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MULTIPLE VERSUS LINEAR IMAGERY IN THE PRESENTATION OF A COMPARATIVE VISUAL LOCATION TASK TO VISUAL AND HAPTIC COLLEGE STUDENTS

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MULTIPLE VERSUS LINEAR IMAGERY IN THE PRESENTATION
OF A COMPARATIVE VISUAL LOCATION TASK TO
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APPROVED BY

DISSERTATION COMMITTEE

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CHAPTER I

INTRODUCTION

Background of the Study

The multi-image presentation (the simultaneous presentation of visual images) is replacing the linear image presentation (the sequential presentation of single images) in many educational situations. While there is little empirical data relating to the effectiveness of multi-imagery as opposed to linear imagery as an instructional tool, it appears to be assumed by its proponents that multi-imagery functions better than linear imagery in situations where immediate visual comparisons are desirable, where compression of visual images into a given time span is required, and where the emotional impact of the large screen frequently characteristic of multi-imagery and the dazzling visual effects that are possible with this medium are important to the learning situation. There is, however, need for empirical data in regard to these assumptions. Only if multi-imagery can be empirically demonstrated to be an effective instructional tool in a cognitive task situation can it move beyond the status of a dazzling and fascinating visual plaything and take a place as a legitimate media instructional system which provides learners with benefits in the cognitive as well as in the affective domain. It was hoped that the present study would provide such empirical support for the instructional value of multi-imagery.

The author does not believe that studies which attempt to show a global superiority of multiple image presentations over linear ones meet the real needs of current media research. Even if it as assumed that multiple imagery is an effective device in many instructional situations, the possibility should be considered that it may be more effective for some learners on some types of tasks than for other learners and other tasks. Research in which the three major components of:

1. unique medium-message characteristics,
2. psychological requirements of the learning task, and
3. learner characteristics

interact is ideal for the media field as it attempts to build a solid empirical base and a prescriptive framework of theory. Research of this kind is what Salomon calls for in his statement that media researchers should be concentrating on "... inquiry into the relations between unique media attributes and their unique psychological functions under specific task requirements and specific learners" (Salomon, 1970, p. 41). He conceptualizes this type of interactive research as follows:

> ... a three dimensional cube where stimuli, tasks, and individuals interact. The uniting tie is the psychological function that is relevant to a certain learning task and which is accomplished by particular modes of presentation. (Salomon, 1970, p. 46)

The present study was designed to investigate the relative effectiveness of multiple imagery in a specific task in which immediate comparison of visual images was necessary. The primary characteristic of multiple imagery which was theorized to be influential in such a task is its simultaneity of visual images. Such a task requires the apprehension, retention, and utilization of visual cues as basic psychological processes. Since learners possess individual differences in learning styles, the possibility must be considered that these processes are easier for some learners than for others. Such a possibility introduces cognitive style into the study. One cognitive style variable which appears intuitively to be related to the effect of multiple imagery is Viktor Lowenfeld's concept of perceptual type. In extensive research, Lowenfeld (1945, 1957) identified two distinct types of individuals with two distinctly different styles of perception. He called these two distinct types the visual type and the haptic type.

The visual type was defined by Lowenfeld (1957) as a person who reacts to his environment as a spectator and whose main sensory intermediaries are his eyes. The haptic individual was defined as a normally sighted person who reacts to his environment subjectively and who uses his eyes as primary sensory intermediaries only when he is compelled to do so. He prefers to rely on muscular sensations, kinesthetic experiences, and tactile impressions.

One of the principal distinctions between visuals and haptics is that while visuals can mentally retain visual imagery, haptics cannot (Lowenfeld, 1945). A consideration of the lack of ability of the haptic to hold visual images mentally and to make quick mental note of visual cues suggests that he may have considerable difficulty with certain types of visual learning tasks. It also suggests a possible relationship to the simultaneity of multiple imagery. It seems reasonable that simultaneous multiple images used in a task requiring apprehension, retention, and utilization of visual cues might accomplish a theoretical process known as supplantation. This phenomenon occurs when a mental process is executed explicitly for a learner which he is unable to perform for himself (Salomon, 1970). It seems possible that providing supplantation is what simultaneous multiple images could do for haptic individuals in a task with the psychological task requirements of rapid discrimination, assimilation, and mental retention of visual cues and the making of visual comparisons. In a linear image presentation, a visual image and its details and relationships would have to be retained mentally by the learner from image to image. This is a difficult process, especially for haptics, and lack of ability to perform this mental function could seriously hamper performance. It seems reasonable that the function could be supplanted by a multiple image presentation. With multiple imagery, there is far less need for mental retention of visual images and details; all necessary information can be viewed simultaneously. Image retention is only necessary for the small amount of time required to shift one's eyes and attention from image to image. Thus, the psychological task requirement of mental image retention is heavily supplanted by the visual simultaneity inherent in the medium of task presentation. This should be advantageous to all learners in a task requiring visual comparison and location, but it should be of particular benefit to haptic individuals.

This study was designed to investigate one combination of media characteristics, psychological task requirements, and learner characteristics in accord with an interactive research heuristic such as that proposed by Salomon. It examines the effects of linear and multiple imagery presentations of a comparative visual location task on students of the visual and haptic perceptual types. The study attempts to determine whether multiple imagery is more effective that linear imagery in a cognitive task involving visual comparisons, and whether it is equally effective for students with two distinctly different styles of perception.

Statement of the Problem

The problem for this study was as follows: What is the relationship between the cognitive style variable of perceptual type and the treatment variable of linear or multiple imagery on a comparative visual location learning task?

Purpose of the Study

It was the purpose of this study to determine whether the use of multiple imagery results in improved performance on a comparative visual location task by either visual or haptic college students. If the performance of both groups was improved by the use of multiple imagery, it was also the author's purpose to determine whether this improvement was of equal magnitude for both groups.

Three general questions were investigated:

1. Is the performance of _either_ visual or haptic college students on a comparative visual location task improved when simultaneous multiple imagery is used?

2. Is the performance of _both_ groups improved when simultaneous multiple imagery is used?

3. If the performance of both groups is improved, does one group show greater improvement than the other?

It was not the purpose of this study to attempt to equate multiple and linear image presentations on the basis of absolute time spent by a learner on each single image. An inherent advantage of simultaneous multiple images is that the viewer is able to selectively deploy attention among the images presented to him. He may utilize a given viewing time span as he finds necessary. It was felt by the author that removal of this aspect of multiple imagery would constitute the removal of an inherent characteristic of the multi-image medium. Therefore no attempt was made to do so in the research design. The only attempt at equating the viewing time for the multiple and linear image treatments was the provision that the _total_ time allowed for viewing _all_ images in each task item was equal for both treatments.

Statement of Hypotheses

Rationale for hypotheses. Since the experimental task, a comparative visual location task, was expected to be made easier by the supplantation provided by multiple imagery, it was expected that, in general, performance on the task in terms of both score and mean latency, by both visuals and haptics would be superior with multiple than with linear image presentation. Since the task required visual discrimination, and since supplantation was expected to aid both visuals and haptics, it was expected that, over all, visuals would perform better than haptics. Since supplantation of visual image retention was theorized to be more vital for haptics than for visuals, it was expected that haptics would show greater improvement in performance of the experimental task than visuals when multiple imagery was used.

Specific hypotheses. The following were the hypotheses tested in the study:

H_{01}: There is no difference between scores made by visuals and haptics on a comparative visual location task.

H_1: Visuals make higher scores than haptics on a comparative visual location task.

H_{02}: There is no difference between scores made on a comparative visual location task with a multiple image and a linear image presentation.

H_2: Scores are higher on a comparative visual location task with a multiple image presentation than with a linear image presentation.

H_{03}: There is no interaction of aptitude and treatment on scores on a comparative visual location task with multiple and linear image presentations.

H_3: There is an ordinal interaction of aptitude and treatment on scores on a comparative visual location task with multiple and linear image presentations.

H_{04}: There is no difference between mean latencies made by visuals and haptics on a comparative visual location task.

H_4: Visuals make lower mean latencies than haptics on a comparative visual location task.

H_{05}: There is no difference between mean latencies on a comparative visual location task with a multiple image and a linear image presentation.

H_5: Mean latencies are lower on a comparative visual location task with a multiple image presentation than with a linear image presentation.

H_{06}: There is no interaction of aptitude and treatment on mean latencies on a comparative visual location task with multiple and linear image presentations.

H_6: There is an ordinal interaction of aptitude and treatment on mean latencies on a comparative visual location task with multiple and linear image presentations.

Limitations of the Study

One limitation of the present research lies in the fact that the subjects for the study were drawn exclusively from undergraduates enrolled in Education 4160, Media and Technology in Teaching, at the University of Oklahoma. Generalization of the results of the study beyond this population is therefore valid only to the extent that the population sampled is representative of other populations.

A second limitation of the study is that no test was given to determine if any of the subjects had visual handicaps. They were questioned concerning visual handicaps, and all subjects reported that they had no such handicaps except those corrected by corrective optics. It was assumed, on this basis, that all subjects were normally sighted or wore optics which gave them normal visual acuity.

A third limitation is that no consideration was made of the intelligence of the subjects. The author found no evidence in the research literature that perceptual type is related to intelligence. In addition, the principle of randomization was built into the research design. Beyond this, however, the effect of intelligence was not considered in this study.

A final limitation of the study is that it is relatively learner-specific and task-specific. It does not attempt to investigate some global, over all effect of multiple imagery. It is limited to an investigation of the effect of multiple imagery on learners with specific perceptual attributes and performing a specific type of visual task.

Operational Definition of Terms

The following definitions were applied in this research:

Visual perceptual type (Visual): A subject was designated as visual if he scored 60% or more correct on *Successive Perception Test I*, gave 12 or more visual responses on Lowenfeld's *Visual-Haptic Word Association Test*, and made at least one visual response and no haptic responses on the drawing version of Lowenfeld's *Test of Subjective Impressions*.

Haptic perceptual type (Haptic): A subject was designated as haptic if he scored 60% or more incorrect on *Successive Perception Test I*, gave 12 or more haptic responses on Lowenfeld's *Visual-Haptic Word Association Test*, and made at least one haptic response and no visual responses on the drawing version of Lowenfeld's *Test of Subjective Impressions*.

Multi-imagery: In this research, multi-imagery refers to the simultaneous presentation of three separate images projected by three separate projectors, utilizing the total projected area of each projector in a 35 mm format.

Linear imagery: In this research, linear imagery refers to the sequential presentation of three separate images, each projected by the same projector, utilizing the total projected area of the projector in a 35 mm format.

Comparative visual location task: This refers to the experimental task for this research. It is a task in which the subject must view three pictures (in the form of color 35 mm slides) of a complex and unfamiliar piece of equipment. These three pictures are progressively wide shots: that is, a close-up of a particular criterion item on the equipment, a medium shot, and an over-all shot of the entire piece of equipment. On the first close-up picture only, a specific criterion item on the equipment is identified with an arrow. The subject must compare the three pictures and, utilizing visual cues, mentally locate on each subsequent picture the criterion item which was originally marked with an arrow. After the removal of the three pictures from the subject's view, he must locate on a photographic print of the entire piece of equipment the criterion item. The entire task consists of 16 such items.

Performance on the comparative visual location task: Two performance variables were examined. These two variables were as follows:

1. number of correct responses on the task, and
2. average time to respond.

These two variables are refered to in the study as score and mean latency respectively.

Supplantation: The explicit and overt performance for a learner of a mental function which he is unable to perform covertly. In this study, the retention of visual image for comparison is the process which was supplanted by the use of multiple imagery.

Significance of the Study

This study represents an effort to add new empirical support to the propositions that 1) multiple imagery can be used effectively as an instructional tool in a cognitive task, 2) that supplantation can be accomplished through the proper use of media, and 3) that students of the haptic perceptual type can be aided without harm to students of the visual perceptual type through the proper use of media. By lending empirical support to these three concepts concerning media utilization, it is hoped that the study will serve as a basis for an effort of further research in multiple imagery, perceptual style, and related media/task/learner interactions.

CHAPTER II

REVIEW OF SELECTED LITERATURE

This study is concerned with three major areas of research and theory. These three areas are:

1. visual and haptic perceptual types,
2. supplantation theory, and
3. multiple imagery.

The review of literature presented here represents what the author believes to be most significant as background for the present study. The review is presented in three major sections, one for each of the primary areas of importance to the study.

Literature Relevant to Visual-Haptic Perception

Research in the area of perception deals, in general, with the ways in which information is obtained and processed. *Visual* perception has been one of the most heavily researched branches of the general field of perceptual studies.

Theory in the area of visual perception might be broken into two primary schools of thought. One school of thought, represented by the writings of Rudolf Arnheim, treats visual perception as a characteristic which is essentially the *same* for all humans. Arnheim stresses the close ties of visual perception to thought processes, the importance of training in "visual thinking," and the trainable nature of visual perceptual skills. He does not acknowledge individual differences in perceptual-cognitive functioning, except as a matter of degree (Arnheim, 1969).

In contrast to this viewpoint is a school of thought in visual perception which stresses the existance of individual differences in the very nature of perceptual-cognitive processes. Like Arnheim, theorists in this second school of thought believe there is a close link between visual perception and thought. Unlike Arnheim, however, they do not believe that the visual perception process is essentially the same for all learners. They place emphasis on individual differences in perceptual style and the thought processes which result from perceptual style. Among the theorists who advocate the existance of individual differences in visual perceptual style is Viktor Lowenfeld. Lowenfeld conceptualizes individual differences in visual perceptual style in terms of a perceptual typology characterized by two distinct perceptual types: the visual type and the haptic type. These two types are, according to Lowenfeld, entirely different in their reaction to and processing of visual stimuli.

The Lowenfeld typology of individual differences in perceptual style is appealing to the author for three reasons:

1. an intuitive interest in the typology

2. a perceived ability to observe characteristics typical of visual and haptic types among students

3. a perceived relationship between the typology and the task and treatment variables of this study.

For these reasons, Lowenfeld's visual-haptic perceptual typology was selected as the learner-characteristic variable for this study.

Lowenfeld's typology. The visual-haptic perceptual typology was developed by Lowenfeld in extensive research in Austria and the United States in the field of art education. In his early work, Lowenfeld (1939) demonstrated the existence of two distinct creative types, based on two unlike types of perception of and reaction to the world of experiences. Somewhat later, Lowenfeld conducted studies which indicated that "the distinction which is true for creative types can also be made among individuals" (Lowenfeld, 1945, p. 100). He called his two perceptual types the visual type and the haptic type, and developed a battery of tests through which perceptual type may be identified for individuals (Lowenfeld, 1945).

An individual of the visual perceptual type was identified by Lowenfeld as one who has a tendency to use his eyes as the main intermediary for his sensory impressions. An extremely visual person is "... entirely lost in the dark and depends completely on his visual experience of the ... world" (Lowenfeld, 1957, p. 203). The visual type is perceptually an observer, usually approaching things from their appearance and feeling as a spectator. He has a tendency to transform kinesthetic and tactile experiences into visual ones.

Lowenfeld identified the haptic individual as one who is normally sighted, but who uses his eyes only when compelled to do so. He prefers to rely on touch and kinesthesis. The main sensory intermediary for the haptic type is his "body-self," that is, muscular sensations, kinesthetic experiences, touch impressions, and other physical sensations. The haptic is a subjective type who reacts emotionally and physically to visual experiences. He does not discriminate visual detail well, nor does he integrate visual details into wholes, visualize kinesthetic or tactile experiences, or mentally maintain visual images (Lowenfeld, 1957).

The tests developed by Lowenfeld (1945) for identifying individuals of the visual and haptic perceptual types are based on the principal distinctions between the two types which are discussed above. His five Tests for Visual and Haptic Aptitudes are as follows:

1. Test of Integration of Successive Impressions. One of the principal characteristics of visuals is the ability to see a visual whole, break it up and see its component details, and then resynthesize the details back into a whole. This test is based on the ability of the visual to integrate partial visual experiences into whole perceptual units. It requires the subject to view patterns a small section at a time and then choose, from among several variants, the patterns he saw. Since this task requires a perceptual skill typically possessed by visuals but not by haptics, visuals typically perform far better on it than do haptics.

2. Test of Subjective Impressions. Lowenfeld developed two forms of this test. The first is a drawing task in which the subject is asked to draw a glass or a chessboard on a table. Lowenfeld found that visuals typically respond by drawing an objective view of the table in proper perspective, while haptics typically draw a subjective impression, ignoring perspective and relating themselves to the object on the table.

An alternate version of this test requires the subject to estimate the number of floors in a building with which he is familiar but not certain of the number of floors it contains. He is then asked how he reached his estimation. A visual response reflects objective and visual imagery, usually mentally picturing the building from the outside and counting the floors. A haptic response reflects a subjective and kinesthetic approach, usually imagining personally climbing the flights of stairs of the building and counting the floors.

3. Visual-Haptic Word Association Test. This test presents the subject with a group of 20 words which elicit equally well visual and haptic responses. Visual responses (such as "climb/tree") are those in which a visual object is given as the association. Such a response conveys an objective, visual perception of an external object. Haptic responses (such as "climb/hard") are those in which a muscular, physical, kinesthetic, or emotional word is given as the association. Such a response conveys a subjective and physical involvement and a kinesthetic and internal rather than a visual and external orientation.

4. <u>Visualization of Kinesthetic Experience</u>. Visuals tend to transform kinesthetic and tactile experiences into visual ones. Haptics, however, are content with the tactile or kinesthetic modality itself. This test is a measure of ability to visualize tactile experiences. The subject is given geometric figures of increasing complexity cut into thick cardboard or plywood. While blindfolded, the subject follows with one finger the outline of a figure while a finger of his other hand remains at the starting point as a guide. After returning his moving finger to the starting point and removing his blindfold, he is asked to recognize visually the figure he has perceived kinesthetically from among five figures drawn on a tablet. Since they tend to visualize and integrate tactile and partial experiences, visuals score higher on this test than do haptics.

5. <u>Test of Tactile Impressions</u>. This test determines if a subject can recognize figures which are perceived through tactile experience. Simple geometric figures as large as the palm of a hand are placed one at a time into a bag. For each item, the subject has before him a tablet with several similar figures drawn on it. He is asked to reach into the bag and hold, touch, and move the figure in his hand. He is then asked to recognize the correct figure on the tablet. Correct responses are counted as haptic responses.

The distribution of visual and haptic perceptual types appears to be stable across populations. In extensive research, Lowenfeld (1945) found that, although most people fall between the two extremes of the typology, about 75% show appreciable tendency toward one type of perception or the other. He reported that approximately 50% are of the visual perceptual type, not quite 25% are of the haptic type, and slightly over 25% are of indeterminate type. These percentages are quite similar to those established by Walter (1953). Walter reported electroencephalographic data (see below) which indicates the occurrence of "visualizers," "non-visualizers," and "mixed types" in percentages very similar to those established by Lowenfeld for his typology. In a more recent study, Ausburn (L. J., 1975) reported obtaining a distribution of visuals, haptics, and indefinites very similar to Lowenfeld's.

<u>Electroencephalographic studies</u>. Lowenfeld hypothesized that visual and haptic perceptual style may be linked to innate physiological sources. There is at least limited empirical support for this hypothesis. This support comes from studies using an electroencephalograph (EEG) to measure electrical activity in the human brain called alpha rhythms. In the research cited previously, Walter (1953) studied alpha activity through the use of an EEG. After testing 600 subjects, he reported that one group of persons had persistent alpha rhythms, which are usually recorded when the mind is at rest, even when their minds were alert and active. He reported that individuals with persistent alpha rhythms which are hard to block with mental effort, tended to prefer auditory, kinesthetic,

or tactile perceptions rather than visual imagery. Thus he observed a relationship between perceptual modality preference and the alpha activity of a "visualizer" (the M type) "with few if any alpha rhythms"; a "non-visualist" (the P type) "with persistent alpha activity"; and a "mixed type" (the R type) "with a responsive alpha rhythm" (Walter, 1953). The distribution of these types reported by Walter is very similar to the distribution of visuals, haptics, and indefinites reported by Lowenfeld. His statement that evidence suggests that the alpha rhythm characteristics of individuals are innate and probably hereditary (Walter, 1953) suggests Walter's support for the premise held by Lowenfeld that perceptual type is linked to innate physiological characteristics.

A study by Drewes (1958) adds further support for Lowenfeld's typology and for his premise that perecptual type is linked to innate physiological characteristics. Using an EEG, Drewes recorded the alpha rhythms of subjects as they attempted to mentally visualize and manipulate geometric figures to form various combinations on a table. From these alpha rhythm recordings, he divided his subjects into three types: visualizers, nonvisualizers, and responsives. He also recorded Rorschach responses for these groups. He reported that the responses of the visualizers tended to be whole and three-dimensional forms, while those of nonvisualizers tended to be more kinesthetic in nature. The distribution reported by Drewes was as follows: visualizers, approximately 25%; non-visualizers, approximately 25%; and responsives, approximately

50%. While these figures reported by Drewes are not identical to Lowenfeld's, his study does lend support for the existence of perception which is visual and haptic in nature and which may be linked to innate electrical patterns of activity in the human brain.

Visual-haptic aptitude and scholastic achievement. A few studies have found relationships between visual-haptic aptitude and scholastic achievement. Erickson (1964 and 1966) found that students of the visual perceptual type showed superior performance in mechanical drawing over students of the haptic perceptual type. Erickson (1969) also reports a study in which he found that the mean level of reading achievement for haptic students was one-half to one grade level below that of visual students. Bruning (1974) found a significant positive correlation between visual aptitude as defined by Lowenfeld and achievement in reading and mathematics for eleventh grade students.

Lateralization of the human brain. Lowenfeld's visual-haptic typology represents two sets of information processing methodologies. This is not inconsistent with a relatively new line of research (begun in the 1950's) on information processing in the human brain. This research has led to the development of the concept of hemispheric lateralization, which may be defined as the tendency for aptitudes and abilities to be first processed by both hemispheres of the brain and then gradually to become specialized in one hemisphere or the other. Each hemisphere has an information processing mode for which it is dominant.

Until the twentieth century, the focus of attention was on the left hemisphere of the brain. This was due primarily to the fact that it was the first side of the brain discovered to have a special function: language. Thus, the left hemisphere was called the major or dominant hemisphere, while the right hemisphere was called the minor or subordinate hemisphere. Nebes (1975) states that:

> The prevailing theory for many years was that, while the right hemisphere might be capable of preliminary analysis of sensory information and the direction of simple motor acts, all higher mental functions either were carried out in the left hemisphere, or were under its direct supervision (Nebes, 1975, p. 13).

Studies conducted during the past 20 years, however, have led to the discovery of "right hemispheric dominance on many types of tasks, and the subsequent replacement of the concept of dominance by one of hemispheric specialization" (Nebes, 1975, p. 14). Although it is now generally recognized that while all aspects of verbal and non-verbal processing are not strictly and exclusively lateralized to the left and right hemispheres respectively (Krashen, 1975; Gazzaniga, 1975), there is a pronounced tendency for the left hemisphere to excel in verbal information processing and for the right hemisphere to excel in managing visual spatial tasks (Gazzaniga, 1975; Krashen, 1975; Nebes, 1975). Thus one hemisphere of the brain is related most clearly to visual perception. Nebes makes the following comment concerning the right hemisphere:

> The right side of the brain probably processes information differently from the left, relying more on imagery than on language, and being more synthetic and holistic

> than analytic and sequential in handling data. It is certainly important in perceiving spatial relationships. It is also probably the neural basis for our ability to take the fragmentary sensory information we receive, and construct from it a coherent concept of the spatial organization of the outside world - a sort of cognitive spatial map within which we plan out actions (Nebes, 1975, p. 16).

Debes (1975) has hypothesized that the right hemisphere of the brain is, in fact, the seat of visual literacy in most people. While he states that it may be some time before research verifies this hypothesis, he points out that it fits all currently known facts concerning the dominance of the right hemisphere in visual tasks.

The concept of hemispheric lateralization poses a possible physiological aspect of Lowenfeld's visual and haptic perceptual types. It raises the possibility that individuals of the visual type have a greater degree of development or dominance of the right hemisphere than individuals of the haptic type. This is an area of research which appears to the author to merit investigation.

Literature Relevant to Supplantation Theory

The construct of supplantation is defined by Salomon (1970) as follows:

> To supplant mental processes means to _execute them explicitly for the learner_. A mental process is supplanted when an analogous process is overtly executed in front of the learner's eyes. Thus, _supplantation is the function accomplished by an explicit presentation of what would otherwise have to be done covertly by the learner himself, such that a certain learning objective will be attained_ (Salomon, 1970, p. 47).

Salomon (1970) hypothesized that supplantation of mental processes can serve in two capacities:

1. It can provide compensation for what the learner cannot execute mentally for himself, thus helping him to attain a particular learning objective.

2. It can provide the learner with an image of a situation, a process, or a transformation which he can store for future use in a covert form.

In the literature pretaining to supplantation theory, three major principles have emerged:

1. Supplantation of a mental process which is not necessary to the learning task at hand does not facilitate its attainment. Thus, knowledge of the nature of the mental processes underlying a task is necessary in order to devise a presentation to attain it through supplantation (Salomon, 1970).

2. A presentation designed for supplantation must be sufficiently explicit to provide enough supplantation of mental process to allow an item to be learned, a concept to be attained, or a principle to be formulated. Salomon states that "supplantation is not an all or none function" (Salomon, 1970, p. 50). He states that on a continuum of supplantation, various points can be identified. These points include presentations which attempt only to <u>induce</u> the necessary mental activities by showing nothing but the beginning state of a process; presentations that short-circuit the necessary chain of mental transformations by presenting the initial situation and its final modification; presentations which provide the initial situation and its transformation; and finally, presentations

which attempt to be most explicit and to supplant as much as possible (Salomon, 1970). Salomon's conclusion is that various amounts of supplantation can be effective. How much is necessary in a given situation is a function of task requirements and learner characteristics.

3. In order for supplantation to occur, a presentation must contain information which the learner is capable of placing into his cognitive structure and his stage of development. Berlyne (1965) states that transformations are not learned simply as a result of witnessing the transformations in question. Ausubel (1968) claims that such transformations are not learned until the learner can assimilate them into his cognitive structure, hence giving them "meaning."

Since supplantation is an internal process, it presence must be inferred from observation of its results. Several examples of studies implying supplantation should serve to illustrate the type of research being conducted in the area of supplantation theory.

In a study in which film was used to show explicit demonstrations, Sullivan (1967) demonstrated that children's conceptions of conservation, space, and causality can be modified through such demonstrations. When the mental processes involved in the formation of these concepts were supplanted through the use of explicit film presentations, the result was better performance on tasks requiring grasp of the concepts.

Gentile, Kessler, and Gentile (1960) reported the supplantation of the process of finding an association. In an experimental treatment, they provided the required association for subjects and observed the results. They reported that while relationships given to subjects which are congruent with those the subject would have generated by himself facilitate performance on analogy items, given relationships which are incongruent with those the subject would have generated hinder performance. They also reported that when a treatment is used in which relationships are given to subjects, they do not generate their own relationships. They concluded that this treatment would probably not facilitate transfer since the subject is not given any practice opportunity.

Sieber (1969) wished to find a way to overcome the debilitating effect that high levels of anxiety have on learning. First, it was found that debilitation takes place primarily in complex learning tasks. Then it was suggested by Sieber that one common attribute of such tasks is their reliance on memory of previously executed moves which lead up to a solution. It was hypothesized that anxiety affects learning indirectly by actually interfering with retention of the intermediate moves and their consequences, and thus affects the observable attainment of a solution. Sieber hypothesized that if highly anxious subjects are provided with visual stimuli which retain the necessary information in front of them, that is, supplant the process of mental retention, then no debilitating effect is observed. In his experiment, high and low anxiety subjects were presented with a complex task. When no "memory supports" (drawings of already executed moves) were provided, the low anxiety subjects performed better than the high anxiety subjects. When "memory supports" were used, however, high anxiety subjects performed as well as low anxiety subjects.

Literature Relevant to Multi-Imagery

Multi-imagery, the simultaneous presentation of visual images, has become a popular technique for instruction. However, as Fradkin points out, there is still "... a scarcity of evidence supporting this model as a successful learning technique" (Fradkin, 1974, p. 201). He further indicates that the successful development of the multi-image presentation as an educational medium "... still requires an empirical test of what contributes to its effective use as a learning technique" (Fradkin, 1974, p. 203).

Although a considerable amount of research has been recently generated in attempts to compare the effects of multi-imagery with those of linear imagery (the sequential presentation of images) in both the cognitive and affective domains, this research has been plagued with methodological problems and has been contradictory and inconclusive. While some studies (Reid, 1970; Lombard, 1969) indicate the superiority of multi-image presentations, others (Didcoct, 1972; Fradkin, 1971) indicate no significant difference in results with multiple and linear image presentations. Still others (Fradkin, 1974) indicate the superiority of linear imagery. Such contradictory findings are possibly due to the fact that many of the studies which produced them are too "global" in nature. They lack any specific learner/task/medium interactions which might allow the location of specific situations in which multiple imagery may be systematically advantageous.

While there is very little sound data concerning the relative effectiveness of multi-imagery in specific learning situations, there is considerable data and theory bearing on the technical aspects of the medium and the relationships of this data to learning. This literature may be divided into four principal areas:

1. simultaneity of visual images
2. screen size
3. information density
4. perception of multiple images

The review of literature which follows concentrates on these four areas. Before examining the literature relevant to each area, however, it would be expedient to present a theory of multiple imagery developed by Perrin which interrelates the first three areas. He states the theory as follows:

> Media such as films, television, filmstrips, and slides have, until now, presented their images sequentially. In sequential montage the meaning of each new image is determined by the context of what has gone before. In its temporal aspects, sequential montage is analogous to verbal language, where several elements in series determine the total meaning. Simultaneous images interact upon each other at the same time, and this is of significant value in making comparisons and relationships. An important contributing factor is screen size. On small screens, the overall identity of the image is most significant. On large screens (or screens side-by-side), the viewer makes his own montage of different image elements, increasing the probability of learning comparative information. The immediacy of this kind of communication allows the viewer to process larger amounts

> of information in a very short time. Thus information density is effectively increased, and certain kinds of information are more efficiently learned (Perrin, 1969, p. 369).

This conceptualization of multiple imagery as an interaction of the three factors of simultaneity, screen size, and information density serves as a springboard into the literature relevant to each of these areas and to the area of the physical perception of multiple images.

<u>Simultaneity of visual images</u>

For tasks requiring visual comparisons, it has been considered axiomatic that multiple images are more effective than sequentially presented, or linear, images. The reason for this superiority is the simultaneity of multiple images (Perrin, 1969). Viewing images simultaneously rather than sequentially is assumed to make comparison of them such simpler. There are numerous learning tasks in which this advantage might be important. Millard (1964) lists many kinds of classroom situations in which simultaneous presentation would be advantageous:

> The multiple-image technique enables the teacher to make comparisons, to illustrate the development of interrelated concepts, show relationships, and to otherwise combine the capability of several photographic aids either simultaneously or in some programmed pattern or sequence for instructional purposes.
>
> Using multiple images, we can effectively treat comparisons of the physical, geographical, environmental, dimensional, and spatial characteristics of objects and events. Dichotomies, alternatives, differences, likenesses, and many other forms of comparison can likewise be efficiently handled by this method.

> In a similar way presentations involving relationships, parts to whole, diagrams of apparatus, model to object, form to function, and the like, can be displayed with multiple images (Millard, 1964, p. 108).

As examples of ways to use multiple images for instructional tasks, Perrin (1969) suggests that the following are effective:

1. question on one screen, answer on a second
2. action and reaction on two different screens
3. alternate courses of action on different screens.

He states that the possibilities are great, but that the instructional effectiveness of the uses devised will, of course, depend on the ability of the teacher to capitalize on the unique instructional and communicative powers of each type of projected materials, and to program them into a unified and dynamic presentation (Perrin, 1969).

It is posited by some that the simultaneity of multiple images makes them very useful in learning by association. Gagne (1965) states that association is one of the most basic mechanisms of learning. Low (1968), who worked on the Canadian National Film Board's Labyrinth at Expo 67, hypothesized that the complex of simultaneous visual associations is especially crucial to memory and to conceptual learning:

> Our awareness of several sensory simultaneous stimuli is probably one of the reasons why memory seems locked in the mind in such a peculiar manner.
>
> Perhaps no single impression triggers certain memory combinations, but a group of impressions received simultaneously often may trigger long forgotten memories. Emotions also often seem totally mysterious in the way they come and go. Poetry uses an amalgam of thought, feelings, and word images poured in quick succession as an assault on the unconscious. Some poets seem im-

> patient with the sequential quality of words and phrases and compress language in what seems to be an effort to achieve a kind of simultaneity. Roman Kroitor speaks of multi-screen being to single screen what the language of poetry is to the language of prose (Low, 1968, p. 185).

Visual images are extremely rich in information and in the range of associations they may stimulate. Perrin (1969) points out, however, that users of multiple images should be cautioned that poor use of them can have detrimental effects. Without careful control by the communicator, some associations conflict with the intended message and are detrimental. Relevance, realism, and simplicity of visual stimuli have been shown to be important in learning from book illustrations (Spaulding, 1956) and in learning from films (May and Lumsdaine, 1958). They are at least equally as important in presentations using multiple imagery (Perrin, 1969).

Cue summation theory. Another caution concerning the simultaneity of multiple images which emerges from the literature is that the theory of cue summation may be invalid in some contexts. Cue summation is a general theory which holds that the more cues are given through various communication channels, the more learning results. Perrin (1969), however, points out that the use of simultaneous multiple images places a heavy burden on the visual channel and that in the multiplication of visual stimuli, irrelevant as well as relevant detail is increased. Thus, great care must be taken to see that the visual stimuli are clear and simple and that detail included is relevant. Otherwise, the result is not cue summation, but confusion. He states that although the need for clear and simple images in multiple image presentations is obvious, it is at this time necessary for the producer to make a subjective judgement as to what is clear and simple, for research has as yet established no guidelines.

In his extensive review of multi-channel communication, Hartman (1961) cautioned that cue summation actually occurs only under special conditions. He reported findings which indicate that when verbal and visual elements are combined, the added cues can produce a great many extraneous cognitive associations. He is critical of the use of verbal and visual elements in many educational materials, particularly in educational films:

> A common practice among multiple channel communicators has been to fill the channels, especially the pictorial, with as much information as possible. The obvious expectation is for additional communication to result from the additional information. However, the probability of interference resulting from the additional cues is very high. The hoped-for enhanced communication resulting from a summation of cues occurs only under special conditions. Most of the added cues in the mass media possess a large number of extraneous cognitive associations. The possibility that these associations will interfere with one another is probably greater than that they will facilitate learning (Hartman, 1961, p. 255).

It is clear that if Hartman is correct, then particular care must be taken when sound is added to a multi-image presentation. One must be certain that the information placed in the two channels complements rather than interferes with each other.

In his suggestions for needed research in multi-imagery, Fradkin (1974) emphasizes the need to research cue summation in multi-image communication. He states his belief that:

> ... if the intent of a multi-image presentation is to produce cognitive learning the producer must be aware of the necessity for related material allowing purposeful cue summation of information. The result of unrelated material with no cue summation might well produce an aesthetic 'happening' but not the learning of specific informational points (Fradkin, 1974, p. 215).

In a recent study, Fradkin and Meyrowitz (1975) report results which give support to this statement. In this study, two advantages of multi-imagery were compared. These two advantages are the ability of multi-imagery to increase the amount of time a visual if left on the screen, and the ability to reinforce conceptual relationships by physically juxtaposing pertinent visuals. This latter ability provides a form of cue summation by visually reinforcing relationships. In this study, three treatments of the same subject material were designed: a linear image presentation and two different multi-image presentations. All presentations had identical verbal content on audio tape, identical visuals on slides, and identical timing for changing of visuals (one at a time). In the linear presentation, visuals were presented singly in sequential order. In one multi-image presentation, three visuals were shown simultaneously and were changed in succession from left to right. In the other multi-image presentation, the screens were used to outline the subject material. Although only one slide was added at a time, it was placed in logical sequence with the material already presented. Opaque slides were used to eliminate images that were no longer relevant to the material shown. It was felt by the authors that the first multi-image presentation emphasized the time variable, leaving each visual on the screen as long as possible; while the second multi-image presentation emphasized the advantage of conceptual reinforcement, cue summation, and the avoidance of conflicting cues. The results of this study showed no difference between the linear and multi-image presentations. Difference was found, however, when the two multi-image presentations were compared. Subjects who viewed the conceptually organized presentation demonstrated greater learning on a cognitive test than did those who viewed the presentation which allowed maximum viewing time for each visual. These results lend support to the hypothesis that cue summation and avoidance of conflicting cues is important in the design of multi-image presentations produced for cognitive learning situations.

Audience factors and simultaneity. The assumption is sometimes made that audiences of all age levels benefit equally from the simultaneity of multiple imagery. The research in this area is limited. However, the research which is available does not support this assumption. Roshka (1958 [1960]), Maladin (cited by Perrin, 1969), and Allen and Cooney (1963) found simultaneous presentations effective with young children. Maladin found that four primary classes had difficulty relating images shown successively to one another. Using groups nine to eleven years old, he found that the number of recollections and the ability to organize material improved when simultaneous images were used in presentation. Allen and Cooney and Roshka found that simultaneity had less effect with older children. Allen and Cooney, for example, found that simultaneous images of mixed factual-conceptual material had significant advantages for sixth graders but not eighth graders. Perrin (1969) concluded that further research is necessary to ascertain for what types of learning at what age levels simultaneity of images has advantages. He suggests that perhaps the advantages of simultaneous images might extend to higher age levels with more difficult concepts or that perhaps the associations made through simultaneous images might be particularly important in the initial stages of learning.

It is possible that there are also differences in affective reactions to multi-image presentations among various age groups. While this has not been well documented through research, Beckman (1975) states that it has been his observation that "there seems to be a direct correlation between the age of an individual and how favorably he reacts to a multi-image presentation on a first time basis" (Beckman, 1975, p. 29). He states that he has observed that young people "almost invariably" react favorably to multi-image presentations. He suggests that the reason for this is that:

> The medium is very, very rapid. And young people seem to be used to this. Watch them look at television while they study, and with the stereo on at the same time. They switch channels, tune in, tune out (Beckman, 1975, p. 29).

Beckman states that older people, on the other hand, have been "conditioned to watch programs from beginning to end. It starts ... and stops, and that's it, one thing at a time" (Beckman, 1975, p. 29). Consequently, they are usually confused and overwhelmed at their initial encounter with the rapidly-moving montage of multi-imagery. Beckman concludes, however, that:

> This does not mean that older people will never be receptive to multi-image. At first they are overwhelmed. But most become much more aware and receptive after two or three experiences (Beckman, 1975, p. 41).

While there is little empirical data concerning the cognitive and affective impacts of multi-imagery on various age groups, what evidence is available suggests that differences may in fact exist. This is an area which appears to the author to merit further investigation.

Large screens

One of the major and inherent advantages of multi-imagery is the large screen effect that is necessarily coupled with the simultaneous projection of two or more images, making the projection area two or more times the normal projection width.

Simulation of real environment. The advantages of large screens have long been recognized by users of simulators for training visual coordination tasks. It has long been accepted that large screens provide better approximations of "real" environments. The Waller Gunnery Trainer encompassed the trainee in a spherical wall representing a 180-degree field of view. Aircraft simulators likewise require a wide visual field (Perrin, 1969). Graham (1965) states that projected images are effective in representing large three-dimensional environments because distant space perception is based on monocular cues: relative size, interposition, linear perspective, aerial perspective, motion parallax, and light and shade.

In professionally produced films and slides, monocular cues such as those listed above are usually enhanced by composition, movement, and light effects, such as rim lighting which accentuates the outlines of important objects. The bright image, rich in monocular depth cues, on a screen sufficiently distant to eliminate conflicting cues from accommodation, convergence, and stereoscopic vision, simulates a total environment. This is further enhanced by large screens which occupy a field wide enough to utilize the peripheral vision (Perrin, 1969).

Murroughs (1953) states that Cinerama is an excellent example of a system which utilizes peripheral vision:

> Normally, as we move forward, we are dependent on what we can see to the right and left. These peripheral objects appear to move out (to the right and left) and curve around us backward to either side. This apparent movement helps us to judge the distance straight ahead and tells us where we are. The very wide angle of vision and curved screen in Cinerama both serve to make this an important cue to tridimensional vision. In the field of art, great pictures capture and 'manipulate' the observer so he becomes part of the scene. His ego center is the center of visual space set by the canvas, or by Cinerama. If you must look for the details of tall objects in a painting you feel small. When you look down over a valley or into a gorge you 'feel' you are on top and some persons become dizzy. In Cinerama we actually sit in the leading car of a roller-coaster as we top the rise of a track. The view is spread out before us. As we 'plunge' down the incline the field quickly enlarges with more peripheral detail flying outward and around (past us) adding a terrifying realism to the experience causing many in the audience to grip their seats. In the same manner we glide along slowly

> in a gondola while the panorama on either side slides by slowly, or we fly through valleys between walls of canyons we can almost touch (Murroughs, 1953, p. 656).

It is Perrin's conclusion that "large screens provide the physical and psychological factors necessary for realism and involvement, and may be comparable to real environments for many training purposes" (Perrin, 1969, p. 373).

Visual acuity. It would seem intuitively logical to assume that tasks requiring high visual acuity should benefit from the use of simultaneous images and their accompanying large screens. A study by Blackwell (1963), however, suggests that caution must be observed when operating on the assumption that increased visual acuity accrues from large screens. Blackwell found that in normal room environments, visual acuity is enhanced by increase in illumination and degraded by uneven lighting, reflections, and glare. He combined these into a single factor which he called relative contrast sensitivity, which he discussed as followed:

> Difficult tasks require relatively high levels of background luminance, whereas easy tasks require low levels of relative contrast sensitivity and luminance.... Thus, when more contrast sensitivity is supplied to the visual system, not only can the learner read smaller print or handwriting of lower contrast, but he can also detect more subtle changes in facial expression, and for example detect smaller differences in texture or pattern (Blackwell, 1963, p. 40).

The implication of Blackwell's findings is that screens should be fully illuminated and that projection materials should be of correct density. Insufficient illumination or dense slides and films degrade visual acuity.

If large screens are achieved with loss of illumination, other possible advantages of the larger screen may be negated (Blackwell, 1963).

Other information concerning screen size, glare, and visual acuity is provided by Logan. Logan (1948) depicts the field of view of the observer as a central "glare zone" encompassing a 60-degree field, the "binocular zone" as a field of 120 degrees, with the "monocular zone" for each eye extending the total field to a total of 180 degrees. While these figures are somewhat arbitrary, they provide some useful guidelines in determining screen size and the nature of the surrounding environment. Logan feels that the central "glare zone" is the most critical. He points out that small screens such as home television with a 15-degree field of view are limited, not only by lack of image information, but by glare and distractions from the surrounding environment. The small screens used for projection in most educational establishments are similarly limited. Perrin (1969) points out that modern wide screen theatres encompass a 30-degree field at the maximum viewing distance, so that all viewing positions are relatively favorable in terms of glare.

Perrin (1969) states that another source of glare which has long been recognized is the wide black background used on the smaller, conventional-type movie screens. This expands the contrast ratio in the central zone of vision without adding information, which is another way of describing glare. In 1937 RCA introduced a screen with a gray background called the SynchroScreen to increase eye comfort for theatre audiences. Larger and wider screens achieve a similar effect (Perrin, 1969). Smith and Schlanger (1961) utilized a very wide screen with edges blending into the surroundings in the Colonial Williamsburg Theatre. Schlanger (1966) recommends a similar practice for new 70 mm cinemas. Where the screen itself encompasses a wide field of view, the nature of the surrounding area becomes less critical (Perrin, 1969).

Ambient light is also a contributing factor to relative contrast sensitivity. Visual information is lost where ambient light reflected from the screen exceeds the blackest black in the film (Perrin, 1969). Logan (1948) found in empirical tests that ambient light levels at the screen should not exceed 0.1 foot-Lamberts where the ASA standard screen brightness of 16 foot-Lamberts is used.

Perrin (1969) provides the following summary of screen size and visual acuity:

> Under ideal viewing conditions, the limits of visual acuity will be determined, not by the viewing environment, but by the resolution of the film and visual transmission system. It is for this reason that theatrical film production uses wider than normal film gauges, at least for the initial photography. In this way the larger screen does not have objectionable graininess, and the full visual capability of the observer can be utilized. Thus, visual acuity is directly related to resolution of the image transmission system, screen size, screen brightness, and freedom from degradation due to ambient light, reflections and glare, and distractions within the visual field. Difficult visual tasks require full screen illumination in a glare-free visual field. Visual acuity is reduced with dark images, excessive ambient light, and glare (Perrin, 1969, p. 374).

Physical and physiological effects of large screens. Some researchers feel that the physiological impact of large screens is as important as the psychological impact. Schlanger (1966) introduced the two terms visual impact factor and visual task factor in regard to the physiological impact of large screens. His rule for the visual impact factor is that as screen size increases relative to audience size, the visual impact increases. Some have speculated that the development of large screens and the sheer physical impact they produce was necessary for the survival of the motion picture art. Cornwell-Klyne (1954) stated that the motion picture "would be destined to suffer a slow decline in popularity unless it renewed its vitality in an increasing effort to expand its powers of communication and expression" with a large-screen format. Perrin (1969) points out that movie audiences declined in the late forties because they were watching films on television, but that in the next decade large screen motion pictures provided the added impact necessary for theatres to compete with the convenience of home viewing.

Schlanger's visual task factor relates to the work the viewer must do to extract the necessary information. Schlanger (1966) points out that on the small screens associated with television and narrow gauge films, the resolution of the image is limited. Large screens receiving their images from wide gauge film are rich in detail, and in this respect more closely duplicate a real environment. Thus, the large and well-resolved images produced on wide films and shown on large screens result in less physical effort by the viewer; the visual task factor is reduced.

Perrin (1969) suggests that application of Schlanger's visual task factor also may account for the fact that Travers' ideas on line drawings do not transfer well to actual learning situations. Travers (1966) hypothesized that line drawings are advantageous because they eliminate superfluous detail. However, artists do not extract visual cues in the same manner as do the visual senses, and Travers' experiments show poor transfer of learning from simplified drawings and models to situations in a real learning environment. Perrin believes that Schlanger holds the key. He hypothesizes that the line drawing, like an image with poor resolution, increases the visual task factor to reconstruct visual cues which are lost in the abbreviated form (Perrin, 1969).

Learning from large screens. Barr believes that the primary reason that people learn successfully from presentations on large screens is the psychological impact they produce. He states that the viewer perceives himself as part of the environment instead of "looking through a window." The openness of the large image encourages him to explore and select for himself, giving a sense of reality and participation. Also, the director has relinquished his image-by-image storytelling and has begun to capitalize on the advantage of simultaneous montage (Barr, 1963).

TerLouw believes that the increased learning which he observed with the use of large images is related to the increased interest which they produced. In an informal experiment (TerLouw, 1956), he set up a slide projector with a small screen and invited people individually to view some slides, controlling the rate of presentation for themselves. On repeating the experiment with a large screen, he found the subjects viewed each slide for nearly twice as long. A post-test showed that this second group was better able to answer questions on details and relationships within the pictures.

Information density

With multiple imagery, a greater density of information is possible than with linear imagery. There are many dimensions to information density in multiple-image presentations. Perrin (1969) believes it is first of all important to distinguish between the method of presentation and the mechanism of perception. He states that the theory of multiple images suggests that for making contrasts and comparisons, and for learning relationships, "simultaneous images reduce the task of memory (a dimension of visual task) and enable the viewer to make immediate comparisons" (Perrin, 1969, p. 376).

Langer stresses simultaneity as a key element in visual language:

> Visual forms - lines, colors, proportions, etc. - are just as capable of articulation, i.e. of complex combination, as words. But the laws that govern this sort of articulation are altogether different from the laws of syntax that govern language. The most radical difference is that visual forms are not discursive. They do not present their constituents successively, but simultaneously, so that relations concerning a visual structure are grasped in one act of vision. Their complexity, consequently, is not

> limited, as the complexity of discourse is limited, by what the mind can retain from the beginning of an apperceptive act to the end of it (Langer, 1942, p. 83).

Langer uses the terms "linear" and "nonlinear" to distinguish between verbal and iconic signs. She stresses the sequential ordering, the "strung-out" arrangement of linear (verbal) signs in time and contrasts this to the "all-at-once" character inherent in pictorial signs. Thus, her position is that even single pictures shown in sequential order are essentially nonlinear.

Norberg essentially agrees with Langer's conceptualization:

> Single pictures or more complex iconic displays may be said to be nonlinear not merely because one beholds an entire visual array, all at one time, but because what is perceived has a degree of independent meaning, or openness of meaning, by virtue of the fact that it is not constrained by its place in some grammatical structure of which it is a term or part. The beholder who encounters an iconic sign or display is, of course, not cut off from prior experience. He always relies upon a deposit of past experience ... to cope with the present. But this sort of linearity, this cumulative building of meaning which enters into all perceptions, is something quite different from the formal linearity of signs which are bound together in the grammatical structure of a lingual statement. The nonlinear sign or presentation is free of the latter control, but not of the former (Norberg, 1966, p. 313).

Norberg points out the disadvantages of attempting to use basically nonlinear signs in a linear fashion:

> The point is not that pictorial or other iconic signs cannot be used in a linear fashion; within limits, they can be used this way with some help from verbal signs, but when this occurs they become quasi-verbal symbols, conventional signs that have surrendered some part of their distinctive power as iconic signs (Norberg, 1966, p. 313).

Nonlinearity and simultaneity go hand in hand. The use of visual images, which are inherently nonlinear, allows the presentation of a great deal of information simultaneously rather than sequentially, as with words arranged in sentences and thus bound to grammatical ordering and syntax. Perrin (1969) extends this line of analysis and hypothesizes that when visual images are combined in multi-image presentations, the result is an increase in the amount of information which is presented simultaneously, or in the information density of the presentation.

Organization of information. Information density can be further increased if the information is properly organized. McFee articulates the point of view that visual organization is more important than the actual amount of information present:

> Visual ordering makes messages of content easier. Much of our responding is so fast we are unaware of the processing we do. One of the tasks of the message designer is to make the visual sorting process easier; he selects and organizes visual information so that it is easier for the viewer to assimilate (McFee, 1969, p. 85).

Empirical confirmation of the importance of organization is illustrated by the introduction of a meticulously organized and automated televised intructional system called TeleMation at the University of Wisconsin. It was found there by Hubbard (1961) that a tape lecture of 50 minutes could be boiled down through careful organization to 20 minutes of TeleMation instruction with no loss of material or loss of learning by students. Information density could be significantly increased through proper organization. A similar finding resulted when the Army Ordnance Guided Missile School conducted a series of evaluation studies in 1958. Three 32-hour segments of instruction were selected emphasizing different kinds of subject matter. Instruction time was reduced 19.5 to 41 percent for similar level of achievement, and increased learning was reported for the experimental groups nine weeks later (United States Army, 1959)

Allen and Cooney (1963) have suggested the possibility that time saved in instruction in multi-image presentations is as much a function of care in preparation as of the multi-image delivery of the subject matter.

Rapid and complex imagery. The process of organization of sounds and images to create greater information density is the filmmaker's craft. Images rich in information can communicate instantly their content and context. One can see excellent examples of this in recent fairs and expositions. Charles Eames, for example, for the Moscow Fair, used rapid and complex imagery to achieve a specific kind of learning. On seven screens, each as large as that of a drive-in theatre, he fused many specifics of American life together to communicate to the Russian people the larger concept of how American people live. His approach was designed to determine:

> ... how many images a person could see and digest at one time. The object was to present a group of images that an audience could be aware of but not analyze in a way that would involve them with the subject. In such a presentation the panorama of our way of life would be so general that an audience would assume that it had seen more than it actually had. For example, in one twelve-second sequence of the finished film, 90 separate scenes of freeway overpasses flash by on the screens. No one could possibly count them, but the impression is that of an infinite number (Lightman, 1959, p. 670).

Fleischer (1969) similarly found that he could successfully communicate simultaneously occurring events to a motion picture audience through the use of a large number of images in simultaneous montage as long as they were specific, relevant, and simple in design.

There is apparently real concern among educators that the multi-image producer is more concerned with the "happening" created by rapid and complex multiple images than with the learning which results from them. By creating a swirl of color and movement he can involve and titillate the senses. However, producers of the presentations at Expo 67 insist that their work achieved both excitement <u>and</u> learning. Joel (1967) comments on this:

> Multiple pictures make audiences understand more through feeling than through thinking. Pictures are thrown at spectators with or without words, stories are told without logical sequence; viewers are deliberately thrown off balance both mentally and physically. Film transmits facts, creates moods, and tests moral judgements .... (Joel, 1967, p. 25).

Kappler (1967) also has no doubts that learning takes place, but feels that affective learnings are communicated most effectively from presentations such as those at Expo 67. He observed that the Expo presentation "... certainly drives hardest at sensations and emotions" (Kappler, 1967, p. 28).

Perrin (1969) states that "it seems inconceivable that concepts could be learned without retention of specific facts, or that emotions could be communicated without some factual-conceptual learning also" (Perrin, 1969, p. 378). He sees the size, organization, and pacing of the images as the crucial factors in determining whether units or systems of information are effectively communicated by rapid and complex multi-image montages. He states that, while it is clear that greater densities of information can be perceived when presented via multiple imagery, the major question is this: "Are greater amounts of information learned? And under what conditions? Can the learner be over-excited? Over motivated? Overloaded?" (Perrin, 1969, p. 378)

Arousal and motivation. Commercial producers claim that information density created through multiple imagery results in motivation and arousal. A serious question is whether or not this arousal is beneficial. Research on motivation indicates that increase in motivation improves performance (Smith, 1966), but that there is an optimum level. Eysenck (1963) found that for complex tasks optimum performance is achieved when drive is relatively low; only for simple tasks is the optimum achieved with relatively high drive. Kleinsmith and Kaplan (1963, 1964) and Kleinsmith, Kaplan, and Tarte (1963) found that there is also some confusion between learning and performance, with a person sometimes performing very poorly in highly arousing situations, yet tending to remember most vividly those incidents in his life which were most traumatic or arousing. These researchers measured skin conductivity, and their findings indicated that high arousal associates showed stronger permanent memory and weaker immediate memory than low arousal associates. Low arousal was accompanied by the normal forgetting curve. High arousal responses showed poor immediate recall with reminiscence.

This explains some inconsistencies in research with regard to long term retention. For example, VanderMeer (1951) found color films did not increase immediate learning, but produced greater long term retention. The findings of Kleinsmith suggest that the cause may have been the arousal produced by the color films.

It is apparent that in goal setting, it is important to distinguish the nature of the learning outcome. If immediate performance is the goal, factors which induce arousal (interest, excitement, visual impact, emotion, etc.) should be lower than for situations where long term retention is the goal. Research needs to be conducted to determine if multiple-image montage produces too much arousal to make it useful for some short-term learning tasks. It may be better suited to the inducement of long-term learning through high arousal.

Concerning the types of arousal which facilitate some types of learning, Levonian offers some evidence. He found that a very wide range of stimuli could create arousal, and that:

> ... the effect of arousal induction on retention is independent of the emotion associated with the arousal. This suggests that fear and joy, for instance, would both enhance retention. The suggestion gains support from the fact that even though different sections of the film (carnival sequence, collision sequence, etc.) might be expected to mediate different emotions, the arousal-accessibility phenomenon emerged for items pertaining to each of these sequences (Levonian, 1967, p. 115).

Commercial and educational views of multi-imagery

While the commercial producers of multi-image presentations are apparently convinced that learning results from such presentations, they present no sound empirical support for their beliefs. Nor have educational researchers yet been able to provide such support, In fact, Travers (1966) goes so far as to interpret his findings as indicating that multiple sensory presentations are likely to be of instructional value only when the rate of input of information is very slow, and that the silent film with the alternation of pictures and print appear to find much more theoretical support as an instructional tool.

Perrin comments on the sharp contrast between Travers' viewpoint and that of the commercial producers:

> Travers' statement holds true for immediate performance close to criterion when learning is accomplished at a low level of motivation. The confusion between research and commercial production can be easily explained. The purpose is different, the approach is different, and the communication symbols themselves are different. The commercial productions of Eames and Fleischer are designed to achieve high visual impact, interest, involvement, motivation, and concentration - in modern terminology, to 'turn on' the audience. Research works at low levels of motivation comparable to vigilance tasks; the learning of cognitive associations of nonsense words and symbols is certainly not too stimulating by comparison. Thus, producers and researchers are working at opposite ends of the motivational scale, and at opposite ends of the real-abstract continuum. And while research is studying just a single variable, the commercial producer involves the whole visual sensorium (Perrin, 1969, p. 380).

The viewpoint of multi-imagery espoused by commercial producers does not frequently result in the generation of clean empirical data on its effectiveness. Their concerns are not task-specific, nor do they lend themselves to controlled experimentation. On the other hand, the restriction of multi-imagery to controlled experimental situations in which its effectiveness in presenting a simple cognitive task is evaluated probably does not speak to the full implication or utilization potential of the medium.

Entertainment and education are not viewed by the author as mutually exclusive catagories. Until their approaches and goals become more closely joined, multi-imagery may continue to be trapped between the two viewpoints.

Perception of multiple images

Goldstein quotes a recent brochure of a multi-image programming hardware manufacturer as claiming that "multiprojection as a system of communication works on the basis that people are able to absorb considerable amounts of different visual information simultaneously" (Goldstein, 1975, p. 35). Goldstein points out that this statement likens the viewer of multi-images to a "sponge" and assumes he will simply absorb all of the large amount of visual information flashed before him. He suggests that analysis of three principal areas of perception is necessary to determine the truth of this "sponge" assumption:

1. perception of images which cover a large area of a viewer's field of vision,

2. perception of information that is presented simultaneously, and

3. memory of such information once perceived.

Literature relevant to these three areas is presented in the review which follows.

<u>Perception over a large visual field</u>. The visual field is defined as the area of space which can be seen with the head and eyes held stationary (Goldstein, 1975). Gibson (1950) established that the visual field extends about 180 degrees laterally and 150 degrees vertically. Figure 1 shows Gibson's estimated field of view for both eyes.

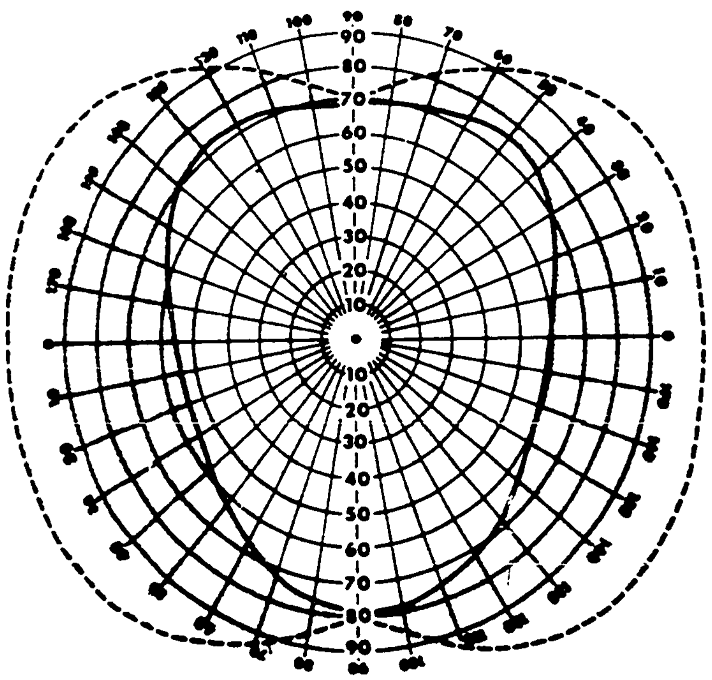

Figure 1. The visual field for both eyes.

Numbers represent degrees of visual angle. The dashed line is the outer boundry of the visual field. The center area represents the area in which the visual fields for the right and left eyes overlap. The dot in the center is approximately the size of the area of foveal vision. (adapted from Gibson, 1950, by Goldstein, 1975)

Goldstein makes the following statement concerning estimation of individual visual field:

> You can estimate the extent of your own visual field by extending your arms in front of you and then, while looking straight ahead, moving them out to the side until you can just barely see your hands. The angle between

> your arms defines the horizontal extent of your visual field. If this angle is ... 160 degrees, you should be able to see the full extent of a movie screen that is 1000 feet across if you are sitting 100 feet away, without moving your eyes or head! (Goldstein, 1975, p. 37)

Although the visual field is large, the area of detailed vision is quite small. The dark spot in the center of Figure 1 illustrates the approximate size of the fovea, the area of the retina of the eye within which the most detailed vision is possible. The image of an object falls within the foveal area, which is about the size of a dime held at arm's length, only when one looks directly at the object. Looking directly at an object is called <u>fixating</u> the object; the image of the fixated object always falls on the fovea (Goldstein, 1975).

Alpern (1962) demonstrated that visual acuity, or ability to see detail, is high at the fovea but drops off rapidly as an object is moved away from the fovea and towards the peripheral retina. Hochberg (1970) conducted experiments which led him to conclude that one cannot see clearly what does not fall on the fovea. There are apparently at least two kinds of vision: detailed foveal vision, and less distinct peripheral vision.

Since the human eye can take in detailed information from only a small portion of the visual field, it is apparent that one can take in detail in a large scene, such as one presented with multiple images, only by scanning the scene, thus shifting foveal vision (fixating) from area to area. Numerous studies have been conducted which reveal the existance of scanning and fixating, and of patterns and generalizations in these processes (Buswell, 1935; Yarbus, 1967; Mackworth, 1967; Gould, 1967; Norton & Stark, 1971a, b). Yarbus (1967) found that a fixation typically lasts from two- to eight-tenths of a second, and that an eye movement typically lasts from one- to eight-hundredths of a second. Because visual acuity is greatly decreased while the eye is moving (Latour, 1962; Volkman, Schick, & Riggs, 1968), it is likely that perception occurs during the actual fixations. These studies suggest that a viewer perceives a picture by means of a large number of fixations separated by rapid eye movements.

Another finding by Yarbus (1967) is that only certain areas of a picture are fixated, that these areas usually receive more than one fixation, and that most of the picture is never fixated at all. Several factors have been isolated which appear to determine which areas are fixated by an observer.

One factor which appears to influence fixations is the amount of information present. Several studies have shown that novel or complex pictures are fixated more than less novel or complex ones (Webb, Matheny, & Larson, 1963; Leckhart, 1966; Faw & Nunnally, 1967). Mackworth and Morandi (1967) found that subjects also tend to fixate on sections of pictures which were rated as highest in informativeness by a group of independent observers.

Yarbus (1967) found that a second major determinant of what areas of pictures are fixated is what the observer wants or is told to look for. He reported that by changing the instructions to subjects, he could alter their fixation and eye movement patterns.

A third major determinant of where an observer looks is change or movement. The "orienting response" to novel stimuli is well documented in learning psychology. Hubel and Wiesel (1962) observed that the visual cortexes of cats react with a burst of nerve impulses to moving stimuli or stimuli which are switched on and off. Neisser (1967) states that when something moves in peripheral vision, it usually captures the attention immediately. Both Gibson (1966) and Moray (1970) suggest that movement in the peripheral visual field triggers an innate fixation reflex to bring the moving stimulus into foveal focus. This all seems to indicate that while peripheral vision is not sensitive to visual detail, it is quite sensitive to movement.

Although peripheral vision is not suited to detecting detail, there is evidence that it plays a major role in the perception of displays, such as a multi-image presentation, which cover a wide visual field. Studies cited above have shown that while one perceives large images by scanning them and fixating parts, only <u>some</u> parts are actually fixated so they fall on the fovea and thus can be seen clearly. A question which still needs to be answered is how the totality of a complex scene is perceived if only parts of it are fixated. The results of an experiment by Biederman (1972) indicate that information received through the periphery appears to play an important role in the perception of large and complex scenes by aiding in the integration of components. Other studies (Mackworth & Morandi, 1967; Williams, 1966) indicate that information from the periphery also plays a role in determining where fixations should occur. Such information reduces random search and guides eye movements to important areas of a scene. This allows the perception of complex scenes with maximum efficiency and minimum time.

Since much of a large and complex visual display must be perceived in peripheral vision, an important issue in determining how well a multi-image display can be perceived is how much information can be taken in peripherally. The general results of experiments on the properties of peripheral vision are summarized by Edwards and Goolkasian (1974). They state that such studies indicate that the ability of the periphery to process information depends on three things: the peripheral region stimulated (the further the peripheral area is away from the fovea, the poorer the perceptual performance), the complexity of the task (the more complex the task, the poorer the performance), and the size of the stimulus (the smaller the stimulus the poorer the performance). Goldstein agrees with the conclusions of Edwards and Goolkasian. He states that:

> Performance generally improves when stimuli are moved closer to the fovea, and are made larger, brighter, or less complex. Thus, there are reports of good performance in the periphery when the stimuli are easily discriminable and/or are located not too far into the periphery (Goldstein, 1975, pp. 44-45).

A person watching a multi-image presentation is simultaneously presented with both foveal and peripheral stimulation. It is therefore necessary to consider whether peripheral information can be well perceived when the subject is attending to other, centrally fixated, stimuli. A few experiments suggest that the amount of information which can be perceived in a particular area of the periphery may be at least partially determined by information being presented elsewhere in the visual field. Mackworth (1965), for example, reports finding that the addition of extraneous, unrelated stimuli to a visual field makes it harder to process peripheral information. Webster and Haslerud (1964) found that attention to a task such as counting the number of flashes of a centrally fixated light or the number of times a tone is sounded results in a decrease in the perception of information simultaneously presented in the outer periphery. Goldstein concludes that "...trying to do two things at once - in this case, monitoring foveal and peripheral vision simultaneously - causes a decrease in performance on one of the tasks" (Goldstein, 1975, p. 46). This leads to the consideration of a second major area in the research dealing with the perception of multiple images.

Perception of simultaneous presentations. The matter of simultaneous information processing was first researched in the auditory channel. Several studies (Cherry, 1953; Mowbray, 1953; Broadbent, 1958) indicating the difficulty of dividing attention between two tasks or attending to more than one message at a time led Broadbent to propose his "filter model" of auditory attention. This model states that the information reaching the observer is carried in a number of "input channels." According to Broadbent human beings can, however, usually attend to a single message at a time because the nervous system is essentially a single communication channel. That is, it can handle only one channel of information at a time. This limited capacity of the nervous system necessitates a "filter" which passes information in the attended channel and filters out information in unattended channels. The nervous system can process information in more than one channel only if the information in the channels is simple or familiar enough that the input channels are not full (Broadbent, 1958).

Although many of the details of Broadbent's model have been replaced or modified, it is now "generally accepted that the auditory system selects, or at least concentrates attention on, one, or a limited number of channels, from the large number of channels available to the listener. This puts definite constraints on the total amount of auditory information that can be processed by the listener" (Goldstein, 1975, p. 47).

In the study of the perception of multi-imagery, it is pertinent to ask whether there is a similar limitation of the amount of visual information that can be perceived and processed simultaneously. In order to consider the simultaneous processing of information in visual channels, it if first necessary to define a visual channel. Although an auditory channel is often defined as the left ear or the right ear, it is not practical to define the left and right eyes as two different channels, since the presentation of different stimuli to each eye results in what Moray (1970) calls "retinal rivalry." This term refers to the fact that when different stimuli are presented to each eye, only one stimulus is usually seen at a time. The stimuli presented to the left and right eyes are perceived alternately, one after the other, rather than simultaneously. Therefore, if the left and right eyes are designated as two separate channels, rivalry would make it impossible for them to be used simultaneously, thus making the study of simultaneous information processing in visual channels impossible.

Kahneman (1973) also notes the difficulty of defining a visual channel. He suggests, for example, that color or size could define a channel in vision, but that it would be difficult to apply this idea to complex stimuli or to areas of a large field of vision.

Goldstein suggests that one alternative is to consider an area in space, such as a particular screen or screen area, as a visual channel. He suggests that:

> ... the right screen would be channel 1, and the left, channel 2. The visual analog of an auditory attention experiment in which two verbal messages are presented simultaneously would then occur when two narrative films, or slide presentations, are shown side by side (Goldstein, 1975, p. 48).

Goldstein points out, however, that multi-image presentations often lack the linearity which characterize information in auditory channels, thus ruining the analogy. He concludes that the best solution is to abandon the term "channel" in discussing vision in favor of the term "input."

Recent studies of simultaneous visual inputs have produced the following information:

1. Two detailed stimuli which are separated by a visual angle cannot be processed simultaneously due to the physiological limitations imposed by the small area of foveal vision. Although some simultaneous perception is possible through peripheral vision, it is limited to detection of crude information (Edwards & Goolkasian, 1974).

2. Under some experimental conditions, a number of stimuli can be processed simultaneously in areas of the visual field only slightly larger than the fovea (Egeth, Jonides, & Wall, 1972).

3. Two different stimuli can be presented simultaneously to the right and left eyes, but they cannot be perceived simultaneously due to retinal rivalry (Moray, 1970).

4. Two different stimuli can be presented simultaneously to both eyes via superimposure, but it is very difficult to perceive them simultaneously. The details of one stimulus are difficult to perceive while attending to the other (Goldstein, 1975).

5. It is possible to present a stimulus that can result in two different perceptions. Two such stimuli are the Necker cube and Rubin's well-known example of reversible figure/ground in which the stimulus can be perceived as either a single vase or two faces. In either case, it is not possible to perceive both configurations simultaneously. Instead, one moves back and forth between the two perceptions (Attneave, 1971).

Goldstein summarizes the research on simultaneous visual inputs as follows:

> ... all ... examples ... lead to the same conclusion: even when the stimuli are presented to the fovea simultaneously, it is difficult or impossible to perceive them simultaneously. Simultaneous perception of a number of visual inputs is not possible due to the nature of foveal vision (we can fixate only on one thing at a time) and the fact that even when stimuli can be presented to the fovea simultaneously we do not necessarily perceive them simultaneously. Thus, with the exception of the small amount of information which may enter through the peripheral visual field ... and situations where small, nonoverlapping stimuli are presented to the fovea ..., it is not possible for multiple images to be perceived simultaneously. Visual input must, therefore, occur sequentially, with the bulk of visual information entering through the almost constantly moving fovea. This means that while it is not strictly possible to see two things 'at once,' nearly simultaneous vision can be accomplished by rapidly switching attention from one part of the visual field to another with eye and head movements (Goldstein, 1975, p. 51).

Goldstein (1975) states that how rapidly a viewer must move his eyes from one area of the screen to another in order to perceive all the information being presented has not yet been established. He points out the need for research in this area, and suggests the following as possible factors influencing the needed speed of movement:

1. the rate at which information is presented
2. the information content of the visual stimuli
3. how much of the presented information must be processed in order to extract the "meaning" of the display

Remembering pictorial information. Even if it is possible to perceive scenes covering large areas by foveal scanning and peripheral vision, it must be determined whether the perceived information can be remembered. This necessitates a consideration of research relating to the retention of pictorial information. Several investigators (Nickerson, 1965;

Shepard, 1967; Standing, Conezio, & Haber, 1970) have shown that observers can recognize pictures which they have seen with an extremely high degree of accuracy (over 90% in all cases reported).

This excellent recognition does not occur equally well, however, under all conditions of presentation. In the experiments cited above, the subjects had at least five seconds to view each picture and were able to pay undivided attention to them. Loftus (1972) found that when subjects are required to perform a distracting task while viewing pictures, their later recognition of the pictures is reduced considerably. Standing et al. (1970) and Potter and Levy (1969) found that while subjects could remember pictures with over 90% accuracy when they viewed the pictures for one or two seconds, their performance dropped off rapidly with shorter exposures. The results of Potter and Levy's experiments are shown in Figure 2.

While subjects can apparently recognize pictures they have seen for a relatively brief time, studies by Haber and Erdelyi (1967) and Haber (1970) show that longer exposure times are necessary if the task is recall of details of the pictures or if the pictures transmit complex ideas.

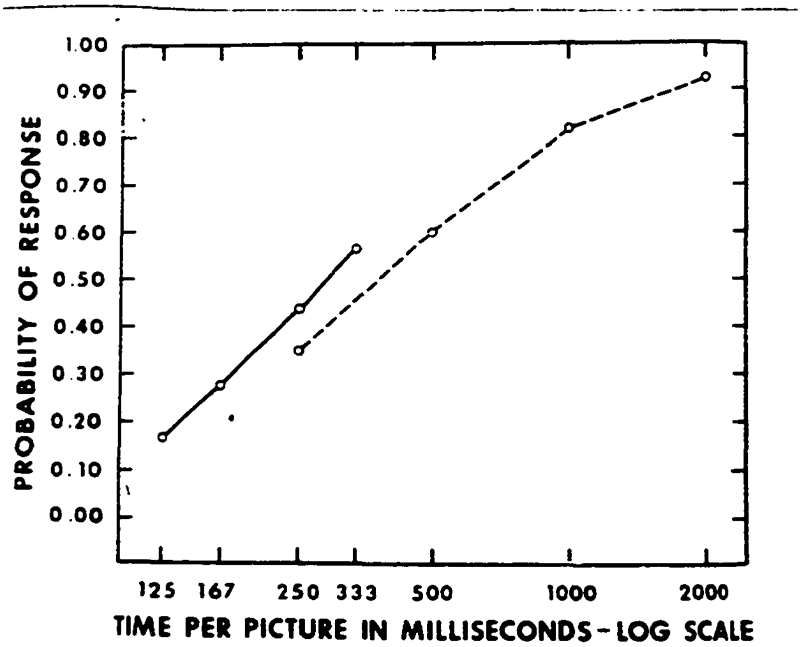

Figure 2. Results of Potter and Levy Experiment.

The data points represent the probability that a picture originally presented would be correctly identified when presented a second time along with other "distractor" pictures which had not been previously presented. The solid and dashed lines represent two different groups of subjects (Potter and Levy, 1969, adapted by Goldstein, 1975).

CHAPTER III

METHODOLOGY

This study is an experimental investigation of the relationship between the cognitive style variable of perceptual type and the treatment variable of linear versus multiple image presentation on a comparative visual location task. This chapter outlines the methodology which was used to conduct the experiment.

Subjects for the Study

The subjects for the study were a group of 200 undergraduate students enrolled in courses in Education at the University of Oklahoma. All subjects used were volunteers. They ranged in age from 19 to 28 years.

Testing Instruments Used

The 200 subjects were administered a battery of three tests. All the tests were either original tests developed by Lowenfeld (1945) for identifying individuals of the visual and haptic perceptual types or variations based on Lowenfeld's tests.

The first test administered to the subjects was Successive Perception Test I. This test (United States Army Air Corps, 1944), which is in motion picture form, was developed by Gibson and associates for use in the World War II Aviation Psychology Program as a part of the pilot selection and training program. Successive Perception Test I is very similar to Lowenfeld's Integration of Successive Impressions (Lowenfeld, 1945). It is based on the same rationale and construct, and is, in fact, a refined version of the Lowenfeld test. The primary distinction between individuals with visual and haptic perception which serves as the basis for both the Lowenfeld test and for Successive Perception Test I is that while visuals have the tendency and ability to integrate partial perceptions into a whole, haptics are satisfied to internalize the separate segments of partial impressions and show neither tendency nor ability to integrate them into whole units.

Successive Perception Test I consists of 38 items: three practice items and 35 actual test items. In each item the subject is shown a pattern a small section at a time behind a moving slot. He is then shown five similar variants from which he must select the one which matches the pattern he saw behind the slot. Figure 3 shows an item of the type used in Successive Perception Test I. Subjects were asked to indicate their response on each item by circling the appropriate letter on an answer sheet. Appendix A shows a sample of the answer sheet used for the administration of Successive Perception Test I.

Successive Perception Test I was developed originally for use in the Army Air Corps cadet program and has been used extensively in that context. It has also been used several

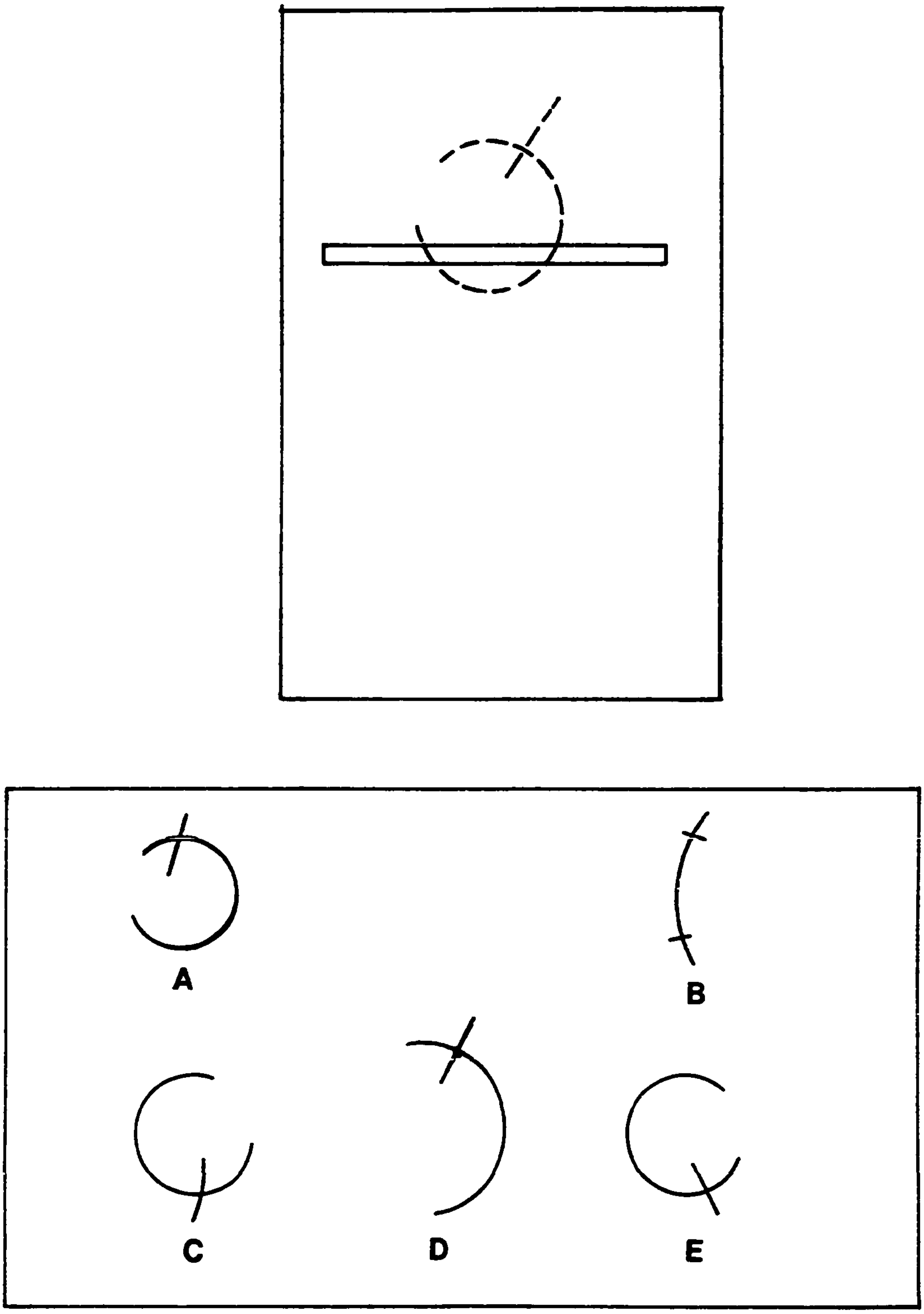

Figure 3. Sample item of the type used in *Successive Perception Test I*

times in educational research dealing with perceptual type and visual aptitude with students ranging from seventh grade to university level (Erickson, 1966 and 1969; Clark, 1971; Bruning, 1974). It was used in pilot research for the present study (Ausburn, F. B., 1975) as a measure of perceptual type. Bruning (1974) states that Gibson reported the reliability of Successive Perception Test I to be .56. The author of the present study measured the test-retest reliability of the instrument, using 80 subjects and a test-retest interval of six weeks. The reliability was found to be .68, which is higher than that previously reported by Gibson.

The second test administered to the subjects was Lowenfeld's Visual-Haptic Word Association Test (Lowenfeld, 1945). This test is composed of 20 words, each of which elicits visual and haptic responses equally well. The subject is given the list of words and asked to react to each word with the first association which comes to mind. Appendix B shows the test in its entirety.

The Visual-Haptic Word Association Test was administered to the subjects and scored according to procedures established by Lowenfeld (1945). The subjects were asked to write their responses. A visual response was defined as an association, such as "climb/mountain", in which a visual object was given as the association. Such an association conveys an objective, visual perception of an external object. A haptic response was defined as an association, such as "climb/difficult", in which a muscular, physical, kinesthetic, or emotional word was given as the association. Such an association conveys a subjective and physical involvement and a kinesthetic, internal orientation rather than a visual, external one.

The third test administered to the subjects was one version of Lowenfeld's Test of Subjective Impressions (Lowenfeld, 1945). The test is a simple drawing task in which the subject is asked to draw two things: a table with a glass on top, and a table with a chessboard on top. This Draw-a-Table Test was scored according to procedures established by Lowenfeld (1945). A visual drawing was defined as objective, with the table drawn in proper perspective. Most visual responses were side-views of the table and were complete with legs. A haptic drawing was defined as subjective, with emphasis on the glass or chessboard as if using the item personally. In haptic drawings, perspective was ignored and the subject related himself to the object on the table. Figure 4 shows typical visual and haptic drawings.

Procedures

The subjects were administered all three tests for perceptual type by the same test administrator (the author). All tests were administered to the subjects in groups, ranging in size from 14 to 22 persons. Successive Perception Test I was administered via a video tape made from the black and white motion picture version. The subjects were classified as visual, haptic, or indefinite in perceptual type on each of the three tests according to procedures developed by Lowenfeld

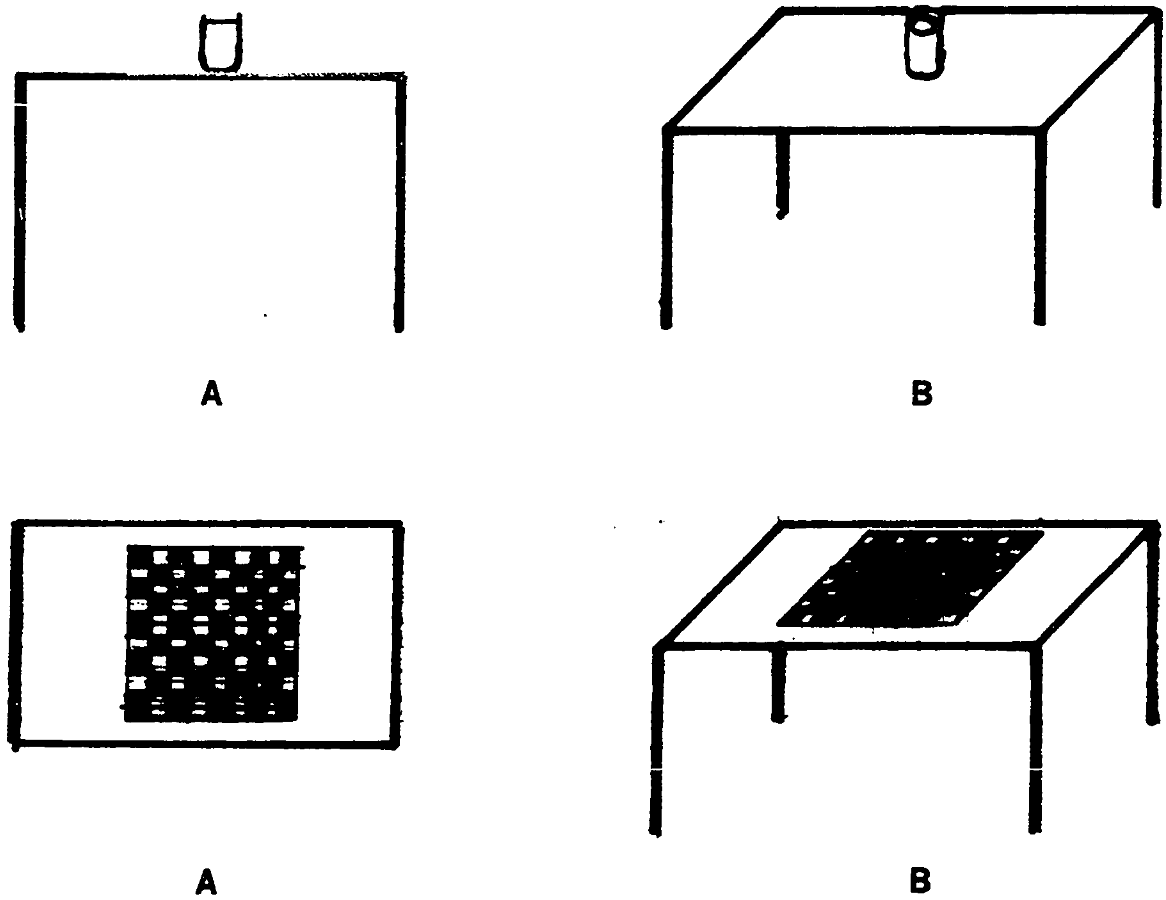

Figure 4. Examples of typical haptic (A)
and visual (B) responses
on the drawing task

(1945). Subjects who scored 60% or more items correct on Successive Perception Test I were classified as visual on that instrument; subjects who scored 60% or more items incorrect were classified as haptic. Subjects who gave at least 12 visual responses on the word association test were classified as visual on that instrument; subjects who gave at least 12 haptic responses were classified as haptic. Subjects who made at least one visual response and no haptic responses on the drawing task were classified as visual on that instrument; subjects who made at least one haptic response and no visual responses were classified as haptic.

Subjects who were classified as visual on all three instruments were identified as visuals for the purposes of this study (N = 96). Subjects who were classified as haptic on all three instruments were identified as haptics for the purposes of this study (N = 45). A chi-square test for goodness-of-fit was performed using the following formula:

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

This test revealed that the obtained distribution of perceptual types (visuals, 48%; haptics, 22.5%; indefinites, 29.5%) was not significantly different from the approximate theoretical distribution of perceptual types posited by Lowenfeld (visuals, 50%; haptics, 25%; indefinites, 25%). The results of the chi-square test are summarized in Table 1.

Table 1

Chi-square Test for Goodness-of-Fit on Obtained and Expected Distributions of Perceptual Types

PERCEPTUAL TYPE	EXPECTED N	OBTAINED N
Visual	100	96
Haptic	50	45
Indefinite	50	59
	TOTAL N = 200	
	df = 2	
	$X^2 = 2.28$*	

* $.50 > p > .30$

From the visual and haptic groups, 40 visuals and 40 haptics were selected at random through the use of a random number table (Glass & Stanley, 1970). Each group of 40 was then randomly split into two groups of 20. One group of 20 visuals (ELV) and one group of 20 haptics (ELH) was then randomly selected to receive linear image presentation of the experimental task. The other two groups of 20 visuals (EMV) and 20 haptics (EMH) were designated as the recipients of multiple image presentation of the experimental task. Figure 5 shows the design of the experiment.

The experimental task for the study was a comparative visual location task. It was designed to test the subjects'

	VISUAL	HAPTIC
LINEAR IMAGE PRESENTATION OF TASK	ELV N = 20	ELH N = 20
MULTIPLE IMAGE PRESENTATION OF TASK	EMV N = 20	EMH N = 20

Figure 5. Design for Experimental Procedures

ability to view three pictures (35 mm color slides) of a complex piece of equipment. These pictures were an extreme close-up, a medium shot, and an over-all shot of the entire piece of equipment. The subjects then were required to locate on a fourth over-all picture a specific criterion item (button, knob, etc.) which had been identified in the first (close-up) picture with an arrow. The test required the subjects to compare the visual location cues found in each of three pictures in order to make the required location identification response on the fourth picture. Appendix C shows examples of pictorial stimuli used in the linear and multiple image presentations of the experimental task.

ELV and ELH received a sequential linear presentation of the three stimulus pictures. The pictures were presented as colored 35 mm photographic slides. The first slide of each piece of equipment showed a tight close-up of the criterion item (button, knob, dial, etc.) on the equipment which was identified by an arrow. This arrow was present only in this first close-up slide for each item. The second slide showed a medium shot of the equipment, and the third showed an over-all shot of the entire piece of equipment. The slides were projected sequentially by a single Carousel projector. Each slide was displayed on the screen for three seconds. This viewing time is well within the time range which research has established as necessary for the eye fixations necessary for recall of detail in pictorial stimuli (see Review of Literature, pages 61 and 62). A pilot study (Ausburn, F. B., 1975) also demonstrated this viewing time to be long enough to allow satisfactory performance on the task, but short enough to make the task discriminating. It was therefore retained in the present study.

The total viewing time for each series of slides (each task item) was nine seconds. The entire experimental task consisted of 16 items, each requiring three separate slides.

After the three slides for each item were viewed by the subject, the projector was turned off, and the subject was given a black and white photographic print of the piece of equipment he had seen in the slides. He was asked to point to the criterion item on the equipment which had been identified in the first close-up slide by an arrow.

EMV and EMH received a multiple image rather than a linear image presentation of the experimental task. Each subject was shown the same slides that were shown to the subjects in ELV and ELH, but the slides for each task item were presented simultaneously by three separate projectors rather than sequentially by a single projector. All three slides for each task item were shown simultaneously for nine seconds. After viewing the slides for each item, the subject was given the same photograph used in the linear presentation and asked to point to the criterion item on the equipment.

The total viewing time for the three slides on each item was identical for the linear and multiple image presentations (nine seconds). No attempt was made, however, to ascertain if subjects receiving the multi-image presentation spent three seconds of viewing time on each of the three slides per item. It was not the purpose of this study to attempt to equate a multiple and linear image presentation on the basis of absolute viewing time spent by a viewer on each single image. It is considered by the author to be an inherent advantage of simultaneous multi-imagery that the viewer is free to selectively deploy his attention among the images presented to him as he finds necessary and efficient. Removal of this aspect of multi-imagery is therefore viewed as removal of a characteristic inherent in the medium. Therefore, the only attempt at equating the viewing time for the multiple and linear image presentations of the experimental task in this study was the equating of the total time allowed for viewing all images in each task item.

For all subjects, record was made of performance on the experimental task. Two performance variables were recorded:

the correctness or incorrectness of each location response, and the response latency for each item. A total number of correct responses (score) and a mean response latency were then computed and recorded for each subject. These served as the dependent measures in the data analysis. Appendix D shows an example of the score sheet used in the experiment.

Statistical Design

The analysis of the data obtained in this study was performed in two separate 2 x 2 analyses of variance of completely randomized factorial design. Dependent variables were two measures of performance on the experimental task. One analysis of variance was used to test hypotheses one, two, and three dealing with scores on the experimental task. The second analysis of variance was used to test hypotheses four, five, and six dealing with mean latencies on the experimental task. Figure 6 shows the statistical design for both analyses of variance.

For both analyses, the independent measures were presentation mode (linear and multiple imagery - Factor A) and perceptual type (visual and haptic - Factor B). There were two levels of each factor. In one analysis, the dependent measure was number of correct responses (score) on the experimental task. For the second analysis, the dependent measure was mean response latency on the experimental task.

FACTOR A, PRESENTATION MODE	FACTOR B, PERCEPTUAL TYPE	
	VISUAL (1)	HAPTIC (2)
(1) LINEAR IMAGERY	X_{111} X_{112} X_{113} . . . X_{1120}	X_{121} X_{122} X_{123} . . . X_{1220}
(2) MULTIPLE IMAGERY	X_{211} X_{212} X_{213} . . . X_{2120}	X_{221} X_{222} X_{223} . . . X_{2220}

Figure 6. Statistical design for 2 x 2 completely randomized factorial analysis of variance

CHAPTER IV

STATISTICAL ANALYSIS OF THE DATA

The data was analyzed in two separate 2 x 2 facotrial ANOVA's of completely randomized design. One ANOVA was used to test hypotheses one, two, and three. The dependent measure was score on the experimental task. The second ANOVA was used to test hypotheses four, five, and six. The dependent measure was mean response latency on the experimental task.

Test of Hypotheses 1, 2, and 3

The following hypotheses were tested in a two-way analysis of variance:

H_{01}: There is no difference between scores made by visuals and haptics on a comparative visual location task.

H_1: Visuals make higher scores than haptics on a comparative visual location task.

H_{02}: There is no difference between scores made on a comparative visual location task with a multiple image and a linear image presentation.

H_2: Scores are higher on a comparative visual location task with a multiple image presentation than with a linear image presentation.

H_{03}: There is no interaction of aptitude and treatment on scores on a comparative visual location task with multiple and linear image presentations.

H_3: There is an ordinal interaction of aptitude and treatment on scores on a comparative visual location task with multiple and linear image presentations.

Score was defined as the number of correct responses made by each subject on the experimental task. Appendix E shows the raw data for the scores of the four experimental groups. Table 2 shows the row, column, and cell means on the score variable.

Table 2

Row, Column, and Cell Means on Score Variable

	VISUAL	HAPTIC	
LINEAR IMAGE PRESENTATION	CELL MEAN = 13.30	CELL MEAN = 9.90	ROW MEAN = 11.52
MULTIPLE IMAGE PRESENTATION	CELL MEAN = 15.30	CELL MEAN = 14.00	ROW MEAN = 14.65
	COLUMN MEAN = 14.22	COLUMN MEAN = 11.95	

Figure 7 presents the cell means graphically, making the score differences between visuals and haptics and between recipients of multiple and linear image task presentations readily apparent. The analysis of variance showed that these differences are significant beyond the .001 level (F for perceptual type = 53.682, df = 1,79, $p < .001$; F for treatment = 101.287, df = 1,79, $p < .001$). This allows the rejection of null hypotheses one and two and the acceptance of alternate hypotheses one and two. The analysis also showed an interaction of perceptual type and treatment which is significant at the .003 level (F = 9.859, df = 1,79, p = .003). This allows the rejection of null hypothesis three. Examination of Figure 7 shows that the interaction is ordinal in nature. This allows the acceptance of alternate hypothesis three. Table 3 shows a summary of the analysis of variance.

Table 3
Analysis of Variance for Scores on Experimental Task

SOURCE	SS	df	MS	F
Perceptual Type	103.516	1	103.516	53.682*
Treatment	195.313	1	195.313	101.287*
Type x Treatment	19.012	1	19.012	9.859**
Error	146.551	76	1.928	
TOTAL	464.391	79		

*$p < .001$
**p =.003

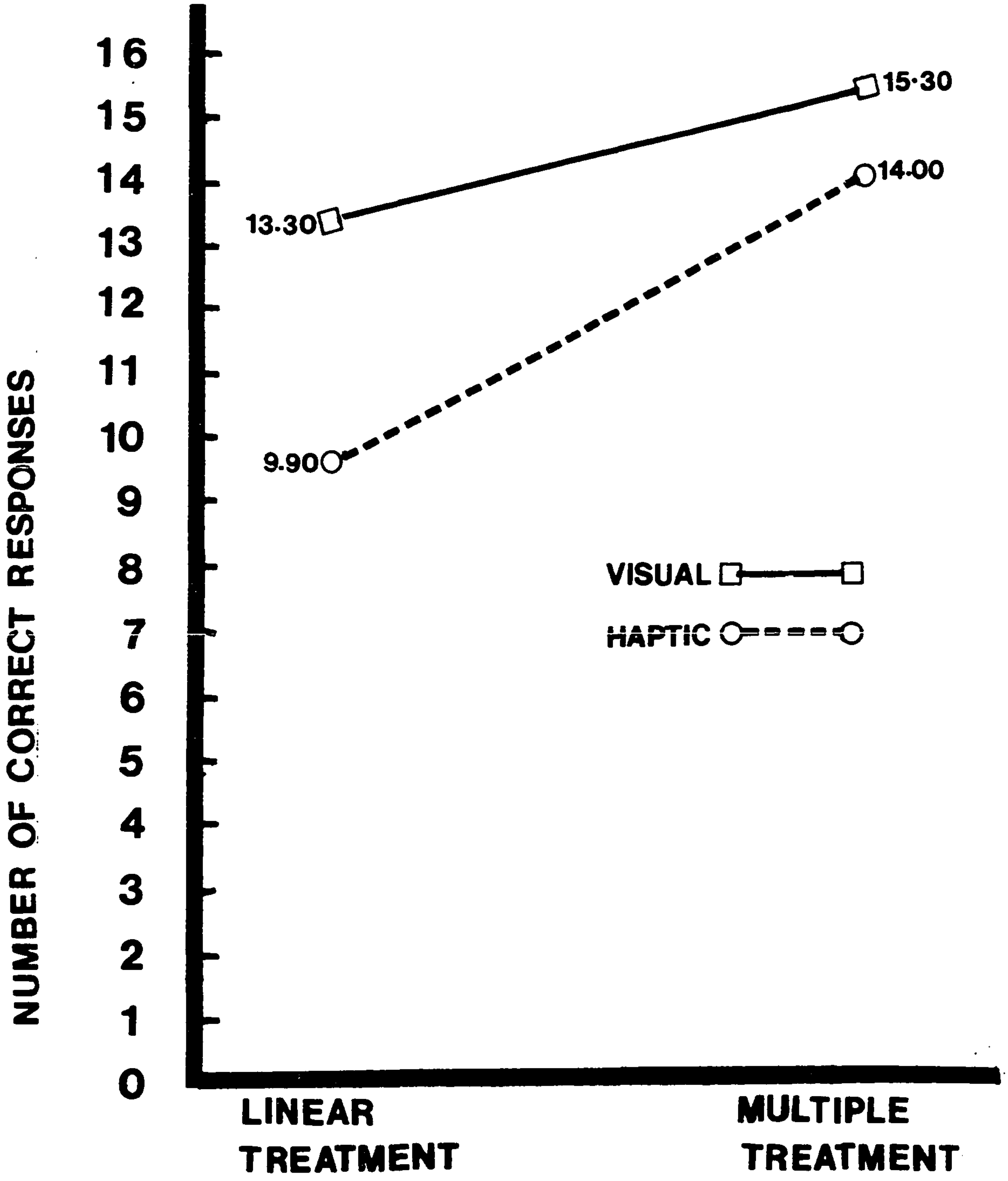

Figure 7. Graph of cell means on score variable

The presence of a significant interaction in the analysis of variance makes the main effects uninterpretable without the computation of tests for simple main effects. Kirk (1968) states that the purpose of tests for simple main effects is to test the significance of each factor at *each level* of the other factor. This is necessary when a significant interaction of factors is present. Thus, in an analysis laid out as follows:

		B	
		b_1	b_2
A	a_1		
	a_2		

the analysis of variance tests only the significance of the difference between a_1 and a_2 at *both* (not each) levels of B and the difference between b_1 and b_2 at *both* levels of A. Tests for simple main effects test the significance of the difference between each of the following:

a_1 and a_2 at b_1

a_1 and a_2 at b_2

b_1 and b_2 at a_1

b_1 and b_2 at a_2

The sums of squares for each test of simple main effects "contains a portion of the corresponding interaction" (Kirk, 1968, p. 180). Table 4 shows the summary table which served as the basis for these tests.

Table 4
AB Summary Table for Tests for Simple Main Effects
(adopted from Kirk, 1968, p. 180)

	b_1	b_2	
a_1	$\sum X = 263$	$\sum X = 198$	$\sum XB$ at a_1 = 461
a_2	$\sum X = 306$	$\sum X = 280$	$\sum XB$ at a_2 = 586

$\sum XA$ at $b_1 = 569$ $\sum XA$ at $b_2 = 478$

$\sum X$ = sum of scores in cell
a_1 = linear image treatment
a_2 = multiple image treatment
b_1 = visual perceptual type
b_2 = haptic perceptual type
n/cell = 20

The sum of squares for each test of simple main effects was computed with the following formulae given by Kirk (1968, p. 180):

$$SS_A \text{ at } b_1 = \sum_{1}^{p} \frac{(AB_{i1})^2}{n} - \frac{(\sum_{1}^{p} B_{i1})^2}{np}$$

$$SS_A \text{ at } b_2 = \sum_{1}^{p} \frac{(AB_{i2})^2}{n} - \frac{(\sum_{1}^{p} B_{i2})^2}{np}$$

$$SS_B \text{ at } a_1 = \sum_{1}^{q} \frac{(AB_{1j})^2}{n} - \frac{(\sum_{1}^{q} A_{1j})^2}{np}$$

$$SS_B \text{ at } a_2 = \sum_{1}^{q} \frac{(AB_{2j})^2}{n} - \frac{(\sum_{1}^{q} A_{2j})^2}{np}$$

p = number of levels of A
q = number of levels of B
n = number of scores/cell

Using these formulae and the data from the summary table (Table 4), the sums of squares were computed as follows:

$$SS_A \text{ at } b_1 = \frac{(263)^2}{20} + \frac{(306)^2}{20} - \frac{(569)^2}{40}$$

$$= 3458.45 + 4681.80 - 8094.02$$

$$= 46.23$$

$$SS_A \text{ at } b_2 = \frac{(198)^2}{20} + \frac{(280)^2}{20} - \frac{(478)^2}{40}$$

$$= 1960.20 + 3920.00 - 5712.10$$

$$= 168.10$$

$$SS_B \text{ at } a_1 = \frac{(263)^2}{20} + \frac{(198)^2}{20} - \frac{(461)^2}{40}$$

$$= 3458.45 + 1960.20 - 5313.02$$

$$= 105.63$$

$$SS_B \text{ at } a_2 = \frac{(306)^2}{20} + \frac{(280)^2}{20} - \frac{(586)^2}{40}$$

$$= 4681.80 + 3920.00 - 8584.90$$

$$= 16.90$$

These sums of squares were then combined with data from the original analysis of variance and used to produce the total ANOVA table shown in Table 5.

Kirk makes the following comments on the level of significance (α) involved in tests for simple main effects:

> The procedure recommended for such tests is to assign the same per family error rate to the simple main-effects tests as that allotted to the over-all F ratio. This can be accomplished by testing each of the simple main-effects ratios for treatments A and B at α/q ... and α/p ... levels of significance, respectively. This procedure divides the over-all α for a main-effects test evenly among the <u>collection</u> of simple main-effects tests.
>
> An examination of contemporary research practices as described in the scientific literature clearly shows that many experimenters prefer to adopt the individual simple main-effects hypotheses as the conceptual unit for error rate. .... Although the error rate for each simple main-effects hypothesis is equal to α, the error rate per family of tests is $(p)(\alpha)$ for ... A and $(q)(\alpha)$ for ...B (Kirk, 1968, p. 181).

Table 5
Analysis of Variance for Scores on Experimental Task, Including Tests for Simple Main Effects
(Adapted from Kirk, 1968, p. 181)

SOURCE	SS	df	MS	F
A (Row, Treatment)	195.313	1 (p-1)	195.313	101.287*
A at b_1	46.23	1 (p-1)	46.23	23.978*
A at b_2	168.10	1 (p-1)	168.10	87.189*
B (Column, Perceptual Type)	103.516	1 (q-1)	103.516	53.682*
B at a_1	105.63	1 (q-1)	105.63	54.787*
B at a_2	16.90	1 (q-1)	16.90	8.766**
A x B (Interaction)	19.012	1 (p-1)(q-1)	19.012	9.859**
Error	146.551	76 (pq)(n-1)	1.928	
TOTAL	464.391	79		

*$p < .001$
**$p < .005$

The former procedure was selected by the author for this study. The alpha-level selected for the study was .01. Therefore the necessary significance level for each test of simple main effects was equal to .01/2, or .005. Since all tests for simple main effects were significant beyond the .005 level (see Table 5 above), it was concluded that:

a_1 (linear imagery) is different from a_2 (multiple imagery at b_1 (visuals)

a_1 (linear imagery) is different from a_2 (multiple imagery at b_2 (haptics)

b_1 (visual) is different from b_2 (haptic) at a_1 (linear imagery)

b_1 (visual) is different from b_2 (haptic) at a_2 (multiple imagery)

Test of Hypotheses 4, 5, and 6

The following hypotheses were tested in a second two-way analysis of variance:

H_{04}: There is no difference between mean latencies made by visuals and haptics on a comparative visual location task.

H_4: Visuals make lower mean latencies than haptics on a comparative visual location task.

H_{05}: There is no difference between mean latencies on a comparative visual location task with a multiple image and a linear image presentation.

H_5: Mean latencies are lower on a comparative visual location task with a multiple image presentation than with a linear image presentation.

H_{06}: There is no interaction of aptitude and treatment on mean latencies on a comparative visual location task with multiple and linear image presentations.

H_6: There is an ordinal interaction of aptitude and treatment on mean latencies on a comparative visual location task with multiple and linear image presentations.

Mean latency for each subject was defined as the mean time to respond on the experimental task. Appendix E shows the raw data for the mean latencies of the four experimental groups. Table 6 shows the row, column, and cell means on the latency variable.

Table 6
Row, Column, and Cell Means on Latency Variable

	VISUAL	HAPTIC	
LINEAR IMAGE PRESENTATION	CELL MEAN = 3.35	CELL MEAN = 5.42	ROW MEAN = 4.39
MULTIPLE IMAGE PRESENTATION	CELL MEAN = 1.82	CELL MEAN = 3.15	ROW MEAN = 2.43
	COLUMN MEAN = 2.59	COLUMN MEAN = 4.24	

Figure 8 presents the cell means graphically, making the mean latency differences between visuals and haptics and be-

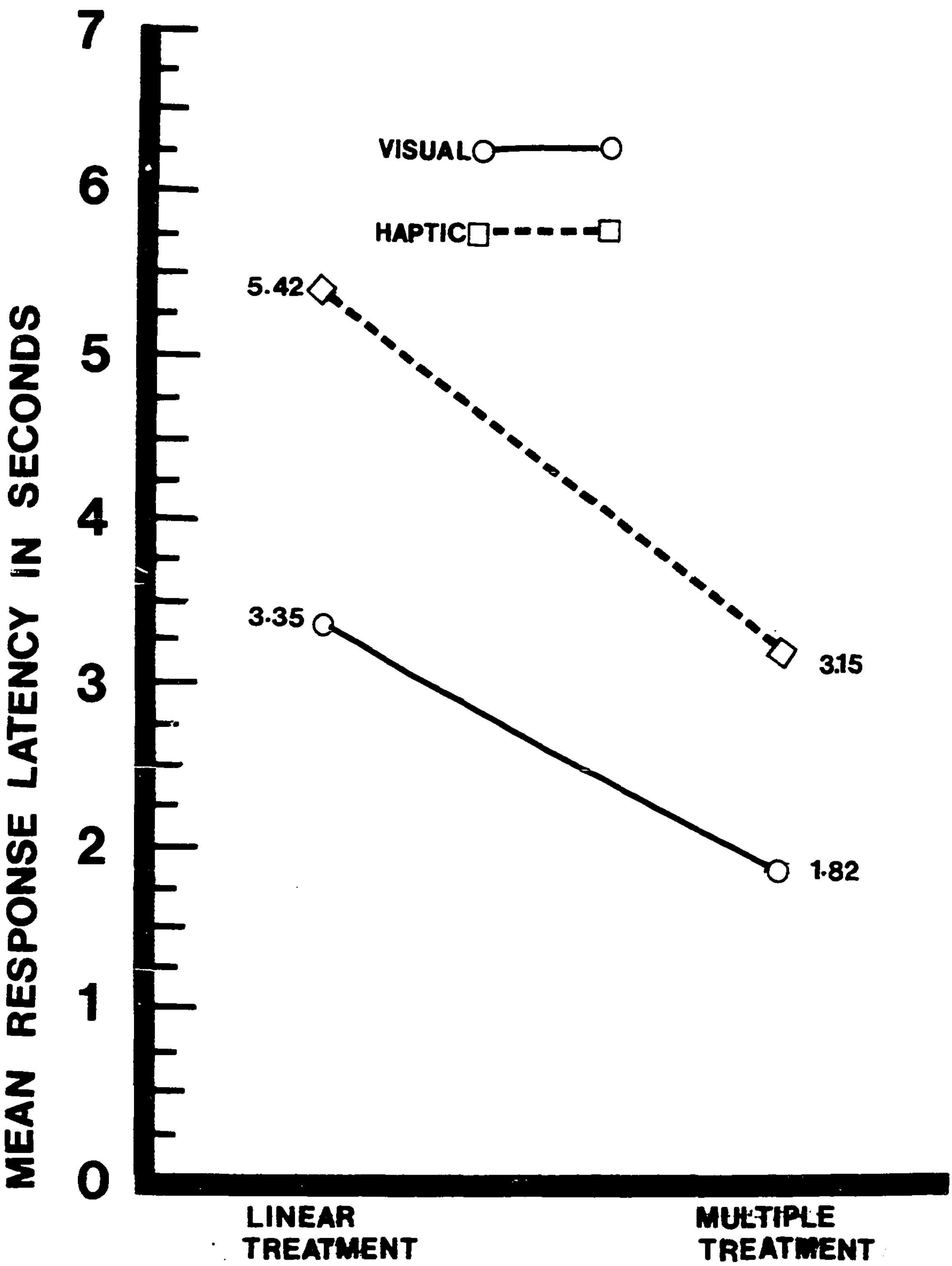

Figure 8. Graph of cell means on latency variable

tween recipients of multiple and linear image task presentation readily apparent. The analysis of variance showed that these differences are significant beyond the .001 level (F for perceptual type = 26.180, df = 1,79, $p < .001$; F for treatment = 36.958, df = 1,79, $p < .001$). This allows the rejection of null hypotheses four and five and the acceptance of alternate hypotheses four and five. The analysis also showed no significant interaction of perceptual type and treatment (F for interaction = 1.719, df = 1,79, p = .19). This supports the retention of null hypothesis six. Table 7 shows a summary of the analysis of variance.

Table 7
Analysis of Variance for Mean Latencies on Experimental Task

SOURCE	SS	df	MS	F
Perceptual Type	54.291	1	54.291	26.180*
Treatment	76.642	1	76.642	36.958*
Type x Treatment	3.565	1	3.565	1.719**
Error	157.605	76	2.074	
TOTAL	292.102	79		

*$p < .001$
**p = .19

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER RESEARCH

Summary

The study here reported represents an experimental investigation into the relationship between the cognitive style variable of perceptual type and the treatment variable of linear versus multiple imagery on a comparative visual location task.

A group of 200 undergraduate students were administered a battery of three measures of perceptual type as defined by Lowenfeld's visual-haptic typology. These three measures were Successive Perception Test I, Lowenfeld's Visual-Haptic Word Association Test, and one version of Lowenfeld's Test of Subjective Impressions. Subjects who were identified as visual on all three instruments were classified as visuals for the purposes of this study (N = 96). Subjects who were identified as haptic on all three instruments were classified as haptic for the purposes of this study (N = 45). Forty visuals and forty haptics were selected at random and then randomly assigned to receive linear and multiple image presentations of an experimental task.

The experimental task was designated a comparative visual location task. This task involved the viewing of a group of three successively wide-angle photographic slides of a complex piece of equipment and the subsequent utilization of visual location cues to identify the location of a criterion item on a fourth picture. The entire task consisted of 16 such items.

One group of visuals and one group of haptics received a linear image presentation of the task in which the three slides for each task item were presented sequentially by a single projector. The other two groups received a multiple image presentation in which each group of three slides were presented simultaneously by three separate projectors. The total viewing time for the three slides of each task item was identical for the linear and multiple image presentations (nine seconds).

Two dependent measures were obtained from the experimental task. The two measures were score (defined as the number of correct responses), and mean latency (defined as the mean time to respond). These two measures were analyzed in two separate 2 x 2 factorial analyses of variance. All hypotheses were tested at the .01 level of significance.

The first ANOVA tested the differences between visuals and haptics and between recipients of linear and multiple image presentations on the score variable. Although significant main effects were found for both perceptual type and image treatment, a significant interaction of the two factors was also found. This made the main effects uninterpretable until tests for simple main effects were computed.

After tests for simple main effects were computed, the following findings were obtained concerning the score variable:

1. Visuals made higher scores on the comparative visual location task than haptics with linear image treatment.

2. Visuals made higher scores on the comparative visual location task than haptics with multiple image treatment.

3. Visuals made higher scores on the comparative visual location task with multiple image treatment than with linear image treatment.

4. Haptics made higher scores on the comparative visual location task with multiple image treatment than with linear image treatment.

5. There was an ordinal interaction of perceptual type and image treatment on the scores on the comparative visual location task.

An examination of the graph of the cell means on the score variable (Figure 7, p. 80) indicates that the interaction of perceptual type and image treatment is ordinal in nature rather than disordinal; that is, the graph lines do not cross. The interaction was there interpreted as an indication that <u>both</u> visuals and haptics benefited from multiple image task presentation. Both perceptual types made higher scores on the experimental task with multiple image presentation than with linear image presentation. Visuals therefore obtained higher scores than haptics with both presentation treatments. Haptics, however, benefited more than visuals from multiple image presentation, as indicated by the steeper rise in the graph line for haptics. This fact accounts for the significant interaction found in the analysis of variance (Glass and Stanley, 1970).

A second 2 x 2 factorial analysis of variance tested the differences between visuals and haptics and between recipients of linear and multiple image presentations on the mean latency variable. This analysis produced significant main effects on both perceptual type and image treatment and no significant interaction. The following findings were obtained:

1. Visuals made lower mean latencies than haptics on the comparative visual location task.

2. Mean latencies were lower on the comparative visual location task with multiple image treatment than with linear image treatment.

3. There was no interaction of perceptual type and image treatment on mean latencies on the comparative visual location task.

Conclusions and Implications

Although generalization of the findings of the present study is limited by the nature of the sample used, there are three major conclusions that emerge from the findings here reported:

1. Visuals perform better than haptics on a comparative visual location task such as the experimental task reported in this study. They perform better in terms of both score and mean latency; that is, they give more correct responses and do so more quickly than haptics.

2. Performance is better on this type of task when simultaneous multiple imagery is used than when sequential linear imagery is used. Superior performance occurs on both score and mean latency variables; that is, more correct responses are given, and given more quickly, with multiple imagery than with linear imagery.

3. Although both visuals and haptics perform better with multiple than with linear imagery, haptics show the greater benefit. This is especially true on the score, or number of correct responses, variable.

Several implications arise from these conclusions which appear to the author to be of importance:

1. The findings of this study are consistent with the expectations which stem from Lowenfeld's theoretical construct of a visual-haptic perceptual typology. Lowenfeld's conceptualization of visual and haptic perception definitely supports the hypothesis that visuals should perform better than haptics on a visual task such as the one used in this study. The results obtained from this study bear out this hypothesis, thus lending support to Lowenfeld's proposed typology.

2. The findings of this study lend empirical support to the superiority of multiple imagery in this specific task situation. While no generalized claim for the superiority of multiple imagery can be made from the findings reported here, the data does seem to indicate the superiority of multiple imagery for the specific task used in this study. Since

empirical support for the value of the multi-image format in a cognitive task situation has been scarce in the research, it is felt that the findings reported here represent a contribution to the available knowledge concerning the value of multi-imagery as an instructional tool.

3. The findings of this study imply the presence of supplantation, produced by the multiple image treatment. Supplantation of the mental process of retaining images for comparison by the use of simultaneous image presentation appears to have produced superior performance on the experimental task. This lends support to the existance of the supplantation process, indicates a specific advantage of multi-imagery, and supports the idea that supplantation can be produced through proper use of media to the benefit of learners.

4. The findings of this study imply that haptic learners can be benefited by the proper application of media. Several studies have isolated and studied aspects of haptic perception, but none were found which indicated instructional treatments which might interact with it for the learner's benefit.

Suggestions for Further Research

The study reported here appears to the author to generate several related areas of research. The first research recommendation is replication of the present study with subjects from various age groups. This is necessary to determine whether the results obtained in this study are generalizable to all age groups or whether there are upper and/or lower age limits for the observed results.

A second area of research which is recommended is a series of studies which investigate the use of multiple and linear imagery at various viewing time intervals and information density levels. The significant question to be answered by such studies is how much information can be compressed into how short a viewing time through the use of multiple imagery. Such studies could approach multi-imagery in a manner similar to compressed speech. They could eventually establish specific information density levels and viewing times for both linear and multiple imagery at which performance of specific types of tasks drops off for learners with specific perceptual characteristics and abilities. This could establish "compressed vision" principles parallel to those currently being established for compressed speech. Adjunct to these "compressed vision" studies might be a group of studies in which the results of combining visual and auditory compression are investigated. Such studies would combine the multi-image and compressed speech treatment variables.

There are several areas of research dealing with the visual-haptic perception variable which are also recommended. The first of these would represent an attempt to locate specific learning situations in which learners with visual or haptic perception have difficulty. It might, for example, be determined whether visuals, who tend to try to visualize non-visual experiences, have difficulty learning abstract concepts in algebra which are not visualized for them; while haptics, who cannot visualize abstractions, are content to learn nonvisualized abstract algebraic concepts but have difficulty with concepts in geometry which they cannot visualize. Research could probably locate numerous such learning tasks in which the presence or absence of visual aptitude plays an important role. A similar area of research which merits investigation is the consequence of pairing teachers of one perceptual type with learners of the other perceptual type. Research could determine whether this is detrimental to learners and whether teachers of one perceptual type can be trained to structure and present instruction for learners of the other type.

Another area of research which would be profitable is the isolation and identification of what mental processes need to be supplanted in order to assist learners with visual and haptic perception. After locating tasks with which each perceptual type encounters difficulty, the next step seems to be to identify what mental processes underlie these tasks. If these processes can be supplanted through the use of the proper medium of task presentation, the tasks should become less difficult for learners.

A final area of research should be the development and testing of specific instructional treatments which supplant specific mental processes which underlie tasks with which learners with visual or haptic perception have difficulty.

The research suggestions presented here represent not specific research questions, but rather a system of research which is interactive in nature and which might ultimately lead to a prescriptive body of theory in media utilization. By identifying specific interactions of learner perceptual characteristics, psychological task requirements, and media supplantation capabilities, it may be possible to develop a body of theory which would allow the accurate prediction of performance on a given task by a learner with given perceptual characteristics and a given mode of task presentation.

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APPENDIX A

ANSWER SHEET FOR SUCCESSIVE PERCEPTION TEST I

NAME ______________________________________

Circle the letter of the correct answer. ANSWER <u>ALL</u> ITEMS!

1.	A	B	C	D	E	21.	A	B	C	D	E
2.	A	B	C	D	E	22.	A	B	C	D	E
3.	A	B	C	D	E	23.	A	B	C	D	E
4.	A	B	C	D	E	24.	A	B	C	D	E
5.	A	B	C	D	E	25.	A	B	C	D	E
6.	A	B	C	D	E	26.	A	B	C	D	E
7.	A	B	C	D	E	27.	A	B	C	D	E
8.	A	B	C	D	E	28.	A	B	C	D	E
9.	A	B	C	D	E	29.	A	B	C	D	E
10.	A	B	C	D	E	30.	A	B	C	D	E
11.	A	B	C	D	E	31.	A	B	C	D	E
12.	A	B	C	D	E	32.	A	B	C	D	E
13.	A	B	C	D	E	33.	A	B	C	D	E
14.	A	B	C	D	E	34.	A	B	C	D	E
15.	A	B	C	D	E	35.	A	B	C	D	E
16.	A	B	C	D	E	36.	A	B	C	D	E
17.	A	B	C	D	E	37.	A	B	C	D	E
18.	A	B	C	D	E	38.	A	B	C	D	E
19.	A	B	C	D	E						
20.	A	B	C	D	E						

APPENDIX B

LOWENFELD'S VISUAL-HAPTIC WORD ASSOCIATION TEST

(Adapted from Lowenfeld, 1945)

Beside each word given below, write your immediage reaction to it. Please write your first impression.

greeting ______________________

walking ______________________

looking ______________________

climbing ______________________

talking ______________________

lifting ______________________

thinking ______________________

drawing ______________________

catching ______________________

hearing ______________________

pulling ______________________

swimming ______________________

riding ______________________

running ______________________

jumping ______________________

listening ______________________

reaching ______________________

touching ______________________

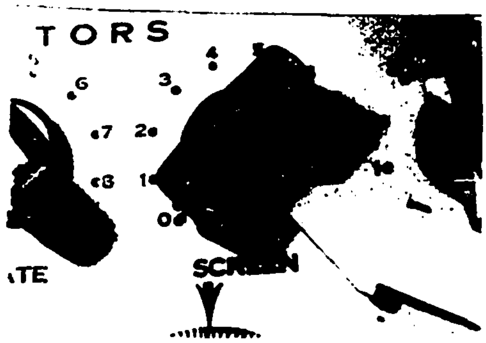
stretching ______________________

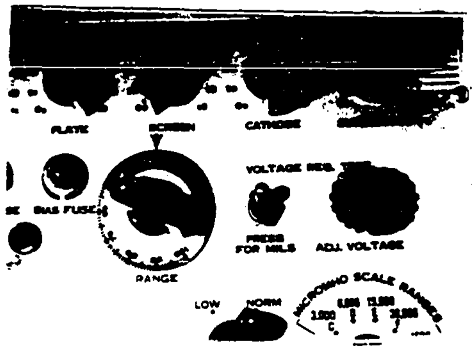
breathing ______________________

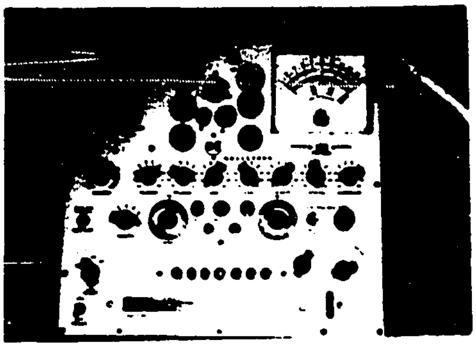
APPENDIX C

SAMPLE OF PRESENTATION OF EXPERIMENTAL TASK WITH LINEAR IMAGERY

These three images were presented sequentially, one at a time:

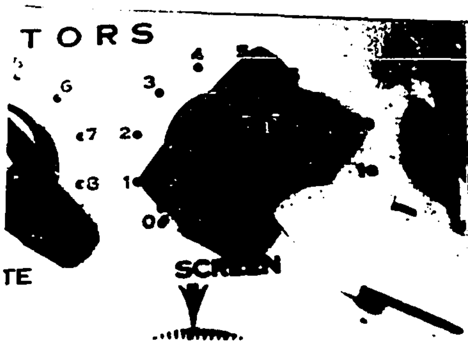


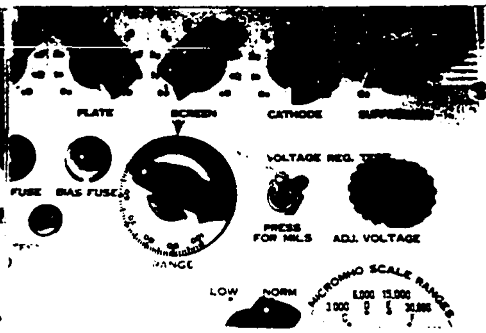


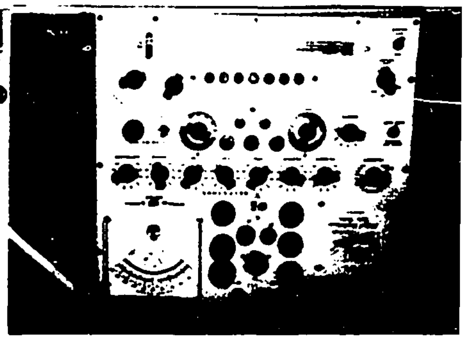


SAMPLE OF PRESENTATION OF EXPERIMENTAL TASK
WITH MULTIPLE IMAGERY

These three images were presented simultaneously:







APPENDIX D

SAMPLE SCORE SHEET FOR EXPERIMENTAL TASK

SUBJECT'S NAME ____________________

PERCEPTUAL TYPE __________ IMAGE TREATMENT __________

ITEM NUMBER	CORRECT/INCORRECT RESPONSE	LATENCY
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

TOTAL NUMBER CORRECT __________

MEAN LATENCY (Seconds) __________

APPENDIX E

RAW DATA ON EXPERIMENTAL TASK (SCORE VARIABLE)

(Scores have been ranked within each cell)

	VISUALS	HAPTICS
	10	8
	11	8
	11	8
	12	8
	12	8
	12	9
	13	9
	13	9
	13	10
	13	10
LINEAR	13	10
IMAGE	13	10
PRESENTATION	14	10
	14	10
	14	11
	14	11
	15	12
	15	12
	15	12
	16	13
	14	10
	14	12
	14	12
	15	13
	15	13
	15	14
	15	14
	15	14
	15	14
MULTIPLE	15	14
IMAGE	15	14
PRESENTATION	16	14
	16	14
	16	14
	16	14
	16	16
	16	16
	16	16
	16	16
	16	16

RAW DATA ON EXPERIMENTAL TASK (MEAN LATENCY VARIABLE)

(Scores have been ranked within each cell)

	VISUALS	HAPTICS
LINEAR IMAGE PRESENTATION	1.0	2.6
	1.5	2.9
	1.7	3.4
	1.9	3.8
	2.1	4.0
	2.1	4.6
	2.5	4.8
	2.8	4.8
	3.0	4.8
	3.0	5.1
	3.4	5.1
	3.7	5.3
	3.8	5.4
	3.9	5.4
	4.1	5.5
	4.2	6.2
	4.3	6.2
	4.9	8.2
	5.3	9.1
	7.9	11.3
MULTIPLE IMAGE PRESENTATION	.9	1.6
	1.0	2.1
	1.1	2.3
	1.1	2.5
	1.4	2.6
	1.4	2.6
	1.4	2.6
	1.4	2.6
	1.5	2.6
	1.5	2.7
	1.6	2.8
	1.6	3.0
	1.7	3.2
	1.8	3.3
	1.8	3.4
	1.9	3.4
	2.4	4.2
	2.9	4.3
	3.8	4.3
	4.2	4.8