed is progressively altered" and that "where familiarity with three-dimensional spatial relationships is important in learning the material, movies have an inherent advantage that cannot easily be equalled by filmstrips." In reporting the results of this study in their consideration of the psycholinguistics of cinema, Pryluck and Snow (1967) speculated that an equally reasonable explanation for these effects would be that the depicted movement facilitated for the subjects the process of "cognitive transformation" in the sense that Guilford used it. Guilford (1967) defined transformations as "changes of various kinds, of existing or known information in its attributes, meaning, role, or use" and included among the most common transformations in figural information "changes in sensory qualities and quantities, in location (movement), and in arrangement of parts."

Allen and Weintraub (1968), in a study that preceded the present one and which used most of the same pictorial stimuli, investigated the motion variable by comparing the effects of motion pictures, sequenced

still pictures, and still pictures, all of which were silent. They found the motion picture mode of presentation superior to either of the still picture modes in over 70% of the stimulus sequences. This superiority prevailed regardless of the subject matter content, the instructional objective being served, the interaction between content and objectives, the grade level of the subjects, or the sex of the subjects. The serial ordering of the content seemed to be most susceptible to influence and concept learning least susceptible by the motion picture mode of visual presentation. In general, it was not possible to determine the precise reasons for this superiority. However, where such phenomena as speed, directionality, action and reaction, changing viewpoint, and progressive changes were necessary for an understanding of the content, the motion picture mode appeared to be favored over the still modes of presentation.

Other studies have found no differences in learning when instructed by motion or still pictures. Allen, Filep and Cooney (1967), using motion pictures and still pictures to supplement programed verbal instruction, found no differences between the two visual presentation modes. In a study on the audio implementation of still and motion pictures, Allen, Cooney and Weintraub (1968) found no significant differences in performance under the two pictorial presentation conditions either for different mental ability level groups or when supplemented by different kinds of audio narration. In an unpublished study Fishell and Koch (date unpublished) compared sound motion pictures to three adapted sound filmstrips and found that there were no significant differences between the two modes.

Auditory vs. Printed Verbal Presentations. The main body of research comparing auditory and printed presentations of the same material were reported by Hartman (1961b) and Hsia (1968). Hartman concluded that the "print channel is more effective than the audio when the information to be presented is difficult or complex and the subjects are reasonably literate. The audio channel is a more efficient communicator than print when the subjects are illiterate, and in many specific instances when less difficult material is used. The audio channel is also considered more attention-demanding when interruption of attendance to visual stimuli is required, but under conditions of continuous simultaneous audio-print presentation of non-redundant information, neither channel has as yet demonstrable advantage in gaining attention." These generalizations advanced by Hartman received general agreement from Hsia (1968) and from Severin (1967).

Media Relationships to Instructional Objectives or Tasks

There is as yet no firmly established set of rules, guidelines, or principles for the selection of appropriate instructional media to meet specified instructional objectives, and there is little experimental evidence to point the way for the making of instructional decisions. At the same time, a number of attempts are being made to develop a taxonomy of instructional media in relation to the accomplishment of various learning tasks and with different kinds of learners.

Miller (1956) classified behavior into six categories of tasks: perceiving, recalling procedures, recalling nomenclature, interpreting, making logical inferences, and performing manual operations. Bloom and Others (1956) developed a taxonomy of educational objectives categorized into three major domains: cognitive, effective, and psychomotor. The cognitive domain was then subdivided into the knowledge, comprehension, application, analysis, synthesis, and evaluation objectives. Gagné and Bolles (1959) proposed four kinds of tasks having their own peculiar conditions for learning efficiency: identification, following procedures, concept using, and motor skills. Parker and Downs (1961) advanced six military training objectives: learning identifications, learning perceptual discriminations, understanding principles and relationships, learning procedural sequences, making decisions, and performing perceptual motor acts.

Later, Gagné (1962b) classified behavior into sensing, identifying, and interpreting categories. In his book on the conditions of learning, Gagné (1965) identified eight types of learning--signal, stimulus-response, chaining, verbal association, multiple-discrimination, concept, principle, and problem solving--and eight functions of the instructional situation that must be performed by its components--presenting the stimulus, directing attention, providing a model of expected performance, furnishing external prompts, guiding thinking, inducing transfer, assessing attainments, and providing feedback. Gage (1968) presented a list of technical skills, some of which overlapped with Gagné's functions: establishing set, establishing appropriate frames of reference, achieving closure, using questions, recognizing and obtaining attending behavior, control of participation, providing feedback, employing rewards and punishments, and setting a model.

Several attempts have been made to assign specific media to the accomplishment of the different instructional objectives. Parker and Downs (1961) considered the appropriateness of five different classes of training media for the accomplishment of six different military training objectives. The five classes of training media--simulators, training devices, training aids, teaching machines or automated training systems, and training parts--set forth by Parker and Downs are differentiated by their physical characteristics as pieces of equipment rather than by their perceptual or psychological attributes. As a result, this classification scheme for media application has little relevance to the present study. Gagné (1965) made a more determined effort to relate selected media to the component functions of the instructional situation and rated each of the media--objects, demonstrations, oral communication, printed, still pictures, silent motion pictures, sound motion pictures, and teaching machines--as to its ability to perform each function. Allen (1967) also attempted to rate a number of common instructional media types in relation to six learning objectives: learning factual information, learning visual identifications, learning principles, concept and rules, learning procedures, performing skilled perceptual-motor acts, and developing desirable attitudes, opinions and motivations. The most intensive effort to bring together what is known about media characteristics and effectiveness as related to types of learning in the prepara-

tion of actual instructional units was made by Briggs and Others (1967) and Briggs (1970), yet this matching of media with learning types was done on an intuitive basis. Recently, Tosti and Ball (1969) described an approach to instructional design and media selection, but also used an intuitive basis for the selection of specific media for the accomplishment of the instructional objectives.

The most intensive attempt to determine the instructional effectiveness of different media in meeting different instructional objectives was made by Allen and Weintraub (1968). They limited their study to an investigation of the motion variable, comparing motion and still pictures, but they studied these media for three different learning objectives—knowledge of specific facts, serial ordering, and the learning of concepts--in the science, motor skills, and social studies subject matter areas. Their findings pointed up the fact that concept learning appeared to be less subject to influence by the mode of visual presentation than either the learning of specific facts or serial ordering. Serial ordering of the content seemed to be most susceptible to influence by the motion picture mode, and the mode of visual presentation seemed to have the least influence upon performance in presenting specific facts in science and concepts in motor skill content. The present study expands the scope of the Allen and Weintraub study, using most of the same stimulus materials and two of the same treatment modes.

Media Relationships to Learner Characteristics

There is little evidence bearing directly on the question of media-learner relationships. Although some past research attention has been given to the relationships of mental ability to learning from different kinds of instructional media (Hoban and van Ormer, 1950; Allen, 1960), little study has been made of the relationships of various learner characteristics to more specific design characteristics of the media or to the instructional objective for which the communication is employed. Snow and Salamon (1968), in an important paper on aptitudes and instructional media, concluded that media attributes should interact with learner aptitudes.

There is evidence from a number of studies, as reported by Allen (1960), that students of high intelligence usually learn more from visual presentations than those of medium or low intelligence. In addition, in many cases, those of lower intelligence students appear to make a greater increment in learning when exposed to visual rather than verbal stimuli. In a recent study Gropper (1966) found a significant relationship between IQ and mode of presentation, the higher ability subjects profiting more from the verbal presentation of science concepts and principles than from the visual presentation and the lower ability subjects profiting more from the visual presentation. Studies by Allen, Cooney and Weintraub (1967) and Allen and Weintraub (1968) found no significant differences between achievement of high and low non-language mental ability groups or high and low vocabulary mental ability groups. However, it was noted in

both experiments that the low mental ability subjects scored at a significantly lower mean level than the high mental ability subjects.

Comparison of Multi-Channel and Single-Channel Effects

The comparison of multi-channel with single-channel presentation modes has been a subject of controversy for some time. Four major reviews of the research on this variable resulted in conflicting evidence. Day and Beach (1950), Hartman (1961b) and Hsia (1968) all found evidence from prior research favoring the multi-channel modes of presentation, in which a pictorial or print communication was combined with a redundant or related audio narration, over the single-channel modes, in which the pictorial, print, or audio narration was used alone. Travers (1967), on the other hand, citing evidence from Broadbent's (1958) model of the information transmission process relating to the capacity of the central nervous system to handle information, refuted these findings, concluding that "information received when two sense modalities are used is equal to the amount received when only one sense modality and one transmission of information is involved."

Severin (1967) questioned the value of Travers' conclusions because of the irrelevance of the content of the experimental materials to real situations. He emphasized the use of cue summation and stimulus generalization as the premises of comparative evaluation between single-channel and multi-channel presentation modes, contending that the theory of cue summation predicts an increase in learning as the number of cues increases. He concluded that it was cue summation which could account for the conflicting findings among the work of Travers (1968), Hartman (1961a), and his own experimentation. Severin found that there were no differences in learning between single-channel and multi-channel presentation modes when the material presented was in fact redundant, but also concluded that the multi-channel appeared to be superior to single-channel when relevant cues were used.

Conway (1967) questioned the validity of the conclusions drawn by Hartman (1961b) and Severin (1967) on two counts. The first criticism was that neither investigator provided a relevant learning situation, and second, that the focus on the relationship between channels lacked practicality to "real world" situations. Conway's point of attack has been largely on the coding of the content in the messages and the responses that are elicited to them. If channels are redundant, they should elicit exactly the same responses. If this holds, one can conclude that there would, in fact, be no more learning from multi-channel than from single-channel presentation modes. The point remains, however, that in real world situations, instructional materials are not presented in this redundant manner.

The question of single-channel versus multi-channel superiority is still an open one and may depend, along with other factors, upon such things as the nature of the material presented in the two channels, the

simultaneity of the presentation, the conditions of information processing, and the redundancy of the cues presented.

Hierarchies of Learning

Within recent years considerable attention has been given to the study of learning hierarchies, or the mediation of positive transfer from lower level task competencies to higher levels, the attainment of each higher level depending upon the mastery and transfer of the skills learned at the subordinate lower levels. Gagné and his associates have spearheaded the research and theoretical investigation of this problem (Gagné and Paradise, 1961; Gagné, 1962b; Gagné and Others, 1962; Gagné, 1968), and Briggs (1968) has considered the sequencing of instruction in accordance with such hierarchies of competence. These studies generally confirmed the prediction that rate of learning depends less upon basic learner abilities and more on achievement of subordinate categories as learning progresses up the hierarchy. The evidence is less clear concerning the existence of hierarchies of verbalizable knowledge than it is of intellectual skills. Whereas Gagné (1967) at one time generalized the ideas of learning hierarchies to subject matter fields of knowledge entities, he repudiated this attempt in a later paper (Gagné, 1968), questioning whether such verbalizable knowledge of what the learner knows could be structured in the same way that intellectual skills could. It is to this question of hierarchies of verbalizable knowledge that the present study is directed.

CHAPTER II

METHOD AND PROCEDURES

The experiment was designed to gather data relative to the learning effects of seven different visual-verbal presentation modes. Each of the treatments contained the same relative information and was presented to fifth and sixth grade students who were randomly assigned to the treatments. The learning effects were measured by specially prepared objective tests designed to measure the amount of knowledge acquired for each of five learning objectives or tasks.

Experimental Design

Five separate experiments were conducted, one on each of five learning objectives or tasks: making identifications, making comparisons, formulating classifications or concepts, drawing generalizations, and making application of learning to new situations. In each experiment, a 3 x 7 factorial design was employed, using the two-way analysis of variance technique in order to determine effects of the main variables under study and their interactions. The main variables studied were the seven different visual-verbal presentations modes--sound motion picture, silent motion picture, sound still picture, silent still picture, sound print, print, and sound--and the mental ability level of the subjects: high, medium, and low.

A total of 617 fifth and sixth grade students from the Bellflower School District (California) were used in the study. They were stratified by mental ability and assigned at random to the different experimental treatments.

A posttest design was used without a control group because the objectives of the experiment were concerned with differential effects rather than the question of whether the treatments produced more learning than no treatment.

Experimental Variables

Presentation Modes

Seven different visual-verbal presentation modes were designed to contain the same information:

1. Motion pictures with spoken verbal (MpS) were presented using both live and animated pictorial material. The narration was designed to describe simultaneously and redundantly the content of the visual mode. The narration described what was shown in the motion picture and presented no supplementary information not in the visual.

2. Silent motion pictures (Mp) made use of the exact visual material used in treatment number 1 without a spoken verbal.

3. Still pictures with spoken verbal (SpS) consisted of reproductions of selected frames of the motion picture films and the exact spoken verbal used in treatment number 1.

4. Silent still pictures (Sp) consisted of the same still pictures as used in treatment number 3 without a spoken verbal.

5. Print with spoken verbal (PrS) used the spoken verbal of the above treatments presented via audio tape players plus the same verbal material in printed form.

6. Print (Pr) treatments used only the content of the verbal treatments presented in printed form.

7. Spoken verbal (S) consisted of the spoken verbal material presented via audio tape players.

Mental Ability

Three levels of mental ability (MA) were stratified in the experiments. The fifth grade subjects were grouped by scores on the Verbal Battery of the School and College Ability Tests (Educational Testing Service, 1957). The sixth grade subjects were grouped by the Verbal Battery (Level D, Form 1) of the Lorge-Thorndike Intelligence Tests (1964).

All subjects below the fourth grade in reading ability were eliminated from the experimental population. For the fifth grade subjects, scores on the Word Meaning and Paragraph Meaning sections of the Sequential Tests of Educational Progress (Educational Testing Service, 1963) were used to measure verbal achievement. Subjects who ranked at the 13th percentile or below on one or both parts were eliminated from the experimental population. The Stanford Paragraph Meaning scores from the Intermediate Battery of the Stanford Achievement Test (Kelley et al., 1964) were used to identify the sixth grade subjects to be eliminated from the experimental population.

The high (H), medium (M), and low (L) mental ability (MA) grouping was done by making frequency distributions of the standardized test scores for the fifth grade subjects and the sixth grade subjects for each of the schools used in the study. The distributions were divided into thirds and produced the following group breakdown for the fifth

grade subjects in all of the schools used in the experiment.

HMA - 68% and above
MMA - 52% up to and including 61%
LMA - 42% and below

The breakdowns for high, medium and low ability students for the sixth grade subjects used in the study are shown below by content number and title of the contest used in that school.

Content #1 - Thailand	HMA	105 and above
	MMA	96-104
	LMA	95 and below
Content #2 - Irrigation	HMA	105 and above
	MMA	96-104
	LMA	95 and below
Content #3 - India	HMA	112 and above
	MMA	99-111
	LMA	97 and below
Content #4 - Labor	HMA	108 and above
	MMA	99-107
	LMA	98 and below
Content #5 - Heat	HMA	106 and above
	MMA	96-105
	LMA	95 and below
Content #6 - Salamanders	HMA	107 and above
	MMA	97-106
	LMA	96 and below
Content #7 - Mountains	HMA	107 and above
	MMA	97-106
	LMA	96 and below

Learning Objectives or Tasks

The variables of presentation mode and mental ability were studied for each of five learning objectives or tasks. These objectives were arranged in the following assumed hierarchical order, from lower order processes to higher:

1. Making identifications as to the specific physical characteristics or names of things and events.

2. Making comparisons that serve to determine the likenesses, differences, or matching of things and events.

3. Formulating classifications which require the categorizing, conceptualizing, or grouping of phenomena with respect to certain attributes or relationships.

4. Drawing generalizations from concepts to formulate principles, rules, or laws.

5. Making application of learning to new situations or to the solution of problems.

Each of the learning objectives or tasks was treated as a separate experiment, and the criterion performance data on each were separately analyzed for each of the seven content area stimuli.

Experimental Population

The total experimental population consisted of 617 fifth and sixth grade students from the Bellflower Unified School District (California). There were 305 fifth grade subjects and 312 sixth grade subjects.

Eight schools were used in the study. Two were used during the development of the criterion measure and six were used for the conduct of the main experiment. The schools used for the experiment were selected on two criteria: (1) the total population of fifth and sixth grade students, and (2) the facilities available at the school.

A list of the available students was obtained from the principals of each of the schools used in the study. Next, the students of each of the schools were stratified into high, medium, and low mental ability. They were then randomly assigned to one of seven treatment groups. Where possible, an even number of boys and girls were assigned to each of the twenty-one cells to control for sex differences. When cells had four replications, the remainder of the students were placed in a pool to be used at the time of the experiment in case of any absences. In one of the schools the student population was of sufficient size to conduct two content area experiments.

Dependent Variables

Seven performance tests were developed for the study, one for each of the content areas. They are presented in Appendix A. The performance tests consisted entirely of verbal items and employed a basic multiple choice format which allowed the experimenter to score each response as a binary item. The subjects responded to items for each of the objectives under study. The total number of items for each content area and each learning objective or task is presented in Table 1.

TABLE 1

NUMBER OF TEST ITEMS FOR EACH CONTENT AREA AND LEARNING OBJECTIVE

	Identification	Comparison	Classification	Generalization	Application	Total
1 Thailand	13	12	20	12	11	68
2 Irrigation	24	24	9	24	24	105
3 India	25	13	19	13	12	82
4 Labor	16	12	17	12	12	69
5 Heat	21	19	20	12	12	84
6 Salamanders	28	19	9	18	18	92
7 Mountains	18	11	5	18	18	70
						570

All of the test materials went through a tryout-revise-tryout-revise developmental process. In both tryouts, fifth and sixth grade students were exposed to the motion picture spoken verbal treatments. The subjects responded on specially prepared answer sheets as the questions were projected onto a screen at the front of the room. The stems of each of the items were read aloud to the students while they were required to read and respond to the choices by marking their answer sheets. During this phase observations as to time to completion, acceptance of the material, and procedural matters were made. The results of the tryouts were analyzed on a Honeywell 800 computer using the Kuder-Richardson Formula #20. Since the number of items was relatively small for each of the objectives, the reliability figures were distorted. Items were revised by observing the Phi coefficient and the proportion responding correctly. The criteria were to develop items having a Phi coefficient significant at or beyond .05 level and a proportion correct of between .300 to .700 (Guilford, 1965). The final test reliability coefficients were determined from the analysis of variance tables presented in Chapter III. Guilford (Chapter 17, 1965) maintained that "reliability is measured by the ratio of true variance to total variance, or by one minus the ratio of error variance to total variance [p. 44]."

The reliability coefficients computed in the above manner for the posttest are presented in Table 2 by content area and objective.

The retention test utilized the same instrument as the posttest.

Experimental Stimulus Materials

Subject Matter

The content materials included color motion picture film, color slides, audio tape, and printed booklets. Seven existing commercially produced silent super 8mm color motion pictures were selected as meeting the criteria for instruction in the five learning objectives. The following films were used:

#1 (Thailand)	"Floating Markets of Thailand" (Produced by International Communications Foundation)
#2 (Irrigation)	"Egyptian Village Irrigation" (Produced by Gateway Films)
#3 (India)	"Transportation in India" (Produced by International Communications Foundation)
#4 (Labor)	"Use of Labor in Eastern Europe" (Produced by International Communications Foundation)

TABLE 2

RELIABILITY COEFFICIENTS OF THE POSTTEST

Content	Objective	Reliability Coefficient
1 Thailand	Identification	.408
	Comparison	.259
	Classification	.321
	Generalization	.178
	Application	.250
	Combined Objectives	.429
2 Irrigation	Identification	.528
	Comparison	.376
	Classification	.113
	Generalization	.398
	Application	.036
	Combined Objectives	.557
3 India	Identification	.315
	Comparison	.252
	Classification	.190
	Generalization	.242
	Application	.155
	Combined Objectives	.300
4 Labor	Identification	.386
	Comparison	.165
	Classification	.385
	Generalization	.279
	Application	.281
	Combined Objectives	.348
5 Heat	Identification	.306
	Comparison	.433
	Classification	.366
	Generalization	.235
	Application	.207
	Combined Objectives	.386
6 Salamanders	Identification	.386
	Comparison	.539
	Classification	.333
	Generalization	.187
	Application	.243
	Combined Objectives	.473
7 Mountains	Identification	.370
	Comparison	.264
	Classification	.318
	Generalization	.330
	Application	.236
	Combined Objectives	.423

#5 (Heat)	"Heat Can Do Work" (Produced by International Communications Foundation)
#6 (Salamanders)	"Salamanders" (Produced by Film Associates)
#7 (Mountains)	"Dome and Volcanic Mountains) (Produced by Film Associates)

The seven films varied in length from two to three minutes and covered material in the social studies and science curriculum areas not normally taught in the fifth or sixth grades, but suitable for upper elementary students. The selected films met the criteria of containing only a limited number of predominant concepts.

The four social studies content areas portrayed certain aspects of life in various foreign countries. The "Thailand" content portrayed the conduct of the daily markets along the canals of a city. The "Irrigation" content presented three methods of irrigation used along the Nile River in Egypt. The content area of "India" presented various patterns of life in the cities and countryside. The final social studies content of "Labor" portrayed various jobs done by men and women in eastern Europe. The visual treatments for the social studies areas all were made up of live photography.

The science content area "Heat" presented three ways in which steam can be used to do work. The content area of "Salamanders" portrayed four kinds of salamanders and how they differ from one another in form and habitat. The last area "Mountains" presented two kinds of mountains, dome and volcanic, how they formed and how they differed. This was the only content area which used some animation techniques in the visual treatments.

Development of Stimulus Material

A total of 49 separate experimental treatments were developed for the experiment. With the exception of "Salamanders" the study utilized material from a previous experiment by Allen and Weintraub (1968) and were employed in order to enhance generalization of findings between the two studies.

The criteria for selection were: (1) content had to be sufficiently novel to minimize the effect of prior knowledge yet be comprehensible to the subjects; (2) the visual content had to be readily describable in verbal terms; (3) the content had to be presented in short periods of time; (4) the content had to be applicable to the five learning objectives or tasks.

Verbal narrations were developed for each film using a "redundant sound" technique utilized in a media study by Allen, Cooney and Weintraub (1968). "Redundant sound" was defined as being narration that described literally and simultaneously in the audio narration content that appeared in the visual. The verbal narration developed for the motion picture was also used for the spoken verbal in all presentation modes with sound and in printed form for the print mode.

The next step was to reproduce selected frames from the super 8mm motion pictures onto half frame 35mm Ektachrome transparencies for the still picture treatments. The criteria for selection of the specific frames were: (1) that each time the scene changed in the motion picture treatment a frame was taken and; (2) in the case of a pan or zoom, the frames selected had to contain the information which was being described in the narration at its best visual point. All still picture sequences were reproduced on a Repronar slide copier and were of comparable quality to the super 8mm film treatments.

The motion picture sound treatments were developed by having a magnetic sound stripe applied to the edited release prints by a laboratory and then recording the spoken verbal directly on the stripe using a tape recorder and a sound projector. Still picture sound treatments were developed by recording the spoken verbal on a tape recorder and adding an actuating or advancing pulse to the audio tape. The inaudible pulses were added to the tape at precisely the same time as the motion picture treatment would change scenes, thus enabling precision control of the exposure of the images to the subjects. The silent motion picture and silent still picture treatments were made by simply turning the audio amplifiers down to an inaudible level when presenting the stimuli to the subjects.

The printed verbal treatment was developed by reproducing the spoken verbal treatment in typed form. The seven printed verbal treatments used in the study are presented in Appendix B.

Conduct of the Experiment

The motion picture treatments were presented with Bauer, Model T2, super 8mm sound projectors having zoom lenses. The still pictures were presented with Kodak Carousel, Model AV 900, slide projectors also having a zoom lens which enabled the matching of image size. The spoken verbal materials, with the exception of the motion picture with spoken verbal treatments, were presented with a Norelco, Model 1000, LCH cassette tape player and pulsing control system for advancing slides.

The projection screen was a portable matte white six foot square model, and the projectors and the tape player were placed on a portable projection stand at the rear of each of the rooms used in the experiment.

Organizational procedures were worked out with each of the principals and the teachers in advance of the experiment. On the day of the experiment, teachers were given 3" x 5" cards with the students' names

printed on them. They were separated into groups and each group was assigned a specific time at which to appear at the room where the experiment was being conducted. As the students arrived, the assignment card was given to a monitor and the student's name was checked off of a master list. In the case of an absentee, another student was assigned at this time if available from the pool. However, it was not always possible to equalize the cell sizes.

Each of the groups contained essentially twelve subjects, four high ability, four medium ability, and four low ability. Each was seated and given a clip board to which was attached a pencil and one of the specially prepared answer sheets. The subjects then responded to the verbal directions of a second monitor at the front of the group. They were given practice responding to the two kinds of items used on the criterion test.

The items were projected onto the screen at the front of the room. The stems of each of the items were read aloud by the monitor in the front of the room while the subjects were required to read the choices to themselves and mark their responses on the answer sheets.

When it was ascertained that all the subjects understood the procedure to be used, they were asked to close their answer sheets and give close attention to the stimulus material. After presentation of the experimental treatment, the questions were then projected on the screen, one at a time at a fixed pace, and the stems were read aloud by the monitor. The subjects recorded responses on the answer sheets. Presentation of each experimental treatment consumed about 30 minutes.

The retention test was administered from 10 to 14 days after the posttest and was given entirely in printed form with the subjects responding on the same kinds of answer sheets.

Preparation of the Data for Analysis

Each of the students had been assigned an identification number by the school district. This number, along with a number to indicate sex, one to identify the content area, one to indicate grade, and one to indicate mental ability level were entered as a 10 digit identification number on an IBM No. 510 sense score sheet. After all responses were transferred from the subjects' answer sheets to the sense score sheets, they were machine scored on each objective and the total scores transferred mechanically to IBM cards.

The IBM cards were then used for all further statistical analyses performed.

Statistical Tools Employed

Two basic statistics were used in the primary analysis of the

data. The first was a two-way analysis of variance which employed the computer program BMD 95V (Dixon, 1968). The program was designed to test the linear hypothesis model which was applicable to the study, employing a two-way analysis of variance. The program was executed on a Honeywell H-800 computer. The second statistical analysis performed used the computer program program BMD 07V (Dixon, 1968) which calculated a one-way analysis of variance and either single or multiple comparisons among means using Duncan's Multiple Range Test. The critical value or ranges were supplied by the user. Duncan's Multiple Range Test was used because comparisons were to be made between all means, in other words, a posteriori comparisons (Kirk, 1968). Duncan (1965) has argued that as the number of groups that are to be compared increases, it is realistic to believe the test more likely to detect real differences. This increase in power does however, decrease the protection level (Kirk, 1968).

In addition, a special computer program was written to compute the proportion of positive transfer in the analysis of hierarchy patterns between the levels of learning objectives or tasks. The X^2 test was employed to determine the significance of the difference between the observed and the expected proportions of positive transfer.

All of the BMD 07V programs and the hierarchical analysis were executed on an IBM 360 computer. The statistical computations were all performed at the Computer Sciences Laboratory of the University of Southern California.

CHAPTER III

RESULTS

Test results were analyzed separately in each of the seven stimulus content areas for each of the five learning objectives or tasks and for all learning objectives combined. The objective of this analysis was to compare the effectiveness of the seven visual-verbal presentation modes with high, medium, and low mental ability subjects in performing the different cognitive learning tasks. Both the immediate learning and the retained learning were measured. In addition, analyses were made of performance on individual test items and for the hierarchical patterns of learning.

Experiment One: Identification Objective

Experiment One was concerned with the Identification learning objective or task. Those criterion test items in each of the seven stimulus content areas that dealt with the making of identifications (i.e., the learning of specific physical characteristics or names of things and events) were analyzed to determine the effectiveness of the seven visual-verbal presentation modes as related to learners of different mental ability levels. The mean performance test scores on both the immediate posttests and the delayed retention tests are presented in Tables 3 and 4.

Visual-Verbal Presentation Mode

The main objective of the study was the determination of the comparative effectiveness of seven different visual-verbal presentation modes in contributing to the learning of specific identification facts in seven different subject matter content areas. The presentation modes varied on a hypothetical continuum from most concrete to most abstract: sound motion picture, silent motion picture, sound still picture, silent still picture, sound and print combined, print alone, and sound alone. The comparison of the performance by the seven groups on the immediate posttest was made by a two-way analysis of variance, the data being combined for all three mental ability levels to determine the main effects of the presentation modes. The results of these analyses are presented in Table 5.

TABLE 3

POSTTEST PERFORMANCE MEANS AND STANDARD DEVIATIONS ON PRESENTATION MODES BY MENTAL ABILITY LEVEL ON THE IDENTIFICATION OBJECTIVE

		MpS			Mp			SpS			Sp			PrS			Pr			S		
		N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ
1 Thailand	High	4	11.000	2.000	4	7.500	1.250	4	10.500	1.730	4	7.500	3.109	4	10.250	.957	4	9.000	1.825	4	7.750	1.892
	Med.	4	11.750	.500	4	8.500	1.910	4	10.000	1.410	4	9.000	2.943	4	8.250	2.061	4	7.750	.957	4	8.000	1.825
	Low	4	8.750	1.710	4	7.750	1.260	4	7.500	.577	4	8.250	.957	4	10.000	1.630	4	8.000	2.440	4	8.500	1.290
2 Irrigation	High	4	18.750	1.258	4	17.000	2.160	4	15.750	2.217	4	11.250	4.500	4	15.750	1.258	4	19.750	.957	5	17.600	3.701
	Med.	4	15.250	2.217	7	15.285	1.889	4	14.250	4.031	4	12.750	.957	4	14.250	3.095	4	12.500	5.696	4	15.250	2.061
	Low	4	13.500	1.732	4	14.500	.577	4	17.000	5.741	4	11.500	1.000	4	13.500	2.516	4	12.250	.957	4	13.250	.957
3 India	High	4	20.000	2.708	6	17.666	2.422	4	19.000	2.449	4	16.250	2.217	3	15.333	2.645	4	18.500	1.732	4	19.500	1.732
	Med.	6	18.833	2.714	6	18.000	2.280	6	18.833	2.639	4	17.250	2.500	3	18.000	1.290	4	18.250	.957	4	17.750	2.629
	Low	7	18.285	2.058	6	14.666	3.502	7	16.142	3.436	3	15.333	.577	4	14.500	3.000	4	15.250	1.500	4	16.500	2.380
4 Labor	High	4	12.250	2.753	4	11.750	.957	4	11.000	1.154	4	10.000	1.414	4	10.250	2.061	4	11.250	2.362	4	10.000	.816
	Med.	4	10.500	3.109	4	9.250	2.061	4	11.250	2.061	4	8.500	.577	4	11.500	3.109	4	7.750	2.629	4	11.250	.957
	Low	4	11.500	1.732	4	8.500	1.290	4	12.250	1.500	4	7.500	2.645	4	9.750	1.892	4	10.250	2.872	4	10.250	.957
5 Heat	High	4	16.750	2.217	5	17.600	1.673	4	14.000	4.242	4	12.750	3.304	4	13.750	2.753	4	14.500	2.380	4	15.750	2.986
	Med.	4	13.750	2.500	4	13.250	1.707	4	12.000	3.915	4	12.750	2.500	5	13.400	2.701	4	13.500	1.914	4	11.500	2.380
	Low	4	14.500	3.415	4	13.500	2.516	4	14.000	3.464	3	10.333	2.309	4	13.500	5.196	4	14.250	.500	4	11.000	2.160
6 Salamanders	High	4	19.250	4.573	4	15.500	4.123	4	20.250	4.991	3	18.000	2.645	4	15.750	2.500	5	17.600	4.098	4	18.000	2.000
	Med.	4	19.500	3.109	4	14.000	1.154	4	17.250	4.500	3	13.333	4.725	3	19.333	4.041	4	15.750	1.250	4	16.000	3.559
	Low	4	18.750	3.201	4	15.000	4.320	4	15.250	4.645	4	15.000	2.943	4	15.500	1.914	3	13.330	4.725	4	10.500	2.380
7 Mountains	High	4	13.000	2.160	4	13.500	1.290	3	16.000	1.000	4	15.500	1.290	4	15.500	3.109	6	12.660	1.032	4	14.500	2.643
	Med.	5	12.000	3.162	5	12.200	3.563	4	13.000	2.943	4	11.750	1.500	4	12.000	1.414	6	12.160	1.329	5	11.200	1.643
	Low	6	12.830	3.060	5	12.000	1.414	6	11.000	2.566	4	11.750	1.258	4	11.750	.957	6	13.160	.983	6	12.500	1.048

TABLE 4

RETENTION TEST PERFORMANCE MEANS AND STANDARD DEVIATION ON PRESENTATION MODES BY MENTAL ABILITY LEVEL ON THE IDENTIFICATION OBJECTIVE

		MpS			Mp			SpS			Sp			PrS			Pr			S		
		N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ
1 Thailand	High	4	9.000	2.449	4	7.500	.577	3	10.000	2.000	4	7.750	.500	4	8.250	1.500	2	7.000	1.414	4	5.500	2.645
	Med.	4	10.000	.816	4	6.750	2.629	3	10.000	1.000	4	7.500	1.732	3	9.000	1.732	4	6.750	2.753	4	6.750	1.500
	Low	2	8.500	.707	4	7.500	1.732	4	9.000	2.000	5	6.660	2.516	3	8.660	2.309	4	6.000	1.154	4	8.000	1.414
2 Irrigation	High	3	16.660	2.516	4	16.250	2.061	4	13.250	4.787	4	11.000	2.708	4	14.500	4.203	4	17.000	3.162	4	14.500	3.872
	Med.	5	14.600	2.792	7	13.570	3.258	4	14.000	1.845	3	12.660	2.081	4	13.750	1.892	4	11.000	2.449	5	12.400	2.190
	Low	4	15.250	.500	4	13.500	1.91	4	13.750	3.362	4	13.000	2.449	3	14.330	1.154	4	13.750	4.319	4	12.000	1.414
3 India	High	4	18.500	1.000	5	16.400	2.073	4	18.750	2.629	4	18.750	3.403	3	18.330	2.516	4	17.500	1.732	4	19.250	2.061
	Med.	6	16.660	2.065	6	16.660	2.804	5	18.660	1.966	4	17.250	2.872	4	17.750	2.217	4	16.750	1.892	4	17.500	1.707
	Low	7	16.000	4.041	5	15.600	4.335	7	16.000	2.160	3	16.000	1.732	2	16.000	.000	3	17.660	4.041	4	16.750	1.892
4 Labor	High	3	12.000	1.000	4	9.750	1.707	4	11.000	2.943	3	10.660	1.154	4	9.000	2.708	3	10.660	2.081	4	11.500	5.250
	Med.	3	12.000	2.645	4	9.000	1.414	4	9.000	1.825	4	9.500	1.290	4	10.750	2.061	4	8.750	1.500	4	10.750	4.500
	Low	4	11.000	.816	4	8.250	1.892	4	11.750	1.500	4	6.250	1.500	4	10.000	4.546	4	10.250	4.349	3	10.000	2.645
5 Heat	High	4	17.000	2.160	5	18.000	1.870	3	14.660	3.511	2	15.500	.707	4	12.250	2.872	5	10.330	2.081	4	12.750	2.629
	Med.	4	14.250	2.753	4	12.500	3.872	4	13.750	2.629	4	12.000	4.760	5	13.600	4.393	4	13.000	2.449	5	11.350	2.886
	Low	3	11.660	6.027	3	13.660	4.163	4	12.500	5.567	3	9.330	1.527	3	12.660	7.023	3	11.660	2.081	5	11.000	1.414
6 Salamanders	High	4	17.500	3.196	4	14.750	2.061	4	18.750	2.926	3	15.000	5.291	3	13.330	2.181	5	16.600	4.827	3	13.660	1.527
	Med.	4	16.000	2.708	4	13.750	2.500	3	16.660	3.214	4	14.250	2.217	3	13.660	4.041	4	14.250	.500	3	13.660	1.154
	Low	4	16.750	4.645	3	17.000	1.000	4	15.500	4.203	5	14.600	3.646	2	15.000	.000	3	11.330	1.154	2	13.000	1.414
7 Mountains	High	4	12.750	2.217	4	14.000	1.154	2	16.500	.707	4	15.250	.500	3	17.000	1.732	5	12.200	.836	4	14.000	2.708
	Med.	4	11.500	2.886	5	11.800	2.774	4	13.750	2.629	4	12.750	1.892	4	12.000	1.414	6	12.000	2.366	5	10.800	2.167
	Low	6	12.000	2.966	5	12.400	1.949	5	11.400	1.816	4	11.750	1.500	4	10.750	2.061	6	13.500	1.870	5	11.600	2.408

TABLE 5

ANALYSIS OF VARIANCE FOR POSTTEST AND RETENTION TEST SCORES OF THE IDENTIFICATION OBJECTIVE

Content	Source	Posttest				Retention Test			
		df	MS	F	Prob.	df	MS	F	Prob.
1 Thailand	Presentation Modes (A)	6	12.39	3.98	< .01	6	13.91	4.13	< .01
	Mental Abilities (B)	2	3.39	1.09	—	2	1.59	.47	—
	A × B	12	4.51	1.44	< .25	12	1.33	.39	—
	Within	63	3.16			54	3.36		
2 Irrigation	Presentation Modes (A)	6	22.97	3.98	< .01	6	12.53	1.57	< .25
	Mental Abilities (B)	2	53.86	9.48	< .01	2	17.406	2.18	< .25
	A × B	12	15.01	2.64	< .01	12	8.64	1.08	—
	Within	67	5.68			65	7.96		
3 India	Presentation Modes (A)	6	12.23	2.01	< .10	6	1.66	.47	—
	Mental Abilities (B)	2	33.37	5.50	< .01	2	24.62	3.54	< .05
	A × B	12	6.00	.98	—	12	2.86	.41	—
	Within	76	6.07			72	6.93		
4 Labor	Presentation Modes (A)	6	12.07	2.98	< .05	6	11.01	1.49	< .25
	Mental Abilities (B)	2	7.22	1.78	< .25	2	7.03	.95	—
	A × B	12	6.12	1.51	< .25	12	5.92	.80	—
	Within	63	4.04			58	7.37		
5 Heat	Presentation Modes (A)	6	13.34	1.62	< .25	6	17.27	1.39	< .25
	Mental Abilities (B)	2	38.56	4.70	< .05	2	38.42	3.09	< .10
	A × B	12	6.15	.75	—	12	9.43	.75	—
	Within	64	8.20			56	12.44		
6 Salamanders	Presentation Modes (A)	6	42.72	3.35	< .01	6	20.18	2.00	< .10
	Mental Ability (B)	2	41.69	3.27	< .05	2	7.27	.72	—
	A × B	12	11.76	.92	—	12	6.21	.65	—
	Within	60	12.72			53	10.04		
7 Mountains	Presentation Modes (A)	6	2.32	.55	—	6	6.23	1.38	< .25
	Mental Ability (B)	2	51.77	12.41	< .01	2	56.68	12.68	< .01
	A × B	12	5.95	1.42	< .25	12	8.24	1.83	< .10
	Within	77	4.16			72	4.48		

Significant differences at or beyond the .05 level were found in four of the seven content areas--for three of the social studies stimuli and for one of the science stimuli. The content areas of "India" and "Heat" reached the .10 and .25 levels of significance, and only "Mountains" produced no significant differences among the presentation mode means.

Table 6 shows the results of the Duncan Multiple Range Test for all treatment comparisons and all subject matter content areas. In these a posteriori multiple comparisons tests the .05 level was used to determine significance. The Motion Picture Sound treatment was predominantly the most effective presentation mode, showing superiority to one or more of the other treatments in six of the seven content areas. The Still Picture Sound treatment showed superiority in three content areas, the silent Motion Picture in two, and Print Sound, Print alone, and Sound alone each in one area. The least effective mode of presentation was the silent Still Picture, showing inferiority for six of the seven content areas. The silent Motion Picture, Print alone, and Sound alone treatments were each inferior to the Motion Picture Sound in two of the content areas, and the Sound alone treatment was inferior to the Still Picture Sound treatment in one case. There appeared to be no discernible patterns of effects between the social studies and science subject matter areas.

Mental Ability Level

A second objective of the study was the determination of the relationships of mental ability to the learning of specific identification facts in the seven different content areas. Subjects were grouped for analysis at three mental ability levels: high, medium, and low. The comparison of the performance by the three mental ability groups on the immediate posttest was by a two-way analysis of variance combined for all seven presentation modes to determine the main effects of the mental ability variable. The results of this analysis are presented in Table 5.

Significant differences at or beyond the .05 level were found in five of the seven content areas--for two of the social studies stimuli and for all three of the science stimuli. The content area of "Labor" reached the .25 level of significance, and only "Thailand" produced no significant differences among the presentation mode means.

Table 7 shows the results of the Duncan Multiple Range Test for all treatment comparisons and all subject matter content areas. The subjects with High Mental Ability achieved significantly superior posttest scores to either the Medium or Low Mental Ability groups in four of the comparisons. In one comparison ("Salamanders") the High Mental Ability subjects were superior to the Low Mental Ability subjects.

TABLE 6

SUMMARY OF PRESENTATION MODE POSTTEST AND RETENTION TEST FOR THE IDENTIFICATION OBJECTIVE

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
1 Thailand	MpS > Sp/Pr/S/Mp	SpS > S/Sp/Mp/Pr MpS > Sp/Mp/Pr PrS > Pr
2 Irrigation	MpS/SpS/Mp > Sp Pr/S/PrS	MpS > S/Sp
3 India	MpS > Sp	
4 Labor	SpS/MpS > Sp	MpS > Mp
5 Heat	MpS/Mp > Sp	Mp/MpS > PrS/Sp/S/Pr SpS > Sp/S/Pr PrS > Pr
6 Salamanders	MpS > Pr/Sp/Mp/S SpS > S	SpS/MpS/ > Mp/Sp/Pr/PrS/S Mp > Pr/PrS/S Sp > S
7 Mountains		SpS > Sp/PrS/Mp/Pr/S/MpS Sp/PrS > Pr/S/MpS Mp > MpS

Interaction between Presentation Mode and Mental Ability Level

A third objective of the study was the determination of the interactions between the seven visual-verbal presentation modes and the three mental ability levels. The comparison was made by a two-way analysis of variance, and the results are presented in Table 5.

Only one interaction was significant at or beyond the .05 level of significance—in the "Irrigation" content—but three interactions were significant at the .25 level. In order to discover the relationships of presentation mode to mental ability, a separate analysis was made at each mental ability level by means of the Duncan Multiple Range Test using the .05 level to determine significance. The results of the comparisons in which significant differences were found are presented in Table 8.

When the splits by mental ability level were examined, the overall superiority of the Motion Picture Sound and Still Picture Sound treatments and the inferiority of the silent Still Picture at all mental ability levels was found. There was a decided tendency for the pictorial presentation modes (with the exception of the silent Still Picture) to show a general superiority to the verbal presentation modes, being particularly pronounced for the Low Mental Ability groups. The one significant interaction revealed by the analysis of variance ("Irrigation" content) appeared to be related to a shift from superiority of the Motion Picture Sound, Print Sound, Print alone, and Sound alone with the High Mental Ability groups to an inferiority with the Low Mental Ability groups.

Retention of Learning

The fourth objective of the study was the determination of the duration of the learning as measured by a retention test from 10 to 14 days after the exposure to the stimuli. The two-way analyses of variance for the retention tests are presented in Table 5, and the results of the comparisons in which significant differences were found on the presentation modes and mental ability levels are presented in Tables 6, 7, and 8.

There was a tendency for the same patterns of difference to prevail in the retention tests as in the posttests, with the superiority of the pictorial presentation modes becoming even more pronounced over the verbal modes. That is, the pictorial modes tended to maintain their significantly superior positions and to reduce their inferior positions, whereas the verbal modes did just the opposite. For the combined data from all mental ability levels (Table 6), only in the "India" content did the posttest differences fail to persist in the retention test. In the "Mountains" content differences were found in the retention test only.

TABLE 7

COMPARISON OF MENTAL ABILITY LEVELS ON POSTTEST AND RETENTION TEST FOR THE IDENTIFICATION OBJECTIVE

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
1 Thailand		
2 Irrigation	High > Med/Low	High > Med
3 India	High/Med > Low	High > Low
4 Labor		
5 Heat	High > Med/Low	High > Low
6 Salamanders	High > Low	
7 Mountains	High > Med/Low	High > Med/Low

TABLE 8

SUMMARY OF SIGNIFICANT COMPARISONS AMONG POSTTEST AND RETENTION TEST PRESENTATION MODES FOR MENTAL ABILITY LEVELS ON IDENTIFICATION OBJECTIVE

Content	Duncan Multiple Range Test ($\alpha = .05$)	
	Posttest	Retention Test
HIGH MENTAL ABILITY		
#1 Thailand	MpS > Mp/Sp/S	SpS > Pr
#2 Irrigation	Pr/MpS/Mp/SpS/PrS/S > Sp Pr > SpS/PrS/S/Sp	Pr/MpS/Mp > Sp
#5 Heat	Mp > Sp	Mp > PrS/Pr MpS > Pr
#6 Salamanders	SpS > S	SpS > PrS/S
#7 Mountains	SpS > Pr	PrS/SpS > MpS/Pr
MEDIUM MENTAL ABILITY		
#1 Thailand	MpS > Mp/PrS/S/Pr	MpS/SpS > Mp/Pr/S
#3 India	MpS/SpS/Pr/Mp > PrS	
#4 Labor	PrS > Pr	
#5 Heat		
#6 Salamanders	MpS > Sp	
LOW MENTAL ABILITY		
#1 Thailand		SpS > Pr
#2 Irrigation	SpS > MpS/PrS/S/Pr/Sp	
#3 India	MpS > Mp	
#4 Labor	SpS > Sp	SpS/MpS > Sp
#6 Salamanders	MpS > S	Mp/MpS > Pr

Although the same general differences among mental ability levels were found on the retention tests as on the posttests (Table 7), there was a tendency for these differences to be reduced somewhat. On the splits by mental ability levels (Table 8), in every one of the five content areas in which significant posttest differences were found for the High Mental Ability groups, differences were also found in the retention test. However, in only one case was this true for the Medium Mental Ability subjects and in only two cases for the Low Mental Ability groups.

Multi-Channel Effects

The fifth objective of the study was the determination of the comparative effectiveness of single-channel (silent treatments) and multi-channel (sound treatments) presentation modes. Although there was a noticeable tendency for the multi-channel modes to show gains over the single-channel modes, these differences were statistically significant in only two of the seven comparisons between the motion picture modes, in two of the seven comparisons between the still picture modes, and in none of the seven comparisons between the print modes (Table 6). However, on the retention test these differences increased to three comparisons between motion picture modes, four comparisons between still picture modes, and three cases between print modes. In one case the silent motion picture was superior to the sound motion picture. These patterns of differences appeared to show no particular relationship to the different mental ability levels.

Intra-Channel Effects

The sixth objective of the study was to determine the comparative effectiveness of the different presentation modes within each of the two channel configurations (sound and silent). An inspection of the summary data in Table 6 shows that, although there were few significant differences on the posttests--the only difference being a very slight inferiority of the still picture mode--more differences emerged on the retention tests with some indication of superiority for the pictorial over the verbal presentation modes. These differences did not appear to be a function of the mental ability level of the subjects.

Summary of Findings

The analyses of the performance data for the Identification learning objective or task resulted in the following conclusions:

1. The Motion Picture Sound treatment was the most effective overall mode of visual-verbal presentation, and the Still Picture Sound treatment was the next most effective at all mental ability levels.

2. The silent Still Picture treatment was the least effective mode of presentation at all mental ability levels.

3. The High Mental Ability subjects achieved significantly superior scores to either the Medium or Low Mental Ability subjects.

4. The same general patterns of effectiveness prevailed in the retention tests.

5. The pictorial (motion and still picture) multi-channel (sound) presentation modes were more effective than the single-channel (silent) modes. There were no channel-mode effects with the verbal (print) modes of presentation. These differences tended to increase in the retention test.

6. Intra-channel differences were found only in the delayed retention tests, in which the pictorial presentation modes were found to be slightly more effective than the verbal presentation modes.

Experiment Two: Comparison Objective

Experiment Two was concerned with the Comparison learning objective or task. Those criterion test items in each of the seven stimulus content areas that dealt with the making of comparisons (i.e., the determination of the likenesses, differences, or matching of things and events) were analyzed to determine the effectiveness of the seven visual-verbal presentation modes as related to learners of different mental ability levels. The mean performance test scores on both the immediate posttest and the delayed retention test are presented in Tables 9 and 10.

Visual-Verbal Presentation Mode

The main objective of the study was the determination of the comparative effectiveness of seven different visual-verbal presentation modes in contributing to the learning of comparisons of things and events in seven different subject matter content areas. The comparison of the performance on the immediate posttest was made by a two-way analysis of variance, the data being combined for all three mental ability levels to determine the main effects of the presentation modes. The results of these analyses are presented in Table 11.

Significant differences were found at or beyond the .05 level in three of the seven content areas--for one of the social studies stimuli and for two of the science stimuli. The content areas of "Irrigation" and "Mountains" reached the .25 level of significance.

Table 12 shows the results of the Duncan Multiple Range Test for all treatment comparisons and all subject matter areas. In these a posteriori multiple comparison tests the .05 level was used to determine significance. The Motion Picture Sound treatment was predominantly the most effective presentation mode, showing superiority to one or more of the other treatments in three of the seven content areas. The Print Sound and the silent Motion Picture showed superiority in one content

TABLE 9

POSTTEST PERFORMANCE MEANS AND STANDARD DEVIATIONS ON PRESENTATION MODES BY MENTAL ABILITY LEVEL ON THE COMPARISON OBJECTIVE

		MpS			Mp			SpS			Sp			PrS			Pr			S		
		N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ
1 Thailand	High	4	8.750	2.500	4	7.500	1.000	4	7.250	2.061	4	6.250	2.500	4	8.500	2.081	4	8.250	.500	4	7.000	1.825
	Med.	4	7.500	.577	4	6.750	1.250	4	7.000	2.160	4	8.250	2.061	4	6.500	1.000	4	6.750	1.892	4	6.500	1.000
	Low	4	6.750	1.258	4	7.000	2.160	4	6.750	1.707	4	5.500	2.081	4	7.500	.500	4	5.750	2.217	4	6.000	1.154
2 Irrigation	High	4	14.250	1.258	4	14.250	2.061	4	14.500	1.914	4	15.500	3.109	4	15.000	1.632	4	13.400	2.886	5	13.200	2.280
	Med.	4	16.000	2.160	7	15.142	1.463	4	14.500	3.000	4	11.250	1.258	4	14.250	1.500	4	11.250	1.707	4	13.500	1.732
	Low	4	13.000	3.366	4	13.750	2.060	4	15.750	1.707	4	13.750	1.253	4	11.000	3.559	4	12.750	.500	4	12.250	1.500
3 India	High	4	9.500	1.732	6	10.500	1.048	4	8.000	2.160	4	9.000	1.632	3	9.000	1.000	4	9.500	1.290	4	7.500	1.000
	Med.	6	9.333	1.751	6	9.166	1.169	6	10.000	1.414	4	8.500	1.732	4	9.750	1.500	4	8.250	1.258	4	8.500	2.586
	Low	7	7.857	1.772	6	9.000	1.549	7	8.571	2.370	5	6.660	2.516	3	10.333	2.081	4	8.750	1.258	4	7.750	1.258
4 Labor	High	4	9.500	1.290	4	8.500	1.290	4	0.250	1.707	4	8.000	1.414	4	8.750	.957	4	9.000	1.154	4	8.250	1.258
	Med.	4	9.000	.816	4	7.500	1.000	4	8.000	2.160	4	8.000	.816	4	7.750	1.258	4	8.750	.957	4	8.250	1.258
	Low	4	8.750	1.500	4	7.750	1.500	4	7.250	1.500	4	8.250	2.753	4	9.250	.957	4	8.750	.957	4	8.250	2.061
5 Heat	High	4	16.500	.577	5	16.000	2.000	4	15.750	2.217	4	13.500	3.415	4	14.500	1.290	4	15.250	2.629	4	15.500	2.645
	Med.	4	16.250	1.258	4	13.250	3.304	4	15.000	1.414	4	11.750	2.217	5	14.200	1.303	4	10.750	.500	4	13.500	2.380
	Low	4	15.250	2.362	4	12.500	4.434	4	14.250	3.593	5	9.660	2.886	4	13.500	1.000	4	12.50	.732	4	12.250	2.500
6 Salamanders	High	4	15.500	2.081	4	12.500	1.914	4	14.250	2.986	3	12.330	2.081	4	10.250	2.217	5	12.400	2.702	4	9.750	2.217
	Med.	4	16.500	1.732	4	11.000	3.366	4	9.750	3.862	3	8.330	1.154	3	11.660	1.527	4	9.250	2.061	4	11.750	2.362
	Low	4	13.250	3.095	4	11.500	1.732	4	12.250	1.258	4	11.750	1.892	4	10.750	1.707	3	9.000	3.000	4	9.000	.816
7 Mountains	High	4	6.750	2.061	4	8.000	2.160	3	9.330	1.154	4	8.500	1.290	4	8.250	1.500	6	6.660	1.366	4	7.000	1.414
	Med.	4	7.000	.816	5	7.000	1.000	4	8.750	.500	4	6.250	2.217	4	7.000	1.414	6	6.660	2.065	5	6.400	1.516
	Low	6	7.330	1.505	5	6.600	1.673	6	6.000	2.607	4	6.500	2.516	4	7.000	1.825	6	6.160	1.722	6	6.330	1.632

TABLE 10

RETENTION TEST PERFORMANCE MEANS AND STANDARD DEVIATIONS ON PRESENTATION MODES BY MENTAL ABILITY LEVEL ON THE COMPARISON OBJECTIVE

		MpS			Mp			SpS			Sp			PrS			Pr			S		
		N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ
1 Thailand	High	4	7.000	1.632	4	6.750	2.061	3	7.660	.577	4	6.000	1.825	4	7.500	2.380	2	7.500	.707	4	6.750	.500
	Med.	4	7.500	1.914	4	8.000	1.825	3	8.000	1.000	4	7.000	1.825	3	8.330	2.081	4	7.250	1.258	4	7.750	.957
	Low	2	2.000	.000	4	7.250	2.061	4	7.250	.957	3	7.330	.577	3	7.000	1.732	4	6.500	2.380	4	8.500	1.000
2 Irrigation	High	3	12.660	3.214	4	14.500	2.380	4	12.250	2.061	4	13.000	2.000	4	12.500	1.914	4	13.750	1.258	4	12.000	3.366
	Med.	5	14.200	2.280	7	15.000	2.449	4	14.750	1.500	3	11.330	2.309	4	13.250	2.986	4	10.000	3.162	5	13.600	3.435
	Low	4	14.250	1.500	4	13.500	2.316	4	15.250	1.707	4	11.500	1.914	3	13.660	.577	4	11.750	1.500	4	11.250	3.595
3 India	High	4	9.000	.816	5	7.400	1.516	4	7.500	.577	4	8.750	1.258	3	8.660	2.309	4	7.750	1.892	4	8.750	1.892
	Med.	6	8.660	1.861	6	8.830	1.329	6	8.830	.752	4	8.500	.577	4	9.750	2.753	4	9.250	.500	4	7.750	.957
	Low	7	7.285	2.214	5	9.400	1.516	7	9.250	1.380	3	8.330	.577	2	6.500	4.949	3	8.330	2.081	4	9.000	1.825
4 Labor	High	5	8.660	2.081	4	8.000	2.160	4	7.750	2.217	3	8.660	2.081	4	8.750	1.258	3	8.000	2.645	4	10.500	1.732
	Med.	5	8.330	1.527	4	7.250	1.707	4	7.750	2.500	4	8.000	1.414	4	8.000	.816	4	8.750	.957	4	8.250	3.500
	Low	4	8.250	.957	4	7.500	1.732	4	7.250	2.061	4	8.750	1.258	4	9.500	2.380	4	9.750	2.061	3	7.330	1.154
5 Heat	High	4	16.250	3.095	5	17.200	2.167	3	13.000	3.464	2	11.500	4.949	4	13.750	2.061	3	13.330	3.511	4	11.250	2.872
	Med.	4	15.000	2.943	4	11.500	1.000	4	14.500	1.732	4	11.250	1.258	4	14.200	2.387	4	12.750	2.629	3	11.660	2.309
	Low	3	15.330	2.516	3	13.666	5.131	4	14.750	2.500	3	10.330	2.081	3	11.660	4.725	3	14.330	2.080	5	12.000	3.391
6 Salamanders	High	4	14.750	1.707	4	12.750	3.304	4	12.750	2.362	3	12.000	1.000	3	10.000	1.732	5	12.400	2.190	3	9.333	2.309
	Med.	4	13.500	3.785	4	10.500	2.880	3	9.660	2.516	4	10.000	1.414	3	10.330	2.516	4	10.000	2.160	3	11.000	2.000
	Low	4	11.500	3.511	3	11.000	1.732	4	12.500	.577	5	11.600	.894	3	10.500	.707	3	10.000	2.000	2	8.500	.707
7 Mountains	High	4	6.500	1.732	4	8.250	2.061	2	9.000	.000	4	8.000	2.160	3	9.000	1.000	5	6.800	1.303	4	7.250	1.707
	Med.	4	7.000	.816	5	6.400	2.509	4	7.500	1.000	4	5.000	1.414	4	5.750	2.061	6	5.500	1.224	5	6.800	1.483
	Low	6	6.660	3.204	5	6.000	1.581	5	6.400	2.408	4	5.250	1.707	4	5.750	.500	6	6.660	.816	5	6.800	1.303

TABLE 11

ANALYSIS OF VARIANCE FOR POSTTEST AND RETENTION TEST SCORES ON THE COMPARISON OBJECTIVE

Content	Source	Posttest				Retention Test			
		df	MS	F	Prob.	df	MS	F	Prob.
1 Thailand	Presentation Modes (A)	6	2.45	.83	—	6	1.12	.43	—
	Mental Abilities (B)	2	9.14	3.09	< .10	2	2.66	1.02	—
	A × B	12	2.66	.90	—	12	1.01	.38	—
	Within	63	2.95			54	2.65		
2 Irrigation	Presentation Modes (A)	6	11.48	2.67	< .05	6	11.48	1.95	< .10
	Mental Abilities (B)	2	6.34	1.41	—	2	.151	.02	—
	A × B	12	8.01	1.78	< .10	12	6.09	1.09	—
	Within	67	4.47			65	5.87		
3 India	Presentation Modes (A)	6	4.66	1.72	< .25	6	.13	.03	
	Mental Abilities (B)	2	3.54	1.22	—	2	2.45	.08	—
	A × B	12	3.085	1.06	—	12	3.91	1.41	< .25
	Within	76	2.88			72	2.76		
4 Labor	Presentation Modes (A)	6	2.56	1.23	—	6	2.28	.61	—
	Mental Abilities (B)	2	1.32	.66	—	2	3.10	.83	—
	A × B	12	.64	.31	—	12	2.26	.61	—
	Within	63	2.07			58	3.70		
5 Heat	Presentation Modes (A)	6	25.84	4.39	< .01	6	23.47	2.93	< .05
	Mental Abilities (B)	2	34.60	5.88	< .01	2	3.61	.45	—
	A × B	12	5.28	.89	—	12	7.91	.98	—
	Within	64				56	7.98		
6 Salamanders	Presentation Modes (A)	6	36.52	6.74	< .01	6	13.96	2.70	< .05
	Mental Ability (B)	2	18.45	3.41	< .05	2	13.56	2.62	< .10
	A × B	12	10.27	1.89	< .10	12	4.96	.96	—
	Within	60	5.41			53	5.16		
7 Mountains	Presentation Modes (A)	6	4.44	1.49	< .25	6	3.85	1.19	—
	Mental Ability (B)	2	11.88	4.00	< .05	2	23.37	7.55	< .01
	A × B	12	2.60	.88	—	12	3.53	1.14	—
	Within	77	2.96			72	3.09		

TABLE 12

SUMMARY OF PRESENTATION MODE POSTTEST AND RETENTION TEST COMPARISONS FOR THE COMPARISON OBJECTIVE

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
1 Thailand		
2 Irrigation	MpS > Pr	Mp > S/Sp/Pr SpS > Sp/Pr
3 India	PrS/Mp > S	
4 Labor		
5 Heat	MpS > S/Pr/Sp	MpS > PrS/S/Sp Mp > S/Sp SpS > Sp
6 Salamanders	MpS > SpS/Mp/Sp/PrS/S	MpS > Mp/Sp/Pr/PrS/S SpS > S
7 Mountains		

area. The least effective modes of presentation were the Sound alone and Print alone treatments, each showing inferiority in three of the content areas. The silent Still Picture was inferior in two cases. There appeared to be no discernible patterns of effects between the social studies and science subject matter areas.

Mental Ability Level

A second objective of the study was the determination of the relationships of mental ability to the learning of comparisons of things and events in the seven content areas. Subjects were grouped for analysis at three mental ability levels: high, medium, and low. The results of the two-way analyses of variance are presented in Table 11.

Significant differences at or beyond the .05 level were found in three of the seven content areas--all for the science stimuli. The content area of "Thailand" reached the .10 level of significance.

Table 13 shows the results of the Duncan Multiple Range Test for all treatment comparisons and all subject matter content areas. The subjects with High Mental Ability achieved significantly superior post-test scores than Low Mental Ability subjects in three of the content areas and to the Medium Mental Ability subjects in one of the content areas.

Interaction between Presentation Mode and Mental Ability Levels

A third objective of the study was the determination of the interactions between the presentation modes and the mental ability levels. The comparison was made by two-way analyses of variance, and the results are presented in Table 11.

No interactions were significant at or beyond the .05 level, and in only two cases were they significant at the .10 level. In order to discover the relationships of presentation mode to mental ability, separate analyses were made at each mental ability level by means of the Duncan Multiple Range Test, using the .05 level to determine significance. The results of the comparisons in which significant differences were found are presented in Table 14.

When the splits by mental ability level were examined, the overall superiority of the Motion Picture Sound treatment at all levels were found. The Still Picture Sound treatment was also quite effective. The Print alone, silent Still Picture, and Sound alone treatments all demonstrated a decided inferiority, none showing statistical superiority in any of the comparisons. There was a strong tendency for the pictorial presentation modes (with the exception of the silent Still Picture) to show an overall superiority to the verbal presentation modes at all mental ability levels.

TABLE 13

COMPARISON OF MENTAL ABILITY LEVELS ON POSTTEST AND RETENTION TEST FOR THE COMPARISON OBJECTIVE

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
1 Thailand	High > Low	
2 Irrigation		
3 India		
4 Labor		
5 Heat	High > Med/Low	
6 Salamanders		High > Med
7 Mountains	High > Low	High > Med/Low

Retention of Learning

The fourth objective of the study was the determination of the duration of the learning as measured by a retention test from 10 to 14 days after the exposure to the stimuli. The two-way analyses of variance for the retention tests are presented in Table 11, and the results of the comparisons in which significant differences were found are presented in Tables 13, 13 and 14.

There was a tendency for the same patterns of difference to prevail in the retention tests as in the posttests, with a superiority for the pictorial presentation modes over the verbal modes. These results held for all three mental ability levels. On the mental ability level comparisons for the combined presentation modes there was a tendency for the differences to be reduced from the posttest to the retention test, and one new difference appeared.

Multi-Channel Effects

The fifth objective of the study was the determination of the comparative effectiveness of single-channel (silent treatments) and multi-channel (sound treatments) presentation modes. Although there was a noticeable tendency for the multi-channel modes to show superior gains over the single-channel modes, only three statistically significant differences appeared, all at the Medium Mental Ability level as shown in Table 14. Each of the multi-channel modes showed a superiority in one case.

In only three cases--two in the still pictures and one in the motion pictures--were there multi-channel effects on the retention test, all favoring the multi-channel modes.

Intra-Channel Effects

The sixth objective of the study was to determine the comparative effectiveness of the different presentation modes within each of the two channel configurations (sound and silent). An inspection of the data in Table 14 demonstrates the superiority of the pictorial treatments (except silent Still Picture) at all mental ability levels. The Motion Picture Sound treatment was superior to the Print Sound treatment in three cases, the Still Picture Sound treatment was superior to the Print Sound treatment in two cases, and the silent Motion Picture was superior to all other single-channel modes in one instance. In no case did the verbal presentation modes show any superiority to the pictorial modes.

In the retention test these same patterns of superiority held with the two motion picture treatments gaining in effectiveness over the verbal treatments.

TABLE 14

SUMMARY OF SIGNIFICANT COMPARISONS AMONG POSTTEST AND RETENTION TEST PRESENTATION MODES FOR MENTAL ABILITY LEVELS ON THE COMPARISON OBJECTIVE

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
HIGH MENTAL ABILITY		
#3 India	Mp > SpS/S	
#5 Heat		Mp/MpS > Sp/S
#6 Salamanders	MpS/SpS > PrS/S	MpS > S
#7 Mountains	SpS > Pr	
MEDIUM MENTAL ABILITY		
#2 Irrigation	MpS/Mp/SpS/PrS > Sp/Pr	Mp > Sp/Pr SpS/MpS > Sp
#5 Heat	MpS > Pr/Sp SpS > Pr	
#6 Salamanders	MpS > S/PrS/Mp/SpS/Pr/Sp	MpS > Sp/Pr/SpS
LOW MENTAL ABILITY		
#2 Irrigation	SpS/MpS > PrS	Mp > Sp/S
#3 India	PrS > Sp	Mp/SpS > PrS
#5 Heat	MpS > Sp	MpS > Sp
#6 Salamanders	MpS > S/Pr	SpS > S

Summary of Findings

The analyses of the performance data for the Comparison learning objective or task resulted in the following conclusions:

1. The Motion Picture Sound treatment was the most effective overall mode of visual-verbal presentation at all mental ability levels.

2. The Print alone, Sound alone, and silent Still Picture were the least effective modes of presentation at all mental ability levels.

3. The High Mental Ability subjects achieved significantly superior scores to either the Medium or Low Mental Ability subjects.

4. The same general patterns of effectiveness prevailed in the retention test.

5. The multi-channel superiority over the single-channel modes was only slightly apparent, on both the posttests and retention tests, and then only at the Medium Mental Ability level.

6. The pictorial modes (motion and still picture) were superior to the verbal presentation modes at all mental ability levels, on both the posttest and retention test, with the exception of the silent Still Picture.

Experiment Three: Classification Objective

Experiment Three was concerned with the Classification learning objective or task. Those criterion test items in each of the seven stimulus content areas that required categorizing, conceptualizing, or grouping of phenomena with respect to certain attributes or relationships were analyzed to determine the effectiveness of the seven visual-verbal presentation modes as related to learners of different mental ability levels. The mean performance test scores on both the immediate posttest and the delayed retention test are presented in Tables 15 and 16.

Visual-Verbal Presentation Mode

The main objective of the study was the determination of the comparative effectiveness of seven different visual-verbal presentation modes in contributing to the learning of classification of phenomena in seven different subject matter content areas. The comparison of the performance on the immediate posttest was made by two-way analyses of variance, the data being combined for all three mental ability levels to determine the main effects of the presentation modes. The results of these analyses are presented in Table 17.

A significant difference at or beyond the .05 level was found only in the "Labor" stimulus content area.

TABLE 15

POSTTEST PERFORMANCE MEANS AND STANDARD DEVIATIONS ON PRESENTATION MODES BY MENTAL ABILITY LEVEL ON THE CLASSIFICATION OBJECTIVE

		MpS			Mp			SpS			Sp			PrS			Pr			S		
		N	X̄	σ	N	X̄	σ	N	X̄	σ	N	X̄	σ	N	X̄	σ	N	X̄	σ	N	X̄	σ
1 Thailand	High	4	15.500	2.645	4	13.500	1.732	4	15.250	1.500	4	13.250	1.258	4	14.500	.577	4	13.750	2.217	4	13.000	2.160
	Med.	4	13.000	2.160	4	13.500	1.914	4	13.500	1.000	4	12.250	1.500	4	13.000	3.545	4	11.250	1.707	4	12.250	2.872
	Low	4	12.750	2.753	4	14.000	1.414	4	12.000	.816	4	10.500	2.516	4	13.000	4.760	4	10.500	1.732	4	12.750	1.500
2 Irrigation	High	4	5.500	.577	4	5.500	1.732	4	5.250	3.201	4	4.250	2.061	4	3.750	1.892	4	6.250	.500	5	4.400	2.073
	Med.	4	4.750	1.258	7	4.571	1.718	4	4.750	1.892	4	3.750	1.707	4	5.500	1.732	4	4.000	1.414	4	4.000	1.414
	Low	4	4.750	.500	4	5.250	1.707	4	4.750	.957	4	3.500	1.290	4	4.250	2.061	4	4.750	1.707	4	4.000	1.632
3 India	High	4	11.750	2.872	6	10.666	2.943	2	13.000	2.000	4	8.750	2.629	3	10.666	1.154	4	12.500	2.081	4	11.000	1.632
	Med.	6	11.000	1.788	6	10.666	4.131	6	12.166	2.401	4	9.750	3.201	4	9.250	.957	4	10.000	1.632	4	11.000	2.449
	Low	7	11.428	2.299	6	10.833	2.136	7	11.285	1.253	3	10.666	2.516	3	11.333	1.527	4	9.500	1.290	4	11.000	.817
4 Labor	High	4	12.750	.957	4	10.000	2.943	4	10.250	2.500	4	10.250	1.250	4	9.750	1.500	4	10.250	1.892	4	11.000	2.449
	Med.	4	10.250	2.217	4	10.250	.957	4	12.500	1.000	4	8.250	2.061	4	12.750	1.258	4	10.250	.957	4	9.000	3.162
	Low	4	12.500	1.000	4	7.250	2.362	4	12.500	2.886	4	9.250	3.304	4	9.000	2.160	4	9.750	2.986	4	9.250	1.258
5 Heat	High	4	16.250	1.258	5	15.400	2.302	4	15.250	.957	4	14.750	1.258	4	11.500	3.415	4	13.750	1.892	4	13.000	3.366
	Med.	4	12.000	3.559	4	13.500	1.290	4	15.000	1.825	4	13.000	3.366	5	13.400	2.073	4	12.500	1.000	4	13.250	2.872
	Low	4	13.250	2.061	4	12.750	1.892	4	14.750	1.500	3	9.666	1.154	4	13.750	2.362	4	12.000	2.708	4	13.500	1.732
6 Salamanders	High	4	4.000	1.414	4	4.750	1.258	4	6.500	1.732	3	4.666	1.154	4	4.250	.957	5	6.000	1.581	4	4.000	.816
	Med.	4	5.750	1.258	4	4.500	1.290	4	5.500	2.081	3	3.000	2.645	3	5.000	2.000	4	5.000	.816	4	3.250	1.500
	Low	4	4.750	3.304	4	3.750	1.500	4	5.000	1.825	4	4.000	2.160	4	3.500	1.290	3	4.333	1.154	4	3.500	1.290
7 Mountains	High	4	6.750	.500	4	6.250	.957	3	6.000	1.000	4	6.000	1.154	4	6.250	1.500	6	5.833	1.471	4	6.500	1.290
	Med.	4	5.000	1.825	5	5.600	1.140	4	6.250	.957	4	6.250	.957	4	7.000	.817	6	6.000	1.264	5	6.600	.894
	Low	6	5.666	1.632	5	5.200	1.095	6	4.833	1.722	4	5.750	1.500	4	5.500	1.290	6	6.666	.516	6	4.000	1.673

TABLE 16

RETENTION TEST PERFORMANCE MEANS AND STANDARD DEVIATIONS ON PRESENTATION MODES BY MENTAL ABILITY LEVEL ON THE CLASSIFICATION OBJECTIVE

		MpS			Mp			SpS			Sp			PrS			Pr			S		
		N	X̄	σ	N	X̄	σ	N	X̄	σ	N	X̄	σ	N	X̄	σ	N	X̄	σ	N	X̄	σ
1 Thailand	High	4	14.750	3.304	4	12.250	1.707	3	15.333	1.527	4	12.250	1.500	4	11.250	2.872	2	11.500	.707	4	10.500	2.081
	Med.	4	12.750	2.872	4	11.750	2.986	3	12.666	2.309	4	11.500	1.290	3	11.333	3.214	4	11.250	2.872	4	10.000	2.581
	Low	2	13.000	.000	4	11.750	1.707	4	11.000	1.414	3	9.000	2.645	3	12.333	2.516	4	8.000	2.943	4	12.250	1.892
2 Irrigation	High	3	6.000	.000	4	5.500	1.290	4	7.000	.816	4	5.000	1.414	4	3.250	2.986	4	6.500	1.000	4	4.750	1.258
	Med.	5	3.800	1.095	7	5.714	1.704	4	5.500	2.380	3	5.666	1.527	4	4.500	1.732	4	3.250	1.707	5	4.600	1.516
	Low	4	5.000	.816	4	5.750	.957	4	5.750	1.258	4	3.000	1.414	3	4.000	1.000	4	3.750	.500	4	3.250	.500
3 India	High	4	10.500	2.081	5	9.800	3.114	4	12.500	1.000	4	12.500	1.732	3	12.666	1.527	4	13.250	1.707	4	11.500	3.696
	Med.	6	9.333	1.632	6	11.000	2.449	6	10.833	1.471	4	11.250	2.629	4	11.250	.957	4	11.250	2.629	4	9.750	3.593
	Low	7	12.857	1.573	5	9.600	1.516	7	9.428	2.760	3	11.333	3.785	2	11.000	2.828	3	8.666	.577	4	9.750	4.500
4 Labor	High	3	15.666	1.154	4	11.250	2.061	4	11.000	1.414	3	11.333	1.527	4	10.000	2.828	3	10.000	1.000	4	14.000	3.559
	Med.	3	10.666	.577	4	10.500	1.914	4	11.000	2.000	4	10.500	1.290	4	10.750	2.986	4	8.250	2.629	4	10.000	5.773
	Low	4	11.500	1.914	4	8.750	2.362	4	9.000	1.414	4	10.250	7.753	4	11.750	2.217	4	11.000	4.690	3	8.666	1.154
5 Heat	High	4	16.250	1.500	4	14.200	2.588	3	13.000	1.732	2	15.500	.707	4	13.000	2.943	3	9.000	4.582	4	13.000	4.242
	Med.	4	12.750	5.560	4	13.750	1.500	4	12.000	2.160	4	13.500	2.081	5	12.800	2.049	4	14.500	.577	3	10.333	2.516
	Low	3	13.333	2.081	3	11.666	2.081	4	12.000	2.828	3	8.666	1.527	3	15.000	2.645	3	11.333	1.527	5	13.400	3.646
6 Salamanders	High	4	5.250	1.258	4	3.500	1.290	4	5.750	2.061	3	4.333	1.154	3	3.666	2.516	5	6.200	1.303	3	3.666	.577
	Med.	4	5.500	1.732	4	4.250	2.217	3	5.333	1.154	4	3.500	2.516	3	5.000	2.000	4	3.750	2.217	3	4.000	1.000
	Low	4	4.250	3.304	3	2.666	2.516	4	5.000	.816	5	4.400	1.516	2	2.500	.707	3	4.333	.577	2	2.500	.707
7 Mountains	High	4	6.750	.957	4	6.500	1.290	2	7.000	.000	4	6.500	1.000	3	7.000	1.000	5	6.000	1.000	4	6.750	.957
	Med.	4	6.750	.957	5	6.400	1.516	4	6.500	1.000	4	6.500	1.000	4	7.250	.500	6	6.333	1.211	5	5.000	1.220
	Low	6	6.500	1.048	5	5.000	1.414	5	5.800	1.095	4	5.250	.957	4	6.000	2.000	6	6.333	.816	5	4.400	3.646

TABLE 17

ANALYSIS OF VARIANCE FOR POSTTEST AND RETENTION TEST SCORES ON THE CLASSIFICATION OBJECTIVE

Content	Source	Posttest				Retention Test			
		df	MS	F	Prob.	df	MS	F	Prob.
1 Thailand	Presentation Modes (A)	6	10.175	2.009	< .10	6	14.713	2.631	< .05
	Mental Abilities (B)	2	26.583	5.250	< .01	2	13.015	2.327	< .10
	A × B	12	3.070	.606	—	12	5.887	1.052	—
	Within	63	5.063			54	5.591		
2 Irrigation	Presentation Modes (A)	6	2.856	.397	—	6	8.785	4.157	< .01
	Mental Abilities (B)	2	2.470	.862	—	2	7.675	3.632	—
	A × B	12	1.693	.589	—	12	4.295	2.032	< .05
	Within	67	2.864			65	2.113		
3 India	Presentation Modes (A)	6	7.950	1.501	< .25	6	2.756	.469	—
	Mental Abilities (B)	2	2.832	.534	—	2	14.453	2.458	< .10
	A × B	12	3.440	.630	—	12	8.272	1.407	< .25
	Within	76	5.295			72	5.870		
4 Labor	Presentation Modes (A)	6	12.116	2.711	< .05	6	5.753	.821	—
	Mental Abilities (B)	2	5.132	1.148	—	2	15.816	2.258	< .25
	A × B	12	7.786	1.740	< .10	12	7.943	1.135	—
	Within	63	4.468			58	7.001		
5 Heat	Presentation Modes (A)	6	11.102	2.180	< .10	6	9.272	1.188	—
	Mental Abilities (B)	2	14.878	2.921	< .10	2	8.788	1.126	—
	A × B	12	7.619	1.490	< .25	12	13.610	1.743	< .10
	Within	64	5.090			56	7.800		
6 Salamanders	Presentation Modes (A)	6	5.768	2.074	< .10	6	6.202	1.891	< .10
	Mental Ability (B)	2	5.143	1.849	< .25	2	5.637	1.719	< .25
	A × B	12	3.323	1.135	—	12	2.460	.751	—
	Within	60	2.780			53	3.288		
7 Mountains	Presentation Modes (A)	6	.560	.324	—	6	2.780	1.418	< .25
	Mental Ability (B)	2	8.274	5.054	< .01	2	8.800	4.490	< .05
	A × B	12	2.789	1.703	< .10	12	1.530	.660	—
	Within	77	1.636			72	1.960		

The results of the Duncan Multiple Range Test (Table 18), used to make multiple comparisons among all the treatments for the "Labor" content, showed the Motion Picture Sound and Still Picture Sound treatments significantly superior (at the .05 level) to the other treatments.

Mental Ability Level

A second objective of the study was the determination of the relationships of mental ability to the learning of classifications of phenomena in the several content areas. Subjects were grouped for analysis at three mental ability levels: high, medium, and low. The results of the two-way analyses of variance are presented in Table 17.

Significant differences at or beyond the .05 level were found in two of the seven content areas--for "Thailand" and "Mountains." The content area of "Heat" reached the .10 level of significance.

As shown in Table 19, the Duncan Multiple Range Test for all treatment comparisons found the High Mental Ability groups performing at a significantly superior level to the Medium and Low Mental Ability groups for the "Thailand" content and to the Low Mental Ability group for the "Mountains" content.

Interaction between Presentation Mode and Mental Ability Levels

A third objective of the study was the determination of the interactions between the presentation modes and the mental ability levels. The comparisons were made by two-way analyses of variance, presented in Table 17.

No interactions were significant at or beyond the .05 level, and in only one case was there an interaction at the .10 level. In order to discover the relationships of presentation mode to mental ability a separate analysis was made at each mental ability level by means of the Duncan Multiple Range Test, using the .05 level to determine significance. The results of the comparisons in which significant differences were found are presented in Table 20.

When the splits by mental ability were examined, an overall superiority of the Still Picture Sound treatment and inferiority of the silent Still Picture at all mental ability levels were found. There was a tendency for the pictorial presentation modes (with the exception of the silent Still Picture) to show a general superiority to the verbal presentation modes at the High Mental Ability level.

Retention of Learning

The fourth objective of the study was the determination of the duration of the learning as measured by a retention test from 10 to 14

TABLE 18

SUMMARY OF PRESENTATION MODE POSTTEST AND RETENTION TEST COMPARISONS FOR THE CLASSIFICATION OBJECTIVE

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
1 Thailand	MpS > Pr	MpS > Sp/S/Pr SpS > Pr
2 Irrigation		SpS > Sp/Pr/S/PrS Mp > S/PrS
3 India		
4 Labor	MpS/SpS > S/Sp/Mp	
5 Heat	SpS > PrS/Pr/S	
6 Salamanders	SpS > PrS/Sp/S	SpS > PrS/Mp/S MpS > S
7 Mountains		MpS/PrS > S

TABLE 19

COMPARISON OF MENTAL ABILITY LEVELS ON POSTTEST AND RETENTION TEST FOR THE CLASSIFICATION OBJECTIVE

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
1 Thailand	High > Med/Low	High > Low
2 Irrigation		
3 India		High > Low
4 Labor		High > Med/Low
5 Heat		
6 Salamanders		High > Low
7 Mountains	High > Low	High/Med > Low

days after the exposure to the stimuli. The two-way analyses of variance for the retention tests are presented in Table 17, and the results of the comparisons in which significant differences were found are presented in Tables 18, 19, and 20.

The same general pattern of effects was maintained on the retention tests in two of the four content areas where differences were found on the posttests. In addition two other content areas showed retention test differences. These differences followed the same pattern as the posttests and predominantly favored the pictorial presentation modes (with the exception of the silent Still Picture) over the verbal modes, this superiority becoming even more pronounced. That is, the pictorial modes increased their significantly superior positions, whereas the verbal modes increased their inferior positions. The differences among the mental ability groups for the combined presentation mode data (Table 19) increased from significant differences in two content areas to differences in five content areas, all showing a superiority for the High Mental Ability group.

Multi-Channel Effects

The fifth objective of the study was the determination of the comparative effectiveness of single-channel (silent treatments) and multi-channel (sound treatments) presentation modes. Although there was a noticeable tendency for the multi-channel modes to show superior gains over the single-channel modes, these differences were statistically significant in only one instance between the motion picture modes and two instances between the still picture modes. No differences were found between the print modes. None of these differences persisted when tested for retention about two weeks later, although one additional difference appeared favoring the multi-channel mode (Table 18). When the data were split by mental ability level (Table 20), three differences appeared favoring the multi-channel modes and one favoring a single-channel mode. These differences appearing for the High and Low Mental Ability groups.

Intra-Channel Effects

The sixth objective of the study was to determine the comparative effectiveness of the different presentation modes within each of the two channel configurations (sound and silent). An inspection of Table 18 shows a superiority for the Still Picture Sound over the Print Sound in two content areas. On the retention tests a distinct advantage for the motion picture and still picture presentation types developed over the print types. When split by mental ability level, motion pictures and still pictures were each superior to print in four instances, and in no case did the print show superiority (Table 20).

Summary of Findings

The analyses of the performance data for the Classification learning objective or task resulted in the following conclusions:

TABLE 20

SUMMARY OF SIGNIFICANT COMPARISONS AMONG POSTTEST AND RETENTION TEST PRESENTATION MODES FOR MENTAL ABILITY LEVELS ON THE CLASSIFICATION OBJECTIVE

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
HIGH MENTAL ABILITY		
#1 Thailand		SpS > Pr/PrS/S MpS > S
#2 Irrigation		SpS > S/PrS Pr/MpS > PrS
#3 India	SpS > Sp	
#4 Labor		MpS > Sp/Mp/SpS/PrS/Pr
#5 Heat	MpS/Mp/SpS > PrS	MpS/Sp/Mp > Pr
#6 Salamanders	SpS > PrS/MpS/S	
MEDIUM MENTAL ABILITY		
#2 Irrigation		Mp/Sp > Pr
#4 Labor	PrS/SpS > S/Sp	
#5 Heat		Pr > S
#7 Mountains	PrS > MpS	PrS > S
LOW MENTAL ABILITY		
#1 Thailand		MpS > Sp/Pr PrS/S > Pr
#2 Irrigation		Mp/SpS > Sp
#3 India		MpS > Pr
#4 Labor	MpS/SpS > Mp	
#5 Heat	SpS/PrS/MpS/S > Sp	PrS/S/MpS > Sp
#7 Mountains	Pr > S	MpS > S

1. The Motion Picture Sound and Still Picture Sound treatments were more effective modes of visual-verbal presentation than the silent Motion Picture, silent Still Picture or Sound alone treatments.

2. The High Mental Ability subjects achieved significantly superior scores to either the Medium or Low Mental Ability subjects.

3. On the retention test the pictorial presentation modes resulted in predominantly higher achievement than the verbal modes.

4. There appeared to be little difference in achievement between single-channel and multi-channel treatment groups.

5. There appeared to be little difference in effectiveness among media types within each of the channels on the posttest. However, there was a decided superiority for the motion picture and still picture presentation types over the print types on the retention test.

Experiment Four: Generalization Objective

Experiment Four was concerned with the Generalization learning objective or task. Those criterion test items in each of the seven stimulus content areas that dealt with the drawing of generalization from concepts to formulate principles, rules, or laws were analyzed to determine the effectiveness of the seven visual-verbal presentation modes as related to learners of different mental ability levels. The mean performance test scores on both the immediate posttests and the delayed retention tests are presented in Tables 21 and 22.

Visual-Verbal Presentation Mode

The main objective of the study was the determination of the comparative effectiveness of seven different visual-verbal presentation modes in contributing to the learning of comparisons of things and events in seven different subject matter areas. The comparison of the performance on the immediate posttests was made by two-way analyses of variance, the data being combined for all three mental ability levels to determine the main effects of the presentation modes. The results of these analyses are presented in Table 23.

Significant differences were found at or beyond the .05 level in two of the seven content areas ("Irrigation" and "India"), both social studies content.

The results of the Duncan Multiple Range Test (Table 24), used to make multiple comparisons among all the treatments, showed an overall superiority for the Print Sound, Still Picture Sound, and Motion Picture Sound treatments to the silent Still Picture, Sound alone, and Print alone treatments.

TABLE 21

POSTTEST PERFORMANCE MEANS AND STANDARD DEVIATIONS ON PRESENTATION MODES BY MENTAL ABILITY LEVEL ON THE GENERALIZATION OBJECTIVE

		MpS			Mp			SpS			Sp			PrS			Pr			S		
		N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ
1 Thailand	High	4	8.500	4.290	4	7.500	.577	4	9.250	1.258	4	8.750	2.500	4	8.250	1.707	4	8.250	2.217	4	9.000	1.632
	Med.	4	8.250	1.258	4	8.500	2.645	4	8.000	.000	4	8.000	1.414	4	8.000	.816	4	6.750	1.500	4	9.000	2.160
	Low	4	7.500	1.914	4	8.250	1.500	4	8.500	1.732	4	7.250	.500	4	7.750	1.707	4	8.000	.816	4	7.750	.957
2 Irrigation	High	4	15.00	1.414	4	13.75	3.403	4	15.00	2.943	4	15.00	1.414	4	17.00	2.160	4	16.75	2.362	5	14.20	3.114
	Med.	4	14.50	3.000	7	14.00	2.708	4	14.50	2.645	4	14.25	1.500	4	12.75	3.304	4	11.25	1.707	4	11.75	1.500
	Low	4	14.50	1.732	4	14.50	2.516	4	14.50	2.081	4	14.25	.500	4	14.50	1.914	4	11.00	2.581	4	11.50	2.081
3 India	High	4	9.750	2.217	6	7.333	2.065	4	7.250	.500	4	6.250	1.500	5	8.000	2.000	4	7.250	.957	4	3.500	1.914
	Med.	6	7.000	1.673	6	7.333	.817	6	7.500	2.073	4	5.500	1.732	4	7.500	1.914	4	7.250	2.629	4	6.500	1.000
	Low	7	6.714	1.253	6	7.166	1.169	7	7.285	2.138	5	5.666	1.527	3	7.333	1.154	4	5.500	1.000	4	5.500	2.380
4 Labor	High	4	9.500	1.000	4	9.000	2.449	4	8.250	1.500	4	9.000	.000	4	9.500	.577	4	9.500	1.732	4	9.500	1.732
	Med.	4	8.500	1.732	4	7.750	1.258	4	8.750	1.258	4	7.750	2.500	4	9.000	.816	4	7.000	3.464	4	8.250	2.362
	Low	4	8.250	.500	4	7.000	2.309	4	7.000	1.825	4	7.250	2.500	4	7.000	1.414	4	9.250	1.892	4	7.250	1.707
5 East	High	4	8.250	2.061	5	8.200	.836	4	6.750	3.304	4	6.500	1.732	4	8.500	3.316	4	6.250	.500	4	7.500	2.380
	Med.	4	6.500	2.081	4	6.500	1.732	4	5.500	1.732	4	7.000	1.825	5	7.400	1.140	4	6.250	2.061	4	7.250	1.707
	Low	4	5.750	1.258	4	6.500	1.000	4	7.500	.577	3	5.000	1.732	4	6.750	2.986	4	5.250	2.629	4	7.750	2.217
6 Salamanders	High	4	13.500	2.380	4	15.000	1.414	3	13.333	2.081	4	13.000	.817	4	12.500	2.380	6	13.166	1.329	4	10.750	1.500
	Med.	4	12.500	.577	5	12.400	1.673	4	14.000	2.000	4	12.250	1.892	4	11.500	2.081	6	13.166	1.722	5	11.200	2.489
	Low	6	11.000	2.190	5	11.400	1.140	6	12.000	3.741	4	9.750	.957	4	10.500	1.914	6	11.333	1.751	6	11.166	3.311
7 Mountains	High	4	9.750	1.707	4	10.000	2.160	4	11.000	1.154	3	8.000	4.582	4	10.750	2.500	5	10.200	2.387	4	10.000	1.414
	Med.	4	10.750	2.872	4	10.250	2.872	4	11.250	.957	3	10.000	3.605	3	10.666	2.081	4	11.000	1.632	4	12.000	2.309
	Low	4	11.250	.500	4	10.750	1.707	4	10.500	1.290	4	9.500	1.000	4	11.500	1.000	3	12.000	2.645	4	9.500	2.380

TABLE 22

RETENTION TEST PERFORMANCE MEANS AND STANDARD DEVIATIONS ON PRESENTATION MODES BY MENTAL ABILITY LEVEL ON THE GENERALIZATION OBJECTIVE

		MpS			Mp			SpS			Sp			PrS			Pr			S		
		N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ
1 Thailand	High	4	6.500	1.732	4	8.750	.500	3	9.000	1.000	4	9.500	2.380	4	8.500	1.732	2	8.000	.000	4	8.500	2.082
	Med.	4	8.500	2.380	4	7.500	2.516	3	8.000	1.000	4	7.000	2.449	3	6.666	1.528	4	7.750	1.500	4	8.250	.957
	Low	2	7.500	.707	4	9.250	1.500	4	9.250	1.500	3	8.333	.577	3	9.000	.000	4	8.750	.957	4	6.250	2.217
2 Irrigation	High	3	16.333	2.517	4	17.500	1.240	4	16.250	2.217	4	14.250	1.707	4	15.750	3.593	4	16.250	.957	4	14.000	2.943
	Med.	5	15.200	1.789	7	14.429	2.299	4	16.500	1.000	3	14.666	2.886	4	11.500	3.109	4	13.000	.816	5	11.000	1.414
	Low	4	14.500	.577	4	12.500	3.416	4	14.250	2.753	4	13.250	2.629	3	11.000	2.000	4	10.750	1.707	4	13.750	1.258
3 India	High	4	7.000	2.943	5	7.400	2.073	4	8.250	1.258	4	7.250	1.258	3	8.666	1.527	4	8.000	1.414	4	8.500	1.000
	Med.	6	6.333	1.169	6	7.500	1.974	6	8.166	.752	4	5.750	1.707	4	7.250	2.217	4	7.000	2.581	4	6.750	2.753
	Low	7	7.142	1.214	5	6.200	1.483	7	6.714	1.603	3	5.666	2.516	2	8.500	2.121	3	7.000	1.732	4	6.000	.816
4 Labor	High	3	8.333	2.081	4	7.500	3.109	4	8.250	1.707	3	10.000	1.000	4	7.500	1.290	3	8.000	1.732	4	11.250	.957
	Med.	3	6.666	2.309	4	6.750	7.707	4	7.750	2.362	4	8.000	1.414	4	9.500	1.290	4	8.500	2.380	4	10.000	2.160
	Low	4	7.500	1.914	4	6.250	1.500	4	8.250	2.362	4	7.250	2.061	4	8.250	2.986	4	8.750	2.753	3	7.000	2.645
5 East	High	4	8.250	1.500	5	8.200	.836	3	7.666	1.527	2	7.000	1.414	4	7.000	2.160	3	6.666	1.527	4	6.750	2.753
	Med.	4	5.750	.957	4	6.000	1.414	4	9.750	2.872	4	6.750	1.258	5	5.800	1.095	4	7.000	1.825	3	7.666	.577
	Low	3	6.000	1.732	3	7.000	1.000	4	6.500	1.290	3	4.666	1.154	3	6.333	2.886	3	6.333	2.081	5	8.000	2.549
6 Salamanders	High	4	9.500	.577	4	10.500	1.914	4	9.500	1.290	3	7.666	2.516	3	11.000	1.732	5	9.600	2.073	3	9.666	4.725
	Med.	4	10.500	5.000	4	9.000	1.154	3	10.666	.577	4	9.500	1.732	3	10.666	2.081	4	9.500	2.380	3	10.333	1.527
	Low	4	11.500	1.290	3	8.666	2.309	4	7.250	2.362	5	10.400	2.509	2	9.000	2.828	3	10.666	1.154	2	11.500	.707
7 Mountains	High	4	14.000	2.449	4	13.750	1.258	2	14.500	2.121	4	15.250	.957	3	12.333	5.507	5	13.800	2.167	4	12.000	2.828
	Med.	4	12.750	2.362	5	12.200	2.387	4	3.750	2.872	4	9.500	1.290	4	12.250	.957	6	11.000	1.673	5	11.600	1.673
	Low	6	10.833	1.7[illegible]	5	10.800	3.563	5	11.400	1.816	4	11.500	3.415	4	11.750	1.500	6	11.500	1.378	5	11.000	3.872

TABLE 23

ANALYSIS OF VARIANCE FOR POSTTEST AND RETENTION TEST SCORES ON THE GENERALIZATION OBJECTIVE

Content	Source	Posttest				Retention Test			
		df	MS	F	Prob.	df	MS	F	Prob.
1 Thailand	Presentation Modes (A)	6	1.603	.645	—	6	1.235	.435	—
	Mental Abilities (B)	2	9.122	1.238	—	2	7.100	2.504	< .10
	A × B	12	.512	.612	—	12	3.876	1.367	< .25
	Within	63	2.484			54	2.834		
2 Irrigation	Presentation Modes (A)	6	13.081	2.336	< .05	6	17.878	3.714	< .01
	Mental Abilities (B)	2	45.426	8.122	< .01	2	9.748	12.413	< .01
	A × B	12	6.52	1.167	—	12	7.809	1.622	< .25
	Within	67	5.597			65	4.813		
3 India	Presentation Modes (A)	6	7.653	2.656	< .05	6	3.652	1.260	—
	Mental Abilities (B)	2	4.405	1.529	< .25	2	9.205	3.012	< .05
	A × B	12	1.260	.438	—	12	1.052	.599	—
	Within	76	2.880			72	3.056		
4 Labor	Presentation Modes (A)	6	1.065	.319	—	6	3.506	1.271	—
	Mental Abilities (B)	2	17.992	5.554	< .01	2	7.742	1.788	< .25
	A × B	12	3.253	.947	—	12	4.188	.967	—
	Within	63	3.327			58	4.329		
5 Heat	Presentation Modes (A)	6	5.490	1.390	< .25	6	2.614	.883	—
	Mental Abilities (B)	2	8.446	2.138	< .25	2	8.525	2.676	< .10
	A × B	12	2.326	.589	—	12	2.702	.848	—
	Within	64	3.949			56	3.184		
6 Salamanders	Presentation Modes (A)	6	4.653	1.001	—	6	3.550	.659	—
	Mental Ability (B)	2	6.757	1.347	—	2	1.034	.192	—
	A × B	12	1.884	.405	—	12	5.068	.941	—
	Within	60	4.645			53	5.383		
7 Mountains	Presentation Modes (A)	6	7.401	1.690	< .25	6	3.743	.640	—
	Mental Ability (B)	2	34.738	7.938	< .01	2	74.679	7.388	< .01
	A × B	12	2.634	.602	—	12	6.658	1.139	—
	Within	77	4.375			72	5.850		

TABLE 24

SUMMARY OF PRESENTATION MODE POSTTEST AND RETENTION TEST COMPARISONS FOR THE GENERALIZATION OBJECTIVE

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
1 Thailand		
2 Irrigation	Mp/PrS/MpS/SpS > S	SpS/MpS > Pr/S/PrS Mp > PrS
3 India	PrS/MpS/SpS > S/Sp	
4 Labor		
5 Heat	PrS > Pr	
6 Salamanders		
7 Mountains	Pr > Sp	

Mental Ability Level

A second objective of the study was the determination of the relationships of mental ability to the drawing of generalizations from concepts in the several content areas. Subjects were grouped for analysis at three mental ability levels: high, medium, and low. The results of the two-way analyses of variance are presented in Table 23.

Significant differences at or beyond the .05 level were found in three of the seven content areas---for "Irrigation," "Labor," and "Mountains."

As shown in Table 25, the Duncan Multiple Range Test for all treatment comparisons found the High Mental Ability groups performing at a significantly superior level to both the Medium and Low Mental Ability groups in the three content areas.

Interaction between Presentation Mode and Mental Ability Levels

A third objective of the study was the determination of the interactions between the presentation modes and the mental ability levels. The comparisons were made by two-way analyses of variance. No interactions were significant at or beyond the .05 level.

In order to discover the relationships of presentation mode to mental ability, a separate analysis was made at each mental ability level by means of the Duncan Multiple Range Test, using the .05 level to determine significance. The results of the comparisons in which significant differences were found are presented in Table 26.

Significant differences among the treatments were found in only three of the content areas---two at the High Mental Ability level and one at the Low Mental Ability level. All differences favored the pictorial (motion picture and still picture) treatment modes over the verbal (print and sound) modes.

Retention of Learning

The fourth objective of the study was the determination of the duration of the learning as measured by a retention test from 10 to 14 days after the exposure to the stimuli. The two-way analyses of variance for the retention tests are presented in Table 23.

When the data were analyzed for all mental ability levels combined, only the "Irrigation" content area showed a persistence of differences from the posttest to the retention test, the differences favoring the pictorial presentation modes over the verbal presentation modes. In the comparison of mental ability levels for the combined presentation modes, two of the three advantages for the High Mental Ability group persisted and two additional significant differences appeared. On the

TABLE 25

COMPARISON OF MENTAL ABILITY LEVELS ON POSTTEST AND RETENTION TEST FOR THE GENERALIZATION OBJECTIVE

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
1 Thailand		
2 Irrigation	High > Med/Low	High > Med/Low
3 India		High > Med/Low
4 Labor	High > Med/Low	
5 Heat		High > Low
6 Salamanders		
7 Mountains	High/Med > Low	High > Med/Low

TABLE 26

SUMMARY OF SIGNIFICANT COMPARISONS AMONG POSTTEST AND RETENTION TEST PRESENTATION MODES FOR MENTAL ABILITY LEVELS ON THE GENERALIZATION OBJECTIVE

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
HIGH MENTAL ABILITY		
#1 Thailand		Sp/SpS > MpS
#2 Irrigation		Mp > Sp/S
#3 India	MpS > S	
#4 Labor		S > Pr/Mp/PrS
#7 Mountains	Mp > S	
MEDIUM MENTAL ABILITY		
#2 Irrigation		SpS > Pr/PrS/S MpS > PrS/S Sp > S
#4 Labor		S > Mp/MpS
#5 Heat		SpS > Pr/Sp/Mp/PrS/MpS
#6 Salamanders		SpS > Mp/PrS/MpS
LOW MENTAL ABILITY		
#1 Thailand		SpS/Mp > S
#2 Irrigation	MpS/Mp/SpS/Sp > Pr	MpS > PrS/Pr SpS > Pr
#3 India		PrS > Sp
#5 Heat		S > Sp
#6 Salamanders		MpS/S > SpS

splits by mental ability (Table 26), in 13 of the 21 content area comparisons statistically significant differences were found on the retention test as compared to only three content area comparisons for the posttest. The Still Picture Sound treatment was the most effective presentation mode at all mental ability levels. The Sound alone treatment was the next most effective, followed by Motion Picture Sound. However, the Sound alone was inferior to the pictorial treatment modes in as many instances as it was superior. The Print Sound and Print alone modes appeared to be the least effective. Overall, there was a distinct superiority for the pictorial treatment modes over the verbal modes.

Multi-Channel Effects

The fifth objective of the study was the determination of the comparative effectiveness of single-channel (silent treatments) and multi-channel (sound treatments) presentation modes. No differences were found for the channel effects on either the posttests or the retention tests.

Intra-Channel Effects

The sixth objective of the study was to determine the comparative effectiveness of the different presentation modes within each of the two channel configurations (sound and silent). There was a slight tendency for the still picture modes to be superior to the print mode, but these differences were not great.

Summary of Findings

The analyses of the performance data for the Generalization learning objective or task resulted in the following conclusions:

1. The Print Sound, Still Picture Sound, and silent Motion Picture treatments were more effective modes of visual-verbal presentation than the silent Still Picture and Sound alone treatments.

2. The High Mental Ability subjects achieved significantly superior scores to either the Medium or Low Mental Ability subjects.

3. On the retention test the pictorial presentation modes resulted in predominantly higher achievement than the verbal modes at all mental ability levels.

4. There appeared to be no difference in achievement between single-channel and multi-channel treatment groups.

5. There appeared to be little difference in effectiveness among media types within each of the channels.

Experiment Five: Application Objective

Experiment Five was concerned with the Application learning objective or task. Those criterion test items in each of the seven stimulus content areas that dealt with making application of the learning to new situations or to the solution of problems were analyzed to determine the effectiveness of the seven visual-verbal presentation modes as related to learners of different mental ability levels. The mean performance test scores on both the immediate posttests and the delayed retention tests are presented in Tables 27 and 28.

Visual-Verbal Presentation Mode

The main objective of the study was the determination of the comparative effectiveness of seven different visual-verbal presentation modes in contributing to the application of learning to new situations in seven different subject matter content areas. The comparison of the performance on the immediate posttest was made by two-way analyses of variance, the data being combined for all three mental ability levels to determine the main effects of the presentation modes. The results of these analyses are presented in Table 29.

A significant difference at or beyond the .05 level was found only in the "Labor" stimulus content area, but five other content areas were significant at the .25 level.

The results of the Duncan Multiple Range Test on all comparisons (Table 30) showed the Sound alone treatment to be superior to all but one of the other treatments in at least two instances. In no case was the Sound alone treatment inferior to other treatments. The Silent Still Picture and Print alone were the least effective treatments.

Mental Ability Level

A secondary objective of the study was the determination of the relationships of mental ability to the application of learning to new situations in the several content areas. Subjects were grouped for analysis at three mental ability levels: high, medium, and low. The results of the two-analyses of variance are presented in Table 29.

Significant differences at or beyond the .05 level were found in two of the seven content areas--for "Irrigation" and "Mountains."

As shown in Table 31, the Duncan Multiple Range Test for all treatment comparisons found the High Mental Ability groups performing at a significantly superior level to both the Medium and Low Mental Ability groups in the two content areas.

TABLE 27

POSTTEST PERFORMANCE MEANS AND STANDARD DEVIATIONS ON PRESENTATION MODES BY MENTAL ABILITY LEVEL ON THE APPLICATION OBJECTIVE

		MpS			Mp			SpS			Sp			PrS			Pr			S		
		N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ
1 Thailand	High	4	7.500	2.645	4	7.000	1.414	4	7.250	1.258	4	5.750	.957	4	7.750	.957	4	7.000	.816	4	7.500	1.290
	Med.	4	8.500	1.914	4	7.500	.577	4	7.500	.577	4	6.500	1.000	4	6.750	1.707	4	6.250	.957	4	8.250	1.258
	Low	4	8.000	.816	4	7.000	1.414	4	7.250	.500	4	7.000	1.632	4	7.000	.000	4	7.750	1.258	4	7.000	.816
2 Irrigation	High	4	15.25	1.892	4	15.75	2.061	4	13.50	3.316	4	13.25	2.061	4	13.00	3.464	4	15.25	1.707	5	13.00	1.414
	Med.	4	11.75	3.201	7	15.00	3.109	4	11.50	5.196	4	11.25	2.872	4	11.25	2.629	4	10.50	2.380	4	12.00	2.943
	Low	4	14.50	3.109	4	12.25	1.892	4	13.75	4.500	4	10.75	2.061	4	11.25	1.707	4	10.75	2.872	4	13.00	4.320
3 India	High	4	6.000	.816	6	5.500	1.224	4	6.250	.957	4	6.750	1.707	3	6.333	2.081	4	4.500	1.290	4	5.000	1.414
	Med.	6	5.333	1.751	6	6.633	1.366	6	4.833	1.834	4	6.000	1.154	4	7.000	1.414	4	5.000	3.366	4	6.750	2.217
	Low	7	5.857	1.069	6	5.833	2.401	7	6.285	.951	3	6.666	.577	3	5.666	2.081	4	4.500	1.914	4	7.000	1.414
4 Labor	High	4	7.000	.816	4	5.500	1.732	4	7.000	.816	4	6.250	1.500	4	6.500	1.914	4	8.750	1.258	4	8.000	1.154
	Med.	4	6.50	1.732	4	6.250	.957	4	7.000	.000	4	5.750	1.707	4	7.000	.816	4	7.500	1.290	4	8.250	1.707
	Low	4	6.000	1.154	4	7.250	2.217	4	6.500	.577	4	6.500	1.290	4	7.750	1.707	4	6.750	1.892	4	7.500	2.380
5 Heat	High	4	5.500	1.732	5	6.200	1.923	4	5.250	2.217	4	6.500	3.511	4	4.500	1.000	4	7.000	1.414	4	7.000	2.160
	Med.	4	7.500	1.00	4	6.000	2.449	4	7.250	2.061	4	6.000	3.265	5	6.200	1.095	4	6.750	.500	4	7.250	2.753
	Low	4	5.000	1.414	4	6.750	2.061	4	4.500	.577	3	6.666	2.309	4	7.000	2.449	4	5.250	1.892	4	9.500	1.000
6 Salamanders	High	4	13.750	.957	4	12.500	2.380	3	14.333	2.081	4	12.750	5.947	4	11.500	2.645	6	12.500	1.760	4	13.750	.957
	Med.	4	11.500	1.290	5	11.60	3.049	4	12.500	1.732	4	11.500	2.380	4	10.500	2.872	6	11.166	2.136	5	11.200	1.923
	Low	6	11.16	1.471	5	10.80	5.898	6	11.666	2.338	4	9.750	1.707	4	11.500	2.516	6	12.333	1.632	6	10.666	2.160
7 Mountains	High	4	9.250	2.217	4	6.000	2.160	4	7.750	1.707	3	6.000	3.000	4	7.750	1.707	5	9.000	2.000	4	8.000	1.414
	Med.	4	8.500	2.516	4	7.500	2.380	4	8.250	1.500	3	7.666	2.081	3	7.333	1.154	4	10.500	1.000	4	7.000	1.414
	Low	4	6.750	.957	4	7.500	1.732	4	7.750	1.892	4	8.000	1.632	4	9.000	1.825	3	8.000	2.000	4	7.750	.957

TABLE 28

RETENTION TEST PERFORMANCE MEANS AND STANDARD DEVIATIONS ON PRESENTATION MODES BY MENTAL ABILITY LEVEL ON THE APPLICATION OBJECTIVE

		MpS			Mp			SpS			Sp			PrS			Pr			S		
		N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ
1 Thailand	High	4	7.000	.816	4	6.500	1.732	3	7.000	1.000	4	6.500	.577	4	8.500	1.290	2	8.500	.707	4	8.000	.816
	Med.	4	8.000	.816	4	7.500	.577	3	7.666	.577	4	7.000	.816	3	8.000	1.732	4	7.250	.957	4	7.500	1.000
	Low	2	8.000	.000	4	7.250	1.707	4	7.000	.816	3	7.333	1.527	3	7.333	1.527	4	8.000	1.875	4	8.250	.500
2 Irrigation	High	3	16.666	2.081	4	16.250	2.061	4	15.500	1.732	4	14.750	4.193	4	15.250	1.892	4	15.500	1.290	4	13.250	2.061
	Med.	5	13.800	4.086	7	15.000	3.651	4	16.500	4.358	3	14.000	3.605	4	12.000	1.632	4	11.750	2.629	5	11.600	2.607
	Low	4	16.250	2.217	4	14.000	2.828	4	16.750	2.217	4	13.750	1.892	3	14.000	1.000	4	12.000	3.829	4	15.750	2.061
3 India	High	4	7.250	.500	5	6.000	1.000	4	6.750	2.500	4	5.500	1.000	3	3.666	1.154	4	5.500	2.516	4	6.250	2.217
	Med.	6	5.666	1.632	6	6.500	.836	6	5.666	1.751	4	6.000	2.309	4	5.250	1.500	4	6.250	2.217	4	5.500	2.380
	Low	7	5.714	1.380	5	7.600	1.516	7	6.857	2.267	3	6.666	2.081	2	5.000	1.414	3	6.333	2.081	4	7.750	.500
4 Labor	High	3	5.333	1.527	4	6.250	1.707	4	6.000	1.414	3	7.000	1.000	4	7.000	1.414	3	8.000	2.645	4	14.500	8.698
	Med.	3	7.333	.577	4	7.250	1.258	4	6.750	.500	4	7.000	.816	4	6.750	1.707	4	8.750	.957	4	10.500	7.937
	Low	4	6.250	1.500	4	6.250	2.362	4	7.500	.577	4	7.000	2.449	4	11.500	7.325	4	10.250	8.098	3	6.666	1.527
5 Heat	High	4	8.500	1.732	5	6.200	2.774	3	5.333	1.154	2	4.500	.707	4	5.250	2.629	3	7.333	1.527	4	7.750	1.500
	Med.	4	7.750	1.258	4	7.500	3.000	4	8.250	.957	4	5.750	2.629	5	7.200	3.033	4	7.750	1.892	3	7.666	3.214
	Low	3	7.333	3.055	3	8.333	1.527	4	4.000	1.154	3	7.000	2.645	3	7.333	2.309	3	4.666	2.081	5	7.000	3.240
6 Salamanders	High	4	8.750	2.500	4	9.000	3.741	4	7.750	1.892	3	7.000	2.645	3	10.333	2.309	5	7.600	1.140	3	9.000	1.732
	Med.	4	8.750	.500	4	9.750	2.986	3	6.333	2.081	4	8.250	1.500	3	6.666	3.214	4	8.500	1.000	3	8.333	.577
	Low	4	8.750	1.892	3	7.666	2.081	4	8.250	.500	5	8.600	1.516	2	8.500	.707	3	7.666	1.527	2	10.000	.000
7 Mountains	High	4	13.750	.957	4	13.750	1.892	2	14.500	2.421	4	12.750	1.258	3	12.000	2.000	5	12.000	2.000	4	13.250	.957
	Med.	4	17.250	1.258	5	11.800	2.489	4	12.250	2.061	4	11.000	2.000	4	11.250	1.707	6	11.500	1.974	5	12.000	4.472
	Low	6	12.666	2.250	5	11.000	2.236	5	12.400	2.408	4	10.500	3.696	4	12.000	1.154	6	12.333	1.966	5	11.600	1.949

TABLE 29

ANALYSIS OF VARIANCE FOR POSTTEST AND RETENTION TEST SCORES ON THE APPLICATION OBJECTIVE

Content	Source	Posttest				Retention Test			
		df	MS	F	Prob.	df	MS	F	Prob.
1 Thailand	Presentation Modes (A)	6	2.930	1.845	< .25	6	2.152	1.666	< .25
	Mental Abilities (B)	2	.253	.159	—	2	5.160	.123	—
	A × B	12	1.166	.734	—	12	.937	.725	—
	Within	63	1.587			54	1.295		
2 Irrigation	Presentation Modes (A)	6	15.587	1.791	< .25	6	18.112	2.260	< .05
	Mental Abilities (B)	2	36.112	4.150	< .05	2	18.929	2.360	< .25
	A × B	12	7.30	.835	—	12	7.270	.908	—
	Within	67	11.686			65	8.006		
3 India	Presentation Modes (A)	6	4.059	1.480	< .25	6	4.376	1.424	< .25
	Mental Abilities (B)	2	.398	.145	—	2	3.396	1.105	—
	A × B	12	1.086	.761	—	12	2.227	.725	—
	Within	76	2.741			72	3.071		
4 Labor	Presentation Modes (A)	6	5.151	2.369	< .05	6	28.109	1.848	< .10
	Mental Abilities (B)	2	.111	.051	—	2	.685	.045	—
	A × B	12	1.860	.859	—	12	15.331	1.008	—
	Within	63	2.174			58	15.207		
5 Heat	Presentation Modes (A)	6	6.674	1.726	< .25	6	6.973	1.296	—
	Mental Abilities (B)	2	2.113	.530	—	2	9.107	1.692	< .25
	A × B	12	5.086	1.277	—	12	5.905	1.097	—
	Within	64	3.980			56	5.379		
6 Salamanders	Presentation Modes (A)	6	5.759	1.722	< .25	6	3.464	.877	—
	Mental Ability (B)	2	1.088	.325	—	2	1.484	.376	—
	A × B	12	3.744	1.119	—	12	3.538	.896	—
	Within	60	3.343			53	3.964		
7 Mountains	Presentation Modes (A)	6	3.997	.753	—	6	4.603	.920	—
	Mental Ability (B)	2	30.968	5.820	< .01	2	16.487	3.296	< .05
	A × B	12	3.349	.631	—	12	1.804	.360	—
	Within	77	5.303			72	5.001		

TABLE 30

SUMMARY OF PRESENTATION MODE POSTTEST AND RETENTION TEST COMPARISONS FOR THE APPLICATION OBJECTIVE

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
1 Thailand	MpS > Pr/Sp S > Sp	PrS > Sp
2 Irrigation		MpS > Pr/SpS/Mp Sp > Mp
3 India	Sp/PrS/S > Pr	Mp/S/SpS > PrS
4 Labor	S > MpS/Mp/Sp Pr > Mp/Sp	S > Sp/SpS/Mp/MpS
5 Heat	S > MpS/PrS	
6 Salamanders	SpS > Sp/PrS	
7 Mountains		

Interaction between Presentation Mode and Mental Ability Levels

A third objective of the study was the determination of the interactions between the presentation modes and the mental ability levels. The comparisons were made by two-way analyses of variance, results of which are presented in Table 29. No interactions were significant at or beyond the .05 level.

In order to discover the relationships of presentation mode to mental ability a separate analysis was made at each mental ability level by means of the Duncan Multiple Range Test, using the .05 level to determine significance. The results of the comparisons in which significant differences were found are presented in Table 32.

Although the Print alone and Sound alone treatments appeared to be superior to other modes of presentation, there was no indication that such superiority was related to mental ability level of the subjects.

Retention of Learning

The fourth objective of the study was the determination of the duration of the learning as measured by a retention test from 10 to 14 days after exposure to the stimuli. The two-way analyses of variance for the retention tests are presented in Table 29, and the results of the comparisons in which significant differences were found are presented in Tables 30, 31, and 32.

Differences persisted in three of the five content areas in which differences were found on the posttest, but in only one case ("Labor" content area) were they in the same general direction. Additional differences were found in "Irrigation." There was no particular pattern to the changes found between the posttests and retention tests. The same general differences were found on the mental ability level comparisons between the post and retention tests.

When an analysis was made by splits at the three mental ability levels (Table 32) statistically significant differences were found in 9 of the 21 content area comparisons on the retention tests. These differences tended to reverse the pattern on the posttest and predominantly favored the pictorial presentation modes over the verbal modes. The only exception was the maintenance of posttest gains on the retention test for the Sound alone treatment. Differences appeared in the retention tests that did not occur in the posttests at all mental ability levels.

Multi-Channel Effects

The fifth objective of the study was the determination of the comparative effectiveness of single-channel (silent treatments) and

TABLE 31

COMPARISON OF MENTAL ABILITY LEVELS ON POSTTEST AND RETENTION TEST FOR THE APPLICATION OBJECTIVE

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
1 Thailand		
2 Irrigation	High > Med/Low	High > Med
3 India		
4 Labor		
5 Heat		
6 Salamanders		
7 Mountains	High > Med/Low	High > Low

TABLE 32

SUMMARY OF SIGNIFICANT COMPARISONS AMONG POSTTEST AND RETENTION TEST PRESENTATION MODES FOR MENTAL ABILITY LEVELS ON THE APPLICATION OBJECTIVE

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
HIGH MENTAL ABILITY		
#3 India	Sp > Pr	MpS/SpS > PrS
#4 Labor	Pr > PrS/Sp/Mp S > Mp	S > Sp/PrS/Mp/SpS/MpS
#5 Heat		MpS > Sp
#6 Salamanders		PrS > Sp
MEDIUM MENTAL ABILITY		
#1 Thailand	MpS > Pr	
#2 Irrigation		SpS > PrS/Pr/S
#6 Salamanders	Pr > Mp/PrS/S	Mp > PrS/SpS
#7 Mountains		MpS > S/Mp/Pr/PrS/Sp
LOW MENTAL ABILITY		
#2 Irrigation		SpS/MpS > Pr
#5 Heat	S > Pr/MpS/SpS	Mp > Pr/SpS

multi-channel (sound treatments) presentation modes. No consistent differences were found that would indicate superiority of either the single- or multi-channel modes on either the posttest or retention test.

Intra-Channel Effects

The sixth objective of the study was to determine the comparative effectiveness of the different presentation modes within each of the two channel configurations (sound and silent). The few instances in which significant differences occurred tended to favor Print alone and Sound alone modes in the posttest. No consistent differences were found in the retention test.

Summary of Findings

The analyses of the performance data for the Application learning objective or task resulted in the following conclusions:

1. The Sound alone treatment was the most effective mode of presentation, and the Print alone and silent Still Picture were the least effective.

2. The High Mental Ability subjects achieved significantly superior scores to either the Medium or Low Mental Ability subjects in two content areas.

3. On the retention test, when analyzed by mental ability levels, the pictorial presentation modes resulted in higher achievement than the verbal modes, with the exception of the Sound alone treatment, which retained its posttest gains.

4. There appeared to be no difference in achievement between single-channel and multi-channel treatment groups.

5. There appeared to be little difference in effectiveness among media types within each of the channels.

Combined Results for All Learning Objectives

Inasmuch as each subject was administered the tests for all five learning objectives or tasks for a particular subject matter content area, it was possible to total these five test scores for a combined score on the entire test. When viewed as a single test with sub-parts, the results of the five experiments reported above could each be considered a subtest of the total test. This section reports on the results of the combined test. The mean performance test scores on both the immediate posttests and the delayed retention tests are presented in Tables 33 and 34.

TABLE 33

POSTTEST PERFORMANCE MEANS AND STANDARD DEVIATIONS ON PRESENTATION MODES BY MENTAL ABILITY LEVEL ON THE COMBINED OBJECTIVES

		MpS			Mp			SpS			Sp			PrS			Pr			S		
		N	X	σ	N	X	σ	N	X	σ	N	X	σ	N	X	σ	N	X	σ	N	X	σ
1 Thailand	High	4	51.25	8.732	4	43.00	2.944	4	49.50	2.646	4	41.50	5.916	4	49.25	2.630	4	40.25	4.717	4	44.25	0.076
	Med.	4	49.00	2.582	4	44.75	2.500	4	46.00	4.320	4	44.00	5.292	4	42.50	5.972	4	38.75	3.403	4	44.00	4.243
	Low	4	43.75	4.113	4	44.00	3.367	4	42.00	2.944	4	38.50	6.807	4	45.50	6.608	4	40.00	4.690	4	42.00	1.826
2 Irrigation	High	4	68.75	3.304	4	68.25	6.292	4	64.00	8.981	4	59.25	6.185	4	94.50	5.916	4	76.50	3.873	5	60.40	9.154
	Med.	4	62.25	8.655	7	64.00	6.557	4	59.50	5.447	4	53.25	5.252	4	58.00	7.594	4	49.50	6.028	4	56.50	3.873
	Low	4	62.25	2.872	4	60.25	2.062	4	65.75	8.995	4	53.75	3.948	4	54.50	6.137	4	51.50	6.758	4	54.00	5.477
3 India	High	4	56.00	8.602	6	52.67	4.179	4	55.50	5.447	4	47.00	7.528	3	52.00	6.557	4	52.25	2.630	4	48.50	2.380
	Med.	6	51.50	5.541	6	51.50	7.007	6	53.33	3.983	4	50.00	3.266	4	48.00	2.708	4	48.75	6.946	4	50.50	4.435
	Low	7	50.14	3.716	6	47.50	4.550	7	49.57	4.820	3	45.00	1.000	3	52.67	2.082	4	43.50	1.732	4	47.75	4.425
4 Labor	High	4	51.00	4.899	4	44.75	7.042	4	44.75	2.217	4	43.50	3.697	4	44.75	3.948	4	48.75	2.062	4	46.75	3.594
	Med.	4	44.75	7.805	4	41.00	2.449	4	47.50	2.646	4	38.25	3.948	4	48.00	5.228	4	41.25	1.708	4	45.00	7.528
	Low	4	47.00	2.582	4	37.75	6.021	4	45.50	5.802	4	38.75	10.658	4	42.75	1.893	4	44.75	8.421	4	42.50	5.196
5 West	High	4	63.25	6.292	5	63.40	4.336	4	57.00	8.869	4	54.00	6.733	4	52.75	8.995	4	56.75	3.500	4	56.75	11.042
	Med.	4	56.00	6.272	4	52.50	2.646	4	54.75	4.573	4	50.50	5.508	5	54.60	6.107	4	49.75	6.021	4	52.75	8.221
	Low	4	53.75	8.694	4	52.00	3.162	4	55.00	8.165	3	41.33	1.528	4	54.50	9.609	4	49.25	4.573	4	54.00	4.690
6 Salcanders	High	4	57.75	6.602	4	48.75	4.573	4	59.75	9.215	3	49.00	5.568	4	48.75	3.775	5	55.20	8.106	4	45.75	5.679
	Med.	4	61.00	6.633	4	47.25	2.872	4	52.00	8.832	3	42.33	7.095	3	54.00	6.557	4	49.50	1.732	4	50.00	6.928
	Low	4	54.75	9.743	4	48.50	3.697	4	50.75	8.461	4	48.25	2.986	4	50.25	5.560	3	46.67	5.686	4	40.25	4.349
7 Mountains	High	4	53.75	2.500	4	55.25	3.862	3	59.00	4.359	4	55.75	2.754	4	54.00	9.832	6	50.83	4.579	4	52.50	5.636
	Med.	4	48.00	4.761	5	48.80	5.271	4	54.50	4.203	4	48.00	5.099	4	47.75	4.031	6	49.17	3.817	5	46.60	5.128
	Low	6	48.00	5.967	5	46.00	5.568	6	45.50	8.871	4	43.50	3.697	4	46.25	4.573	6	49.67	2.658	6	44.67	7.866

TABLE 34

RETENTION TEST PERFORMANCE MEANS AND STANDARD DEVIATIONS ON PRESENTATION MODES BY MENTAL ABILITY LEVELS ON THE COMBINED OBJECTIVES

		MpS			Mp			SpS			Sp			PrS			Pr			S		
		N	X	σ	N	X	σ	N	X	σ	N	X	σ	N	X	σ	N	X	σ	N	X	σ
1 Thailand	High	4	44.25	8.382	4	41.75	3.686	3	49.00	3.606	4	42.00	5.598	4	44.00	7.257	2	42.50	2.121	4	42.25	6.021
	Med.	4	46.75	5.315	4	41.50	7.047	3	46.33	3.512	4	40.00	4.397	3	43.33	4.163	4	40.25	7.411	4	40.25	3.304
	Low	2	45.00	.000	4	43.00	6.272	4	43.50	4.203	3	38.67	6.636	3	44.33	4.163	4	37.25	6.076	4	43.25	5.795
2 Irrigation	High	3	68.33	4.726	4	70.00	2.449	4	64.25	9.069	4	58.00	4.761	4	61.25	8.995	4	69.00	2.944	4	58.50	11.446
	Med.	5	61.60	7.861	7	63.71	8.958	4	57.25	5.500	3	58.33	7.024	4	55.00	6.976	4	49.00	7.528	5	53.20	3.347
	Low	4	65.25	3.594	4	59.25	7.632	4	65.75	4.113	4	54.50	2.380	3	57.00	3.464	4	52.00	7.071	4	56.00	3.742
3 India	High	4	52.25	4.924	5	47.00	3.536	4	53.75	4.857	4	52.75	2.754	3	52.00	3.000	4	52.00	5.099	4	54.25	8.617
	Med.	6	47.17	2.714	6	50.50	6.091	6	52.17	3.764	4	48.75	7.320	4	51.25	3.862	4	50.50	5.802	4	47.00	7.071
	Low	7	49.00	7.506	5	48.40	3.782	7	48.29	5.251	3	48.00	1.000	2	47.00	8.485	3	48.00	3.000	4	48.75	4.924
4 Labor	High	3	48.00	4.359	4	42.75	6.702	4	44.00	7.523	3	47.67	4.619	4	42.25	5.909	3	44.67	4.619	4	41.75	19.923
	Med.	3	45.00	6.557	4	40.75	4.787	4	42.25	2.754	4	43.00	2.449	4	45.75	5.123	4	43.00	.817	4	49.50	21.734
	Low	4	44.50	3.786	4	37.00	7.832	4	43.75	3.030	4	39.50	8.347	4	51.00	16.021	4	50.00	20.607	3	39.67	4.041
5 West	High	4	66.25	8.098	5	63.80	6.573	3	53.67	7.234	2	54.00	2.828	4	52.25	9.215	3	46.67	11.676	4	51.50	9.747
	Med.	4	55.50	10.755	4	50.75	2.986	4	53.25	8.251	4	48.75	3.775	5	53.60	7.701	4	55.00	3.266	3	48.67	6.429
	Low	3	53.67	7.234	3	54.33	11.590	4	49.75	9.012	3	40.00	2.646	3	53.00	13.748	3	43.33	3.786	5	51.40	7.162
6 Salcanders	High	4	55.75	4.924	4	50.50	3.109	4	54.50	6.952	5	46.00	6.928	3	48.33	5.774	5	52.40	7.635	3	45.33	6.506
	Med.	4	54.25	11.587	4	47.25	9.069	5	48.67	8.337	4	45.50	5.323	3	46.33	10.017	4	46.00	.817	3	47.33	1.528
	Low	4	52.75	12.693	3	47.00	4.359	4	43.50	4.796	5	49.60	5.050	2	45.50	3.536	3	44.00	2.646	2	42.50	.707
7 Mountains	High	4	53.75	5.038	4	56.25	6.500	2	61.50	.707	4	57.75	4.031	3	57.33	10.970	5	50.20	5.070	4	55.25	7.932
	Med.	4	50.25	3.304	5	48.00	7.033	4	53.75	7.632	4	44.75	5.775	4	48.50	3.873	6	46.33	2.251	5	46.20	2.672
	Low	6	48.67	6.250	5	45.20	5.718	5	47.40	6.731	4	44.25	9.535	4	46.25	2.630	6	50.33	8.452	5	45.40	11.845

Visual-Verbal Presentation Mode

The main objective of the study was the determination of the comparative effectiveness of seven different visual-verbal presentation modes in contributing to the learning of five different objectives in seven different subject matter content areas. The comparison of the performance on the immediate posttests was made by two-way analyses of variance, the data being combined for all three mental ability levels to determine the main effects of the presentation modes. The results of these analyses are presented in Table 35.

Significant differences at or beyond the .05 level were found in six of the seven content areas, only "Mountains" failing to reach significance.

A summary of the results of the Duncan Multiple Range Test for all treatment comparisons and all subject matter content areas is shown in Table 36. In these a posteriori multiple comparison tests the .05 level was used to determine significance. The Motion Picture Sound and the Still Picture Sound treatments were predominantly the most effective presentation modes. In no cases were they inferior to other modes of presentation, and, together, they accounted for 29 of the 35 instances of statistically significant comparisons (18 for Motion Picture Sound and 11 for Still Picture Sound). The silent Still Picture was the least effective of the presentation modes, showing inferiority in 15 of the 35 significant comparisons. The Print alone and Sound alone treatments also appeared to be less effective than the two sound pictorial treatments.

Mental Ability Level

A second objective of the study was the determination of the relationships of mental ability to the combined learning objectives on the total test. Subjects were grouped at the high, medium, and low mental ability levels. The comparison of the performance by the three mental ability groups on the immediate posttest was by two-way analyses of variance combined for all seven presentation modes to determine the main effects of the mental ability variable. The results of these analyses are presented in Table 35 and show that significant differences at or beyond the .05 level were found in six of the seven content areas, only "Salamanders" failing to reach significance.

A summary of the results of the Duncan Multiple Range Test for the three treatment comparisons and all subject matter content areas is shown in Table 37. The High Mental Ability level groups achieved significantly superior total posttest scores to the Low Mental Ability groups in all six of the significant cases and to the Medium Mental Ability groups in three of the significant cases. In no case did the Medium Mental Ability groups achieve at a level superior to the Low Mental Ability groups.

TABLE 35

ANALYSIS OF VARIANCE FOR POSTTEST AND RETENTION TEST SCORES ON THE COMBINED OBJECTIVE

Content	Source	Posttest				Retention Test			
		df	MS	F	Prob.	df	MS	F	Prob.
1 Thailand	Presentation Modes (A)	6	79.94	3.57	.01	6	63.61	2.02	.10
	Mental Abilities (B)	2	104.38	4.66	.05	2	15.62	.50	
	A × B	12	30.83	1.38	.25	12	10.50	.33	
	Within	63	22.40			54	31.44		
2 Irrigation	Presentation Modes (A)	6	185.05	4.71	.01	6	254.12	5.87	.01
	Mental Abilities (B)	2	571.69	14.54	.01	2	288.34	6.66	.01
	A × B	12	88.14	2.24	.05	12	84.32	1.95	.05
	Within	67	39.31			65	43.32		
3 India	Presentation Modes (A)	6	55.82	2.31	.05	6	7.48	.27	
	Mental Abilities (B)	2	100.59	4.17	.05	2	96.50	3.46	.05
	A × B	12	20.31	.84		12	19.29	.69	
	Within	76	24.12			72	27.93		
4 Labor	Presentation Modes (A)	6	71.91	2.55	.05	6	102.56	.99	
	Mental Abilities (B)	2	93.12	3.30	.05	2	98.78	.96	
	A × B	12	27.44	.97		12	99.46	.97	
	Within	63	28.25			58	102.74		
5 Heat	Presentation Modes (A)	6	113.59	2.54	.05	6	156.63	2.50	.05
	Mental Abilities (B)	2	297.84	6.66	.01	2	158.65	2.53	.10
	A × B	12	43.27	.97		12	65.80	1.05	
	Within	64	44.68			56	64.51		
6 Salamanders	Presentation Modes (A)	6	233.67	5.78	.01	6	94.34	2.03	.10
	Mental Abilities (B)	2	90.15	2.23	.25	2	59.25	1.28	
	A × B	12	49.22	1.22		12	20.02	.43	
	Within	60	40.40			53	46.46		
7 Mountains	Presentation Modes (A)	6	36.06	1.25		6	58.16	1.37	.25
	Mental Abilities (B)	2	535.47	18.49	.01	2	629.12	14.84	.01
	A × B	12	31.69	1.09		12	46.72	1.10	
	Within	77	28.95			72	42.38		

TABLE 36

SUMMARY OF PRESENTATION MODE POSTTEST AND RETENTION TEST COMPARISONS FOR THE COMBINED OBJECTIVES

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
1 Thailand	MpS > Mp/S/Sp/Pr SpS > Sp/Pr	SpS/MpS > Sp/Pr
2 Irrigation	MpS > PrS/Pr/S/Sp Mp > Pr/S/Sp SpS > Sp	SpS/MpS/Mp > PrS/Sp/Pr/S
3 India	SpS > Pr/Sp MpS > Sp	
4 Labor	MpS/SpS > Mp/Sp PrS > Sp	
5 Heat	MpS > Pr/Sp Mp/SpS > Sp	MpS > S/SpS/Pr/Sp Mp > Sp
6 Salamanders	MpS > Pr/PrS/Mp/Sp/S SpS > Mp/Sp/S Pr > S	MpS > Mp/Pr/Sp/PrS/S
7 Mountains		

TABLE 37

COMPARISON OF MENTAL ABILITY LEVELS ON POSTTEST AND RETENTION TEST FOR THE COMBINED OBJECTIVES

Content	Duncan Multiple Range Test (α = .05)	
	Posttest	Retention Test
1 Thailand	High > Low	
2 Irrigation	High > Med/Low	High > Med/Low
3 India	High > Low	High > Low
4 Labor	High > Low	
5 Heat	High > Med/Low	High > Low
6 Salamanders		
7 Mountains	High > Med/Low	High > Med/Low

Interactions between Presentation Mode and Mental Ability Level

A third objective of the study was the determination of the interactions between the seven visual-verbal presentation modes and the three mental ability levels. Two kinds of comparisons were made: by a two-way analysis of variance to determine the interactions between presentation mode and mental ability level and by the Duncan Multiple Range Test for all treatment comparisons in each of the mental ability levels. Table 35 shows that significant interactions occurred in only the "Irrigation" content area.

When analyses were made of the splits of the subjects at each mental ability level (Table 38), the Motion Picture Sound and Still Picture Sound treatments were predominantly the most effective treatment modes at all three mental ability levels. In no cases were they inferior to other modes of presentation, and, together, they accounted for 30 of the 43 instances of statistically significant comparisons (16 for Motion Picture Sound and 14 for Still Picture Sound). The silent Still Picture was the least effective at all mental ability levels, showing inferiority in 21 of the 43 significant comparisons. The Sound alone and Print alone were also less effective than other presentation modes.

Retention of Learning

The fourth objective of the study was the determinations of the duration of the learning as measured by a retention test from 10 to 14 days after exposure to the stimuli. The two-way analyses of variance for the retention tests are presented in Table 35.

Significant differences were found at or beyond the .05 level with only the "Irrigation" and "Heat" content areas, although two other content areas were significant at the .10 level and one at the .25 level.

A summary of the results of the Duncan Multiple Range Test for all treatment comparisons and all subject matter content areas (Table 36) showed a tendency for the same general patterns of significance to prevail as on the posttests, but at a lower level, only 26 significant comparisons appearing. The major exception to this finding was the increased effectiveness of the silent Motion Picture treatment and the reduced inferiority of the silent Still Picture treatment. Overall, the pictorial treatment modes showed a strong superiority over the verbal treatment modes.

The analyses of variance of comparisons of the effects of mental ability levels when the data were combined for all treatments showed three content areas to be significant at or beyond the .05 level and one at the .10 level (Table 35). The comparison of these differences by means of the Duncan Multiple Range Test indicated that four of the six content areas that demonstrated an advantage for the High Mental Ability groups maintained this superiority.

TABLE 38

SUMMARY OF SIGNIFICANT COMPARISONS AMONG POSTTEST AND RETENTION TEST PRESENTATION MODES FOR MENTAL ABILITY LEVELS ON THE COMBINED OBJECTIVES

Content	Posttest	Retention Test
HIGH MENTAL ABILITY		
#1 Thailand	MpS > S/Mp/Sp SpS/PrS > Sp	
#2 Irrigation	Pr/MpS > S/Sp	Mp > PrS/S/Sp Pr > S/Sp
#3 India	MpS > S/Sp	
#4 Labor		
#5 Heat	Mp > PrS	MpS > Sp/SpS/S/PrS/Pr Mp > Pr
#6 Salamanders	SpS > Sp/Mp/PrS/S MpS > S	
#7 Mountains		SpS > Pr
MEDIUM MENTAL ABILITY		
#1 Thailand	MpS > Pr	
#2 Irrigation	Mp > Sp/Pr MpS/SpS > Pr	SpS > PrS/S/Pr Mp > S/Pr MpS > Pr
#3 India		
#4 Labor	PrS/SpS > Sp	
#5 Heat		
#6 Salamanders	MpS/PrS/SpS > Sp	
#7 Mountains		
LOW MENTAL ABILITY		
#1 Thailand	PrS > Sp	
#2 Irrigation	SpS > PrS/S/Sp/Pr MpS > Pr	SpS/MpS > Sp/Pr
#3 India	PrS > Sp/Pr	
#4 Labor	MpS > Sp/Mp	
#5 Heat	SpS/PrS/S/MpS > Sp	Mp/MpS/PrS > Sp
#6 Salamanders	MpS/SpS > S	
#7 Mountains		

When comparisons were made among the presentation modes for each of the three mental ability levels separately, there appeared to be no discernible interactions between presentation mode and mental ability level.

Multi-Channel Effects

The fifth objective of the study was the determination of the comparative effectiveness of single-channel (silent treatments) and multi-channel (sound treatments) presentation modes. There was a noticeable tendency for the pictorial multi-channel modes to show gains over the single-channel modes, these differences being significant for the Motion Picture Sound in three content areas and for the Still Picture Sound in six content areas. Thus, out of a total of fourteen comparisons of the pictorial modes, differences in favor of the multi-channel modes were found in 66 percent of the cases. On the other hand, the Print Sound mode showed no superiority to its Print alone single-channel counterpart. In no case was a single-channel mode superior to the multi-channel mode of the same type. On the retention test, much of these gains were lost, only one Motion Picture Sound treatment being superior to the silent Motion Picture and two Still Picture Sound treatments being superior to the silent Still Picture.

Intra-Channel Effects

The sixth objective of the study was to determine the comparative effectiveness of the different presentation modes within each of the two channel configurations (sound and silent). The data in Table 36 shows that the motion picture treatments were superior to still picture, print, and sound treatments in six instances and the Print mode to the Sound mode in one instance on the posttest. On the retention test the motion picture treatments maintained the same level of superiority, and the still picture treatments were superior in one case. In no case did the verbal modes surpass the pictorial modes, nor did any other mode show superiority to the motion picture modes.

Summary of Findings

The analysis of the performance data for the combined results for all learning objectives or tasks resulted in the following conclusions:

1. The Motion Picture Sound and Still Picture Sound treatments were the most effective presentation modes.

2. The silent Still Picture treatment was the least effective presentation mode at all mental ability levels.

3. The High Mental Ability subjects achieved significantly superior scores to either the Medium and Low Mental Ability subjects.

4. The same general patterns of effectiveness prevailed in the retention test.

5. The pictorial (motion and still picture) multi-channel (sound) presentation modes were more effective than the single-channel (silent) modes. There were no channel mode effects with the verbal (print) modes of presentation. These differences tended to decrease in the retention test.

6. The motion picture modes were superior to all other presentation modes on both the posttest and retention test.

Analysis of Individual Test Items

The mean performance scores on each of the test items in the seven content areas were compared by means of analyses of variance. Where significant differences at or beyond the .05 level were found, multiple comparisons among all treatment groups were made by means of the Duncan Multiple Range Test. A tabulation of these analyses is presented in Table 41 of Appendix C. In all, only 41 of the 570 test items reached the .05 significance level, 14 for the Classification objective, 8 for the Generalization objective, 7 for the Comparison objective, and 6 each for the Identification and Application objectives. The "Irrigation" content area had the largest number of significant differences (11) and was the only area in which differences appeared for each of the learning objectives. Each of the 41 significant items were analyzed with the intent of discovering specific characteristics of the visual and sound as they related to learning of the content being tested. This analysis will be presented below as grouped by the learning objective or task being served.

Identification Objective

Of the six significant test items on the Identification objective, two occurred for "Irrigation," two for "Labor," and one each for "Heat" and "Salamanders." An analysis of these questions, the responses to them, and the stimulus material furnished no definitive answers to the results obtained. In the case of three of the questions ("Irrigation," #18f, "Heat" #13b, and "Salamanders" #19a) no explanation can be given.

In question #20c for "Irrigation," however, the correct answer required the recognition that the "crank and screw" method of raising water for irrigation in Egypt used an object that "was shaped like a large log." The inferiority of the verbal treatments to the pictorial treatments could be a function of the need by the verbal groups to transfer the idea of "big hollow wooden pipe" (as presented in the verbal stimuli) to the idea of "log," whereas the pictorial groups received a visual picture of the apparatus.

In the "Labor" content area, two questions (#24f and #25a) showed superiority for the Motion Picture Sound treatment in two cases and for the Still Picture Sound in one case over all or some of the single-channel modes. The recognition of the fact that "women did road work" and that "flower pots were in wooden boxes" may have been enhanced by support the audio gave to the pictorial visuals.

Comparison Objective

Of the six significant test items on the Comparison objective, three occurred for "Irrigation," two for "Thailand," and one each for "Labor," "Heat," and "Salamanders." An analysis of these questions, the responses to them, and the stimulus material furnished no definitive answers to the results obtained. In the case of three of the questions ("Irrigation" #13d, "Heat" #9c, and "Salamanders" #18c) no explanation can be given.

In question #15d for "Irrigation" the correct answer required the recognition that the "pole and pail" and the "crank" methods of raising water for irrigation both "made use of wood." The Sound alone treatment was inferior to five of the other treatments. The audio makes no specific mention of "wood" for the first method and refers only to a "wooden pipe" in the second method. It is possible that this was not sufficient reinforcement of this idea, although both the Print alone and Print Sound treatments performed satisfactorily on the question.

Question #16d for "Irrigation" required that the subject know that, in comparing the "water wheel" and "crank" methods of raising water for irrigation, one method lifted more water than the other. The silent Motion Picture treatment was significantly superior to the three verbal treatment modes, and the other pictorial modes were also high. As a possible explanation for the results, the pictorial modes actually "showed" the amount of water being lifted, whereas, in the verbal modes, the subjects were not told anything about amount of water and had to imply the comparative amounts lifted by the two methods. It is possible that quantity concepts such as "more" or "less" may be implied from pictorial stimuli more readily than from verbal stimuli.

On question #22d in "Labor," it was asked if "men and women did many of the same jobs." The three multi-channel modes were more effective than the single-channel modes, Motion Picture Sound and Still Picture Sound showing significant superiority over the silent Motion Picture, silent Still Picture, and Print alone. It is possible that the supporting audio narration gave support to the visuals and thus enhanced the learning.

Classification Objective

Of the fourteen significant test items on the Classification objective, five occurred for "Labor," four for "Salamanders," three for

"Irrigation," and two for "Thailand." An analysis of these questions, the responses to them, and the stimulus material gave no explanation of the results obtained. Possible reasons for the differences could be suggested in only three of the questions.

In question #6b for "Thailand" the repetition of the crucial cues may have accounted for the superiority of the Sound Motion Picture over the silent Motion Picture and Still Picture, but there is no explanation why that treatment reached significance over the verbal single-channel modes unless the specific mention of these different foods in the sound narration was a more powerful cue to the correct response than a pictorial depiction alone.

The inferiority of the silent Still Picture treatment on question #11 of "Irrigation" could be explained by the fact that the background of the picture of the water wheel method is greatly cluttered, and both the oxen and the gears could be difficult to distinguish in a still picture without audio supplementation. Thus, the Sound Still Picture, Sound Motion Picture and silent Motion Picture were significantly superior to the silent Still Picture. A similar finding was found in Allen and Weintraub's (1968) study for the identical scene, the silent Motion Picture showing significant superiority to the silent Still Picture. The mention of the oxen and gears in the verbal treatments may have been sufficient to cue the correct response for these modes.

The inferiority of the Sound alone treatment on question #12b of "Irrigation" might possibly be attributed to the number of specific facts presented in the audio narration and the difficulty of retaining and organizing these facts to form a concept after only a single linear exposure to them.

Generalization Objective

Of the eight significant test items on the Generalization objective, two each occurred for "India" and "Heat" and one each occurred for "Thailand," "Irrigation," "Salamanders," and "Mountains." The results of only three of the test items was susceptible to interpretation.

Question #8f in "Irrigation," which required the generalization that Egyptian farm workers were "unskilled," showed a significant inferiority for the silent Motion Picture treatment group and a low (but not significant) performance for the Sound Motion Picture group. One possible explanation for these results is that the occurrence of movement itself may give the impression of the complexity of the content being viewed and thus a feeling of "skilled" action taking place. All other treatments were superior to the motion picture versions, although not significantly so in every case.

Two test items in "India" (#3d and #42) showed the silent Motion Picture treatment superior to the verbal treatments and to the silent

Still Picture. These questions related to the ways travel is changing in India and the kinds of freight the animals carried. It is possible that the silent Motion Picture permit the subject to concentrate on the visuals and organize them into a generalization when the visuals very clearly depict the ideas being generalized.

Application Objective

Of the six significant test items on the Application objective, two each occurred for "Irrigation" and "Mountains" and one each for "India" and "Heat." None of the results of the test items was susceptible to interpretation.

Hierarchical Patterns of Living

A further objective of the study was the determination whether some kind of hierarchical relationship existed between learning objectives or tasks. That is, if the learning of a higher order task (e.g., generalization) was related positively to the learning of the next subordinate lower order task (e.g., classification). Because each subject received test items for all five objectives or tasks, it was possible to determine whether such positive transfer occurred. This analysis differed from earlier classical studies on hierarchical learning (Gagné and Paradise, 1961; Gagné and Others, 1962) in that it did not measure the transfer effects on an ordered set of intellectual skills, but rather knowledge about the content of the stimuli.

The results reported here are based upon an analysis made by a specially written computer program designed to calculate the proportion of instances consistent with positive transfer as defined by Gagne and Paradise (1961).[1] The proportions obtained for each of the hierarchical analyses were compared with the proportions expected by chance by means of chi square in a 2x2 contingency table. Of the total of 64 hierarchical analyses computed, 18 tested transfer from the Generalization to the Application task, 19 each tested transfer from the Classification to the Generalization and from the Comparison to the Classification tasks, and 8 tested transfer from the Identification to the Comparison task.

Results of Hierarchical Analyses

In all, only 14 (or 22%) of the 64 hierarchical analyses were found to be significant in the positive direction at or beyond the .10

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[1] Formula for determining positive transfer: $\frac{(++) + (--)}{(++) + (--) + (+-)}$, where (++) indicated passing (to an established criterion level) the designated learning at both higher and lower task levels, (--) indicated failure at both levels, and (+-) passing at the higher level and failure at the lower level.

level, and 3 (or 5%) were found to be significant in the negative direction. The results of these analyses are presented in Table 39.

It would appear that the existence of a hierarchical pattern was not supported by the evidence from this study.

Positive transfer appeared to be most evident from the Generalization to the Application task and from the Comparison to the Classification task. It was least evident from the Identification to the Comparison task. The findings suggest, at least, that the formulation of classifications which require conceptualizing or grouping of phenomena could utilize the same knowledge as the drawing of generalizations from the concepts themselves to formulate principles. Such similarity between conceptualization and generalization has been recognized, and it is not completely clear that they are necessarily different processes. A like observation could be made relevant to the similarity between the making of identifications of specific characteristics and the making of comparisons between these identified characteristics. These two processes may be a part of a single process that could roughly be classified as an identifying function.

It would appear, therefore, that the existence of a hierarchical pattern was not supported by the evidence from this study. This finding was consistent with Gagné's (1968) recent discussion of learning hierarchies in which he made a distinction between the learning of intellectual skills and verbalizable knowledge, concluding that "knowledge entities" probably cannot be formed into learning hierarchies. Yet the fact remains that this study found some evidence of positive transfer of such "knowledge entities" from the Generalization to the Application level (in 22.2% of the cases) and from the Comparison to the Classification level (in 26.3% of the cases), and the question of whether or not the learning of particular knowledge at the lower levels affects the performance at the higher level might still be kept open.

TABLE 39

SIGNIFICANCE OF POSITIVE TRANSFER OF KNOWLEDGE
IN HIERARCHICAL PATTERN ANALYSIS
(CHI-SQUARE)

Transfer to Learning Set	N	Proportion of Positive Transfer		Prob.
		Obs.	Exp.	
"Thailand"				
GEN to APP 1 (Thai markets)	84	.61	.73	
" " " 2 (Thai society)	84	.82	.71	
CLASS to GEN (Thai markets)	84	.58	.70	
COMP to CLASS 1 (Thai markets)	84	.81	.73	
" " " 2 (Thai markets)	84	.92	.73	< .05
IDENT to COMP 1 (Thai markets)	84	.66	.74	
" " " 2 (Thai markets)	84	.65	.74	
"Irrigation"				
GEN to APP 1 (weighted pole)	88	.87	.71	< .10
" " " 2 (screw driver)	88	.74	.71	
" " " 3 (water wheel)	88	.72	.71	
" " " 4 (work and people)	88	.75	.71	
CLASS to GEN 1 (weighted pole)	88	.68	.74	
" " " 2 (screw driver)	88	.80	.74	
" " " 3 (water wheel)	88	.70	.74	
" " " 4 (work and people)	88	.68	.71	
COMP to CLASS 1 (screw & weighted pole)	88	.69	.60	
" " " 2 (weighted pole & water wheel)	88	.59	.60	
" " " 3 (screw and water wheel)	88	.75	.60	
" " " 4 (work and people)	88	.80	.71	
IDENT to COMP 1 (work and people)	88	.70	.71	
"India"				
GEN to APP 1 (India transportation)	97	.76	.71	
" " " 2 (regional transportation)	97	.85	.74	
CLASS to GEN 1 (transportation problems)	97	.83	.70	
" " " 2 (changing travel)	97	.45	.70	< .01
" " " 3 (moving freight)	97	.71	.75	
" " " 4 (regional transportation)	97	.87	.67	< .02
"Labor"				
GEN to APP 1 (characteristics of labor)	84	.87	.71	< .10
" " " 2 (people and country)	84	.83	.71	
CLASS to GEN 1 (types of labor)	84	.82	.74	
" " " 2 (city-rural labor)	84	.48	.71	< .05
COMP to CLASS 1 (man and woman labor)	84	.84	.60	< .02
" " " 2 (people and country)	84	.71	.71	

TABLE 39--Continued

Transfer to Learning Set	N	Proportion of Positive Transfer		Prob.
		Obs.	Exp.	
"Labor"				
IDENT to COMP 1 (types of labor)	84	.51	.74	< .05
" " " 2 (types of labor)	84	.56	.69	
" " " 3 (people and country)	84	.66	.74	
" " " 4 (people and country)	84	.77	.69	
"Heat"				
GEN to APP 1 (pressure)	85	.71	.71	
" " " 2 (work)	85	.61	.71	
CLASS to GEN 1 (pressure)	85	.75	.74	
" " " 2 (expansion)	85	.62	.71	
" " " 3 (work)	85	.89	.74	< .10
COMP to CLASS 1 (pinwheel & bottle/pressure)	85	.86	.67	< .05
" " " 2 (cork & bottle/pressure)	85	.84	.67	< .10
" " " 3 (pinwheel & bottle/expansion)	85	.85	.71	
" " " 4 (cork & bottle/expansion)	85	.79	.74	
" " " 5 (cork & bottle/work)	85	.84	.67	< .10
" " " 6 (pinwheel & cork/work)	85	.78	.67	
"Salamanders"				
GEN to APP 1 (breathing system)	82	.90	.71	< .02
" " " 2 (environment)	82	.76	.71	
" " " 3 (mobility)	82	.78	.71	
CLASS to GEN 1 (breathing system)	82	.69	.71	
" " " 2 (mobility)	82	.47	.74	< .02
COMP to CLASS 1 (tree and newt)	82	.80	.71	
" " " 2 (siren and mud puppy)	82	.84	.71	
" " " 3 (newt and mud puppy)	82	.78	.74	
"Mountains"				
GEN to APP 1 (dome mountains)	98	.81	.71	
" " " 2 (volcanic mountains)	98	.73	.71	
" " " 3 (lava)	98	.86	.71	< .10
CLASS to GEN 1 (dome mountains)	98	.59	.74	
" " " 2 (volcanic mountains)	98	.72	.74	
" " " 3 (lava)	98	1.00	.74	< .001
COMP to CLASS 1 (dome mountains)	98	.66	.67	
" " " 2 (volcanic mountains)	98	.59	.67	
IDENT to COMP (lava)	98	.85	.71	< .10

CHAPTER IV

CONCLUSIONS AND DISCUSSION

This chapter will present the specific conditions that may be derived from the data and discuss their possible implications.

Comparison of Visual-Verbal Presentation Modes

The overall superiority of the pictorial Motion Picture Sound and the Still Picture Sound treatments to the verbal treatment modes at all but the Application learning task level was the most overriding finding of the study. A summary of the comparisons in which differences occurred is given in Table 40. It is apparent that this superiority appeared primarily at the Identification objective level and that it declined as progressively higher order skills were measured, until there was a reversal favoring the Sound alone treatment at the Application objective level. The silent Motion Picture seemed to be the next most effective treatment method overall, followed by Print Sound. When the combined scores for all five learning objectives are examined, the pictorial treatment modes (except for the silent Still Picture) completely dominated the significant comparisons, being superior in 94% of the cases. It is also worth noting that in only four cases for the posttest and four cases for the retention test did the three verbal presentation modes show superiority to the pictorial presentation modes (excluding the silent Still Picture), whereas the three pictorial modes showed superiority to the three verbal treatments in 28 cases on the posttest and 57 cases on the retention test for the five learning objectives levels. For the combined objectives, the verbal modes showed no superiority to the pictorial modes, yet the pictorial modes were superior in 14 cases on the posttest and 16 cases on the retention test.

Given the overall superiority of the two sound pictorial versions, what do the intra-channel comparisons reveal? That is, how do the different presentation modes (motion picture, still picture, print, sound) compare with each other within each of the channel configuration (sound and silent)? The Motion Picture Sound was superior to the Still Picture Sound in one instance on the posttest and retention test and to the Print Sound in one instance on the posttest and five instances on the retention test. The Still Picture Sound treatment was superior to the Print Sound treatment in two instances on the posttest and six instances on the retention test. It would appear, therefore, that although the pictorial treatments were superior to the verbal treatment in the multi-channel configuration, such superiority was not particularly

TABLE 40

SUMMARY OF SIGNIFICANT DIFFERENCES FOR ALL PRESENTATION MODES AT EACH LEARNING OBJECTIVE LEVEL ON POSTTEST AND RETENTION TESTS
(Superiority Indicated for Treatment in Left Column)

Presentation Mode	Learning Objective	MpS	Mp	SpS	Sp	PrS	Pr	S
MpS	Ident		2 (3)*		6 (4)	(2)	2 (3)	2 (3)
	Comp		1 (1)	1	2 (3)	1 (2)	3 (2)	2 (3)
	Class		1		1 (1)		1 (1)	1 (3)
	Gen					(1)	(1)	2 (1)
	App		(1)	(1)	1		1 (1)	
	Comb		3 (1)	(1)	6 (4)	2 (2)	4 (4)	3 (3)
Mp	Ident	(1)			2 (1)	(2)	(2)	(2)
	Comp				(1)			1 (1)
	Class					(1)		(1)
	Gen					(1)		1
	App					(1)		
	Comb				2 (2)	(1)	1 (1)	1 (1)
SpS	Ident	(1)	(3)		2 (4)	(2)	(4)	1 (4)
	Comp				(2)		(1)	(1)
	Class		1 (1)		2 (1)	2 (2)	1 (2)	3 (3)
	Gen				1	(1)	(1)	2 (1)
	App				1	(1)	1	1
	Comb		2		6 (2)	(1)	2 (2)	1 (1)
Sp	Ident	(1)					(1)	(2)
	Comp							
	Class							
	Gen							
	App		(1)				1	
	Comb							
PrS	Ident	(1)			1		(3)	(1)
	Comp							1
	Class							
	Gen				1		1	2
	App				(1)		1	
	Comb				1			
Pr	Ident				1			
	Comp							
	Class							
	Gen				1			
	App		1		1			
	Comb							1
S	Ident				1			
	Comp							
	Class							
	Gen							
	App	2 (1)	1 (1)	(1)	2 (1)	1 (1)	1	
	Comb							

*Posttest comparisons are shown without parentheses and retention test comparisons with parentheses.

notable, being more apparent for retention than for immediate learning. With the single-channel silent treatments, there appeared to be little practical difference between the silent Motion Picture mode and the Print alone and Sound alone modes or between the latter two treatments.

The most notable differences appeared in the comparisons of these three treatment modes with the silent Still Picture, the silent Still Picture showing some slight tendency toward inferiority (a total of only eight instances for the posttest and three instances for the retention test). This inferiority of the silent Still Picture to the silent Motion Picture confirmed Allen and Weintraub's (1968) findings in which they made similar comparisons of silent motion and still picture treatments. Such differences did not appear, however, when sound was added to the motion pictures and still pictures.

As a general conclusion, therefore, it seemed that although some advantage might accrue to the pictorial treatment modes (except for the silent Still Picture), these differences were so slight that no practical differences were apparent. On the other hand, there was some cause to believe that the silent Still Picture was the least effective means of presenting the cognitive information tested. Thus, the Sound Motion Picture and Sound Still Picture superiority revealed in the overall analysis of results seemed to be obtained at the expense of the silent treatments and may not have been a function of any differences in efficacy between the visual-verbal modes of presentation.

Interactions between Mental Ability and Presentation Mode

The results pointed definitely to the superiority of the achievement by High Mental Ability subjects over both the Medium and Low Mental Ability subjects for all learning objectives on both the posttest and retention tests. This finding was predictable. However, the failure of the Medium Mental Ability subjects to perform at a superior level to the Low Mental Ability groups (except in two instances on the posttest and one instance on the retention test) was unexpected. An examination of the interactions between presentation mode and mental ability level was needed to reveal possible reasons for this finding.

There was little of a decisive nature to indicate overall interactions between presentation mode and mental ability level. Taking the three multi-channel treatments, Still Picture Sound demonstrated superiority to the Print Sound at the High Mental Ability level and the Motion Picture Sound to the Print Sound at the Medium Mental Ability level. There were no practical differences at the Low Mental Ability Level. At both the High and Medium Mental Ability levels the Still Picture Sound showed large increases in learning from the posttest to the retention test. For the four single-channel treatments, the silent Motion Picture was superior to the silent Still Picture at the High Mental Ability level, but there were no practical differences at the other mental ability levels. Also, the silent Motion Picture showed retention test gains from the posttest to the retention test at all levels, but par-

ticularly at the High and Low Mental Ability levels.

As a general conclusion, it appears that, when the results were looked at as a whole, no particularly significant interactions occurred between presentation mode and mental ability. There appeared to be no support for the widely held contention that lower mental ability students will profit more from pictorial than from verbal stimuli.

Multi-Channel Effects

Although there was an overall tendency for the pictorial (motion picture and still picture) multi-channel sound treatments to show superiority over the single-channel silent treatments, this advantage did not prevail under all conditions. No advantage was found for the multi-channel Print Sound over the single-channel Print alone mode.

Such findings partially confirm and partially refute Travers' (1967) conclusion that no advantage should accrue to multi-channel presentation. His conclusions were based upon an analysis of research that dealt largely with verbal material, and, therefore, the findings from this study relative to the comparisons of Print Sound with Print alone is comparable. The finding here that, for such verbal material, learning is not enhanced by using two channels is consistent with Travers' findings. On the other hand, Travers' generalization of this conclusion to pictorial material is not supported by the findings of this study. It seems that the addition of sound to a pictorial presentation plays a supporting, cueing, and repetition role that might not be evident when two redundant verbal channels are presented simultaneously. Perhaps the pictures and sound are not actually "redundant" (in that the same words are spoken and printed), but rather "related" (in that the verbal sound describes the pictorial representation) as suggested by Hartman (1961b). Thus, the sound motion picture or still picture does not present simultaneous redundant information, but permits scanning time for the learner and the opportunity to switch attention from one channel to the other. The presentation of print and redundant sound, on the other hand, may result in some interference due to lack of precise fit between reading speed and rate of presentation of the audio.

Comparisons of Learning Objectives

There was a noticeable trend toward a decreased influence of the mode of visual-verbal presentation as higher order skills were tested. That is, more significant differences among treatments were found for the Identification Comparison, and Classification objectives than for the Generalization and Application objectives. Such differences tended to favor the pictorial treatment modes at the lower levels, with a progressive diminution of this advantage as higher order learnings were tested.

The most dramatic reversal of the pictorial dominance was the

superiority of the Sound alone treatment over all other treatments for the Application objective. There is no explanation for this finding. An examination of the audio narration, visuals, and test items revealed no discernible reasons for the results. It may be possible, however, that visuals can add cues that are misleading when an application to a new situation is required, whereas sound or print alone may isolate the specific content to be learned and thus enhance its acquisition. But no evidence to support this contention could be found in the results of this study.

Overall, the findings do indicate that the pictorial modes of presentation have their greatest effects at lower cognitive levels and this seems to be a reasonable conclusion. After all, at the Identification and Comparison levels the learning of specific physical characteristics are being measured, and one would expect that visual representations of such content would prove more beneficial to learning. On the other hand, one might not expect that the concepts, generalizations, and applications of learning required at the higher levels would receive comparable support from such visuals.

Hierarchical Patterns of Learning

The results showed little evidence that a hierarchical pattern existed between higher order and lower order tasks so far as the learning of cognitive information was concerned. The evidence of positive transfer that did appear was from the Generalization task to the Application task and from the Comparison task to the Classification task. It was least evident from the Identification to the Comparison task.

A consideration of these results was given in Chapter III, and there is little that can be added in the form of discussion at this time. It would seem that a further study of such hierarchical patterns in the learning of knowledge entities is indicated in the light of some positive results from this study. The possible existence of hierarchies of learning is of great importance in the design of effective sequences of instruction, and the ordering of such learning objectives as those studied here could furnish valuable insight into the production of instructional materials.

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APPENDIX A

PERFORMANCE TESTS

THAILAND

1. Circle one or more of the things that are most like what you learned about Thailand. [APPLICATION]

   a. a harbor in Alaska
   b. a parking lot in a city
   c. a coastal city on very low land
   d. Olvera Street in Los Angeles
   e. the freeway that goes through Bellflower
   f. a school assembly

2. Circle one or more of the things that are most like the Thailand markets. [APPLICATION]

   a. looking for something in a big crowd
   b. a village market in Mexico
   c. a supermarket in Bellflower
   d. booths at a county fair

3. Circle one or more things that describe the Thailand market place. [GENERALIZATION]

   a. It is a place to buy food only.
   b. Many merchants sold only one product.
   c. Most of the food sold has come from a long distance away.
   d. There is not much choice of what to buy.
   e. It is a place where the entire family shops together.
   f. Frozen foods are also sold here.

4. Circle one or more of the things that best describe what Thailand is like. [GENERALIZATION]

   a. The people live almost entirely on vegetables.
   b. There are many different travel vehicles.
   c. It has a hot and wet climate.
   d. It is difficult to be on time when traveling.
   e. It is a country with many iron mines.
   f. The people do not like to be in crowded places.

5. Circle one or more things that tell about the geography of Thailand. [CLASSIFICATION]

   a. fish, farm products, canals
   b. fish, merchants, weight
   c. children, merchants, women
   d. dress, bridges, wooden docks

6. Circle one or more things that best describe what people eat in Thailand. [CLASSIFICATION]

   a. fish, bread, carrots
   b. fruit, chickens, fish
   c. vegetables, fruit, fresh meat
   d. chicken, apples, bananas

7. From what you learned, circle one or more of the things that best describe what the people of Thailand are like. [CLASSIFICATION]

   a. merchants, farmers, fishermen
   b. merchants, salesmen, sailors
   c. painters, chicken-raisers, loggers
   d. housewives, fishermen, boat-repairmen

8. fish
   clothing [CLASSIFICATION]
   chicken

   The above three things best belong to which one of the following choices?

   a. sold by trading
   b. sold by individual merchant
   c. sold by the package
   d. none of the above

9. vegetables
   chicken [CLASSIFICATION]
   fish

   The above three things best belong to which one of the following choices?

   a. sold by individual merchant
   b. sold by the package
   c. sold by trading
   d. none of the above

10. fish
chicken [CLASSIFICATION]
gasoline

The above three things best belong to which one of the following choices?

a. sold by the package
b. sold by individual merchant
c. sold by trading
d. none of the above

11. clothing
chickens [CLASSIFICATION]
gasoline

The above three things best belong to which one of the following choices?

a. sold by trading
b. sold by individual merchant
c. sold by the package
d. none of the above

12. Circle the things that tell about how the people travel in Thailand. [CLASSIFICATION]

a. canal, bridge, road
b. bridge, canal, paddling
c. automobile, on foot, boat
d. on foot, by automobile, in boats

13. Circle one or more of the things you learned about that are correct. [COMPARISON]

a. Both clothes and handkerchiefs were hung up near the docks.
b. The chickens and fish were both sold from boats.
c. Everything sold in the market was fresh and uncooked.
d. Clothing and farm products were both sold from boats.
e. Fish and vegetables were both sold by weight.
f. One merchant sold both fish and vegetables.

14. Circle one or more of the things you learned about that are correct. [COMPARISON]

a. Women handled the boats more skillfully than men.
b. Men and women traveled in the same way.
c. Men and women both shopped.
d. Canals were used for travel, but not for a market place.
e. The same jobs were done by men and women.
f. Same things sold on docks and boats.

15. Circle one or more of the things that are correct about the Thailand people. [IDENTIFICATION]

a. Women cooked chickens.
b. Bridges were used only to view the market activity.
c. Children sold products.
d. Men and women did the shopping.
e. Shopping was done by women and children.
f. People shopped from their boats.

16. Circle one or more of the things that are correct about the markets of Thailand. [IDENTIFICATION]

a. Foot bridges crossed the canals.
b. Cloth was sold from boats.
c. The docks were made of cement and tile.
d. Motorboats carried farm products.
e. Cloth was sold by weight.
f. Chicken was sold from a boat.
g. Gasoline for the boats was sold from the docks.

IRRIGATION

1. The water raising tool that used the crank and screw is most like which of the following things? (Circle one or more of the correct answers.) [APPLICATION]

a. a man sawing a stick
b. a man loading a truck
c. a man turning on a water faucet
d. a man drilling a hole in a board
e. a man sharpening a pencil
f. a man pouring water into a pipe

2. The water raising tool that used the pole and pail is most like which of the following things? (Circle one or more correct answers.) [APPLICATION]

   a. a man prying up a nail in a board with a hammer
   b. a man watering the yard
   c. a man rolling a barrel
   d. a man drinking through a straw
   e. a man loading a truck
   f. a man turning on a water faucet

3. The water raising method that used the water wheel is most like which of the following things? (Circle one or more correct answers.) [APPLICATION]

   a. delivering water by truck
   b. a boy pedalling a bicycle
   c. a man rowing a boat
   d. a ditch-digging machine
   e. the side-paddle boat at Disneyland
   f. turning a pipe valve

4. Circle one or more of the following things that are most like the people you just learned about. [APPLICATION]

   a. tomato and orange pickers of California
   b. slave labor on a cotton plantation
   c. irrigation and farming in America today
   d. skills of American factory workers
   e. a person planting a small garden in the city
   f. fishermen along the beach

5. Circle one or more of the things that best describe the water wheel method. [GENERALIZATION]

   a. The flow of water to the fields is not even.
   b. It does not lift the water, but just makes it move faster.
   c. The water is used to do work.
   d. It gets the most water with the fewest workers.
   e. The power to run it is very simple.
   f. Non-human power can be used.

6. Circle one or more of the things that best describe the pole and pail method. [GENERALIZATION]

   a. It gives a very even flow of water.
   b. It shows how water is made to do work.
   c. It works on the idea of the lever.
   d. It is very simple to operate.
   e. A large amount of water can be lifted.
   f. It uses the forces of nature instead of manpower.

7. Circle one or more of the things that best describe the crank and screw method. [GENERALIZATION]

   a. It needs a skilled worker to run it.
   b. It shows how water is made to do work.
   c. It works like a teeter totter.
   d. It uses the same idea as a fishing reel.
   e. It shows a different use for a common tool.
   f. The flow of water is even.

8. Circle one or more of the things that are like the people and their work in Egypt. [GENERALIZATION]

   a. Most jobs were done with physical labor.
   b. The machinery used suited the kind of work to be done.
   c. Women do the same jobs as men.
   d. Egyptian tool use is about the same as that of an American farmer.
   e. There appears to be no electric power.
   f. Farm workers are skilled.

9. lifting
   even flow of water [CLASSIFICATION]
   one man

The above three things best belong to which one of the following choices?

   a. the pole and pail method
   b. crank and screw method
   c. water wheel method
   d. none of the above

10. container
    stone [CLASSIFICATION]
    rope

The above three things best belong to which one of the following choices?

   a. water wheel method
   b. crank and screw method
   c. pole and pail method
   d. none of the above

11. animal
containers [CLASSIFICATION]
gears

The above three things best belong to which one of the following choices?

a. crank and screw method
b. water wheel method
c. pole and pail method
d. none of the above

12. Circle one or more of the things that describe the people and their work. [CLASSIFICATION]

a. simple tools, work in fields, make tools
b. homemade tools, manual labor, work in fields
c. electric power, water is hard to get, people work hard
d. hoe fields, work easy to learn, men and women work
e. tools run by people, heavy rainfall, water is important
f. simple work, machines, grow food

13. In comparing the water wheel to the pole and pail tool, circle one or more of the things that are correct. [COMPARISON]

a. They both used oxen.
b. They both lifted about the same amount of water.
c. They both used rope and wood.
d. The water was lifted by hand in both.
e. The same kind of containers were used in both.
f. They both had an even flow of water.

14. Circle one or more of the things you learned about that are correct. [COMPARISON]

a. Men and women did the same jobs.
b. The different tools would probably be used in different part of the country.
c. Most of the things were done by physical labor.
d. All three tools took about the same amount of time to build.
e. Two of the methods lifted water from the river, but the other method put it back in the river.
f. It took about the same amount of work to run all three tools.

15. In comparing the pole and pail method to the crank method, circle one or more of the things that are correct. [COMPARISON]

a. They both used rope.
b. They both lifted about the same amount of water.
c. One used clay jars but not the other.
d. Both were made of wood.
e. Neither of them used animals for power.
f. They both had an even flow of water.

16. In comparing the water wheel to the crank method, circle one or more of the things that are correct. [COMPARISON]

a. They both used the same kind of power to run them.
b. They both used jars.
c. They both were at the very edge of the river.
d. One lifted more water than the other.
e. They both emptied their water into a ditch.
f. They both used rope and wood.

17. Circle one or more of the things that you learned about the work and people of Egypt. [IDENTIFICATION]

a. Irrigation was often done by flooding the fields with water.
b. Water ran in cement ditches back into the river.
c. Oxen were used to plow the fields.
d. The climate was warm and dry.
e. The river emptied into many small ditches.
f. Hoes were used to keep the weeds from clogging up the water wheel.

18. Circle one or more of the things that are correct for the pole and pail method. [IDENTIFICATION]

a. The pail was filled at the upper level and emptied at the lower level.
b. It was turned by hand.
c. The weighted end of the pole was pulled down by the men.
d. A large stone was used for a weight.
e. Rope and metal were used to make the tool.
f. The pail was filled directly from the river.

19. Circle one or more of the things that are correct for the water wheel method. [IDENTIFICATION]

a. Oxen were driven by whip.
b. It used gears made of wood.
c. It was turned by hand.
d. The jars were fastened to the wheel by wooden clamps.
e. The mars emptied into a ditch at a higher level.
f. The jars were filled by dipping into a large pool of water.

20. Circle one or more of the things that are correct for the crank and screw method. [IDENTIFICATION]

a. Both ends were open.
b. Two men took turns running it.
c. It was shaped like a large log.
d. There was an even flow of water from the tool.
e. When the crank was turned, the water moved upward.
f. It was shaped like a wheel.

INDIA

1. Circle one or more of the best things that are like the transportation in India. [APPLICATION]

a. the assembly line in an auto factory
b. driving home from work at 5 o'clock
c. a museum exhibit showing all kinds of ways people travel
d. a person who is never on time
e. a town in the jungles of Africa
f. a school playground

2. Circle one or more of the best things that are like travel in India. [APPLICATION]

a. using a computer to solve problems
b. making tea in a coffee pot
c. using skis on the snow
d. staying in the room during a fire drill
e. putting chains on your tires in the snow
f. eating breakfast in the morning and supper at night

3. Circle one or more of the things that tell what travel is like in India. [GENERALIZATION]

a. Freight moves only by animals.
b. People travel mostly on animals.
c. It is easy to move from place to place.
d. Ways of travel are changing.
e. In the city traffic is controlled in some way.
f. You need a bike to travel in the city.

4. Circle one or more of the things that would tell you which part in India you might be in. [GENERALIZATION]

a. the kinds of freight the animals carried
b. whether or not there is a policeman
c. the way people passed each other on the road
d. the kinds of vehicles seen
e. amount of freight carried
f. whether or not people walked
g. whether or not animals were used

5. freight boats
cranes [CLASSIFICATION]
camel

The above three things best belong to which one of the following choices?

a. mountain travel
b. city travel
c. travel in the countryside
d. river-seaport areas
e. none of the above

6. oxen
carts [CLASSIFICATION]
bicycles

The above three things best belong to which one of the following choices?

a. city travel
b. travel in the countryside
c. mountain travel
d. river-seaport travel
e. none of the above

7. donkeys
walking [CLASSIFICATION]
elephants

The above three things best belong to which one of the following choices?

a. river-seaport areas
b. city travel
c. travel in the countryside
d. mountain travel
e. none of the above

8. buses
bicycles [CLASSIFICATION]
animals

The above three things best belong to which one of the following choices?

a. travel in the countryside
b. city travel
c. mountain travel
d. river-seaport travel
e. none of the above

9. sheep
trails [CLASSIFICATION]
small freight

The above three things best belong to which one of the following choices?

a. city travel
b. mountain travel
c. travel in the countryside
d. river-seaport areas
e. none of the above

10. buffalo
people walking [CLASSIFICATION]
children carried

The above three things best belong to which one of the following choices?

a. city travel
b. mountain travel
c. river-seaport travel
d. travel in the countryside
e. none of the above

11. Circle one or more groups of things that show the problems of travel in India. [CLASSIFICATION]

a. boats, donkeys, elephants
b. policemen, sheep, large loads
c. animals on road, speed of trucks, condition of road
d. traffic jams, speed of trucks, many bicycles

12. Circle one or more groups of things that tell travel is changing. [CLASSIFICATION]

a. rough roads, sheep trails, mountains
b. buses, bicycles, ships
c. buffalo, trucks, traffic jams
d. donkeys, camels, elephants

13. Circle one or more groups of things that had to do with the moving of freight. [CLASSIFICATION]

a. boat, auto, camel
b. elephant, camel, boat
c. sheep, cart, boat
d. train, bicycle, cart
e. camel, buffalo, donkey

14. Circle one or more of the groups of things which are correct. [COMPARISON]

a. Buffalo were used in both the mountain and country areas.
b. Animals carried freight in both the city and country.
c. Means of transportation were same in both the city and country.

d. The camel was used at the seaport and in the country.
e. Trains, elephants, and buses carried different things.
f. Bicycles were used mostly in the city.
g. Camels were used at the seaport and in the country.

15. Circle one or more of the groups of things which are correct. [COMPARISON]

a. Roads were crowded in the city, but not in the country.
b. Methods of travel are changing faster at the seaport than in the city.
c. People pulled carts in both the city and country.
d. People and animals both pulled carts.
e. Both people and animals carried freight.
f. The same vehicles were seen on the roads in both the country and city.

16. Circle one or more of the things you learned about transportation in India. [IDENTIFICATION]

a. New and old-fashioned vehicles carry people.
b. Carts carried freight in the country.
c. Camels, trucks and trains carried all the freight.
d. Camels, donkeys and elephants all carried freight.
e. Freight was carried on boats.

17. Circle one or more of the things that were used for transportation in the country. [IDENTIFICATION]

a. horse carts
b. trucks
c. elephant
d. buffalo
e. camels
f. automobile

18. Circle one or more of the things used for travel at the river and seaport area. [IDENTIFICATION]

a. elephant
b. automobiles
c. camel
d. freight boats
e. carts
f. horses
g. buffalo
h. passenger boats

19. Circle one or more of the things used for travel in the city. [IDENTIFICATION]

a. motorcycles
b. sheep
c. buffalo
d. bicycles
e. camel
f. horse carts

LABOR

1. Circle one or more of the things most like the way of life in Eastern Europe. [APPLICATION]

a. life on a cotton plantation
b. a junk yard with many old autos
c. city with many appliance repair shops
d. a country with both cities and farms
e. life in Canadian cities
f. jobs women do in America

2. Circle one or more of the things most like the work in Eastern Europe. [APPLICATION]

a. grape and orange pickers in California
b. picking cotton by machine
c. jobs done by workers in a cafeteria
d. jobs women do in America
e. camels carrying loads across the desert
f. assembly workers in a factory

3. Circle one or more of the things you learned about that describe work in Eastern Europe. [GENERALIZATION]

a. Work is done quickly.
b. Most jobs are done by physical labor.
c. Almost all the jobs are done by men.
d. Animals and machines often do the same kinds of work.
e. There are more skilled than unskilled workers.
f. People and machines often do the same kind of work.

4. Circle one or more of the things you learned about that describe what Eastern Europe is like. [GENERALIZATION]

a. Country roads are in good condition.
b. People enjoy much recreation.
c. Many people work on building projects.

d. Farms employ many machine operators.
e. The country is moving toward modernization.
f. The country depends more upon machines than upon human labor.

5. street cleaners
ditch diggers [CLASSIFICATION]
factory workers

The above three things best belong to which one of the following choices?

a. life in the countryside
b. city life
c. seaport life
d. none of the above

6. men and women working
machines [CLASSIFICATION]
animals

The above three things best belong to which one of the following choices?

a. city life
b. seaport life
c. life in the countryside
d. none of the above

7. cheap labor
use of machines [CLASSIFICATION]
good roads

The above three things best belong to which one of the following choices?

a. life in the countryside
b. seaport life
c. city life
d. none of the above

8. crane
boat [CLASSIFICATION]
freight

The above three things best belong to which one of the following choices?

a. seaport life

b. city life
c. life in the countryside
d. none of the above

9. pails of water
drying clothes [CLASSIFICATION]
leveling land

The above three things best belong to which one of the following choices?

a. life in the countryside
b. seaport life
c. city life
d. none of the above

10. loading trucks
building houses [CLASSIFICATION]
making pots

The above three things best belong to which one of the following choices?

a. life in the countryside
b. seaport life
c. city life
d. none of the above

11. washing clothes
cleaning streets [CLASSIFICATION]
raising train crossing gate

The above three things best belong to which one of the following choices?

a. human power
b. animal power
c. machine power
d. none of the above

12. plowing fields
inspecting clay pots [CLASSIFICATION]
washing clothes

The above three things best belong to which one of the following choices?

a. animal power
b. human power

c. machine power
d. none of the above

13. cleaning streets
making ditches [CLASSIFICATION]
seeding fields

The above three things best belong to which one of the following choices?

a. machine power
b. animal power
c. human power
d. none of the above

14. ship loading
building dams [CLASSIFICATION]
hauling hay

The above three things best belong to which one of the following choices?

a. animal power
b. machine power
c. human power
d. none of the above

15. making fields ready
hauling hay [CLASSIFICATION]
plowing

The above three things best belong to which one of the following choices?

a. human power
b. animal power
c. machine power
d. none of the above

16. digging ditches
driving bulldozers [CLASSIFICATION]
train crossing guard

The above three things best belong to which one of the following choices?

a. women's work
b. both men's and women's work

c. men's work
d. none of the above

17. cleaning streets
digging ditches [CLASSIFICATION]
carrying bricks

The above three things best belong to which one of the following choices?

a. men's work
b. women's work
c. both men's and women's work
d. none of the above

18. crossing guard
bricklayer [CLASSIFICATION]
bulldozers

The above three things best belong to which one of the following choices?

a. both men's and women's work
b. men's work
c. women's work
d. none of the above

19. cleaning streets
loading ships [CLASSIFICATION]
stripping logs

The above three things best belong to which one of the following choices?

a. women's work
b. men's work
c. both men's and women's work
d. none of the above

20. inspecting pots
painting ornaments [CLASSIFICATION]
digging ditches

The above three things best belong to which one of the following choices?

a. both men's and women's work
b. women's work
c. men's work
d. none of the above

21. planting fields
sweeping streets [CLASSIFICATION]
inspecting pots

The above three things best belong to which one of the following choices?

a. women's work
b. men's work
c. both men's and women's work
d. none of the above

22. Circle one or more of the following which are correct. [COMPARISON]

a. Men and women did many of the same jobs.
b. The same skill is needed for most jobs.
c. Women had more skilled jobs than men.
d. Women did the easier kinds of work.
e. Women did mostly hand labor.
f. Women did more skilled jobs than men.

23. Circle one or more of the things that are correct about Eastern Europe. [COMPARISON]

a. People do the same kind of work in the city and in the country.
b. Many people are needed to farm, but few people are needed in factories.
c. Modern machines are used in the city, but not in the country.
d. People worked hard in the country, but not in the city.
e. More machines were used in the country than in the city.
f. More people worked at city jobs than at country jobs.

24. Circle one or more of the following that you learned about Eastern Europe. [IDENTIFICATION]

a. Basements were dug by machine.
b. Oxen were used on farms.
c. drawing water from a well
d. things made in the city
e. animals used for travel
f. Women did road work.
g. loading trucks by hand

25. Circle one or more of the following that you learned about Eastern Europe. [IDENTIFICATION]

a. flower pots in wooden boxes
b. washing clothes in the river
c. land leveling device
d. drinking water for animals
e. automated factories
f. train crossing guard
g. building construction
h. making hand tools
i. women inspecting watches

HEAT

1. Circle one or more of the ways that things move that are most like what you just learned. [APPLICATION]

a. drilling a hole
b. looking through a telescope
c. baking a cake
d. drawing a circle
e. throwing a stone
f. filling a glass with water

2. Circle one or more of the things that are most like the way things were done. [APPLICATION]

a. pushing a lawn mower
b. reading a book on science
c. riding a bicycle
d. cooking a meal
e. rowing a boat
f. watching a TV program

3. Circle one or more of the things that describe what you learned about. [GENERALIZATION]

a. For every action there is a reaction.
b. The power for the experiments was the water.
c. The glass tubes do work.
d. Steam makes heat
e. Steam pulls things.
f. Steam and heat do the same things.

4. Circle one or more of the things that describe the things you learned about. [GENERALIZATION]

a. Steam and heat were the same.
b. More water will cause more pressure.

c. Steam puts forth more pressure than does water.
d. Steam can move things in any direction.
e. Steam takes up the same amount of space as water.
f. Pressure is the same as steam.

5. From what you learned, circle one or more of the following that describe the idea of expansion. [CLASSIFICATION]

a. a cork moving in the test tube
b. small tubes on bottle
c. a bottle going around
d. steam causing bottle to move
e. bubbles forming in the water
f. pin wheel going around

6. From what you learned, circle one or more of the things that describe the idea of work being done. [CLASSIFICATION]

a. the bottle turning because the steam was escaping
b. pressure moving the cork
c. test tube in the clamps
d. the cork in the test tube
e. bottle sitting on electric plate
f. steam hitting the fan
g. the hollow tubes of the bottle

7. From what you learned, circle one or more of the following that describe the idea of pressure. [CLASSIFICATION]

a. water boiling
b. starting the heater plate
c. pulling
d. effect of steam escaping
e. what steam does to the work in the test tube
f. steam going through the air
g. putting the water in the bottle.

8. Circle one or more of the things that are correct for the pin wheel and the hanging bottle experiments. [COMPARISON]

a. Corks were in the same place in both.
b. Steam was present in both.
c. Both used wire.
d. Bottles turned in both.
e. More water was needed in the pin wheel than in the hanging bottle experiment.
f. Heat was used in both.

9. Circle one or more of the things that are correct for the test tube and the hanging bottle experiments. [COMPARISON]

   a. Corks popped out in both.
   b. Steam was used in the hanging bottle but not in the test tube experiment.
   c. About the same amount of heat was used in both experiments.
   d. Bubbles were formed in the water in both.
   e. Something turned in both.
   f. Corks were in the same place in both.
   g. Neither of them showed the steam escaping.

10. Circle one or more of the following that are correct when comparing the test tube experiment to the pin wheel experiment. [COMPARISON]

   a. The cork moved in the test tube but not in the pin wheel experiment.
   b. There was pressure from steam with the pin wheel but not with the test tube experiment.
   c. Wheels turned in both.
   d. Heat was used in both.
   e. Water turned to steam in both.
   f. The use of heat was more important with the pin wheel than with the test tube experiment.

11. Circle one or more of the things that are correct for the hanging bottle experiment. [IDENTIFICATION]

   a. The bottle did not turn.
   b. Wire was used.
   c. Steam escaped from only one tube.
   d. The bottle had two tubes.
   e. The cork popped out.
   f. The steam turned a small pin wheel.
   g. All the water was used up.
   h. There were bubbles in the water.

12. Circle one or more of the things that are correct for the pin wheel experiment. [IDENTIFICATION]

   a. A test tube was used.
   b. One small tube was used.
   c. There was a cork in the bottle.
   d. There were no bubbles in the water.
   e. Steam turned the bottle.
   f. Wire was used.

13. Circle one or more of the things that are correct for the test tube experiment. [IDENTIFICATION]

a. The test tube turned around.
b. The cork moved.
c. Steam escaped from two small tubes.
d. Two clamps were used.
e. Bubbles were formed.
f. The water was all used up.
g. Steam from the test tube moved a fan.

SALAMANDERS

1. The physical appearance of salamanders is most like which of the following? (Circle one or more correct answers.) [APPLICATION]

a. a fish
b. a dog
c. a game of crack-the-whip
d. a boy just out of a shower
e. a spider
f. a soldier crawling

2. The ways that salamanders move are most like which of the following? (Circle one or more correct answers.) [APPLICATION]

a. playing hopscotch
b. riding in a car
c. riding a skate board
d. an airplane taking off
e. writing a letter
f. operating a bicycle

3. The living habits of salamanders are most like which of the following? (Circle one or more correct answers.) [APPLICATION]

a. putting water into an aquarium
b. choosing which pans to use in cooking a meal
c. using different kinds of dog food
d. finding a shady place
e. feeding a bird
f. building houses for different families

4. Salamanders look like which of the following things? (Circle one or more correct answers.) [GENERALIZATION]

   a. They all need air to breathe
   b. They each breathe in a different kind of way.
   c. Different salamanders have different kinds of eyes.
   d. They all have the same number of toes on their front feet.
   e. Their bodies all look very similar.
   f. They are four different colors.

5. Salamanders move around in which of the following ways? (Circle one or more correct answers.) [GENERALIZATION]

   a. They all use their legs to help them move.
   b. They all wiggle their bodies to help them move.
   c. They all use their tails to help them move.
   d. The way they move is decided by how long they are.
   e. They move in any direction.
   f. They usually move slowly.

6. Salamanders have which of the following kinds of living habits. (Circle one or more correct answers.) [GENERALIZATION]

   a. They can all live either in water or on land.
   b. For the most part, they get their food on the land.
   c. Salamanders are hard to find.
   d. Salamanders would usually be found in wet and damp places.
   e. They usually swim on the surface of ponds.
   f. Sometimes salamanders are found in open fields.

7. gills
   snake-like body [CLASSIFICATION]
   small eyes

The above three things best belong to which one of the following choices?

   a. salamanders living on land
   b. salamanders living in water
   c. salamanders living on land and in water
   d. none of the above.

8. four toes
five toes [CLASSIFICATION]
no tail

The above three things best belong to which one of the following choices?

a. salamanders living on land and in water
b. salamanders living on land
c. salamanders living in water
d. none of the above

9. four legs
spots on body [CLASSIFICATION]
holes for breathing

The above three things best belong to which one of the following choices.

a. salamanders living on land
b. salamanders living on land and in water
c. salamanders living in water
d. none of the above

10. external gills
gray skin [CLASSIFICATION]
four legs

The above three things best belong to which one of the following choices?

a. newt salamander
b. tree salamander
c. mud puppy salamander
d. siren salamander
e. none of the above

11. swimming
dark gray [CLASSIFICATION]
four legs

The above three things best belong to which one of the following choices?

a. newt salamander
b. mud puppy salamander
c. siren salamander
d. tree salamander
e. all of the above

12. lives in water and on land

holes in nose [CLASSIFICATION]

four legs

The above three things best belong to which one of the following choices?

a. newt salamander
b. tree salamander
c. mud puppy salamander
d. siren salamander
e. none of the above

13. spots on skin

climber [CLASSIFICATION]

lives on land

The above three things best belong to which one of the following choices?

a. newt salamander
b. tree salamander
c. mud puppy salamander
d. siren salamander
e. all of the above

14. snake-like

two legs [CLASSIFICATION]

small eyes

The above three things best belong to which one of the following choices?

a. newt salamander
b. mud puppy salamander
c. siren salamander
d. tree salamander
e. all of the above

15. walking

swimming [CLASSIFICATION]

four legs

The above three things best belong to which one of the following choices?

a. mud puppy salamander
b. tree salamander

c. newt salamander
d. siren salamander
e. all of the above

16. Circle one or more of the things that are correct when comparing the tree salamander to the newt salamander. [COMPARISON]

a. They both can live on land.
b. They both breathe through their noses.
c. They both have spots on their skin.
d. One has four legs and the other two legs.
e. They have a different number of toes.
f. They move about in different ways.

17. Circle one or more of the things that are correct for both the mud puppy and the siren salamander. [COMPARISON]

a. They both have spots on their skin.
b. One of them breathes through its skin and the other does not.
c. They both have gills on the outside.
d. One uses its legs for moving and the other does not.
e. They both live in water.
f. They both have four legs.

18. Circle one or more of the following things that are correct when comparing the newt salamander to the mud puppy. [COMPARISON]

a. They both can live in water or on land.
b. One of them has spots on its skin.
c. They breathe in the same way.
d. They are different colors.
e. They both have four feet.
f. Both have the same size eyes.
g. They both move around in the same way.

19. Circle one or more of the things that would help you identify the mud puppy. [IDENTIFICATION]

a. lives in water
b. two holes in its nose
c. external gills
d. spots on its skin
e. eyes bulge out
f. brown skin
g. yellow and gray in color

20. Circle one or more of the items that would help you identify the newt salamander. [IDENTIFICATION]

a. dark gray in color
b. does not have spots on its skin
c. has gills
d. lives in water and on land
e. has only two feet
f. has four toes on its feet
g. tiny eyes in sides of head

21. Circle one or more of the things that would help you identify the tree salamander. [IDENTIFICATION]

a. lives in water and on land
b. eyes stick out
c. four toes on front feet and five toes on back feet
d. green spots on brown skin
e. two stubby legs
f. hides under rocks
g. has fan-like gills for breathing

22. Circle one or more of the things that would help you identify a siren salamander. [IDENTIFICATION]

a. lives in water and on land
b. brown in color
c. spots on its skin
d. body is short
e. two legs
f. tiny eyes
g. breathes through holes in its nose

MOUNTAINS

1. The formation of a volcanic mountain is most like which of the following things? (Circle one or more correct answers.) [APPLICATION]

a. putting air into a balloon
b. ants making an anthill
c. mining for gold in a mine
d. building a pyramid
e. a broken fire hydrant
f. squeezing toothpaste out of a tube

2. The action of molten lava is not like which of these things? (Circle one or more correct answers.) [APPLICATION]

a. oatmeal cooking in a pan
b. baking a cake

c. melting ice cream
d. cleaning up after a flood
e. making a concrete driveway
f. plowing a field

3. The formation of a dome mountain is most like which of the following things? (Circle one or more correct answers.) [APPLICATION]

a. a tire blowing out
b. a broken water main
c. blowing soap bubbles with a toy pipe
d. opening an umbrella
e. dumping a load of gravel in a driveway
f. drilling an oil well

4. Circle one or more of the things that tell what a volcanic mountain is like. [GENERALIZATION]

a. uneven and jagged
b. looks like sharp, broken stone
c. pressure moving ground but not breaking it
d. an earthquake
e. a rounded hill
f. a water well

5. Circle one or more of the things that tell what a dome mountain is like. [GENERALIZATION]

a. a crack in the top of the ground
b. a result of molten rock under the ground
c. a round pile of lava
d. a bulge on the earth's surface
e. remains of an explosion
f. pressure moving earth's layers without breaking them

6. Circle one or more of the answers that are correct about molten lava. [GENERALIZATION]

a. formed deep in the earth
b. forms black rock when it cools
c. melted iron and copper
d. resists heat
e. rock that is burned up and destroyed by a fire
f. color depends on temperature

7. melted rock underground

round [CLASSIFICATION]

smooth

The above three things best belong to which one of the following choices?

a. volcanic mountain
b. molten lava
c. dome mountain
d. none of the above

8. black

sharp [CLASSIFICATION]

hard

The above three things best belong to which one of the following choices?

a. dome mountain
b. volcanic mountain
c. molten lava
d. none of the above

9. lava rocks

smoke [CLASSIFICATION]

steam

The above three things best belong to which one of the following choices?

a. molten lava
b. dome mountain
c. volcanic mountain
d. none of the above

10. steep sides

jagged rocks [CLASSIFICATION]

open top

The above three things best belong to which one of the following choices?

a. dome mountain
b. molten lava
c. volcanic mountain
d. none of the above

11. reddish yellow
hot
liquid
[CLASSIFICATION]

The above three things best belong to which one of the following choices?

a. dome mountain
b. volcanic mountain
c. molten lava
d. none of the above

12. The two kinds of mountains you learned about are the same in what ways? (Circle one or more correct answers.) [COMPARISON]

a. Both have melted and cooled rocks on the surface.
b. Steam escapes from both.
c. Melted rock flows from both.
d. Both have cracks under the earth.
e. Both are formed by the force of melted rock.

13. If you compare melted rock and cooled lava rocks, which of the following are correct? (Circle one or more correct answers.) [COMPARISON]

a. Both result from gas, steam and pressure.
b. They come from same place.
c. They are the same color and hardness.
d. Both result from weather effects.
e. They are both sharp.
f. They are not found in the same places.

14. Circle one or more of the things you learned about melted rock. [IDENTIFICATION]

a. It is very hard.
b. It is always thrown into the air.
c. It is brown in color.
d. It is reddish yellow in color.
e. It is very hot.
f. It is black in color.

15. Circle one or more of the things that you learned about volcanic mountains. [IDENTIFICATION]

a. They are openings in the earth's surface.
b. They are made from flowing lava.
c. Melted rock stays below the surface of the earth.
d. They are smooth.
e. They are a reddish-yellow color.
f. Steam and smoke escape when they are formed.

16. Circle one or more of the things you learned about dome mountains. [IDENTIFICATION]

a. cracks in the earth's surface
b. the weather wears the ground away
c. formed by an eruption
d. a lava flow on the earth's surface
e. steam escapes from the ground
f. melted rock below the ground

APPENDIX B

VERBAL STIMULUS TREATMENTS

Thailand

Much of Thailand is made up of canals and waterways. Some motor boats and many small paddle boats crowd the narrow waterways. Besides being used for transportation, the waterways serve as the main market places.

Women, in their paddle boats, bring loads of different kinds of fresh food to sell in the market.

The wooden docks along the waterways are crowded with women and children who have come to sell and shop. They buy several kinds of vegetables which are sold by weight. Fish also are sold. They are carefully weighed in a basket while the customer watches.

The docks are lined with baskets of farm products. Each merchant sells only one or two kinds of products. The waterways are so crowded there hardly seems room for any more boats, but somehow the skillful people paddle their boats along.

The small foot-bridges that cross the canals are favorite places to watch the activities of the busy market. The canals of Thailand are always filled with activities.

In some of the small boats lining the waterways, men cook chickens to sell. Other boats filled with farm products move about.

Along the sides of the canals, there are also many shops that sell colorful handkerchiefs and clothing. These are hung up along the canals in front of the small shops.

The crowded, floating markets of Thailand are rapidly changing scenes of activity.

Irrigation

The Nile River is the Egyptian farmer's main source of water. The banks of the river are very sandy, and in some places very few plants grow. The fields are higher than the river, so the farmers use a number of tools to lift the water from the river to their fields.

One tool looks like a playground teeter totter. A long pole is placed across the top of a post. A pail is tied with a rope to one end of the long pole. On the other end is a weighted basket. The worker empties the pail and pulls down on the rope to refill it. The weighted end then rises. When the pail is full, the weighted basket helps raise it.

Some farmers use heavy stones in place of the weighted basket. They fill the pail with water from the river. Then the heavy stone helps them lift the full pail up to the fields above. There the pail is emptied.

Another tool they use is a large wheel made of wood and rope. Many large clay jars are attached to the wheel. As the wheel turns, the jars scoop water from a ditch below. As the jars reach the top of the wheel, the water empties into another ditch at a higher level.

The wheel is turned by two oxen attached to the wheel through an arrangement of gears. A woman urges them on by hitting them with a stick. As the oxen walk in a circle, the water wheel slowly turns, and a steady flow of water pours from the jars.

Another tool the Egyptian farmer uses looks like a big hollow wooden pipe. Running through the pipe is something that looks like a large screw.

The bottom of the pipe is placed in a ditch below, and a crank is attached to the top end of the pipe. As the farmer turns the crank, the water is lifted from below along the screw and empties onto the field above.

The farmers control the flow of water through the fields by making or removing small dirt dams with hoes. Each plant is then watered by water flowing between the rows of plants. It takes several workers with hoes to control the water flowing through the fields.

India

The people of India travel in many different ways. Trains are used to carry passengers and freight. In the cities, men pull carts loaded with freight.

Horse and ox-drawn carts move freight and people, while buses and trucks also move on the crowded streets. Some of the ox-drawn wooden carts use wheels from old trucks and cars.

In the city, a policeman, with a brightly colored hat, directs all of the different kinds of traffic. He must control the flow of cars, trucks, buses, motorcycles, bicycles, carts and pedestrians.

Driving a car in the city is quite difficult because of the many different things using the roads. Elephants also use the roads for carrying freight and people.

In the rural areas, donkeys can be seen carrying products to market. The mountain people often use sheep to carry small loads along the narrow trails.

In flat country areas, large wooden and cloth racks are attached to the backs of water buffalo to carry freight. Farm women lead the animals, while the men carry the small children.

Several hundred people can travel at one time on large ferry boats which share the rivers with large and small freight boats. At the seaports, camels are used to carry freight taken from large ocean going ships.

Labor

The farmers of Eastern Europe still do much of their work by hand. Women help plant fields as well as men.

Oxen are used to pull hand-made plows through the fields. Oxen are also used to pull drags made of logs across the rolling hills to make them level. Work horses are used in the fields to move wagons loaded with alfalfa, which is grown in large amounts. Tractors haul several wagons at a time, each loaded with animal food crops.

Water for the animals is obtained by scooping pails of water from wells. Women wash clothes in the rivers and spread them out on the banks to dry.

In the cities, women sweep streets while both men and women dig ditches. Large bulldozers, operated by men, are used on huge dam building projects. Street cleaning machines are also used to clean the main city streets. On other streets, women sweep them clean with brooms.

Building bricks are carried to the brick layers by men and women laborers. Home basements are dug by hand, and only simple machines are used for building.

At train crossings, for safety purposes, a man lowers a steel barrier with a crank to block the road. Hand tools are also used to strip the bark from logs.

In the factories, women pack and carry crates of goods. Men also unload products from trucks by hand. Women color, decorate and package Christmas tree ornaments without machines.

Men form clay flower pots on machines, while women inspect and add the finishing touches by hand. When the flower pots have been placed in wooden crates, men load the crates into trucks with the help of hand trucks.

At the seaports, large cranes are used to load and unload the sea-going ships.

Heat

A small amount of water in a test tube is heated over an electric heater plate. A rubber cork is placed half way down the neck of the test tube. As the water heats up, bubbles begin to form in the water.

The rubber cork, that was placed in the test tube, slowly begins to move toward the open end. Finally, when the cork nears the end, it rapidly pops out.

Another example shows a bottle suspended from a wire. The bottle contains a small amount of water which is again heated.

The bottle has a cork in the top, plus two small open tubes coming out of the neck. The tubes are bent so that they point in opposite directions and let the steam from the boiling water escape. The bottle turns or rotates in the opposite direction to the escaping steam.

In a third example, a small amount of water in a bottle is again heated over an electric heater plate. This time, the bottle has one small tube passing through the cork in the top.

Steam escapes through this tube. The steam is pointed at the blades of several kinds of pin wheels. The pin wheels spin until they are removed from the path of the escaping steam.

Salamanders

This salamander, brown in color, is called a Newt salamander. It has a long tail and lives in or near shallow pools of water. It uses its four legs and tail to move along the bottom of ponds.

On land, it is found near damp rocks and moves very slowly, using only its legs. It is able to cling to the damp rocks because it has four toes on each of its feet. This salamander breathes through a nose with two tiny holes. Its two eyes bulge from the sides of its head. The skin of this salamander always looks wet.

The Tree salamander lives on land and is often found under pieces of loose bark on trees. This salamander also breathes through two tiny holes at the end of its nose. Two eyes bulge from the sides of its head.

Each of its two front feet have four toes. Its two back feet each have five toes. It uses its four legs to move slowly about and is also a very good climber. This salamander has tiny yellow spots on its blackish-brown body.

Another kind of salamander is the Mud Puppy which lives only in water. This salamander has two tiny eyes on the sides of its head. It

moves about on the bottom of ponds by using its four legs and wiggling its body.

Two external gills are located behind its head. They look like small feathers waving in the water and enable it to breathe. The skin of this salamander is a dark gray with small yellow blotches.

A fourth kind of salamander is called a Siren. It has a long, thin, black body and lives only in water. It has only two small stubby legs located just behind the head. The legs can be used for moving along the bottom of ponds. But mainly it uses its long, thin body to wiggle through the water.

This salamander also has external gills which look like feathers sticking out of its body just behind its head. From a distance, it looks like a snake.

Mountains

Some mountains are called dome mountains and look rough and rugged. They are formed when melted rock forces the surface of the earth upward. The melted rock stays below the surface, but the ground is pushed up. After many years, the smooth ground on a dome mountain is worn away.

Volcanic mountains are formed when melted rock is forced through cracks in the crust of the earth. The melted rock then piles up on the surface. The melted rock is sometimes thrown high into the air.

The melted rock, or lava, is a reddish-yellow liquid and is extremely hot. As the lava piles up, it begins to cool and turns hard and black.

Great amounts of smoke and steam escape from the mouth of the volcano with the melted rock.

Sometimes the opening in the top of a volcanic mountain is very far across. The flowing lava often looks like a big river.

APPENDIX C

TABLE 41

MEAN SCORES ON INDIVIDUAL TEST ITEMS SHOWING SIGNIFICANT DIFFERENCES OF ANALYSIS OF VARIANCE

	Mode	$\overline{X}$	ANOVA	Duncan Multiple Range Test ($\alpha = .05$)
Thailand (4d- Generalization)*	MpS Mp SpS Sp PrS Pr S	.667 .167 .750 .750 .500 .333 .583	F=2.561 $p < .05$	SpS/Sp/MpS > Mp
Thailand (5d- Classification)	MpS Mp SpS Sp PrS Pr S	.667 .333 .417 .667 .250 .667 .083	F=3.028 $p < .025$	MpS/Sp/Pr > S
Thailand (6b- Classification)	MpS Mp SpS Sp PrS Pr S	.833 .167 .583 .250 .500 .583 .500	F=2.632 $p < .05$	MpS > Sp/Mp
Thailand (13b- Comparison)	MpS Mp SpS Sp PrS Pr S	.750 .750 .417 .417 .250 .500 .250	F=2.245 $p < .05$	MpS/Mp > Pr/S

*Indicates the "Thailand" subject matter area, question #4d, for the "Generalization" objective.

TABLE 41--Continued

	Mode	$\bar{X}$	ANOVA	Duncan Multiple Range Test (α = .05)
Irrigation (1e- Application)	MpS Mp SpS Sp PrS Pr S	.364 .667 .417 .250 .083 .083 .077	F=3.878 p < .005	Mp > Sp/PrS/Pr/S
Irrigation (3d- Application)	MpS Mp SpS Sp PrS Pr S	.545 .200 .250 .333 .083 .167 .615	F=2.476 p < .05	S > Mp/Pr/PrS MpS > PrS
Irrigation (8f- Generalization)	MpS Mp SpS Sp PrS Pr S	.364 .067 .583 .417 .500 .667 .462	F=2.237 p < .05	Pr/SpS/PrS/S > Mp
Irrigation (9- Classification)	MpS Mp SpS Sp PrS Pr S	.000 .067 .417 .167 .167 .167 .538	F=3.057 p < .025	S > Sp/PrS/Pr/Mp/MpS SpS > Mp/MpS
Irrigation (11- Classification)	MpS Mp SpS Sp PrS Pr S	.727 .733 .833 .167 .513 .500 .462	F=2.780 p < .025	SpS/Mp/MpS > Sp

TABLE 41--Continued

	Mode	$\overline{X}$	ANOVA	Duncan Multiple Range Test (α = .05)
Irrigation (12b-Classification)	MpS Mp SpS Sp PrS Pr S	.909 .733 .833 .583 .667 .750 .308	F=2.381 p < .05	MpS/SpS/Pr/Mp > S
Irrigation (13d-Comparison)	MpS Mp SpS Sp PrS Pr S	.000 .067 .000 .417 .083 .250 .077	F=2.803 p < .025	Sp > PrS/S/Mp/MpS/SpS
Irrigation (15d-Comparison)	MpS Mp SpS Sp PrS Pr S	.818 .400 .750 .667 .583 .583 .154	F=2.895 p < .025	MpS/SpS/Sp/PrS/Pr > S
Irrigation (16d-Comparison)	MpS Mp SpS Sp PrS Pr S	.727 .800 .583 .583 .333 .333 .308	F=2.276 p < .05	Mp > PrS/Pr/S
Irrigation (18f-Identification)	MpS Mp SpS Sp PrS Pr S	.636 .800 .917 .250 .583 .750 .769	F=2.910 p < .025	SpS/Mp/S/Pr > Sp

TABLE 41--Continued

	Mode	$\overline{X}$	ANOVA	Duncan Multiple Range Test ($\alpha = .05$)
Irrigation (20c- Identification)	MpS Mp SpS Sp PrS Pr S	.818 1.000 .833 .667 .083 .500 .538	F=6.950 p < .001	Mp > S/Pr/PrS SpS/MpS/Sp/S > PrS
India (1c- Application)	MpS Mp SpS Sp PrS Pr S	.765 .556 .706 .364 .800 .250 .333	F=2.869 p < .025	PrS/MpS > S/Pr SpS > Pr
India (3d- Generalization)	MpS Mp SpS Sp PrS Pr S	.412 .778 .471 .364 .400 .333 .083	F=2.867 p < .025	Mp > Sp/Pr/S
India (4a- Generalization)	MpS Mp SpS Sp PrS Pr S	.588 .889 .588 .455 .200 .333 .250	F=3.871 p < .001	Mp > Sp/Pr/S/PrS
Labor (13- Classification)	MpS Mp SpS Sp PrS Pr S	.667 .417 .667 .000 .417 .417 .333	F=2.809 p < .025	MpS/SpS > Sp

TABLE 41--Continued

	Mode	$\overline{X}$	ANOVA	Duncan Multiple Range Test (α = .05)
Labor (16-Classification)	MpS Mp SpS Sp PrS Pr S	.417 1.000 .167 .917 .833 .583 .667	F=6.279 p < .001	Mp > Pr/MpS/SpS Sp/PrS > MpS/SpS S > SpS
Labor (17-Classification)	MpS Mp SpS Sp PrS Pr S	.750 .167 .917 .250 .750 .583 .583	F=4.573 p < .001	SpS/MpS/PrS > Sp/Mp Pr/S > Mp
Labor (19-Classification)	MpS Mp SpS Sp PrS Pr S	.750 1.000 .333 .833 .750 .583 .583	F=2.875 p < .025	Mp > Pr/S/SpS Sp/MpS/PrS > SpS
Labor (20-Classification)	MpS Mp SpS Sp PrS Pr S	.667 .000 .750 .083 .250 .250 .667	F=6.722 p < .001	SpS/MpS/S > PrS/Pr/Sp/Mp
Labor (22-Classification)	MpS Mp SpS Sp PrS Pr S	.917 .583 1.000 .583 .833 .500 .750	F=2.415 p < .05	SpS > Mp/Sp/Pr MpS > Pr

TABLE 41--Continued

	Mode	$\bar{X}$	ANOVA	Duncan Multiple Range Test (α = .05)
Labor (24- Identification)	MpS Mp SpS Sp PrS Pr S	.833 .250 1.000 .167 .417 .500 .500	F=5.711 p < .001	SpS > Pr/S/PrS/Mp/Sp MpS > PrS/Mp/Sp
Labor (25- Identification)	MpS Mp SpS Sp PrS Pr S	.833 .250 .583 .417 .667 .500 .167	F=2.933 p < .025	MpS > Mp/S
Heat (2e- Application)	MpS Mp SpS Sp PrS Pr S	.583 .308 .333 .455 .308 .667 .917	F=2.845 p < .025	S > Sp/SpS/Mp/PrS
Heat (4d- Generalization)	MpS Mp SpS Sp PrS Pr S	.167 .462 .667 .727 .462 .667 .750	F=2.266 p < .05	S/Sp/SpS/Pr > MpS
Heat (6f- Generalization)	MpS Mp SpS Sp PrS Pr S	.750 .846 .833 1.000 .462 .500 .667	F=2.435 p < .05	Sp > Pr/PrS Mp > PrS

TABLE 41--Continued

	Mode	$\bar{X}$	ANOVA	Duncan Multiple Range Test ($\alpha = .05$)
Heat (9c- Comparison)	MpS Mp SpS Sp PrS Pr S	.917 .385 .750 .818 .846 .750 .500	F=2.478 p < .05	MpS > S/Mp PrS/Sp > S/Mp
Heat (13b- Identification)	MpS Mp SpS Sp PrS Pr S	.917 .923 1.000 .636 .923 .917 .500	F=3.480 p < .01	SpS > Sp/S Mp/PrS/MpS/Pr > S
Salamanders (4c- Generalization)	MpS Mp SpS Sp PrS Pr S	.583 .417 .333 .364 .545 .000 .583	F=2.270 p < .025	MpS/S/PrS > Pr
Salamanders (8- Classification)	MpS Mp SpS Sp PrS Pr S	.000 .417 .083 .636 .364 .417 .000	F=4.494 p < .001	Sp/Mp/Pr/PrS > SpS/MpS/S SpS > MpS/S
Salamanders (11- Classification)	MpS Mp SpS Sp PrS Pr S	.167 .083 .583 .545 .273 .167 .583	F=2.874 p < .025	SpS/S > MpS/Pr/Mp Sp > Mp

TABLE 41--Continued

	Mode	$\overline{X}$	ANOVA	Duncan Multiple Range Test (α = .05)
Salamanders (14-Classification)	MpS Mp SpS Sp PrS Pr S	.750 .417 .750 .455 .273 .667 .083	F=3.598 p < .005	MpS/SpS > PrS/S Pr > S
Salamanders (15-Classification)	MpS Mp SpS Sp PrS Pr S	.583 .667 .833 .091 .545 .417 .333	F=3.059 p < .025	SpS > S/Sp Mp/MpS/PrS > Sp
Salamanders (18e-Comparison)	MpS Mp SpS Sp PrS Pr S	.667 .333 .917 .727 .727 .250 .500	F=3.182 p < .01	SpS > Mp/Pr Sp/PrS/MpS > Pr
Salamanders (19a-Identification)	MpS Mp SpS Sp PrS Pr S	1.000 1.000 .833 1.000 .545 .583 .917	F=4.120 p < .001	MpS/Mp/Sp/S > Pr/PrS
Mountains (2e-Application)	MpS Mp SpS Sp PrS Pr S	.643 .357 .231 .583 .500 .111 .333	F=2.507 p < .05	MpS > SpS/Pr Sp/PrS > Pr

TABLE 41--Continued

	Mode	$\overline{X}$	ANOVA	Duncan Multiple Test Range (α = .05)
Mountains (3c-Application)	MpS Mp SpS Sp PrS Pr S	.214 .357 .692 .500 .417 .222 .733	F=2.862 p < .025	S/SpS > Pr/MpS
Mountains (6e-Generalization)	MpS Mp SpS Sp PrS Pr S	.500 .929 .692 .417 .833 .778 .667	F=2.156 p < .05	Mp > MpS/Sp PrS > Sp