

1984

The relationship of field dependent/field independent cognitive styles, stimuli variability and time factor on student achievement

Christopher Ivo Atang
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THE RELATIONSHIP OF FIELD DEPENDENT/FIELD INDEPENDENT
COGNITIVE STYLES, STIMULI VARIABILITY AND TIME FACTOR ON
STUDENT ACHIEVEMENT

Iowa State University

Ph.D. 1984

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The relationship of field dependent/field independent cognitive
styles, stimuli variability and time factor
on student achievement

by

Christopher Ivo Atang

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY

Department: Professional Studies in Education
Major: Education (Curriculum and Instructional Media)

Approved:

Signature was redacted for privacy.

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For the Graduate College

Iowa State University
Ames, Iowa

1984

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ACKNOWLEDGEMENTS

"There is a destiny that makes us brothers.
None goes his way alone;
All that we send into the lives of other people
come back to us."

-- Edward Markham.

I am indebted to the members of my doctoral committee: Dr. Lynn W. Glass, Dr. Elaine M. Jarchow, Dr. Larry Ebbers, Dr. Dominick Pellegrino and Dr. Edwin Jones, Jr. for their guidance. I am particularly grateful to my major professor, Dr. Lynn W. Glass for the opportunity of being able to work with him, for the many hours of valuable consultations, advice, suggestions, keen insight, criticism and unflinching interest in my research at all the different stages.

Special thanks must be given to Dr. Richard M. Warren and Ms. Mari Kemis for their help in statistical analysis of research data and computer programming. Thanks also go to Dr. Richard Wright and Dr. Dennis M. Warren for their invaluable help in reading and correcting many parts of the manuscript of this dissertation.

Special recognition is given to the Ford Foundation for partially financing my doctoral course work, and to Iowa State University for partial financial assistance for computer analysis.

Profound gratitude is expressed to the entire ATANG and NDIKUM Families (at home and abroad) for the moral support given me

throughout my studies at Iowa State University. Special thanks go to Dr. Sirri Atang Nomo-Ongolo, Dr. Lucy Atang Oyebog and Dr. Protus G. Atang for their financial assistance.

Most importantly, I would like to express my appreciation to my wife, Jackie, for her understanding, emotional support and encouragement all through the many months of hard work. Also, the many hours of discussion with my wife have been valuable in refining my thoughts as I carried out this study.

Last, but far from least, I would like to express my love and appreciation to my dear children, AZIEBONG, KUBONG, LUM-AWAH and NDIKUM, whose understanding, sacrifice, love and tolerance kept me inspired all through these years of graduate studies. It is to my wife, JACKIE, MY CHILDREN, The Right Rev. Monsignor LUCAS A. ATANG and my dear mother MAMMI MARTINA ATANG, that I dedicate this work.

CHAPTER 1.

INTRODUCTION

The Soviet launching of the first man-made satellite in October 1957, and a second sputnik a month later brought a huge outcry in the United States that was followed by increased emphasis on science and mathematics education. According to Williams et al. (1983), the gains inspired by the challenge of sputnik have been squandered, leaving a generation of young people ill prepared for the new era of technology and global competition.

Concern for the improvement of American education is widely evident today. Several national efforts to improve education are underway, each with its own agenda. Additionally, several state and local groups are planning attacks on what they perceive to be the inadequacies of today's education. These efforts can be aided to some extent by an examination of evidence regarding the educational achievements of school children. For example, data from the National Assessment of Educational Progress, from state assessment studies, and from local testing programs clearly indicate that achievement outcomes differ greatly from school to school, and that quality education is deteriorating rapidly (Tyler, 1983).

The report of the National Commission on Excellence in Education,

"A Nation at Risk" (Gardner et al., 1983), has become one of the most publicized studies of education in recent history. Extensive coverage of the report in the print and electronic media has ignited a national discussion of the public schools. The Commission bluntly stated that "a tide of mediocrity" has devastated public education and suggested, among other things, that educators must demand the best effort and performance from all students, whether they are gifted or less able, affluent or disadvantaged, whether destined for college, the farm or industry. The Commission based its recommendations on the assumption that everyone can learn, and that everyone is born with an urge to learn which can be nurtured regardless of one's background and orientation.

If educators are to demand the best efforts from all students, we must learn more about cognitive styles. Cognitive styles, especially field dependence/field independence, have recently received much attention, probably because they have been related to many learning abilities and activities. According to Ausburn and Ausburn (1978), almost no research has been conducted on the relationship between cognitive styles and instructional designs. In addition, cognitive styles have not been conceived and studied as a single entity. Rather, a number of different factors or dimensions of cognitive styles have been identified and subjected to systematic theoretical and empirical examination (Ausburn and Ausburn, 1978). Therefore, studies designed to investigate these relationships may be useful to

instructional designers.

Field Dependence/Field Independence

The concept of cognitive style refers to psychological dimensions that represent consistencies in an individual's manner of acquiring and processing information (Ausburn and Ausburn, 1978). Each learning style seems to be related to how the individual processes and learns information. An often studied learning style by educational technology researchers, because of its relationship to mediated instruction, is field dependence/field independence. Ausburn and Ausburn (1978) conducted research on cognitive styles and listed field dependence/field independence as the cognitive aspect of a deeply ingrained personality syndrome resulting from environmental influences of early childhood training. Field dependence/field independence is defined as "individual differences as to how we perceive, think, solve problems, learn, and relate to others"; in other words, a life-style (Witkin et al., 1977).

Witkin et al. (1971) discussed field dependence/independence and indicated that the field dependent person had difficulty locating a geometrical figure in a complex pattern. The field independent person, on the other hand, did not have such difficulty locating this same figure. It was determined that this type of person may be more analytical in his/her approach to various kinds of situations.

A frequently used instrument for measuring field dependence and

field independence is the Embedded Figures Test (EFT) (Witkin et al., 1971). The rationale for using the EFT, according to researchers, is to assess broad dimensions of personal functioning as it accurately measures the degree of field dependence/field independence in subjects. The researchers further claim that cognitive styles are the characteristic self-consistent modes of functioning which individuals show in their perceptual and intellectual activities.

Color Realism and Visualized Instruction

The question of whether color or black and white images have an effect on increasing the performances of an individual has been debated by several researchers. For example, in a number of studies relating to the color variable, Otto and Askov (1968) concluded that "the cue value of color in learning is still essentially unclear." Ibison (1952), Maclean (1930), and Rudisill (1952) indicated that students preferred to view colored instructional materials. Kumata (1960) observed that details were remembered better from color advertisements while the principle of the message of the advertisements was retained better in black and white advertisements. Katzman and Nyenhuis (1972) found that color does not improve the learning of materials.

Differences in the results of these studies may be due to

different cognitive styles possessed by learners. Since field dependence/field independence is correlated with one's ability to sift through a series of possible solutions it could also affect one's ability to distinguish and organize the relevant visual cues in an instructional setting. If this rationale is indeed accurate, then field independent subjects could be expected to demonstrate greater ability in imposing such a structure and, hence, should perform better than field dependent subjects in detailed, shaded drawings in color or black and white in an identification posttest such as the one used in the present study.

Realism theories, according to Dwyer (1967), are based on the assumption that learning will be more complete as the number of cues in the learning situation increases. On the other hand, Travers (1964) determined that the realism theories were not a reliable predictor of learning efficiency. Increasing the detail in a visual did not always cause a significant increase in learning.

Educational researchers agree that there is no "one best way" for all students to acquire knowledge. Cronbach (1975) used aptitude treatment interaction (ATI) in order to obtain a better understanding of the relationship between learning styles, such as field dependence/field independence, and instructional treatment. He postulated that different groups of learners performed better under certain circumstances. Cronbach concluded that instruction will be more meaningful to learners if instructional methods or materials are

matched to selected learner characteristics. While previous research in the area of communication media has concerned itself basically with one instructional method compared with another, there is a growing concern that instructional technology be concerned with individual needs. Wager (1975) claimed that learning styles and visualized instruction must be highly correlated to affect learning. In a study of the relationship between cognitive styles and visualized instruction, Elliot (1975) concluded that learning will be more effective if certain design elements, such as color, texture and shape, are used to complement cognitive styles.

Numerous researchers have investigated the processes whereby information is stored and retrieved from the human brain. In other investigations, the use of visuals in instruction has been examined in an attempt to explain, more precisely, how visual materials are perceived and stored during learning. For example, Berry (1977) conducted a series of experiments to investigate how the forms, tones and colors within a given visual affect the later retrieval of information. He found that color modes were superior to black and white modes in facilitating immediate recognition of visual materials.

Statement of Problem

Accepted practice has established the need for carefully prepared and organized materials to augment instruction. However, research has

been less conclusive in identifying characteristics of the materials which contribute to improved learner achievement. In addition, most research efforts have failed to take cognitive style differences into account. It generally has been accepted that not all individuals learn optimally from the same materials or at the same rate. It would appear, therefore, that a significant interaction would exist between an individual's cognitive style and the type of instructional materials which promote optimum learning.

The problem of this study is to investigate whether the cognitive style of an individual has an effect on his/her achievement when self-paced visual instruction in color or black and white is used. Results from this study may aid in determining whether stimuli variability in instructional materials delivered to field dependent/field independent learners for different amounts of time has any effect on student achievement. In addition, the results obtained may alleviate some of the difficulties experienced by most instructional developers in designing visuals that will increase attainment of designated educational objectives.

Purpose

Despite widespread acceptance and use of visual materials for instructional purposes, surprisingly little is known about the effectiveness of different types of visual materials, both from the

standpoint of how learners possessing different cognitive styles react to stimuli variations in visualized materials and how these visuals influence learner achievement of different educational objectives.

Specifically, this research proposes to identify a possible relationship between cognitive styles (field dependence/field independence determined by the Group Embedded Figures Test), stimuli variability in instructional materials (color or black and white shaded drawings), time on task, and their combined effect on achievement. Visualized instructional materials will consist of detailed, shaded drawings in color and black and white of the human heart. The materials are self-paced and were developed by Dwyer, (1967). Results from this study may also aid in determining if stimuli variability in instructional materials delivered to field dependent/field independent learners for different lengths of time have any effect on student achievement.

A secondary purpose of this study was to explore the conflicting theoretical orientations of realism and relevant cue theories as different dimensions of the same theory of instructional media. According to Parkhurst (1975), since the theoretical approaches of the realism and relevant cues theorists contradict one another, perhaps an examination of individual differences among students might be one way of attempting to explain the conflicting results. The realism theorists hypothesized that the more realistic an instructional treatment, the more effectively it will facilitate learning. The

relevant cue theorists disagree with the realists on the ground that the more realistic materials will tend to present too many irrelevant cues which will interfere with learning (Miller 1975; Broadbent, 1958; Travers et al., 1964; Dwyer, 1972a).

Objectives

The objectives of this study are:

1. To investigate the relationship of field dependence, field independence and stimuli variability in instructional materials.
2. To determine if there is any relationship between achievement (as assessed by posttest scores) and treatment groups (stimuli variability).
3. To investigate the amount of time needed by learners with different cognitive styles to process information.

Research Question

In order to consider if field dependence/field independence is significantly related to stimuli variability, and to investigate if the amount of time spent on seeing a visual is different for field dependent or field independent subjects, the following research questions were formulated:

1. Is there a relationship between field dependence/field independence and stimuli variability in instructional materials as determined by achievement posttest scores?
2. Is there a relationship between high school class rank and achievement posttest score?
3. Is there a relationship between field dependence/field independence, knowledge pretest scores, treatment groups and posttest time?

Hypotheses

The following null hypotheses were generated in order to examine the above stated questions:

1. There is no relationship between field dependence/field independence and knowledge pretest scores, and field dependence/field independence and achievement posttest scores.
2. There is no relationship between high school class rank and achievement posttest scores.

3. There is no difference in achievement posttest scores between field dependent and field independent subjects treated with color, black and white, and no illustrations.
4. There is no relationship between achievement posttest time and field dependence/field independence, treatment groups, and knowledge pretest time.

Delimitation

This study is limited to the investigation of the relationship of field dependent/independent learning styles and detailed, shaded drawings in color and black and white instructional materials of the human heart (Dwyer, 1967). The population of this study was also limited to freshmen undergraduates at Iowa State University.

Many individuals fear computer utilization, and this fear can be detrimental to their performance and time on task. The computer familiarization exercise was designed to alleviate some of this computer anxiety.

Definition of Terms

Field Dependence/Field Independence represents the extent to which an individual can isolate stimuli details in a complex spatial

array despite compelling background forces. A field independent individual is better able to perceive the stimuli details in the context as separate from the background than a field dependent individual.

Stimuli Variability refers to a continuum of varying degrees of realistic details in visual illustrations. Line drawing visuals are usually considered least realistic, followed by shaded drawings, then black and white photographs, and colored slides as the most realistic (Dwyer, 1972b).

CHAPTER 2.

REVIEW OF LITERATURE

Research concerning each of the variables under investigation, field dependence/field independence, stimuli variability and time on task, has been conducted with each element being considered independently. Limited work has been done in interrelating cognitive style and color realism. Research activities in the above areas are reviewed in this section.

Field Dependence/Field Independence

The characteristics of field dependent/field independent aspects of individuals are, according to Sheriff and Williams (1980), "process variables; in essence, what is perceived or learned is formulated from either a field dependent or field independent perspective; consistent over time as well as across domains; bipolar: while field dependent subjects tend to stress interpersonal competencies and downplay cognitive restructuring, field independent subjects tend to place emphasis upon cognitive restructuring and downplay interpersonal competencies." Another characteristic is value neutral: "it is not inherently better or worse towards one pole of the field

dependence/field independence dimension or the other" (Witkin et al., 1977).

Messick (1966) regarded field dependence/field independence as the tendency to perceive a perceptual field either analytically (seeing parts of a whole) or globally (as a whole). Field dependence/field independence entails the ability to experience items as discrete from their background and to overcome embeddedness (Ausburn and Ausburn, 1978).

Field dependence "is the tendency to rely on external referents," while field independence "is the tendency to rely on internal referents" (Goodenough and Witkin, 1977). Field dependence/field independence is defined as the extent to which a person perceives part of a field as discrete from the surrounding field (Witkin et al., 1974).

Several studies have been conducted in the area of field dependence/field independence. Among them are studies by Witkin et al. (1971, 1977), Ausburn and Ausburn (1978), Kogan (1971), and Hasib (1979). Synopses of field dependent/field independent characteristics obtained from the review of the above studies reveal that field dependent learners tend to be influenced more by extrinsic reinforcement systems (both positive and negative) than field independent learners (Hasib, 1979). Secondly, Witkin et al. (1971) reported that mean scores on field dependent/field independent tests are slightly higher for males than for females, meaning that males

tend to be more field independent than females. Field independent learners are also reported to be better able to recognize their own strategies for coding and processing information. Field dependent learners have a tendency to be people oriented. This is reflected in their choice of career and subject matter (Witkin et al., 1977). Field independence is highly correlated with academic achievement in the areas of mathematics and science (Witkin et al., 1977). Witkin and his collaborators were of the opinion that the amount of education acquired does not seem to be related to field dependence/field independence. Ausburn and Ausburn (1978) believe that field dependence/field independence involves a tendency to perceive a perceptual field either analytically or globally. They continue to assert that the most important aspect of field dependence/field independence was that of how individuals processed information. This means that field dependence/field independence is the individual's ability or inability to attach structure to unstructured material.

Witkin and his collaborators first identified the concept of field dependence/field independence in relation to how people perceived the vertical in space and defined them as pervasive traits that affected a person's perception and personality (Witkin et al., 1962, 1977). They initially measured field dependence/field independence with the use of a luminous rod and frame. Both rod and frame could be independently rotated clock- and counter-clockwise. The subject sat in front of the rod and frame. When the room was

darkened, the frame was tilted and the subject was asked to place the rod in an upright position. Those who placed the rods in an upright position in relation to the frame's tilt were said to be field dependent, and those who placed the rod upright regardless of the frame's tilt were categorized as field independent. Witkin's rod and frame tests were originally designed to identify peoples' ways of perceiving things. Subjects who were able to locate the vertical or an embedded figure were able to do so because they were analytical. They could separate an entity from its surroundings. At the other extreme were individuals who were apparently greatly influenced by the organization of the field as a whole.

Following the rod and frame method, Witkin proceeded to develop a situation that required subjects to perceive their body positions in relation to a surrounding field. Subjects were seated in a chair that could tilt. The chair was projected into a small room which also could be tilted. Both the chair and the room were positioned at tilted settings and the subject was asked to reposition the chair such that it became upright. This test was known as the body adjustment test (BAT).

Finally, Witkin and his colleagues developed a written measurement. Researchers today often use a modified version of this instrument to test for field dependence/field independence. The test is composed of simple geometric figures which are embedded within more complex figures. This test is known as the Embedded Figures Test

(EFT). The reliability of the EFT, according to Witkin et al. (1971), is satisfactory. Through extensive use of the test, it was found that adequate reliability and validity could be maintained. Reliabilities for the 12-figure, three minute format of the EFT were all based on data obtained by computing scores for tests given in the original full 24-figure, five minute form. In many studies, reliabilities have been found for the original full form test: Linton (1952), .90 for college men and Gardner et al. (1960), .95 for college women. Bauman (1951) reported a test-retest reliability of .89 after a three year interval for both a group of young men and women in their 20s.

In examining the relationship between problem solving and field dependence, Duncker (1945) gave subjects a short stick and asked them to fit it across a doorway. The experimenter left a bottle with a stopper in the room where the experiment was carried out; the stopper was the right size to provide a wedge to make the short stick stay in place. In order to use the stopper, the subject had to learn how to use the stopper in a new function. The results of this study indicated that there was a high relationship between solving this kind of problem and the extent of field dependence/field independence. Duncker found that field dependent subjects had more difficulty in solving this problem.

In another experiment, Witkin et al. (1962) stated that field dependent learners who were tested using ink blots from the Rorschach test (a personality and intelligence test in which a subject

interprets ink blot designs in terms that reveal intellectual and emotional factors) tend to leave a lot of materials as they are, rather than imposing structure on them, with the result that their perceptions are vague and indefinite. On the other hand, field independent learners are likely to impose structure on ink blots, with the result that their perceptions are organized and definite.

Goodenough and Karp (1961) and Karp (1963) found moderate correlations between the full scale of the Wechsler Intelligence Scale (WISC) and scores on the Embedded Figures Test. They concluded that one cannot categorically say that persons who are field independent are superior in general intelligence to persons who are field dependent. Karp (1963) also asserted that the ability of a person to locate a single item from within an embedded context is the criterion used for determining the degree of field dependence/field independence.

The greater connectedness between self and others of field dependent people, and the greater self-other polarity of field independent people, is reflected in differences between them in social sensitivity and interest in people. For example, field dependent people more readily tell others about themselves, reflecting greater emotional openness (Greene, 1973), and they prefer to be with people (Coates, Lord, and Jakobovics, 1975). Ruble and Nakamura (1972) also examined the relationship between relevant social cues and their effect on the performance of field dependent/field independent

subjects and observed that there were differences in responsibility to social cues between field dependent and field independent subjects. They also observed that although field dependent subjects glance around looking for more cues than field independent subjects, they, however, did not utilize the information gained from their glancing. They then concluded that the amount of time spent on glancing does not predict the ability of a child to utilize a social cue, and that field dependent subjects may be more effective in tasks or situations that involve relevant social cues.

Other research findings indicate that field dependent subjects recall more incidental information than field independent subjects (Messick and Damarin, 1964; Goodenough, 1976), suggesting that field dependent subjects would gather more information in situations where much of the information is incidental. Pascual-Leone et al. (1978) believe that field dependent subjects are less likely to select an appropriate strategy for problem solution than field independent subjects. They suggested that field dependent subjects have what they termed a weak "interrupt" function. The interrupt function serves to inhibit the occurrence of irrelevant schemes or strategies for solving a problem.

In investigating subjects' susceptibility to distraction, Bloomberg (1965) experimented with 92 undergraduate male students enrolled in introductory psychology classes at the State University of New York at Buffalo. A circular line drawing eight and one half

inches in diameter was drawn with black ink on white cardboard. Two figures served as relevant stimuli and shared the same boundaries. One figure could be seen as an X, the other as a cross. Two drawings with outlines identical to those of the test stimulus were exposed. The first was a shaded representation of the X-shaped figure and the second was a shaded representation of the Maltese cross. These drawings were shown to ensure that the two relevant figures were perceived.

The shaded drawings were moved after the subjects told the experimenter that they could locate these in the actual drawing. Each subject was asked to turn his head and then turn back to fix the center of the shaded drawing to the original and to count each time a shift appeared from the X to the cross or vice versa. After completing the first task, the subject was asked to repeat it. This time distracting stimuli were introduced by asking the subject to count numbers backwards. A third trial was performed to serve as a check on the stability of the reversal scores. Bloomberg found that field independent subjects reported more reversals than field dependent subjects prior to the introduction of the distracting stimuli. This probably indicates that field dependent subjects are more attentive to distraction. On the other hand, field independent subjects have the ability to work under distracting conditions. This further supports the hypothesis that the differences between field

dependence and field independence can be seen as related to the ambiguity of the task.

Douglas and Kahle (1978) determined that field independent students who used an inductive sequence of instruction reached a higher level of achievement than did the other students ($F=3.66$, $P<.05$) in their training research. The recommendation of this study was to individualize instruction in such a way that global (field dependent) students are matched with deductive materials and analytic (field independent) students are matched with inductive materials.

Wieckowski (1980) investigated the two cognitive styles of field dependence/field independence and reflectivity/impulsivity to find out how these styles interact with color instructional materials in achieving specific learning tasks. Fifty-three third grade students from the Pittsburgh Public School system were used as subjects for the experiment. The children were from middle class socio-economic backgrounds with IQs falling into the average or above average range as measured by the Otis-Lennon Mental Ability Test given in the second grade. None was found to be color blind when given a color vision test. The testing instruments used to determine the two cognitive styles under consideration were the Children's Embedded Figures Test (Karp and Konstadt, 1971) and the Matching Familiar Figures Test (Kagan, 1969). The stimulus materials for the experiment consisted of a set of 400 color slides of natural objects and scenes. Slides with any verbal material, recognizable human figures or unique features

were eliminated. All subjects were shown 100 stimulus slides, 50 black and white slides and 50 color slides randomly chosen from the original set of stimulus slides. This was followed by the recognition set of 200 slides evenly divided between both color modes. These included the 100 stimulus slides just seen and the 100 distractor slides. The slides were randomly placed in a right or left hand position on the screen labeled A or B. Each subject was instructed to state whether slide A or slide B had been seen before. Each recognition item was presented for an interval of eight seconds.

Wieckowski concluded that field dependent subjects would benefit from color treatment, whereas field independent subjects would benefit from the black and white treatment. As far as the achievement of specific tasks is concerned, Wieckowski tentatively concluded that the addition of color is a significant factor. He further contended that for field dependent individuals color may perform the task requirement of visual discrimination and separation (a process they are not able to accomplish themselves). For the field independent individuals, he continued, color may emphasize detail and contrast, thereby enabling these individuals to utilize more completely their ability to disembed a figure from the background.

In a recent study, Krey (1983) experimented on demographic data analysis with 98 sixth grade elementary students (52 females and 46 males) representing four cultural groups (50 whites, 35 Hispanics, seven southeast Asians, and six blacks). After taking the Group

Embedded Figures Test, subjects were given standardized mathematics and reading tests. In addition to these tests, demographic data (sex, race, year of birth, number of parents in the home, and number of siblings in the home) were also included as variables in the study. Results of Krey's study provide confirmation for the analytic/mathematical aspect of field independence. This suggests that Witkin's theory of Psychological Differentiation may have direct instructional application (Witkin et al., 1977). Krey also concluded that there was no significant sex difference in preadolescent children using the Group Embedded Figures Test, and that field dependent/field independent tendencies seem closely linked to individual differences in analytical/mathematical ability.

To investigate learning with visuals through aptitude sensitive instruction, French (1983) experimented with 492 males aged 16-21 years drawn from a college of technical education in Melbourne, Australia. Aptitude groups were designated on the basis of performance on the Group Embedded Figures Test (Witkin et al., 1971). The instructional materials consisted of a series of line drawings which were copied onto filmstrip with an accompanying audiotape. Subjects were pretested for existing knowledge and randomly assigned to one of the treatment combinations. Each treatment was externally paced. Analyses of scores for the pretest revealed that there was no significant difference between field dependence and field independence groups, $t=1.08$, $P>.1$. Further analysis of line scores also revealed

two statistically significant interactions. Simple/complex treatment (degree of informative detail) interacted with field dependence/field independence, $F=6.31$, $P<.05$. According to French, field dependent subjects have difficulty with externally paced, concept attainment tasks which require ability to discriminate and generalize. She further asserted that on line drawings, field independent subjects' performance was most facilitated through the use of line drawings as opposed to complex line drawings. However, field dependent subjects' performance did not appear to be similarly influenced by degree of informative detail.

Based on French's findings, it could be presumed that field independent individuals may have the aptitude to process visuals that have a high degree of irrelevant information (Koran et al., 1971). Yet it is possible that simple line drawings increased abstraction time and processing effort and permitted more efficient and effective processing by field independent subjects. On the other hand, field dependent subjects may have greater difficulty in isolating relevant information in materials with a high degree of irrelevant information (Koran et al., 1971).

Limited work has been done in relating cognitive style and visual stimuli in instructional materials. Research on the use of stimuli variability in instruction has produced conflicting results. A factor that may be contributing to this situation is that of cognitive style. Careful task analysis of variables in the above studies includes the

ability to discriminate and separate details of a picture visually from their background and to analyze the stimuli array for encoding purposes so that a decision can be made at a later time. An examination of learner characteristics or aptitudes suggests that the cognitive style of field dependence/field independence may function in such a task, as field dependent subjects generally experience greater difficulty than field independent subjects in isolating relevant information in materials with a high degree of irrelevant information.

Summary

Field dependent individuals, who rely on external referents for processing information, need more organization and structure in a learning situation. They need more reinforcement in the form of repetition, clarification, and examples of the material to be studied. On the other hand, field independent individuals, who rely on internal referents for processing information, need less organization and structure in a learning situation. According to Witkin, "cognitive styles are concerned with the form rather than the content of cognitive activity," and refer to individual differences as to how we perceive, think, solve problems, learn, and relate to others; in other words a life style (Witkin et al., 1977, p. 15).

Several studies related to field dependence/field independence and their implications in the field of education were discussed. Several investigators have shown that the concept of field

dependence/field independence correlated strongly with one's ability to sift through a series of possible solutions and select the one best solution to a problem. There is also evidence in the studies reviewed which indicates that field dependent and field independent subjects are different in their learning styles. The literature supports the contention that the field independent individual is more likely to achieve success in embedded materials than the field dependent individual. Field dependent individuals seem to be more socially oriented than field independent individuals. Field dependence/field independence, when measured, tends to be a normally distributed variable.

Learning from Visualized Instruction

The utilization of media for instructional purposes has become an integral part of knowledge acquisition. One of the reasons for this is that visual illustrations and lecture methods clarify information better than do traditional lecture methods without visuals. During the past fifty years, numerous studies have been conducted concerning the relative effectiveness of visual materials in learning. A serious limitation of these studies is that the visual materials were usually treated as entire units rather than as combinations of many distinct types of cues or stimuli elements. No attempts were made to identify and examine systematically those elements within a visual display which contributed to improved learning. Rather, the practice of

comparing instructional materials as entire units confounded any attempt to isolate and quantitatively define those characteristics which may have aided or impeded learning. Therefore, this section of the review of literature seeks to provide evidence of the effect of color or black and white cueing on visual instructional materials, especially on learners possessing different cognitive styles. The interrelationship of color with cognitive processes will also be reviewed.

Numerous researchers have investigated the processes whereby information is stored and retrieved from the human brain. In other investigations, the use of visuals in instruction has been examined in an attempt to explain how visual materials are perceived and stored during learning. Berry (1977) conducted a series of experiments to investigate how the individual forms, tones, colors and relationships within a given visual function to affect the storage of that image and its role in later retrieval of visual information.

In recent years, theories have been generated from mental imagery studies. One theory, for example, indicates that mental imagery facilitates learning because it involves the more fundamental feature of organization. It is the general consensus of researchers that individuals learn more from organized (structured) visuals than from unorganized (unstructured) visual materials. In investigating organized versus unorganized visual materials, Bower (1972) found that instruction with organized visuals was superior to instruction without

organized visuals, and that learning under interactive image conditions was superior.

Paivio (1971) proposed that there are distinct verbal and nonverbal processing systems in the mind (dual-process hypothesis). He said nonverbal information is sorted in the mind in the form of mental images, which are stored and retrieved as entities. Paivio proposed that these two systems can function independently but in normal situations frequently interact. Based on Paivio's dual-process hypothesis, Orwig (1979) conducted a study to investigate human memory processing systems. He used shadowing procedures on pictures and concluded that for the subjects examined there exists a nonverbal memory system which, under certain circumstances can function fairly independent of verbal distraction. On the basis of his findings, he concluded that if mental imagery does exist, then individuals may rely on a second memory system as a supplement to the images being stored, especially when a series of visual perceptions start to match the same template.

Borg and Schuller (1979) conducted a study to find out if the use of complex visuals is more effective than simple visuals. One-half of the 80 soldiers chosen for the study used a self-contained learning package made up of a tape-filmstrip lesson with a large number of complex visuals. The other half used an identical package but containing simplified visuals. No significant differences were found in the achievement levels of the two groups.

Levin, et al. (1974) studied the reason why an individual can remember a picture better than the word, and concluded that a picture is seen less than the word. Levin, et al. (1976) also investigated the relationship between the use of visuals in the presentation of subject matter and individual understanding of the presentation. First grade students who participated in the study listened to stories presented orally. The experimental group saw pictures of the described events. The results revealed that the group that saw the pictures did significantly better than the group that did not see them.

In another study, Peng and Levin (1979) investigated the relationship between story-relevant pictures and recall of story information. Sixty-four second graders were divided into four groups, two with pictures and two control groups. In the picture groups, the subjects were shown relevant color pictures while they listened to a tape recorded story. In the control groups, the subjects read each sentence of the story with its taped presentation. They observed that the story-relevant pictures helped the subjects to recall the story.

Summary

Several studies related to learning from visuals were presented in this section. Mental imagery facilitates learning because it involves the more fundamental features of organization. Individuals

learn more from organized rather than from unorganized visuals. Most of the studies reviewed in this section provide evidence that the use of visuals in instruction facilitates learning. Studies which investigated complex versus simple visuals revealed no significant differences.

Color

The use of color in instructional materials is an element requiring further investigation. Color has been considered a significant factor in the design of visuals for instructional applications. Its use, however, has usually been determined, according to Berry (1974), by two considerations totally unrelated to its possible effectiveness as a facilitator of learning. Two factors, the aesthetic appeal of color over black and white illustrations and the considerably higher production cost of color visuals have worked, in conflicting directions, to influence the instructional use of this variable.

A variable compounding the problem of selecting color or black and white is the fact that the great majority of the research regarding color has been inconclusive. In a survey of a number of studies relating to the color variable, Otto and Askov (1968) concluded that the "cue value of color in learning is still essentially unclear."

Some researchers, nevertheless, consider color to be a significant factor in visualized learning. Ibison (1952), Maclean (1930), and Rudisill (1952) reported that students prefer to view colored instructional media. Lumsdaine (1963) indicated that color makes the objects closer to reality and therefore facilitates learning. On the other hand, Katzman and Nyenhuis (1972) found that color does not improve the learning of materials in an experiment using undergraduate students. Twenty-six male and 34 female subjects were tested individually. Each subject was seated 12 feet from a white wall on which a 26 square foot image was projected from a slide projector. All subjects were first exposed to the same three slides. Slide number one was a black and white photograph used as orientation to the experiment. No data were collected from this slide. Slide number two was a black and white poster copied from a magazine. The third slide was in color and was copied from the same magazine. After each of the subjects viewed the first three slides, they were divided into two groups to view more slides. One group viewed the slides in color and the other group viewed the slides in black and white. After the treatment the subjects were asked to complete a questionnaire about the presentation. The researchers concluded that color does not facilitate learning of materials.

Dwyer (1967) conducted a study using color versus black and white visuals. He concluded that color increased students interest in the content material. Dwyer speculated that there is a possibility that

we are dealing with a generation of students conditioned by color television and that color may probably be a pre-requisite of optimum interest to be aroused in a learning situation.

Lamberski (1980) conducted a study to assess the relative effect of color versus black and white coding strategies. The coding was incorporated into self-paced instruction which was intended to facilitate student retention on different cognitive tasks. Major findings indicated that color coded self-paced instructional materials were superior to the black and white coded instructional materials for both immediate and six-week delayed retention and on all task tests (drawing, terminology, identification, and comprehension). However, the presence or absence of the color code in test materials had no significant effect on student achievement. Lamberski concluded that the effectiveness of the color coded instructional materials may reside in their ability to demand sustained student attention and interaction with the content along with their ability to be able to provide an enhanced associative memory structure. Lamberski's results also indicated that the color coding had a more positive impact on tests representing visual tasks (drawing, identification) rather than the more verbal tasks (terminology, comprehension).

Regenscheid (1983) evaluated the effectiveness of color cueing in computer assisted instruction. Thirty kindergarten and first grade students acted as subjects. They were randomly assigned to one of three treatment groups: group one received lecture instruction with

black and white visuals, group two received black and white cued computer assisted instruction, and group three received color cued computer assisted instruction. Regenscheid concluded that the use of color cueing in computer assisted instruction is an effective instructional variable in delayed retention but not as effective as black and white cueing in immediate learning situations.

Learning styles have repeatedly been found to affect the recall of concepts presented in a favored verbal or visual (color or black and white) mode (Daniel and Tacker, 1974). Furthermore, they indicated that learner preference may influence learning by directly influencing attention. Similarly, there is evidence that color materials are preferred over noncolor materials (Chute, 1978). Therefore, a preferred color design strategy may contribute in facilitating cognitive learning in addition to enhancing learner attitude. Such preference for color has been suggested to increase attention and motivation (Dwyer, 1972a). However, it has been found that the preference for color is not a necessary condition for learning. In fact, color preference does not seem to be correlated with concept achievement, and the criterion of preference alone will not dictate the use of color in instructional materials (VanderMeer, 1954; Dwyer, 1972a).

Summary

Color is considered to be a significant factor in visual illustrations. Color is very useful in identification of certain objects. The extent to which color affects learning is still unclear (Otto and Askov, 1968).

One study indicates the value of color in any instructional medium lies in bringing the presentation closer to reality. Another study reports that children prefer a realistically colored picture to uncolored ones. The details in colored advertisements were found to be remembered better in colored presentations.

The addition of color helps improve learning from pictorial materials. Color can also be used to increase students' interests in the content material.

Amount of Time and Learning

While time has been a central variable in experimental studies of human and animal subjects for the past century, it is only recently that it has become an important variable in school-based studies about learning (Bloom, 1974). Carroll (1963) regarded time as the central variable in school learning, and asserted that students differ in the amount of time they need to learn a given set of materials to some set criterion. Carroll stated that the amount of time needed by each

student to reach criterion could be predicted by an appropriate aptitude or achievement test. He contended that if the students were given the amount of time they needed, and if they persevered until they devoted this amount of time to the learning task, they would reach the criterion level of achievement.

Carroll further specified that the quality of instruction and the student's ability to understand the instruction would, when both were optimal, make time needed minimal for each student. If these conditions were less than optimal, the amount of time needed would be increased for each student.

Glazer (1968) and Atkinson (1968) suggested that learners differ by a ratio of about 5:1 in their learning rates. That is, the slowest five percent of the learners take about five times as much time to reach the criterion as do the fastest five percent of the learners.

Studies of various subjects in which learners are free to go at their own rate make it clear that aptitude and general intelligence test scores are predictive of the time required by individuals to complete the particular learning unit to criterion. The correlations, according to Bloom (1974), range from about .50 to about .70.

However, these are studies in which the individuals are under no pressure to learn at a faster rate than they find compatible with their own inclinations. In contrast to this are most school learning situations, which are group-based. In group-based learning situations there is a great deal of pressure on the student to learn at the

same rate as the group. This is probably an inevitable characteristic of group-based learning because the teacher has to teach many learners at the same time, and the teaching function is easier for the teacher if he/she can provide instruction for all students at the same time.

Anderson (1973), Arlin (1973) and Ozcelik (1973) studied the amount of time students spend in active learning. One aspect of their studies was observing the overt activities of students and inferring the proportion of time the student appeared to be attending, working on the learning tasks, or carrying out other modes of learning. Another aspect of these studies was to determine by various recall techniques, what the student did covertly at each stage of the learning process, that is, the extent to which each student did relevant thinking at each of the points sampled and the extent to which the thought processes were related to the ideas considered in the lectures, discussions, or recitations. They found that these indices of the amount of time the student spent directly on the learning (either covertly or overtly) were highly predictive of the learning achievement of the student. They also considered that individual differences played an important role in the amount of time students needed to learn.

The amount of time allowed for a task will partially determine the cue value of color (Gordon et al., 1967). Given unlimited time, color codes in some perceptual tasks have produced superior learner

performance and speed for visual search (Luria and Strauss, 1975). However, when time is limited, color has been found to impair learner speed and precise discrimination of objects (Jones, 1962), having a facilitating effect only in certain low perceptual tasks such as picture recognition (Berry, 1977) or reaction time (Logan, 1976). In more complex tasks, researchers have suggested that the use of color in materials will require more time for people to perceive, process and store information (Dwyer, 1972b; Berry, 1974).

In investigating the relationship of achievement to time with self-paced learning materials, Lamberski (1980) found that the mean time that subjects required to work through a color coded instructional booklet was significantly greater than the time needed to work through the instructional booklet in black and white.

Summary

Time is regarded as the central variable in school learning. Students differ in the amount of time they need to learn a given unit of learning to some set criterion. The amount of time students spend directly on learning (either covertly or overtly) is highly predictive of the learning achievement of the student. Individual differences were also considered to play an important role in the amount of time students need to learn.

Realism Theories

The main objective of increasing the amount of realistic detail in visuals is probably based on the theoretical orientation of a group of theories collectively referred to as "realism theories" (Dwyer, 1967). They are the iconicity theory of Morris (1946), cone of experience theory (Dale, 1946), surrogate fidelity theory (Gibson, 1954) and sign similarity orientation theory (Carpenter, 1953). All these theories are predicated on the assumption that the more realistic an instructional device, the more effectively it will facilitate learning. This assumption is based on the notion that the more realistic materials will present more visual cues, and thus provide more information for the learner to work with in a learning situation.

Dwyer (1972b) conducted a series of studies related to realism theories and developed a 2000 word instructional unit related to the human heart. He also developed eight visual sequences with varying degrees of complexity from simple line drawings in black and white to realistic color photographs of the human heart.

Most of Dwyer's studies are directly relevant to this study. In the initial study by Dwyer (1972b), the control treatment plus three black and white presentations were used. The subjects were 108 college students who were randomly assigned to four treatment groups. Dwyer concluded that the simple line drawing was most effective. The

more realistic illustrations (shaded drawings or realistic photographs) were least effective in complementing oral instruction.

According to Dwyer (1972b), a visual realism continuum would exist from the object or situation itself to a very simplified line representation. He contended that the more qualities a visual has in harmony with the object or situation which it is to denote, the more realistic the visual is said to be. Dwyer asserted that a visual considered to be one hundred percent realistic with respect to a designated object could not be differentiated from the object because it would possess exactly the same qualities possessed by the object. He concluded that oral and verbal symbols would contain a low degree of realism because they would not physically represent the objects. Consequently, it would follow that visual illustrations, ranging from colored photographs to black and white line representations, may vary in their ability to facilitate student achievement of specific educational objectives.

Dwyer (1972a) summarized a series of studies he conducted between 1967 and 1972 in his book, A Guide for Improving Visualized Instruction. The studies were designed to explore the effects of different media attributes (image, size, color, pacing, cues, overt response) on learning a specific scientific concept - the human heart and its functions. Dwyer indicated that most of his studies failed to provide any definitive conclusion about visual realism effectiveness because individual differences were not considered as an experimental

variable. However, in three of his studies, Dwyer (1972a) manipulated two categorical variables (sex and grade levels) and previous knowledge as independent variables to detect any interaction with treatments.

Nine slide treatments designed to teach the heart and its function were administered to 1050 students in grades nine, ten, eleven and twelve (Dwyer, 1969a, 1969b). At each grade level, each of the nine classes was assigned at random to one of the treatment groups. Slides were synchronized with the oral instruction by means of audio tape. The instructional treatments consisted of a simple line drawing, a detailed, shaded drawing presentation, the heart model presentation and the realistic photographic presentation. The students viewed their respective instructional presentations for equal amounts of time and received the same criterion tests. In addition to the immediate testing, delayed retention was measured two weeks later using the same tests.

His findings revealed that the same types of visuals are not equally effective at different grade levels in facilitating student achievement of identical educational objectives. For instance, for twelfth grade students, oral presentation without visuals was most effective in facilitating achievement on the drawing test, while the detailed, shaded presentation was most effective for facilitating achievement on identification, terminology, comprehension and total criterion tests. On the other hand, for ninth, tenth, and eleventh

grade students, simple line drawings were most effective in facilitating achievement on drawing, identification and total criterion tests.

Dwyer (1972a) investigated the relationship between students' prior learning and their achievement on criterion tests designed to measure the achievement of different educational objectives. The three levels of previous knowledge comprising high, medium, and low were defined by establishing cut-off points one-half standard deviation on both sides of the mean which was achieved on the physiology pre-test by students receiving each instructional treatment. There were 587 college students involved in the study. Students in each treatment group received their respective instructional presentation via programmed booklets complemented by means of different types of visual illustrations.

The study demonstrated that students in the low and medium entering behavior groups generally required more time than students in the high entering behavior group to interact with more realistic instructional presentations. Dwyer (1972a) also found that the use of visualization to complement programmed instruction is an effective technique for reducing differences in achievement between students in low and medium entering behavior groups.

Recently, Berry (1983) conducted an experiment to investigate the interaction between cross-cultural differences and pictorial recognition memory for pictures presented in three different color

modes (realistic color, non-realistic color, and monochrome). Subjects (N=74) of either Asian (n=35) or American (n=39) cultural origin participated in the study. The stimulus materials used were the same as those used by Berry (1977) and Wieckowski (1980). He used 150 stimulus slides and 90 distractor slides. All slides were obtained from a pool of travel and geographic scenery slides taken by several amateur photographers in various parts of the United States and Canada. The entire collection was randomly divided into approximate thirds. One third was retained as a realistic color group, a second third was recopied into black and white slides, and the remaining third was altered by photographic reversal to produce a nonrealistic color group of slides. Subjects were then presented with a random distribution of all stimuli and distractor slides for about 15 seconds each. During that time, they responded verbally, either "old" (stimulus seen before) or "new" (distractor slides not seen before). Findings relative to the cultural variable generally showed no significant difference across groups. In terms of the color variable, the Asian group indicated the superiority of both color formats over black and white format. Based on these findings, Berry concluded that color materials (realistic and nonrealistic) tend, in some cases, to produce higher recognition scores, and that black and white stimulus materials tend to produce greater error scores.

In studying the instructional effectiveness of integrating abstract and realistic visualization, Joseph and Dwyer (1982)

experimented with 490 tenth grade public school students enrolled in coeducational health classes and concluded that abstract visualization tends to enhance externally-paced instruction more than self-paced instruction. They also concluded that students who receive instruction accompanied by realistic visualization achieve significantly higher scores than students who receive instruction which is not accompanied by realistic visualization. They finally observed that although the integration of abstract and realistic visualization does not appear to improve effectiveness in general, it may reduce the difference in achievement in students possessing different cognitive styles (field dependence/field independence), particularly when both types of visualization are presented simultaneously.

Summary

Dwyer (1967) indicated that realistic color increased student interest in the content material. Some studies conclude that oral and verbal symbols would contain a low degree of realism, and that pictures would be remembered better than words. One study indicates the value of color in any instructional medium lies in bringing the presentation closer to reality. Another study indicates that abstract visualization tends to enhance externally paced instruction, and that the integration of abstract and realistic visuals does not appear to improve general effectiveness.

CHAPTER 3.

METHODOLOGY

Purpose

The purpose of this study was to identify a possible relationship between cognitive styles, instructional materials, time on task and their combined effects upon achievement. The materials used consisted of instructional programs on the human heart, its parts and function during the diastolic and systolic phases developed by Dwyer (1967).

This experiment was divided into two phases. During phase I, the Group Embedded Figures Test and the color blindness test were administered, while during phase II the pretest, the instructional treatment and the posttest were administered.

Subjects

Eighty-five freshman students in the Iowa State University psychology pool completed all aspects of the study. Thirty-eight students of the original 132 who participated in the Group Embedded Figures Test chose not to participate in the total study. Nine students were dropped because of color blindness. Their field dependence/field independence scores were not significantly different from the eighty-five students who completed the study.

Authorization was granted by the Iowa State University Human Subjects Committee to use Iowa State students in this research (Appendix A), and also to obtain their high school class ranks from the Admissions Office. This was done after the Committee was assured that the rights and welfare of the human subjects were adequately protected.

Instruments

The major instruments for this study consisted of the Group Embedded Figures Test (Witkin et al., 1971), color blindness test (Dvorine, 1953), and a pretest and posttest (Dwyer, 1967) programmed on the Apple II microcomputer by the investigator.

The Group Embedded Figures Test

The GEFT was administered to determine the subject's level of field dependence/field independence. Subjects were classified according to their GEFT scores. Since the early 1970s, the GEFT has been used consistently in research conducted on field dependence/field independence. Its advantages (compared with earlier measures) include cost, availability, large group format, time, ease of transportation, and ease of administration. The GEFT consists of eighteen items. For each item, subjects were asked to locate a hidden figure within the embedded context of a complex pattern. Each subject's score, then, was the number of correct tracings of simple figures on complex

designs (Appendix B). Performance on the GEFT reflects a tendency, in varying degrees of strength, toward analytical or global functioning.

Color Blindness Test

All the subjects were given the Dvorine Pseudo-Isochromatic color blindness test (Dvorine, 1953) immediately after the Group Embedded Figures Test. The test consists of two plates designed to discover quickly and accurately congenital color blindness, the most common form of color blindness. In addition to sophisticated testing instruments, ophthalmologists use this test for initial diagnosis of eye diseases. According to Dvorine, the color vision of the subjects "could be tested by the differing readings of the normal and the abnormal." The subjects were required to read numbers composed of color dots on a background of other colored dots. The colors were chosen (Dvorine, 1953) so as to confuse subjects who have the various forms of color deficiency. The subjects who read the numbers were regarded as people with normal vision, and those who had difficulty reading the numbers, or could not see the numbers at all, were regarded as abnormal or color blind.

Pretest

A multiple choice pretest (Dwyer, 1967) was used to measure the subjects' prior knowledge in the specific content area (Appendix D). The pretest was programmed so that the computer displayed the

questions and recorded the time from initial display until the subject responded to the questions. The computer calculated and recorded the subjects' total number of correct responses for later retrieval and analysis by the experimenter. Programming was done by the investigator with assistance from the Computer Laboratory staff of the Instructional Resources Center in the College of Education at Iowa State University.

Posttest

A multiple choice identification posttest (20 items), also programmed on the Apple II microcomputer, required students to identify the numbered parts on a detailed shaded drawing of the human heart (Appendix E). Each part of the heart that had been discussed in the instruction was numbered on the drawing and appeared in a list on the computer monitor. Students were required to look at the detailed drawing and type in the appropriate identifying response in each multiple choice item. A built in timer was automatically activated when each question appeared on the screen and continued until the subjects typed in a response. The computer calculated and recorded the total number of correct responses and time on task. The objective of this test was to measure the students' ability to identify parts of the heart from information received in the instruction. This test was crucial in this study as it helped to determine the relationship between field dependence/field independence and stimuli variability.

In addition, it assisted in determining the amount of time the subjects needed to attend to visual stimuli on the posttest and to register their responses on the computer keyboard. A Kuder-Richardson Formula 20 reliability coefficient of .79 for the posttest was computed by Dwyer (1972a).

Treatment Measures

The 2000-word instructional unit on the human heart was analyzed to identify those areas in the instruction where critical information was being presented - areas where it might reasonably be expected that students would experience difficulty in comprehending the information. Dwyer identified 39 such areas. Visuals were designed specifically to illustrate the information in each of the critical areas. (Appendix C contains the programmed instruction treatment.)

Detailed, Shaded Drawings in Color Group

The subjects were told to follow the programmed instruction lesson in the booklet provided. The programmed instruction was supplemented by detailed, shaded drawings of the human heart in color. Finally, they were asked to answer the posttest questions (using the computer) as soon as they finished reading the instructional script.

Detailed Shaded Drawings in Black and White Group

This group received the same instructions and treatment given to the color group with the only difference that the programmed instruction treatment was complemented by black and white drawings.

Control (Text-Only) Group

The subjects in this group were treated with only the programmed instruction lesson without visuals.

All treatment groups took the 20-item posttest immediately after the treatment.

Procedure

The following procedures were used in data collection:

Phase I

1. The subjects were administered the GEFT to determine their level of field dependence/independence.

This test was designed to enable researchers to administer it to a large group at the same time. Students of approximately 20 in each group were administered this test.

2. Immediately after the GEFT, the students were administered the Dvorine Pseudo-Isochromatic color blindness test.

Phase II

The subjects were informed that they were participating in research to investigate how learners with different learning styles learn from visual instructional materials. They were also informed of the procedures that would be followed and what was expected of them. This ensured that each subject had an adequate understanding of the task.

3. The subjects went through a computer familiarization session for ten minutes before the actual experiment. This was designed to acquaint them with the microcomputer that was used in the experiment and also to reduce computer anxiety. The activity included familiarization with the computer keyboard with emphasis on the RESET (to stop disk or exit program), RETURN (used to tell the computer to work after information has been fed to it), ARROW KEYS (used to move the cursor to right or left, and to erase mistakes), and the SPACE BAR. Keys that were not used in this experiment, such as the CONTROL key, were ignored.
4. Administration of the pretest to all (three) treatment groups. This test was programmed on the Apple II microcomputer (Appendix D).
5. The subjects were randomly assigned to one of three treatment groups. The treatment groups were as

follows:

- a. Detailed, shaded drawings in color.
 - b. Detailed, shaded drawings in black and white.
 - c. Control (text-only) group.
6. The treatment was administered to the subjects. During the experiment the subjects were advised to follow the programmed instruction booklet (at their own rate). They were told, however, that the computer kept a record of the time they took in responding and also their responses.
 7. The posttest, the last activity in this experiment, was administered. This test was also programmed on the microcomputer.

Experimental Design

As recommended by Campbell and Stanley (1966), the pretest-posttest control-group design was employed to test the relationship of cognitive style, instructional materials with variable stimuli, and learning time. With this design it was probable that the effects (determined by the posttest) were due to experimental treatments interacting with the subjects' cognitive styles.

The experimental design for the present study is represented by the following diagram:

R01	X1	O2
R01	X2	O2
R01		O2

Where

- R = Random assignment of the subjects
- O1 = Pretest
- O2 = Immediate posttest
- X1 = The experimental treatment; detailed, shaded drawings
in color
- X2 = The experimental treatment; detailed, shaded drawings
in black and white

The pretest-posttest-control-group design is one of the most commonly used experimental designs in use by educational researchers. The steps involved in this design are as follows: (1) Randomly assign subjects to experimental and control groups. Random assignment of subjects to treatment groups was accomplished by randomly assigning subjects to groups as they entered the experimental room. (2) Administration of pretest to all treatment groups. (3) Administration of the treatment to the experimental group but not to the control

group. (4) Administration of the posttest to all treatment groups (including the control group). All the groups were given the same pretest and posttest.

For the purposes of statistical analysis, the Group Embedded Figures Test scores, the pretest scores, high school class ranks and the treatment were treated as independent variables. The posttest scores and posttest time were treated as the dependent variable.

Analysis of Data

The Statistical Package for the Social Sciences (Nie, Hull, Jenkins, Steinbrenner and Bent, 1975) and the SPSSX (Nie, 1983) were used in the analysis of the data. WYLBUR was used to provide on-line interactive text editing capabilities that allow the user to create, change, store and display text. The system also provided services for submitting jobs for batch processing and retrieving the resulting output.

Path regression analysis was used to predict the relationship of the other variables to posttest time. Path analysis was originally introduced by Sewell Wright (1960) and has been popularized by Duncan (1966) in the social sciences. It is primarily a method of decomposing and interpreting linear relationships among a set of variables by assuming that "a (weak) causal order among these variables is known, and that the relationships among these variables

are causally closed" (Nie et al., 1975).

The arrows in Figure 1 represent a "weak causal ordering" (Page and Grandon, 1979) and do not assert a direct relation. Assumedly, if there is a causal relation, it is in the direction of the arrows. For example, if there is a causal relationship between pretest scores and posttest scores, then pretest scores must be the cause, because it is prior to the posttest scores.

The path regression analysis was done for both the full models formulated from the theoretical framework and revised models developed using data from the present study. In the full model, the regression equations were computed between all exogenous and related endogenous variables. After examining all of the paths in the full model, the variables with insignificant path coefficients were deleted. In the revised model, a linear regression analysis was computed using treatment groups, pretest time, field dependence/field independence and posttest time. In addition, Pearson product-moment correlation was used to determine if a relationship exists between field dependence/field independence, pretest scores and posttest scores. This test was also used to investigate the relationship between high school class rank and posttest scores. Analysis of variance was used to test the difference in posttest scores between field dependent and field independent subjects in the three treatment groups.

The following null hypotheses of the present study were tested at the statistical significant level of .05 and .01:

1. There is no relationship between field dependence/field independence and knowledge pretest scores, and field dependence/field independence and achievement posttest scores.
2. There is no relationship between high school class rank and achievement posttest scores.
3. There is no difference in achievement posttest scores between field dependent and field independent subjects treated with color, black and white, and no illustrations.
4. There is no relationship between achievement posttest time and field dependence/field independence, treatment groups, and pretest time.

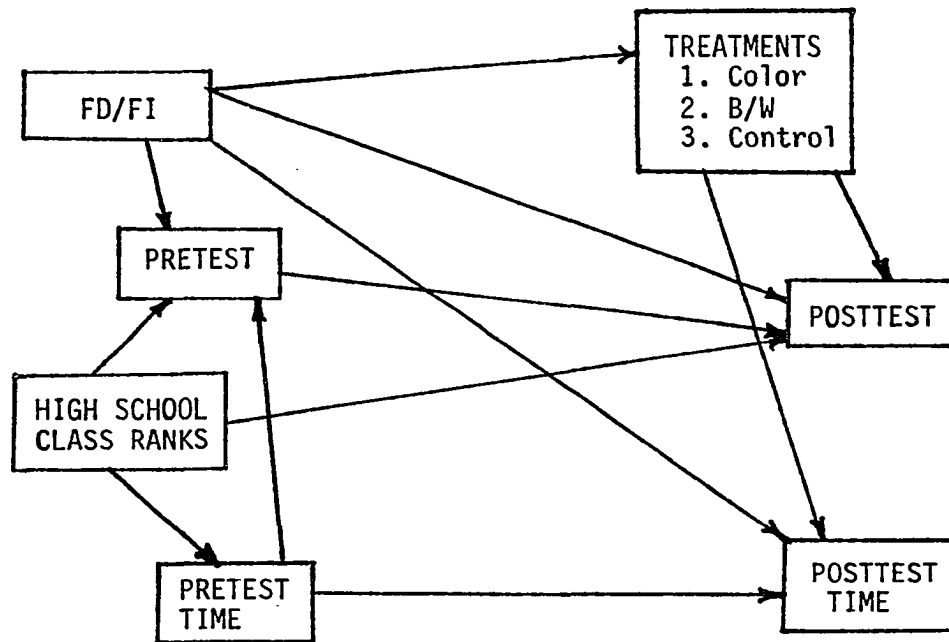


Figure 1. Prediction modeling of the independent and dependent variables

CHAPTER 4.

FINDINGS

This chapter will be divided into two sections. The first section includes descriptive data of the subjects in terms of their field dependence/field independence, pretest scores, posttest scores, pretest time, posttest time and high school class ranks. The second section contains the analysis of the results of the null hypotheses. They will be discussed as follows: first, each hypothesis will be stated, and descriptive data for the variables involved with each hypothesis will be presented. Second, the statistical technique and data used to test the relationship of the variables for each hypothesis will be presented. Third, a summary of the findings for each hypothesis will be presented.

The research undertaken in this study was designed to investigate whether the cognitive style of an individual had an effect on his/her achievement when visual instruction with variable stimuli is used. The second area of investigation was to examine whether or not cognitive style had any relationship with the experimental treatment to affect time taken to assimilate and process information.

One hundred and thirty-two freshman undergraduate students from the Iowa State University psychology pool volunteered to participate

in this study. These 132 students completed the Group Embedded Figures Test (for measuring field dependence/field independence) and the color blindness test during phase I of the study. Eighty-five students completed phase II of the study, 38 of the original 132 chose not to participate and nine were dropped because of color blindness. The 85 students were randomly assigned to one of three programmed instruction treatment groups concerning parts and function of the human heart (Dwyer, 1967). Programmed instruction was enhanced with shaded drawings in color ($n=29$), shaded drawings in black and white ($n=29$), and the control group had no drawings ($n=27$). Phase II data for all subjects consisted of high school class rank obtained from the Iowa State University Admissions Office, pretest and posttest scores on parts and functions of the heart, and total elapsed time to complete the pretest and posttest. The pretest and posttest were taken on an Apple II computer with answers and elapsed time being recorded.

Descriptive Data

Scores on the Group Embedded Figures Test can range from 0-18. The population reported herein had a range of 1-18 with a mean of 12.90 ($SD=4.33$). These scores are similar to the scores reported by Witkin et al., 1971, for men and women college students in an eastern liberal arts college (mean = 12.0, $SD=4.1$ for men; and mean = 10.8, $SD=4.2$ for women). The subjects were divided into thirds; scores of 1-10 were labeled field dependent ($n=23$), scores of 11-15 were labeled

mixed field dependent/field independent ($n=31$), and scores of 16-18 were labeled field independent ($n=31$). The field dependent and field independent groups have a score range similar to the first (0-9 for males and 0-8 for females) and fourth (16-18 for males and 15-18 for females) quartiles of the previously cited study by Witkin et al., 1971 (See Fig. 2).

The field dependence/field independence means were not significantly different in the three treatment groups ($F=1.54$, $Prob.=.22$). The color treatment group ($n=29$) had a mean of 13.28 and a score range of 7-18 ($SD=3.54$). The black and white treatment group ($n=29$) had a mean of 11.79 and a score range of 1-18 ($SD=4.62$). The control group ($n=27$) had a mean of 13.70 and a score range of 1-18 ($SD=4.68$). Table 1 shows the means, standard deviations, minimum and maximum scores of the Group Embedded Figures Test.

Pretest means were not significantly different when subjects were divided by treatment groups ($F=.46$, $Prob.=.63$) or by field dependence/field independence ($F=.19$, $Prob.=.83$). The color treatment group ($n=29$) had a mean of 12.79 ($SD=2.81$). The black and white treatment group ($n=29$) had a mean of 12.83 ($SD=2.71$) and the control group ($n=27$) had a mean of 13.44 ($SD=2.99$). Field dependent subjects ($n=23$) had a mean of 12.83, while field independent subjects ($n=31$) had a mean of 13.26 and mixed field dependent/field independent subjects ($n=31$) had a mean of 12.90. Table 2 indicates that pretest means by field dependence/field independence and treatment groups were

FD = 23											Mixed FD/FI = 31					FI = 31		
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	X				X		X	X	X	X	X	X	X	X	X	X	X	X
	X				X		X	X	X	X	X	X	X	X	X	X	X	X
	X				X		X	X	X	X	X	X	X	X	X	X	X	X
								X	X		X	X	X	X	X	X	X	X
								X	X		X	X	X	X	X	X	X	X
									X		X	X		X	X	X	X	X
														X		X	X	X
														X		X	X	X
																X		X
																		X
																		X

Figure 2. Classification of subjects into field dependent, mixed FD/FI and field independent groups

Table 1

Field dependence/field independence means, standard deviations, minimum and maximum scores of subjects in the three treatment groups

Treatment Groups	N	Mean	SD	Score min.	Range Max.
Color	29	13.28	3.54	7	18
Black & White	29	11.79	4.62	1	18
Control	27	13.70	4.68	1	18
Total Population	85	12.90	4.33	1	18
		F = 1.54	Prob = .220		

Table 2

A comparison of pretest mean scores of subjects by treatment groups and field dependence/field independence

Treatment group	Color	Black & White	Control
	12.79 (29) ^a	12.83 (29)	13.44 (27)
F = .46, Prob = .632			
=====			
FD/FI	FD	Mixed FD/FI	FI
	12.83 (23)	12.90 (31)	13.26 (31)
F = .19, Prob = .83			
=====			
Total Population = 13.01 (85)			

^a() = N.

uniform.

Posttest means were significantly different when subjects were divided by treatment groups ($F=5.08$, Prob.=.008) and were insignificant when posttest means were divided by field dependence/field independence ($F=2.30$, Prob.=.11). The color treatment group ($n=29$) had a mean of 13.28 ($SD=4.12$). The black and white treatment group ($n=29$) had a mean of 12.69 ($SD=4.01$) and the control group ($n=27$) mean was 9.81 ($SD=4.84$). Field dependent subjects ($n=23$) had a mean of 11.48, while mixed FD/FI subjects ($n=31$) had a mean of 11.0 and field independent subjects ($n=31$) had a mean of 13.32. Table 3 shows the subjects' posttest means by treatment groups and by field dependence/field independence. Field independent subjects performed better than mixed FD/FI and field dependent subjects. The color and black and white treatment groups were not significantly different on the posttest scores. However, these groups scored significantly higher than the control group.

Table 4 reports the comparison of the pretest and posttest in the three treatment groups. This comparison was examined through the use of the t-test. The calculated t-value of $-.67$ ($p>.05$) was derived for the color treatment group, $.18$ ($p>.05$) for the black and white group, and 4.53 ($p<.01$) for the control group. The large t-value in the control group accounted for the significant difference.

Pretest time means (in seconds) were significant at the .05 alpha

Table 3

A comparison of posttest mean scores of subjects by treatment groups and field dependence/field independence

Treatment Groups	Color	Black & White	Control
	13.28	12.69	9.81
	(29) ^a	(29)	(27)
F = 5.08, Prob = .008*			
=====			
FD/FI	FD	Mixed FD/FI	FI
	11.48	11.00	13.32
	(23)	(31)	(31)
F = 2.30, Prob = .11			
=====			
Total Population = 11.98			
(85)			

^a() = N.

*Significant at the .01 level.

Table 4

A comparison of means and standard deviations of the pretest and posttest scores by treatment groups

Treatment Group	Test	Mean	SD	t-value	P	Correlation
Color	Pretest	12.79	2.81	-0.67	.51	.42
	Posttest	13.28	4.12			
=====						
Black & White	Pretest	12.83	2.71	0.18	.86	.32
	Posttest	12.69	4.01			
=====						
Control	Pretest	13.44	2.99	4.53	.00*	.52
	Posttest	9.81	4.83			
=====						

*Significant at the .001 level of significance.

level when subjects were divided by treatment groups ($F=3.21$, $\text{Prob}=.046$) and were not significant when pretest time means were divided by field dependence/field independence ($F=1.02$, $\text{Prob}=.37$). The color treatment group ($n=29$) had a mean of 189.66 seconds ($SD=56.26$). The black and white treatment group ($n=29$) had a mean of 212.34 seconds ($SD=59.63$) and the control group ($n=27$) had a mean of 174.56 seconds ($SD=52.62$). Field dependent subjects had a mean of 206.61 seconds, while field independent subjects had a mean of 184.29 seconds and mixed FD/FI subjects had a mean of 190.52 seconds. Table 5 indicates pretest time means for field dependence/field independence and the treatment groups and shows that field dependent subjects spent more time on the pretest as compared to mixed FD/FI and field independent subjects. Subjects in the black and white group also spent more time than those in the color and control groups.

Posttest time means (in seconds) were significantly different when subjects were divided by treatment groups ($F=3.49$, $\text{Prob}=.035$) and were not significant when the means were divided by field dependence/field independence ($F=.41$, $\text{Prob}=.67$). The color treatment group ($n=29$) had a mean of 213.38 seconds and a standard deviation of 50.07. The black and white treatment group ($n=29$) had a mean of 229.10 seconds and a standard deviation of 53.04. The control group ($n=27$) had a mean of 249.48 seconds and a standard deviation of 50.32. Field dependent subjects ($n=23$) had a posttest time mean of 237.70

Table 5

A comparison of pretest time (in seconds) by treatment groups and by field dependence/field independence

Treatment Group	Color	Black and white	Control
	189.66 (29) ^a	212.34 (29)	174.56 (27)
F = 3.21, Prob = .046*			
=====			
FD/FI	FI	Mixed FD/FI	FI
	206.61 (23)	190.52 (31)	184.29 (31)
F = 1.02, Prob = .37			
=====			
Total Population = 192.60			
(85)			
=====			

^a() = N.

*Significant at the .05 level.

seconds while field independent subjects ($n=31$) had a mean of 230.39 seconds. Mixed FD/FI subjects ($n=31$) had a posttest time mean of 224.48 seconds. Table 6 shows posttest time means for field dependence/field independence and the three treatment groups indicating that field dependent subjects spent more time on the posttest than mixed FD/FI and field independent subjects. The control group subjects also took more time on the posttest than the subjects in the color and black and white groups.

High school class rank (coded with 01 as high and 99 as low) was not significant across treatment groups ($F=1.20$, $Prob.=.307$) but was significant across field dependence/field independence ($F=7.02$, $Prob.=.002$). The high school class rank mean for the color treatment group was 21.35 ($SD=17.45$), the black and white group had 27.04 ($SD=18.37$), and the control group mean was 19.72 ($SD=15.49$). High school class rank mean was 30.21 for field dependent subjects ($n=19$), 26.15 for mixed FD/FI subjects ($n=27$) and 13.93 for field independent subjects ($n=28$). Table 7 indicates that field independent subjects had a higher high school class rank mean (13.93) than mixed FD/FI (26.15) and field dependent subjects (30.21).

Table 6

Posttest time means (in seconds) by treatment groups and by field dependence field independence

Treatment Group	Color	Black and white	Control
	213.38 (29) ^a	229.10 (29)	249.48 (27)
F = 3.49, Prob = .035*			
FD/FI	FD	Mixed FD/FI	FI
	237.70 (23)	224.48 (31)	230.39 (31)
F = .41, Prob = .67			
Total Population = 230.21 (85)			

^a() = N.

*Significant at the .05 level.

Table 7

High school class rank means by treatment groups and by field dependence/field independence

Treatment Group	Color	Black and white	Control
	21.35 (26) ^a	27.04 (23)	19.72 (25)
F = 1.20, Prob = .31			
=====			
FD/FI	FD	Mixed FD/FI	FI
	30.21 (19)	26.15 (27)	13.93 (28)
F = 7.02, Prob = .01*			
=====			
Total Population = 22.57 (74)			
=====			

^a() = N.

*Significant at the .01 level.

Tests of Hypotheses

The following research questions were formulated in order to consider if field dependence/field independence is significantly related to time on task and student achievement when instructional materials with variable stimuli are used:

1. Is there a relationship between field dependence/field independence and stimuli variability in instructional materials as determined by achievement posttest scores?
2. Is there a relationship between high school class rank and achievement posttest score?
3. Is there a relationship between field dependence/field independence, knowledge pretest scores, treatment groups and achievement posttest time?

Hypothesis 1:

There is no relationship between field dependence/field independence and knowledge pretest scores, and field dependence/field independence and achievement posttest scores.

Pearson product-moment correlation was calculated for the relationship between field dependence/field independence and pretest scores, and field dependence/field independence and posttest scores for all the subjects in the experimental and control groups.

The results shown in Table 8 indicate little if any correlation between pretest scores, posttest scores and the cognitive style of field dependence/field independence in the three treatment groups. This means that field dependence/field independence had no significant relationship with the pretest ($r=.09$, $p=.21$) and posttest ($r=.14$, $p=.09$). Since no significant relationship was found, hypothesis 1 failed to be rejected.

Hypothesis 2

There is no relationship between high school class rank and achievement posttest score.

This hypothesis was tested by Pearson product-moment correlation using data derived from high school class rank and posttest score. The correlations are reported in Table 8 for high school class rank and posttest scores in a correlation matrix of all variables.

The negative correlation for high school class rank and posttest score was expected since small numbers indicate high standing in one's

Table 8

Pearson product-moment correlation matrix for all variables

	Prescore	Pretime	Postscore	Posttime	FD/FI	HSCR
Prescore	1.00	-.24 (.01) ^a	.37 (.00)	.02 (.45)	.09 (.21)	-.35 (.00)
Pretime		1.00	.01 (.47)	.54 (.00)	-.23 (.02)	.13 (.14)
Postscore			1.00	-.03 (.41)	.14 (.09)	-.21 (.03)
Posttime				1.00	-.11 (.16)	-.04 (.38)
FD/FI					1.00	-.41 (.00)
HSCR						1.00

^a() = Probability level

Prescr = Pretest Score

Pretime = Pretest Time

Postscr = Posttest Score

Posttime = Posttest Time

FD/FI = Field Dep./Field Ind.

HSCR = High School Class Rank

graduation class and large numbers are high achievement scores on the posttest.

Since a correlation of $-.21$ ($p=.03$) was obtained between high school class rank and posttest score, hypothesis 2 was rejected. There is a relationship between the subjects' high school class rank and posttest score.

Hypothesis 3

There is no difference in achievement posttest scores between field dependent and field independent subjects treated with color, black and white, and no illustrations.

The above hypothesis was tested using field dependence, mixed FD/FI, field independence and posttest scores of subjects in the three treatment groups. The results of the analysis of variance test for field dependence/field independence, treatment groups and posttest scores are reported in Table 9. They indicate that the posttest scores of the subjects in the three treatment groups were significantly different ($F=5.92$, $p<01$). There was a difference in posttest scores with regards to field dependence/field independence ($F=3.25$, $p<.05$). A two-way interaction of field dependence/field independence and treatment groups yielded an insignificant F-value.

Table 9

Analysis of variance test of posttest scores by field dependence/field independence and by treatment groups

Source of Variation	Sums of Squares	DF	Mean Squares	F	Significance of F
Main Effects	309.80	4	77.45	4.20	.004*
FD/FI	119.92	2	59.97	3.25	.044**
GROUP	218.36	2	109.18	5.92	.004*
2-Way Interactions	11.84	4	2.96	.16	.96
FD/FI GROUP	11.84	4	2.96	.16	.96
Explained	321.65	8	40.21	2.18	.038**
Residual	1402.31	76	18.45		
TOTAL	1723.95	84	20.52		

*Significant at the .01 level.

**Significant at the .05 level.

This could be interpreted to mean that the interaction of field dependence/field independence and treatment groups had no effect on the posttest scores. The treatment groups accounted for the significant F-ratio of 5.92 ($p < .01$) indicating that both the color and black and white treatments proved superior to the treatment given to the control group subjects. The means listed in Table 10 reveal that the color treatment group had a mean of 13.28, with 12.69 for the black and white treatment group and 9.81 for the control group. Moreover, field independent subjects had a posttest mean of 13.32, mixed FD/FI subjects had a mean of 11.00, and field dependent subjects had a mean of 11.48 indicating that field independent subjects performed better than the others on the posttest.

Since the treatment groups and field dependence/field independence accounted for the difference in posttest scores, hypothesis 3 was rejected.

Hypothesis 4

There is no relationship between achievement posttest time and field dependence/field independence, treatment groups, and knowledge pretest time.

The independent variables of field dependence/field independence, treatment groups, and pretest time were selected to determine if they were predictors of amount of time spent on the posttest,

Table 10

Posttest means of subjects arranged according to treatment groups and field dependence/field independence

Treatment Group		FD/FI	
Color	13.28	FD	11.48
Black and white	12.69	Mixed FD/FI	11.00
Control	9.81	FI	13.32

the dependent variable. Pretest time and treatment groups were selected to partial out any effect that they may have contributed to the posttest time.

The stepwise multiple regression procedure was utilized to determine the combined predictive power of the predictor variables on the dependent variable. Multiple r gave the strength of the relationship between predictor variables included in the regression equation and the dependent, or criterion, variable. The r square indicated the percent of variation in the dependent variable which was explained by the predictor variables. In this study, pretest time, color and black and white groups, as compared to control group, were significant in the prediction of posttest time in the stepwise regression analysis. Field dependence/field independence was not significant. The overall tabulated F -value of 20.63 (with 3 and 81 degrees of freedom) was significant beyond the .01 level, indicating that a relationship did exist between the independent variables and the dependent variable. The results presented in Table 11 indicate that the multiple correlation coefficient r was .66 and the coefficient of determination r square was .43. This can be interpreted to mean that 43 percent of the variability in the posttest time was accounted for or "explained" by the linear combination of pretest time and treatment groups. Since there is a significant relationship between the variables, hypothesis 4 was rejected.

Table 11

Multiple regression analysis on the relationship between posttest time and field dependence/field independence, treatment groups, and pretest time

Analysis of Variance	DF	Sums of Squares	Mean Squares
Regression	3	100955.03	33651.68
Residual	81	132131.16	1631.25

$r = .66$

$F = 20.63$

$r\text{-square} = .43$

Significance of $F = .00^*$

The selected regression equation is: $\hat{Y} = 151.08 + 56X_1 - 44.61X_A - 41.68X_B$

Where $\hat{Y} =$ Posttest time

151.08 = Constant

$X_1 =$ Pretest time

$X_A =$ Dummy variable for treatment group

$X_B =$ Dummy variable for treatment group

*Significant at the .001 level.

CHAPTER 5.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to investigate whether the field dependence/field independence of an individual had a possible relationship with stimuli variability, pretest scores, high school class rank, and their effects on achievement. Achievement was assessed by the subject's performance in the identification posttest (Dwyer, 1967). The study also examined whether or not field dependence/field independence, pretest time and treatment groups had any effect on the amount of time taken for subjects to complete the posttest.

One hundred and thirty-two subjects completed the Group Embedded Figures Test (for measuring field dependence/field independence) and the color blindness test. Eighty-five subjects completed all aspects of the study; 38 of the original 132 decided not to participate and nine were dropped because of color blindness. The 85 subjects were randomly assigned to one of three treatment groups concerning parts and function of the human heart during the diastolic and systolic phases.

To answer the question if there was a significant relationship between a subject's field dependence/field independence, stimuli

variability and time on task, four hypotheses were generated. Data from the pretest, posttest, pretest time, posttest time, high school class rank and the Group Embedded Figures Test were used to test the hypotheses.

Several types of statistical tests were conducted to analyze the data. Pearson product-moment correlation was used to determine if a relationship existed between the subject's field dependence/field independence and the pretest, and field dependence/field independence and the posttest. This technique was also used to investigate the relationship between high school class rank and posttest score. Analysis of variance was used to test the difference in posttest scores between field dependent and field independent subjects in the three treatment groups. Finally, stepwise multiple regression analysis was used to predict posttest time using field dependence/field independence, treatment groups and pretest time.

Summary

The findings were as follows:

1. There is no relationship between field dependence/field independence and knowledge pretest scores, and field dependence/field independence and achievement posttest scores: failed to reject ($r=.09$, $p>.05$ for the pretest, and $r=.14$, $p>.05$ for the posttest). There was no significant relationship between field dependence/field

independence and knowledge pretest scores, and field dependence/field independence and achievement posttest scores.

2. There is a relationship between high school class rank and achievement posttest score ($r=-.21$, $p<.05$): rejected.

3. There is no difference in achievement posttest scores between field dependent and field independent subjects treated with color, black and white, and no illustrations ($F=5.92$, $p<.01$ for treatment groups, and $F=3.25$, $p<.05$ for field dependence/field independence): rejected. Both the treatment groups and field dependence/field independence contributed to the significant difference in achievement posttest scores.

4. There is no relationship between achievement posttest time and field dependence/field independence, treatment groups, and knowledge pretest time ($F=20.63$, $p<.001$): rejected. Forty-three percent of the variability in achievement posttest time was accounted for by the color and black and white treatment groups and knowledge pretest time.

Relationship of Field Dependence/Field Independence and Achievement

The results of this study concluded that no significant relationship existed between field dependence/field independence and pretest scores ($r=.09$, $p>.05$), and field dependence/field independence

and posttest scores ($r=.14, p>.05$). This indicated that the subjects' achievement of specific educational objectives was not affected or predicted by their degree of field dependence/field independence.

This result is close to the findings of Witkin (1977), who found that the cognitive style of field dependence/field independence is concerned with the form rather than the content of cognitive activity. French (1983) found no relationship between field dependence/field independence and pretest scores. Goodenough and Karp (1961), and Karp (1963) found moderate correlations between the Wechsler Intelligence Scale (WISC) and scores on the Embedded Figures Test and concluded that one cannot categorically say that persons who are field independent are superior in general intelligence to persons who are field dependent. Krey (1983) also found that there was no statistical difference between field dependent and field independent subjects in an experiment on field dependence and demographic analysis. However, these results are not consistent with those of Duncker (1945) who concluded that field dependent subjects have more difficulty in problem solving.

It is suspected that this discrepancy is due to the different types of the measurement instruments for testing cognitive style. The present study, including Krey's (1983) and French's (1983), employed the measurement developed by Witkin et al. (1971) while Duncker (1945) employed a different instrument. The Group Embedded Figures Test, as noted repeatedly, assesses the extent to which the organization of the

prevailing 'field' dominates perception of its parts. Field dependent persons "follow the organization of the field as present, whereas field independent persons are able to overcome the organization of the 'field', to break it up in order to locate a sought after component" (Witkin et al., 1971). The present study found no significant relationship between field dependence/field independence and achievement because the pretest and posttest tested the subjects' knowledge of parts and functions of the human heart. Since the tests did not require the subjects to isolate an essential element from the context in which it is presented, it could be concluded that field independent subjects are not superior to field dependent subjects in achievement. Conclusions could be drawn from this and previously cited studies that field dependent individuals are not predictably different from field independent individuals in knowledge tasks. They are also not different in their abilities to learn new information.

Effects of Field Dependence/Field Independence and Stimuli Variability on Student Achievement

The results of this study confirmed that stimuli variability accounted for a significant F-ratio ($F=5.92, p<.01$), indicating that both the color and black and white treatment groups proved superior to the treatment given the control group subjects. There was also a significant difference in posttest scores with regards to field

dependence/field independence ($F=3.25$, $p<.05$), indicating that field independent subjects performed better than field dependent and mixed FD/FI subjects in the posttest measure.

The results confirmed that stimuli variability accounted for the significant difference in posttest scores. This provides support for realism theories (Carpenter, 1953; Dale, 1946; and Morris, 1946). Realism theories, according to Dwyer, are based on the assumption that instruction will be facilitated if the number of cues in the learning situation increases. This result is consistent with the findings of Levin et al. (1974); Berry (1974); and Lamberski (1980); which concluded that subjects who are treated with visuals perform better than those who are not. On the other hand, this conclusion was not supported by Attneave (1954); Dwyer (1972a); and Gorman (1972), who indicated that realism theories were not reliable predictors of student learning.

The results of the present study also confirm that field independent subjects are able to handle more variables or cues in learning than field dependent subjects. The difference in scores between field independent, field dependent and mixed FD/FI subjects indicated that the instructional treatment interacted with cognitive style to produce the posttest differences. Witkin et al. (1977) confirmed that field independent subjects are better at disembedding figures from their backgrounds than are field dependent subjects. Other studies show that field independent individuals are better at

concept attainment (Arbuthnot, 1971; Davies and Klausmeier, 1970; Ruble and Nakamura, 1972). Koran et al. (1971) reported that field independent individuals may have the aptitude to process visuals that have a high degree of irrelevant information and field dependent individuals may have greater difficulty in isolating irrelevant information. The significant interaction of field dependence/field independence and stimuli variability reported in the present and previously cited studies is consistent with Witkin's et al. (1974) hypothesis that field independent subjects are less prone to be influenced by irrelevant perceptual "noise" when they attend to a problem than are field dependent subjects.

It can generally be concluded that the use of visual cueing (black and white and color) devices does indeed facilitate the storage and retrieval of information. It would appear that the process is aided because of a greater number of visual cues present in the learning process. Since the visual cues were in the programmed instruction treatment it was concluded that the increased effectiveness of the color and black and white treatments were due to the factor of realism rather than increased visual complexity. The effectiveness of the visual cues may reside in their ability to demand sustained student attention and interaction with the content along with their ability to be able to provide enhanced associative memory structure. Following Broadbent's (1958) and Traver's (1970) information overload hypothesis visualization may have "jammed" the

information processing system of field dependent individuals, thus preventing the successful decoding and eventual retrieval of information contained in the visuals. Since, however, the black and white visuals did not offer as much detail and contrast, they could be more analytically viewed by field dependent subjects.

Relationship of Field Dependence/Field Independence, Treatment Groups and Time on Task

It was found in this study that pretest time and the color and black and white treatment groups were significant in the prediction of posttest time. Field dependence/field independence was not significant. The overall tabulated F-value of 20.63 ($p < .01$) indicated that a relationship did exist between the independent and dependent variables.

This finding is supported by Gordon et al. (1967) who concluded that the amount of time allowed for a task will partially determine the cue value of color. Furthermore, color codes in some perceptual tasks have produced superior learner performance and speed for visual search (Luria and Strauss, 1975). However, this finding is at variance with Dwyer's (1972a) and Berry's (1974) who suggested that the use of color materials will require more time for individuals to perceive, process and store information. Studies of various subjects in which learners are free to go at their own pace make it clear that

aptitude and general intelligence test scores are predictive of the time required by individuals to complete the particular learning unit to criterion. Bloom (1974) obtained correlations from about .50 to about .70 for such studies. However, in these studies the individuals were under no pressure to proceed at a faster rate than they found compatible with their own inclinations. In this study, the testing instruments were administered to groups of students at the same time, and according to Bloom (1974), a great deal of pressure could be mounted on the subjects to go through the treatment at the same time as the rest of the group.

The data from the present study indicate that there was a correlation between treatment groups, pretest time and posttest time. One of the important findings was that forty-three percent of the variation in posttest time was accounted for or "explained" by the pretest time and treatment groups. In addition, subjects in the control group took the longest time, while subjects in the color treatment group took the shortest time to complete the posttest to criterion.

Although field independent subjects were expected to spend less time on the posttest because of their ability to easily disembed a figure from its background, the results indicated that field dependence/field independence had no significant relationship to posttest time. A corollary of this result is that the posttest did not require the subjects to isolate an essential part from a whole,

but to identify the parts and functions of the human heart already discussed in the programmed instruction treatment; so field dependence/field independence had little or not effect on the time taken to complete the posttest.

The major conclusions of the present study are summarized as follows:

1. Field dependent/field independent cognitive style does not correlate with achievement of specific educational objectives.
2. Field dependent/field independent cognitive style correlates with high school class rank.
3. Generally, field independent subjects perform better than field dependent and mixed FD/FI subjects in achievement when stimuli variability is used.
4. Both the color and black and white treatment groups are superior to the text-only treatment. This means that the use of visualization for instructional purposes tends to facilitate student learning.
5. Field dependence/field independence is not a reliable predictor of time on task.
6. The use of visuals in instructional materials to complement instruction is an effective way to improve student achievement of specific learning objectives.

Implications

The implications of these findings are challenging. The cognitive style of field dependence/field independence and stimuli variability should be considered with respect to possibly adapting alternative teaching techniques to cognitive attributes of students in order to improve their performance and achievement (Cronbach and Snow, 1977; Kogan, 1971). By designing distinct instructional materials to take into account stimuli variability in their content and cognitive structures, it seems likely that field dependent students, as compared to field independent and mixed field dependent/field independent subjects, may benefit from learning facts more readily, retaining information more easily, and retrieving from memory with greater facility.

Although some research has been conducted on field dependence/field independence (Stickle, 1978; Sheriff and Williams, 1980; Douglas, 1978; Witkin, et al., 1974, 1977) there has been no study to investigate the relationship between field dependence/field independence, stimuli variability and time on task. This study has attempted to do this and implies that it may be educationally advantageous to look not only at an individual's cognitive style but also the relationship of these styles with stimuli variability in instructional media and time on task when planning instructional sequences. In other words, by determining each individual's cognitive

profile, the proper combination of media treatments can be prescribed so that a learning goal can be successfully achieved. This research has implications for the manner in which materials are presented in classroom instruction, and suggests that it may be profitable for teachers to present information in such a manner that the cognitive styles of learners, stimuli variability of instructional materials and time on task are taken into consideration. It suggests that instructional developers should consider designing instructional strategies that take into account student differences in abilities, aptitudes, and cognitive styles.

Recommendations for Further Study

Based on the findings from this investigation and the researcher's insights, the following recommendations for further research are made:

1. Replication of this study with subjects in similar or dissimilar cultural and national backgrounds might substantiate the findings here and provide a broader base for generalizations.

2. Since previous studies have reported sex differences on the field dependent/field independent characteristics, a similar study, with a larger population, can be done partialling out the effect of sex and I.Q after testing for field dependence/field independence. The present study did not account for either sex or I.Q which could have attributed to the results presented.

3. Based on the findings of this present study, an attempt to

interpret realism theory and relevant cues theory as not the same theory of instructional media is still open to further investigation.

4. Additional research should focus on the effects of different types of visualization techniques and color cueing in particular, on specific types of human learning.

5. It is further suggested that more research in the area of cognitive style, time on task and stimuli variability be done. A replication of the present study, with more emphasis on time and other elements of the realism continuum, would be beneficial.

6. The use of the microcomputer to test and record the subjects' performances in the testing instruments, as used in this study, is still open to further investigation.

The concept of cognitive style refers to psychological dimensions that represent consistencies in an individual's manner of acquiring and processing information. The present study investigated the cognitive style of field dependence/field independence. There are other styles that should be investigated. Messick (1966) lists several dimensions of cognitive styles including scanning/focusing, cognitive complexity/simplicity, reflectivity/impulsivity, leveling/sharpening, constricted/flexible and hemisphericity (left brain/right brain). Before we thoroughly understand human learning many cognitive styles will need to be investigated.

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APPENDIX A: HUMAN SUBJECTS APPROVAL

Interoffice Communication

106

IOWA STATE UNIVERSITY
of Science and Technology

DATE September 21 1983
TO The Chairperson
Human Subjects Approval Committee
201 Beardshear Hall

FROM Christopher Ivo Atang
N062 Quadrangle



With regards to my research proposal ("The Relationship of Field Dependent/Field Independent Cognitive Styles, Stimuli Variability and Time Factor on student Achievement") approved by your committee on August 26 1983, I am enclosing the following addenda:

1. Students will sign a release for me to obtain their high school class ranks from the Office of Admissions at Iowa State University. (Enclosure).
2. A 10-minute computer familiarization exercise will be conducted to acquaint participants with the microcomputer with the main objective of reducing computer-anxiety. No data will be collected during this exercise.

*Approved for the Committee
A. Stencas
9/21/83*

Before the experimental session, the participants will be asked to read and sign the following:

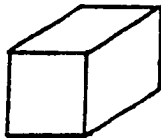
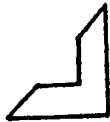
I grant permission for Mr. Atang to obtain my high school class rank from the Office of Admissions to use in his research project. Data will not be reported with my name attached to it.

Name	Social Sec. #	Name	Soc. Sec. #
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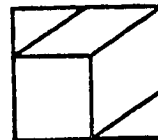
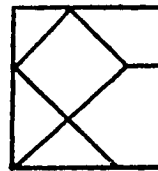
APPENDIX B: GROUP EMBEDDED FIGURES TEST

The following four simple/complex figures are taken from the practice section of the Group Embedded Figures Test.

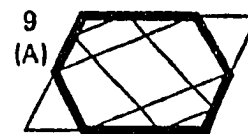
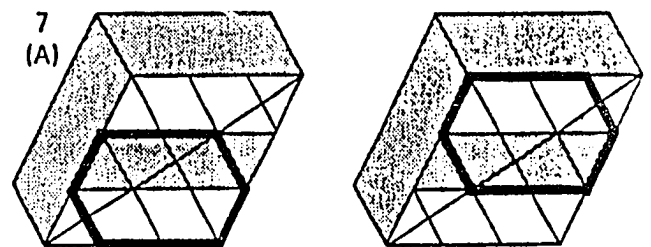
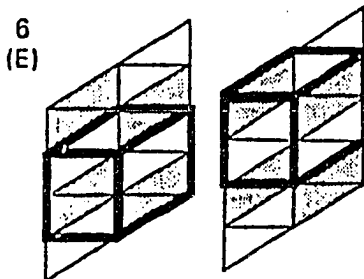
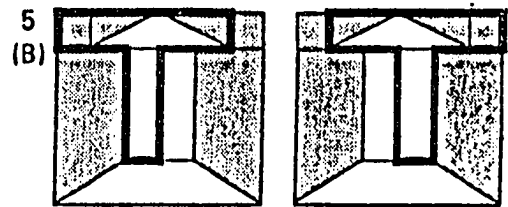
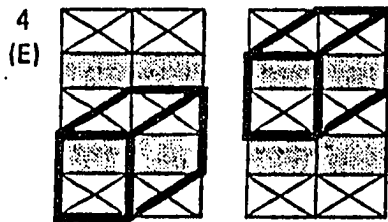
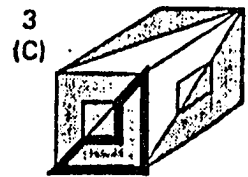
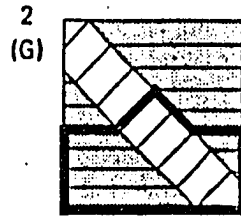
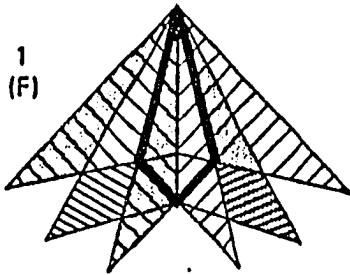
Simple Figure



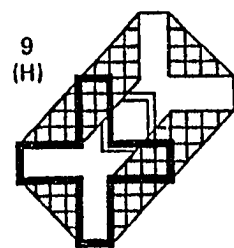
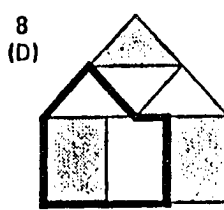
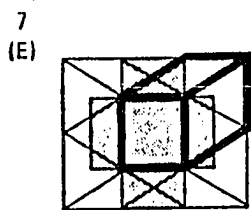
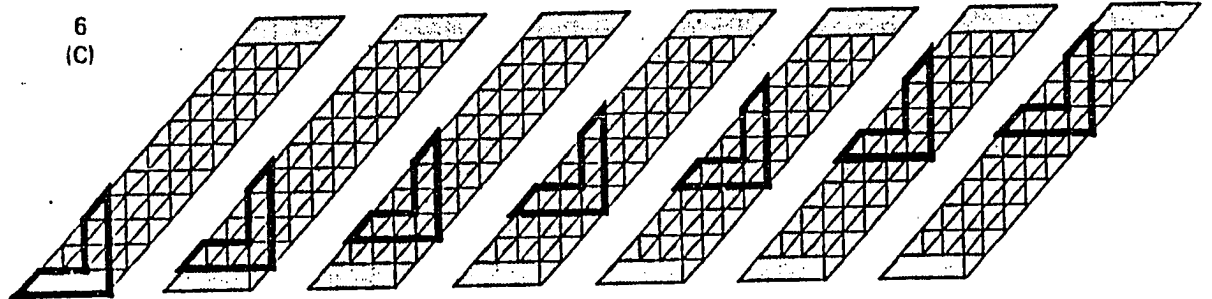
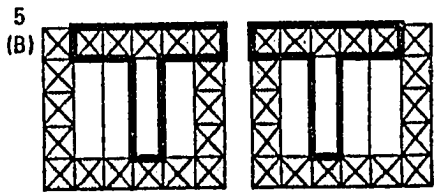
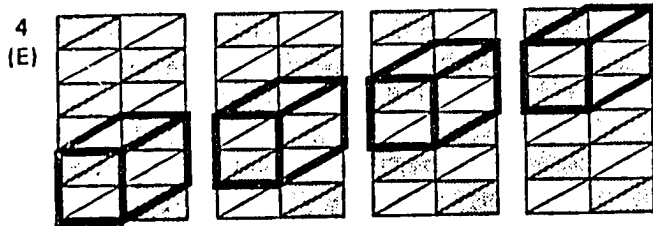
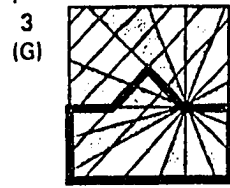
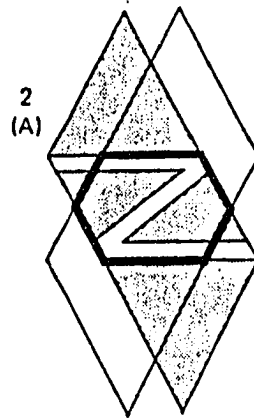
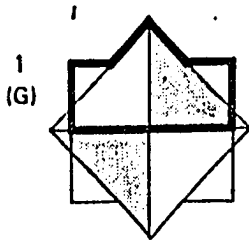
Complex Figure



GEFT-SCORING KEY



Letter designates the simple figure embedded. To receive credit, subject's outline must duplicate the ones shown. For use with the Group Embedded Figures Test by Philip K. Oltman, Evelyn Raskin, and Herman A. Witkin. © Copyright, 1971, by Consulting Psychologists Press, Inc. 577 College Ave., Palo Alto, Calif. 94306. All rights reserved. Reproduction prohibited.



APPENDIX C: PROGRAMMED INSTRUCTION TREATMENT

THE HUMAN HEART:
Parts of the Heart, Circulation of Blood
and
Cycle of Blood Pressure

© Dwyer, F.M. and Lamberski, R.J., 1977

DIRECTIONS

YOU ARE ABOUT TO PARTICIPATE IN AN INSTRUCTIONAL LESSON AND STUDY WHICH IS ATTEMPTING TO INVESTIGATE THE RELATIVE EFFECTIVENESS OF VISUAL ILLUSTRATIONS IN COMPLEMENTING PRINTED INSTRUCTION. THIS PARTICULAR BOOKLET IS ONE OF TWO DIFFERENT TYPES BEING USED.

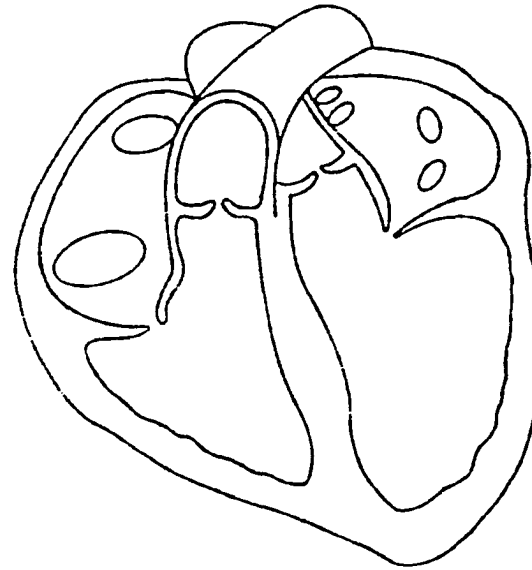
THE SUBJECT MATTER DEALS WITH THE HEART, ITS PARTS AND FUNCTIONS. THE CONTENT MATERIAL FOR EACH BOOKLET IS IDENTICAL. THE ONLY DIFFERENCE IS IN THE TYPE OF VISUAL BEING USED: THAT IS, SOME BOOKLETS ARE IN COLOR, OTHERS ARE IN BLACK AND WHITE. BE ATTENTIVE TO BOTH THE WRITTEN AND THE VISUAL INFORMATION.

ON THE BASIS OF THIS INSTRUCTIONAL BOOKLET, YOU WILL BE GIVEN A TEST CONSISTING OF SEVERAL PARTS. THE RESULTS OF THIS TEST WILL PROVIDE US WITH INFORMATION ASSESSING THE EFFECTIVENESS OF THIS INSTRUCTIONAL BOOKLET.

IT WILL BE TO YOUR ADVANTAGE TO MAKE SURE YOU UNDERSTAND THE INSTRUCTIONAL MATERIAL ON EACH PAGE BEFORE ADVANCING TO THE NEXT PAGE. THERE IS NO TIME LIMIT IN READING THIS BOOKLET.

RIGHT
SIDE

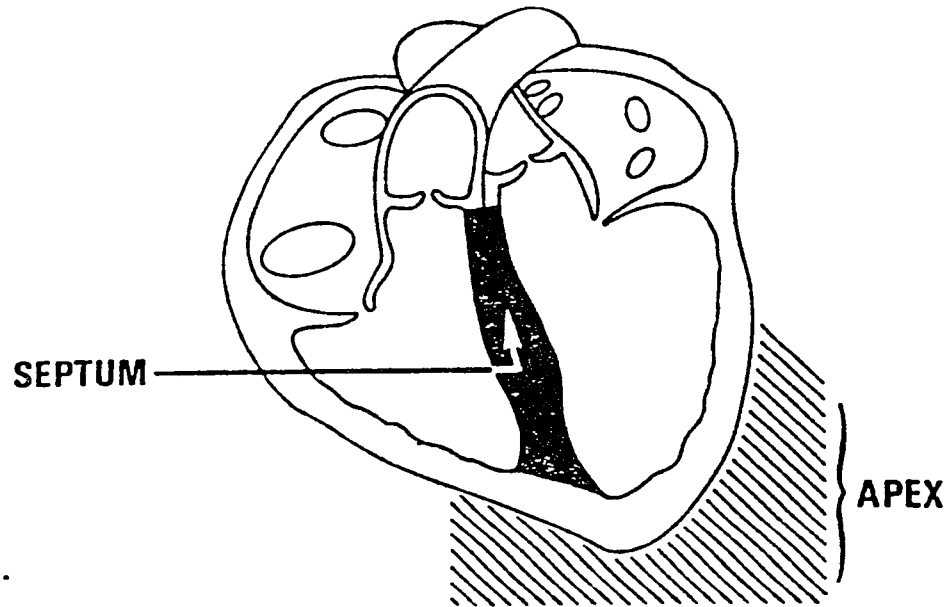
LEFT
SIDE



THE PARTS OF THE HEART

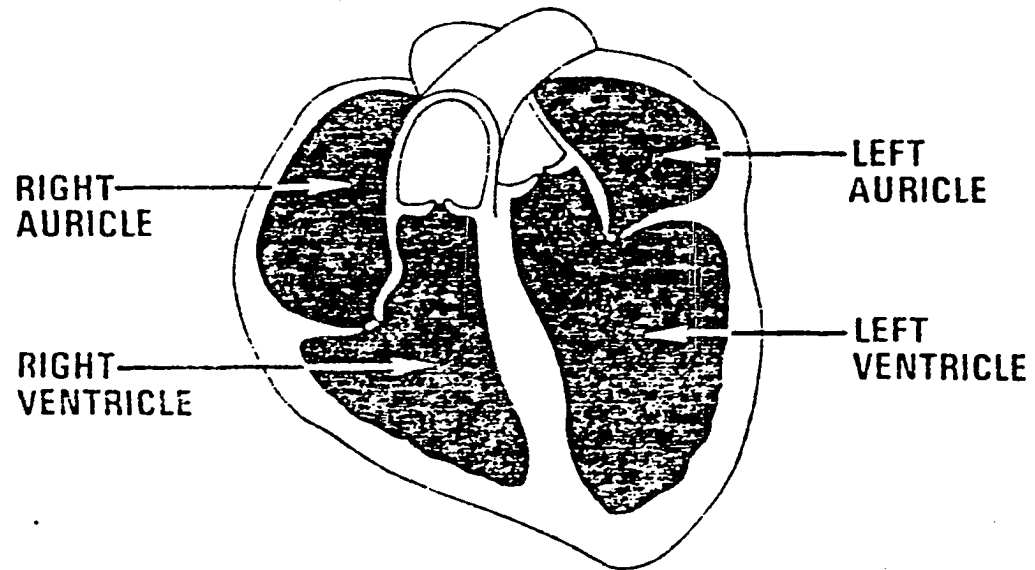
IN ORDER TO BETTER COMPREHEND THE FOLLOWING INSTRUCTION, IT WILL BE HELPFUL TO VISUALIZE A CROSS-SECTIONAL VIEW OF A HUMAN HEART IN A POSITION SUCH THAT YOU ARE FACING A PERSON. THEREFORE, THE RIGHT SIDE OF THE PERSON'S HEART IS TO YOUR VISUAL LEFT, AS SHOWN IN THE ABOVE DIAGRAM. LIKewise, THE LEFT SIDE OF THE PERSON'S HEART WOULD BE ILLUSTRATED ON THE RIGHT SIDE IN THE ABOVE DIAGRAM.

THE HUMAN HEART IS A HOLLOW, BLUNTLY CONICAL, MUSCULAR ORGAN. ITS PUMPING ACTION PROVIDES THE FORCE THAT CIRCULATES THE BLOOD THROUGH THE BODY. IN THE AVERAGE ADULT, THE HEART IS ABOUT FIVE INCHES LONG AND ABOUT TWO AND ONE HALF INCHES THICK. A MAN'S HEART WEIGHS ABOUT 11 OZS. AND A WOMAN'S HEART WEIGHS ABOUT 9 OZS.

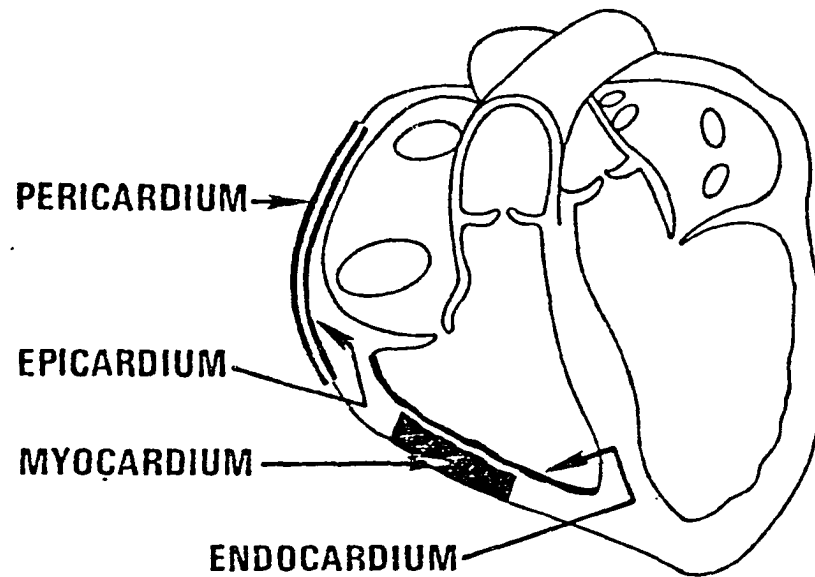


THE HEART LIES TOWARD THE FRONT OF THE BODY AND IS IN A SLANTING POSITION BETWEEN THE LUNGS, IMMEDIATELY BELOW THE BREASTBONE. THE WIDE END POINTS TOWARD THE RIGHT SHOULDER. THE SMALL END OF THE HEART POINTS DOWNWARD TO THE FRONT OF THE CHEST AND TOWARD THE LEFT. THE LOWER PORTION OF THE HEART IS CALLED THE APEX AND IS THE PART THAT YOU FEEL BEATING.

THE HUMAN HEART IS REALLY TWO PUMPS COMBINED IN A SINGLE ORGAN WHICH CIRCULATES BLOOD TO ALL PARTS OF THE BODY. THE HEART IS DIVIDED LONGITUDINALLY INTO TWO HALVES BY THE SEPTUM. THE TWO HALVES MAY BE COMPARED TO A BLOCK OF TWO HOUSES, WHICH ARE INDEPENDENT OF EACH OTHER BUT HAVE A COMMON WALL, THE SEPTUM, BETWEEN THEM.



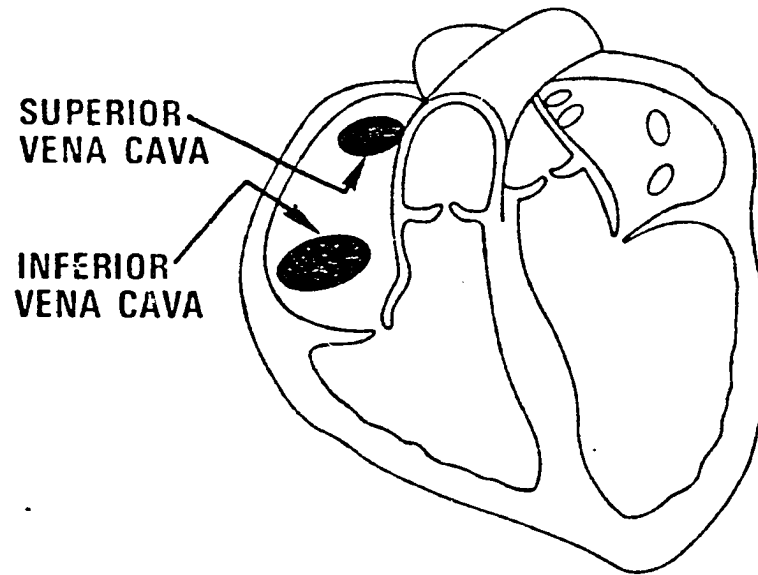
EACH HALF OF THE HEART IS DIVIDED INTO AN UPPER CHAMBER AND A LOWER CHAMBER. THE UPPER CHAMBERS ON EACH SIDE OF THE SEPTUM ARE CALLED AURICLES; THE LOWER CHAMBERS ARE CALLED VENTRICLES. AURICLES HAVE THIN WALLS AND ACT AS RECEIVING ROOMS FOR THE BLOOD, WHILE THE VENTRICLES HAVING THICKER WALLS ACT AS PUMPS MOVING THE BLOOD AWAY FROM THE HEART. ALTHOUGH THERE IS NO DIRECT COMMUNICATION BETWEEN THE RIGHT AND LEFT SIDES, BOTH SIDES FUNCTION SIMULTANEOUSLY.



THE HEART CONTAINS SEVERAL LAYERS OF MEMBRANES AND MUSCLE. THE FIRST SET OF MEMBRANES ENCLOSE THE HEART IN A THIN DOUBLE-WALLED SAC. THE LAYER WHICH FORMS THE OUTER WALL OF THE SAC IS CALLED THE PERICARDIUM. IT IS COMPOSED OF A TOUGH, TRANSPARENT ELASTIC TISSUE. IT PROTECTS THE HEART FROM RUBBING AGAINST THE LUNGS AND THE WALLS OF THE CHEST. THE INNER PORTION OF THE DOUBLE-WALLED SAC IS CALLED THE EPICARDIUM. IT IS ATTACHED TO THE HEART MUSCLE.

THE HEART MUSCLE IS CALLED THE MYOCARDIUM; IT CONTROLS THE CONTRACTION AND RELAXATION OF THE HEART. THE MYOCARDIUM CONSTITUTES BY FAR THE GREATEST VOLUME OF THE HEART AND ITS CONTRACTION IS RESPONSIBLE FOR THE PROPULSION OF THE BLOOD THROUGH THE BODY. THE MUSCLE VARIES IN THICKNESS; FOR EXAMPLE, THE MUSCLE IN THE AURICLE WALLS ARE THIN WHEN COMPARED TO THE THICKNESS OF THE MUSCLE IN THE VENTRICLE WALLS.

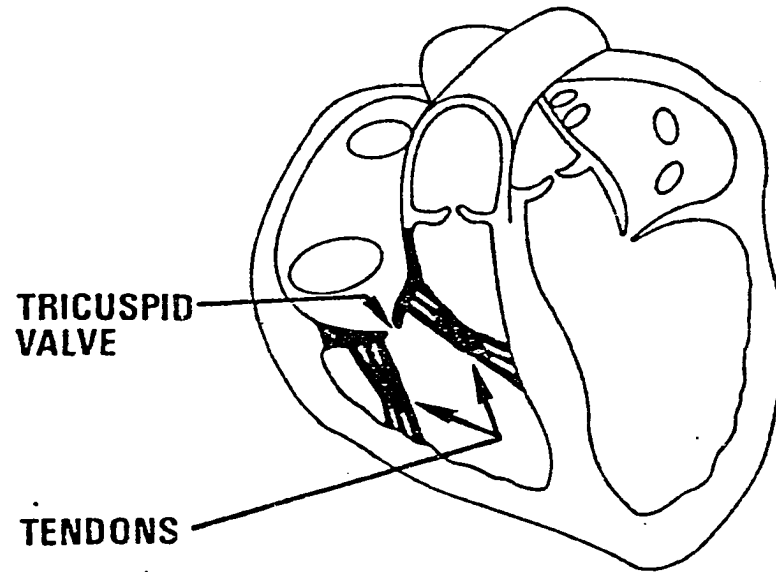
FINALLY THE ENDOCARDIUM IS THE NAME GIVEN TO THE MEMBRANE LINING INSIDE OF THE HEART WALL.



BLOOD ENTERS THE HEART THROUGH VEINS. ONLY VEINS CARRY BLOOD TO THE HEART. THE SUPERIOR AND INFERIOR VENA CAVAS ARE THE TWO VEINS WHICH DEPOSIT BLOOD IN THE RIGHT AURICLE; THERE ARE NO VALVES AT THE OPENINGS OF THESE VEINS.

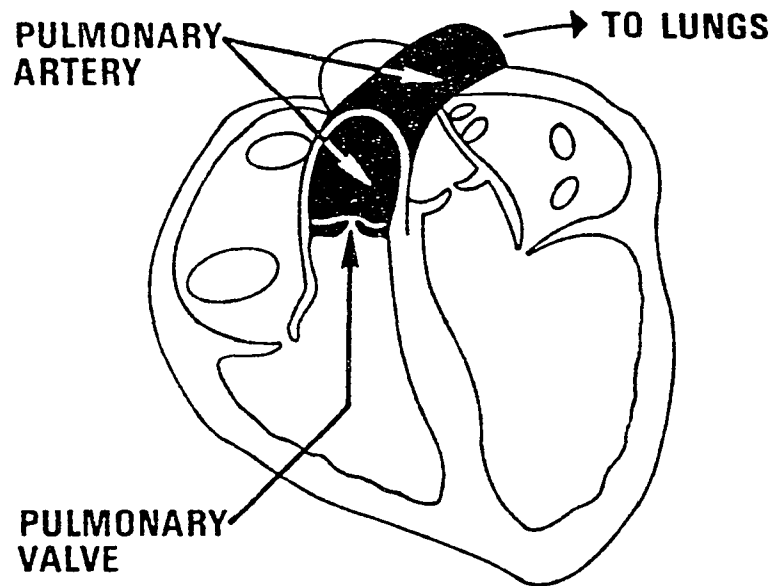
THE SUPERIOR VENA CAVA DEPOSITS BLOOD INTO THE RIGHT AURICLE FROM ALL BODY PARTS ABOVE HEART LEVEL, FOR EXAMPLE, THE HEAD AND ARMS. THE INFERIOR VENA CAVA CARRIES BLOOD FROM PARTS OF THE BODY BELOW HEART LEVEL, FOR EXAMPLE, THE TRUNK AND LEGS, DEPOSITING THE BLOOD IN THE RIGHT AURICLE.

AS BLOOD FROM THE BODY FILLS THE RIGHT AURICLE, SOME OF IT BEGINS TO FLOW INTO THE RIGHT VENTRICLE IMMEDIATELY, THROUGH A COMMON OPENING.



THIS COMMON OPENING, BETWEEN THE RIGHT AURICLE AND RIGHT VENTRICLE, IS CALLED THE TRICUSPID VALVE. THIS VALVE CONSISTS OF THREE TRIANGULAR FLAPS OF THIN, STRONG, FIBROUS TISSUE. THESE FLAPS PERMIT THE FLOW OF BLOOD INTO THE RIGHT VENTRICLE, BUT PREVENT IT FROM FLOWING BACKWARD INTO THE RIGHT AURICLE BECAUSE THE ENDS OF THE FLAPS ARE ANCHORED TO THE FLOOR OF THE RIGHT VENTRICLE BY SLENDER TENDONS.

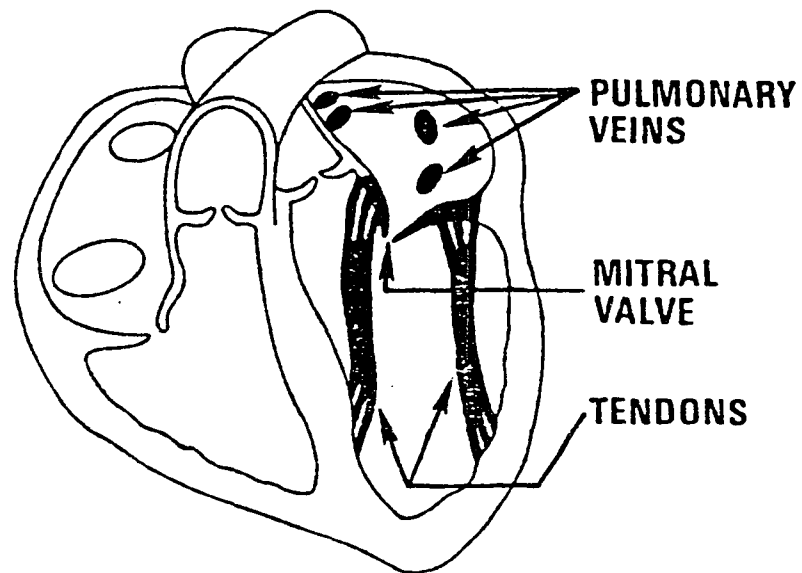
THUS, BLOOD PASSES FROM THE RIGHT AURICLE THROUGH THE TRICUSPID VALVE INTO THE RIGHT VENTRICLE. AS THE RIGHT VENTRICLE IS FILLED WITH BLOOD, BOTH VENTRICLES BEGIN TO CONTRACT CREATING PRESSURE.



WHILE THE BLOOD PRESSURE BEHIND THE TRICUSPID VALVE BRINGS THE FLAPS TOGETHER AND PREVENTS THE FLOW OF BLOOD BETWEEN THE RIGHT AURICLE AND THE RIGHT VENTRICLE, THE CONTRACTION OF THE RIGHT VENTRICLE CONTINUES UNTIL THE BLOOD PASSES HARD ENOUGH TO OPEN THE PULMONARY VALVE.

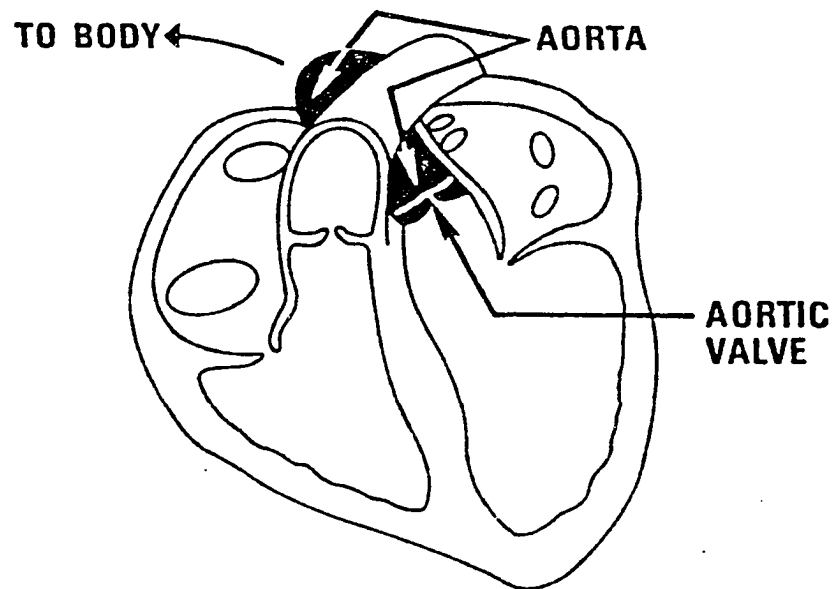
THE PULMONARY VALVE, LOCATED BETWEEN THE RIGHT VENTRICLE AND THE PULMONARY ARTERY, CONSISTS OF THREE FLAPS LIKE THE TRICUSPID VALVE. AS SOON AS THE RIGHT VENTRICLE BEGINS TO RELAX FROM ITS CONTRACTION, THE VALVE FLAPS ARE FILLED WITH BLOOD BACKING UP FROM THE PULMONARY ARTERY. THE FLAPS ARE PRESSED TOGETHER STOPPING THE BLOOD FLOW BACK INTO THE RIGHT VENTRICLE. THE PULMONARY VALVE ONLY OPENS WHEN THE PRESSURE IN THE RIGHT VENTRICLE IS GREATER THAN THE PRESSURE IN THE PULMONARY ARTERY, FORCING THE BLOOD INTO THE ARTERY.

IN THE PULMONARY ARTERY THE BLOOD IS CARRIED AWAY FROM THE HEART TO BOTH THE LEFT AND RIGHT LUNGS WHERE IT IS CLEANSSED AND OXYGENATED.



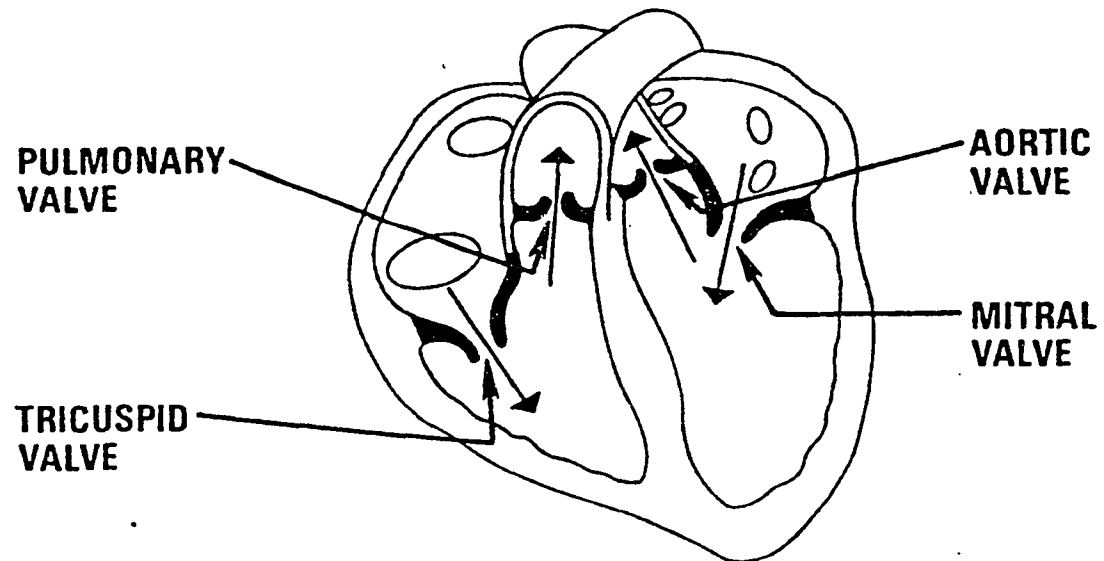
RETURNING FROM THE LUNGS, THE BLOOD ENTERS THE HEART THROUGH FOUR PULMONARY VEINS AND COLLECTS IN THE LEFT AURICLE; THESE VEIN OPENINGS, LIKE THE VENA CAVAS, HAVE NO VALVES. THE LEFT AURICLE THEN CONTRACTS WHEN IT IS FULL, SQUEEZING BLOOD THROUGH THE MITRAL VALVE INTO THE LEFT VENTRICLE.

THE MITRAL VALVE, LOCATED BETWEEN THE LEFT AURICLE AND THE LEFT VENTRICLE, IS SIMILAR IN CONSTRUCTION TO THE TRICUSPID VALVE. AS THE LEFT VENTRICLE CONTRACTS SIMULTANEOUSLY WITH ITS MATE, THE RIGHT VENTRICLE, IT FORCES BLOOD BEHIND THE FLAPS OF THE VALVE THEREBY CLOSING THE PASSAGEWAY BACK TO THE LEFT AURICLE. LIKE THE TRICUSPID VALVE, THE ENDS OF THE MITRAL VALVE FLAPS ARE ANCHORED TO THE FLOOR OF THE LEFT VENTRICLE BY SLENDER TENDONS.



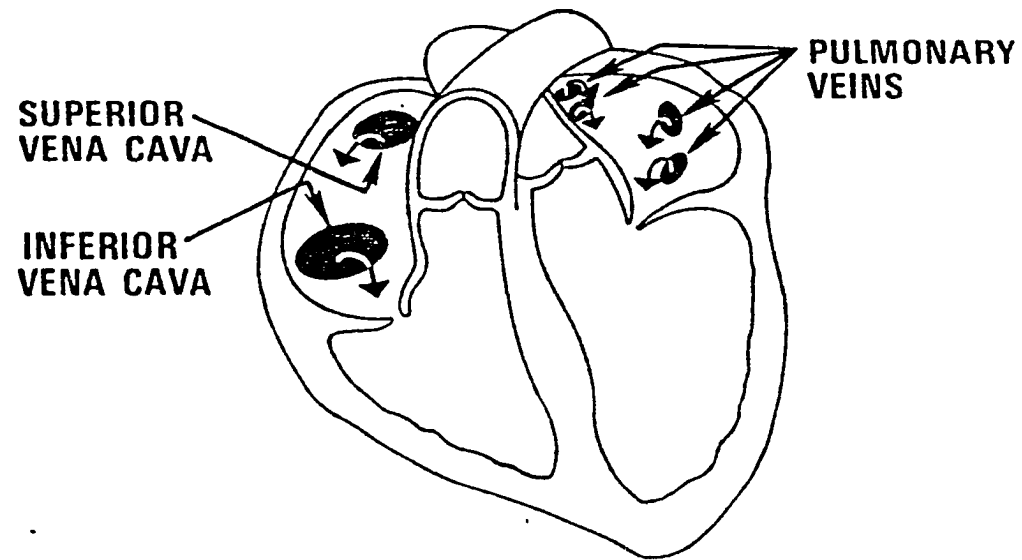
THE CONTRACTION OF THE LEFT VENTRICLE PUMPS THE BLOOD THROUGH THE ENTIRE BODY. FOR THIS REASON IT IS THE LARGEST, STRONGEST, AND MOST MUSCULAR SECTION OF THE HEART. WHEN THE LEFT VENTRICLE IS FILLED WITH BLOOD, IT CONTRACTS RESULTING IN PRESSURE OPENING THE AORTIC VALVE. THE AORTIC VALVE IS SIMILAR TO THE OTHER FLAP LIKE VALVES; THE VALVE STOPS THE BACKWARD FLOW OF BLOOD TO THE LEFT VENTRICLE AND OPENS FOR THE FORWARD FLOW OF BLOOD TO THE AORTA.

THE AORTA IS THE LARGE ARTERY WHICH CARRIES THE BLOOD AWAY FROM THE HEART BACK TO THE VARIOUS PARTS OF THE BODY.

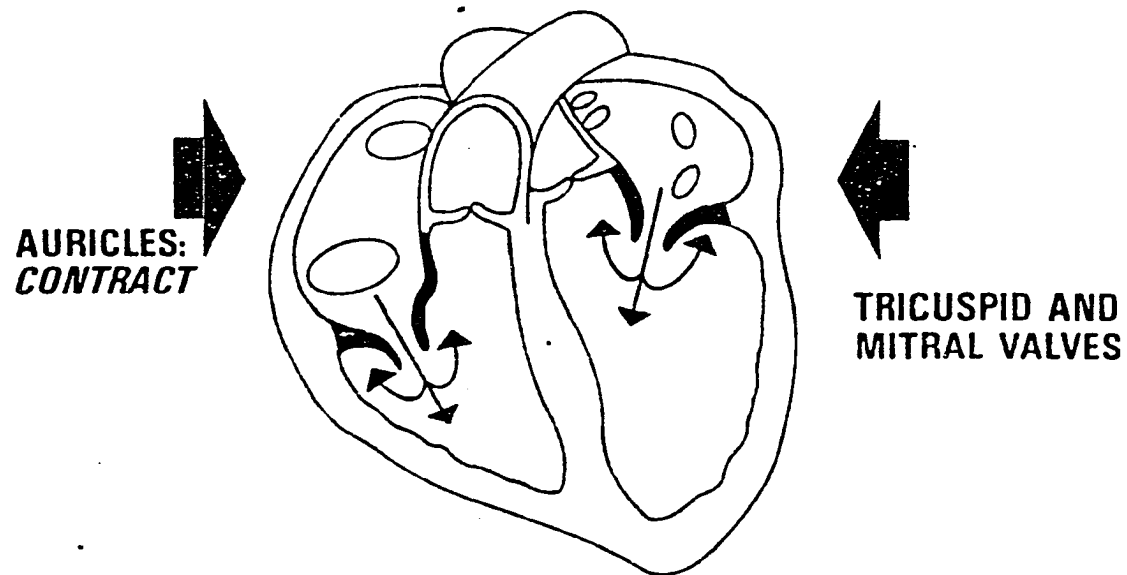


THE CIRCULATION OF BLOOD THROUGH THE HEART

THE DIRECTIONAL FLOW OF BLOOD IN THE HEART IS DETERMINED BY VALVES WHICH ALLOW THE BLOOD TO FLOW IN ONLY ONE DIRECTION. THESE SETS OF VALVES ARE THE TRICUSPID AND MITRAL VALVES, WHICH CONTROL THE FLOW OF BLOOD FROM THE AURICLES TO THE VENTRICLES, AND THE PULMONARY AND AORTIC VALVES WHICH CONTROL THE FLOW OF BLOOD FROM THE VENTRICLES TO THE ARTERIES.

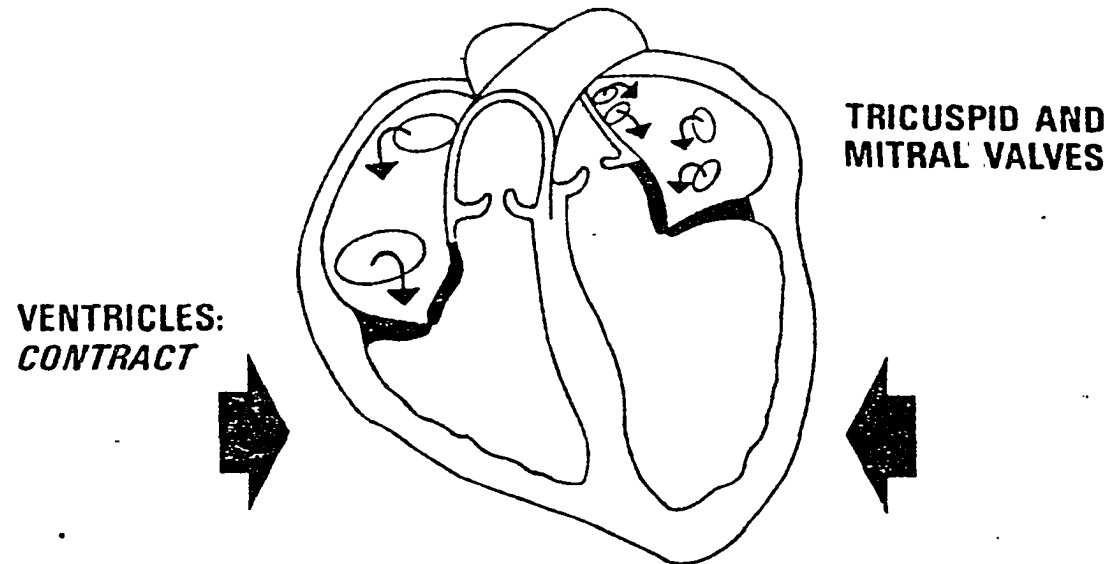


BOTH AURICLES RECEIVE BLOOD SIMULTANEOUSLY THROUGH VEIN OPENINGS WHICH HAVE NO VALVES. THE RIGHT AURICLE RECEIVES ITS BLOOD THROUGH THE SUPERIOR AND INFERIOR VENA CAVAS, WHILE THE LEFT AURICLE RECEIVES ITS BLOOD THROUGH THE PULMONARY VEINS.



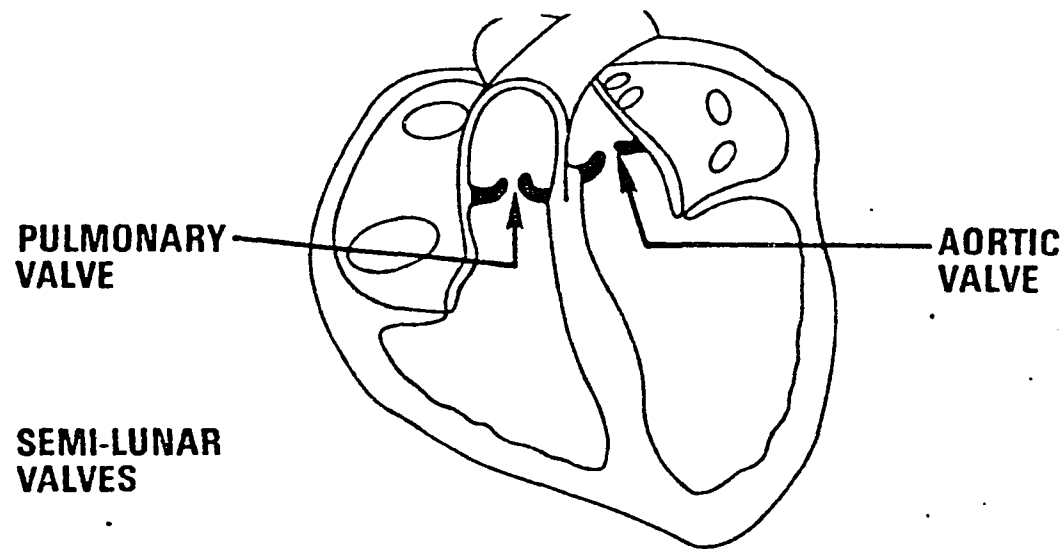
A WAVE OF MUSCULAR CONTRACTION STARTS AT THE TOP OF THE HEART AND PASSES DOWNWARD, SIMULTANEOUSLY, OVER BOTH SIDES OF THE HEART; THAT IS, BOTH AURICLES CONTRACT AT THE SAME TIME AND THEN RELAX AS THE CONTRACTION PASSES DOWN TO THE VENTRICLES. WHEN THE AURICLES ARE CAUSED TO CONTRACT, THEY BECOME SMALL AND PALE AND IN DOING SO THE BLOOD IN THEIR CHAMBERS IS SUBJECTED TO INCREASED PRESSURE WHICH FORCES BLOOD TO THE VENTRICLES THROUGH THE OPENED TRICUSPID AND MITRAL VALVES.

AS THE VENTRICLES FILL, EDDIES OF THE BLOOD FLOAT THE FLAPS ON BOTH THE TRICUSPID AND MITRAL VALVES BACK TO A PARTIALLY CLOSED POSITION.



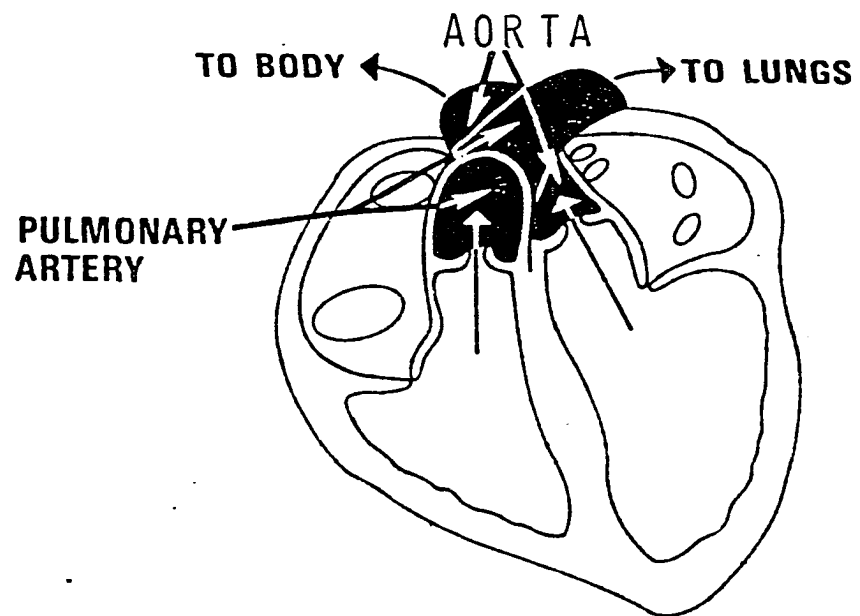
THE INSTANT THAT THE CONTRACTION OF THE AURICLES HAS BEEN COMPLETED, THE VENTRICLES ARE STIMULATED TO CONTRACT. THIS CONTRACTION INCREASES THE PRESSURE IN THE VENTRICLE CHAMBERS FORCING THE TRICUSPID AND MITRAL VALVES COMPLETELY CLOSED, THEREBY PREVENTING BLOOD FROM BEING FORCED BACKWARDS INTO THE AURICLES.

THE AURICLES, RELAXING FROM THEIR CONTRACTION, RECEIVE A CONTINUOUS BLOOD FLOW FROM THE VENA CAVAS AND THE VEINS.



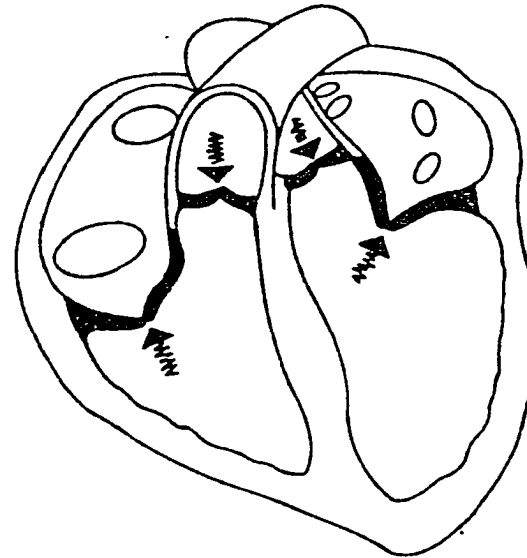
AS THE VENTRICLES CONTINUE TO CONTRACT, PRESSURE IN THESE CHAMBERS FORCE THE PULMONARY AND AORTIC VALVES TO OPEN. THE PULMONARY VALVE, LEADING FROM THE RIGHT VENTRICLE, GUARDS THE ENTRANCE TO THE PULMONARY ARTERY. THE AORTIC VALVE, LEADING FROM THE LEFT VENTRICLE, GUARDS THE ENTRANCE TO THE AORTA OR AORTIC ARTERY.

BOTH ARE 3 FLAPPED VALVES, AND ARE TOGETHER KNOWN AS THE SEMI-LUNAR VALVES. PRIOR TO VENTRICLE CONTRACTION, THE VALVES ARE CLOSED BY BACK PRESSURE PROVIDED BY BLOOD ALREADY IN THE EXIT ARTERIES. WHEN PRESSURE IN THE VENTRICLES BECOMES GREATER THAN THAT IN THE EXIT ARTERIES DUE TO VENTRICLE CONTRACTION, THE SEMI-LUNAR VALVES OPEN.



WITH THE SEMI-LUNAR VALVES OPEN, BLOOD FLOWS FROM THE RIGHT VENTRICLE INTO THE PULMONARY ARTERY ON ROUTE TO THE LUNGS FOR CLEANING AND OXYGEN. SIMULTANEOUSLY, BLOOD FLOWS FROM THE LEFT VENTRICLE INTO THE AORTA FOR DISTRIBUTION THROUGHOUT THE ENTIRE BODY.

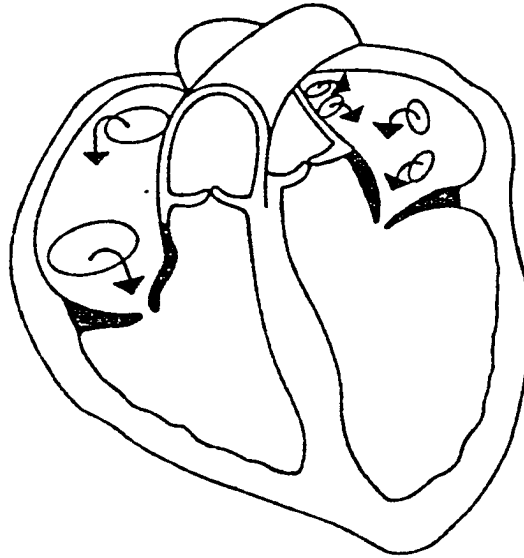
**SEMI-LUNAR
VALVES**



**TRICUSPID AND
MITRAL VALVES**

IMMEDIATELY FOLLOWING THE PUMPING OF BLOOD INTO THE ARTERIES, THE VENTRICLES BEGIN TO RELAX. THIS RELAXATION LOWERS THE PRESSURE WITHIN THEIR CHAMBERS AND THE GREATER PRESSURE IN THE ARTERIES CLOSE THE SEMI-LUNAR VALVES. PRESSURE WITHIN THE VENTRICLES IS SUFFICIENT, HOWEVER, TO MAINTAIN CLOSURE OF THE TRICUSPID AND MITRAL VALVES AGAINST THE ALREADY INCREASING AURICLE PRESSURE.

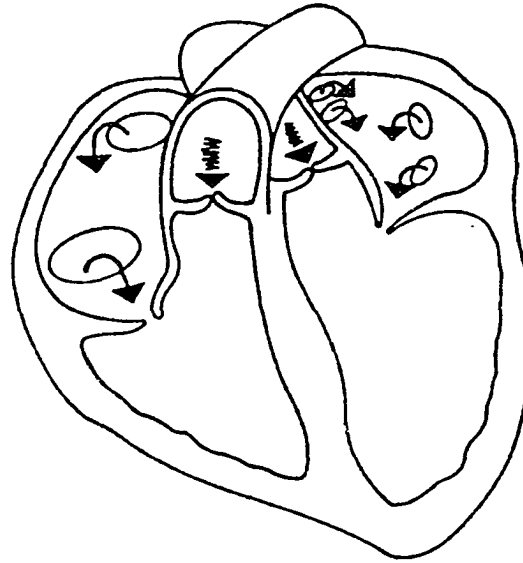
**TRICUSPID AND
MITRAL VALVES**



AS THE VENTRICLES RELAX FURTHER, PRESSURE WITHIN THEM RAPIDLY DECREASES. AT THE SAME TIME BLOOD FLOWING INTO THE AURICLES FROM THE VEINS INCREASES THE AURICLE PRESSURE. DUE TO THE DIFFERENTIAL PRESSURE BETWEEN THE AURICLES AND VENTRICLES, THE TRICUSPID AND MITRAL VALVES ARE FORCED PARTIALLY OPEN.

THE CIRCULATION OF BLOOD THROUGH THE HEART BEGINS AGAIN WITH THE NEXT AURICLE CONTRACTION. AURICLE PRESSURE FULLY OPENS THE TRICUSPID AND MITRAL VALVES RESULTING IN A RAPID FLOW OF BLOOD INTO THE VENTRICLES.

**DIASTOLIC:
LOWEST
PRESSURE**

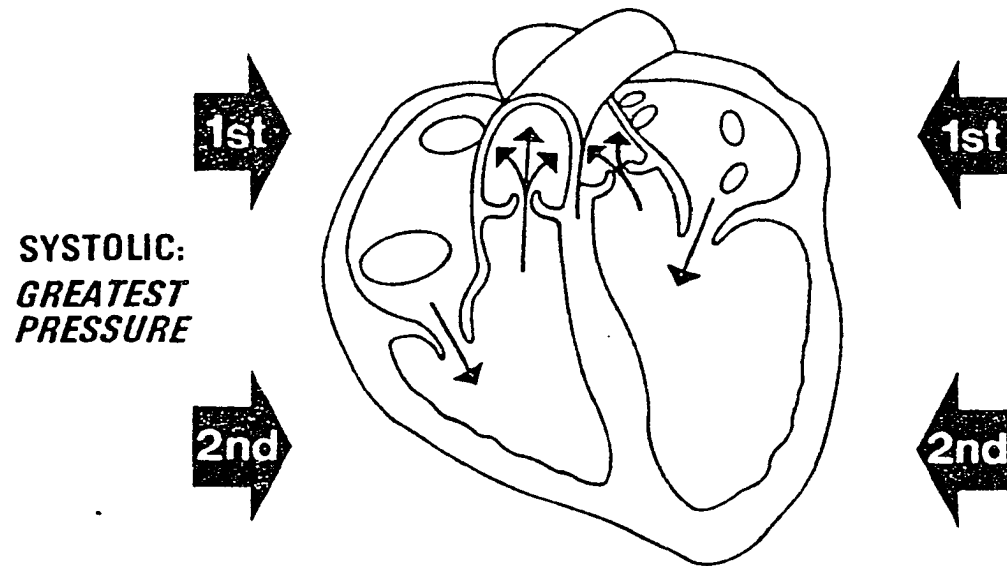


THE CYCLE OF BLOOD PRESSURE IN THE HEART

THE CYCLE OF BLOOD PRESSURE IN THE HEART CONSISTS OF TWO DISTINCT PHASES. ONE OF THESE PHASES IS CALLED THE DIASTOLIC OR RELAXATION PHASE.

IN THE DIASTOLIC PHASE, THE HEART RELAXES BETWEEN CONTRACTIONS. BLOOD FLOWS INTO THE HEART, FILLING BOTH AURICLES. WHILE BLOOD IS FLOWING INTO THE AURICLES, THE ARTERIES STILL MAINTAIN PART OF THE PRESSURE DEVELOPED BY A PRIOR VENTRICLE CONTRACTION. THIS IS THE TIME OF LOWEST PRESSURE IN THE ARTERIES, OR WHAT IS CALLED THE DIASTOLIC PRESSURE.

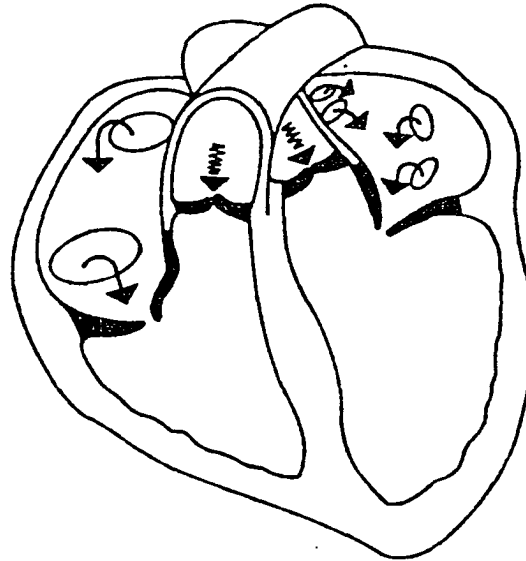
DURING THIS PHASE THE VENTRICLES ARE ALSO RELAXING. THE VENTRICLES ARE SLOWLY BEING FILLED WITH BLOOD, DUE TO THE FULL AURICLES AND PARTIALLY OPENED TRICUSPID AND MITRAL VALVES.



THE SECOND PHASE, THE SYSTOLIC OR CONTRACTION PHASE, BEGINS WHEN THE AURICLES CONTRACT. THE BLOOD IS FORCED THROUGH THE TRICUSPID AND MITRAL VALVES INTO THE VENTRICLES. THE VENTRICLES THEN CONTRACT FORCING THE BLOOD THROUGH THE SEMI-LUNAR VALVES INTO THE PULMONARY AND AORTIC ARTERIES.

THE BLOOD LEAVES THE VENTRICLES UNDER TERRIFIC PRESSURE AND SURGES THROUGH THE ARTERIES WITH A FORCE SO GREAT THAT IT BULGES THEIR ELASTIC WALLS. AT THIS POINT, ARTERIAL BLOOD PRESSURE IS GREATEST; WE REFER TO THIS PRESSURE AS THE SYSTOLIC PRESSURE.

**SEMI-LUNAR
VALVES**



**TRICUSPID AND
MITRAL VALVES**

THE HEART BEGINS TO RELAX AGAIN. THE SEMI-LUNAR VALVES ARE CLOSED; BLOOD FLOWS INTO THE AURICLES FROM THE VEINS; AND THE TRICUSPID AND MITRAL VALVES ARE FORCED PARTIALLY OPEN.

THE DIASTOLIC PHASE BEGINS, AND THE CYCLE OF BLOOD PRESSURE STARTS AGAIN.

- END OF INSTRUCTIONAL MATERIALS -

REVIEW THE INSTRUCTIONAL MATERIALS UNTIL YOU FEEL YOU HAVE MASTERED THE CONCEPTS PRESENTED.

WHEN YOU ARE FINISHED, RAISE YOUR HAND TO RECEIVE THE FIRST PART OF THE TESTING MATERIALS FROM THE PROCTOR.

APPENDIX D: PRETEST

PRETEST:

This test was programmed on the Apple II microcomputer. The questions appeared on the computer monitor, and the subjects were asked to type in the responses.

1. Worn-out red blood cells are decomposed in the
 - a. heart
 - b. lungs
 - c. kidneys
 - d. liver

2. "Swollen glands" means an enlargement of the
 - a. heart valves
 - b. lymph nodes
 - c. vena cava
 - d. portal vein

3. Blood is oxygenated in the capillaries of the
 - a. air sacs
 - b. heart
 - c. muscle
 - d. liver

4. The adult human heart is said to beat approximately ___ times per minute
 - a. 85
 - b. 72
 - c. 60
 - d. 58

5. Blood enters the heart through
 - a. arteries
 - b. vena cava
 - c. the aortic arch
 - d. pulmonary veins

6. Blood leaves the heart through the
- tricuspid valve
 - aorta
 - superior vena cava
 - mitral valve
7. _____ is(are) the thick walled chamber(s) of the heart.
- auricles
 - myocardium
 - ventricles
 - pericardium
 - endocardium
8. The heart consists of two parts; the contraction of the ventricles is called the _____ phase.
- systolic
 - sympathetic
 - diastolic
 - parasympathetic
 - sympatric
9. The portion of the heart which divides it longitudinally into two halves is called the _____.
- myocardium
 - exicardium
 - pericardium
 - septum
10. A blood vessel which carries deoxygenated blood is the _____.
- aorta
 - pulmonary artery
 - hepatic artery
 - pulmonary vein
11. The relaxation of the ventricles is called the _____ phase.
- sympatric
 - sympathetic
 - diastolic
 - systolic

12. Blood from the right ventricle leaves the heart through the
- veins
 - aortic artery
 - pulmonary artery
 - pulmonary vein
 - superior vena cava
13. The _____ is the name given to the inside lining of the heart wall.
- epicardium
 - endocardium
 - pericardium
 - myocardium
 - septum
14. The outside covering of the heart is called the _____
- endocardium
 - epicardium
 - pericardium
 - myocardium
 - none of these
15. The _____ is a passage between the right auricle and the right ventricle.
- mitral valve
 - tricuspid valve
 - septum
 - pulmonary valve
 - aortic valve
16. The chamber of the heart which pumps oxygenated blood to all parts of the body is the
- left auricle
 - right ventricle
 - right auricle
 - left ventricle

17. The backward flow of blood in the veins is prevented by the
 - a. muscles
 - b. valves
 - c. the heart beat
 - d. the lymphatics

18. During the diastolic phase the ventricles are
 - a. fully contracted
 - b. partially contracted
 - c. fully relaxed
 - d. partially relaxed

19. During the systolic phase blood is being forced through the
 - a. pulmonary and aortic arteries
 - b. superior and inferior vena cavae
 - c. tricuspid and mitral valves
 - d. pulmonary veins

20. When the heart relaxes the
 - a. auricles relax first, then the ventricles
 - b. right side relaxes first, then the left side
 - c. left side relaxes first, then the right side
 - d. ventricles relax first, then the auricles

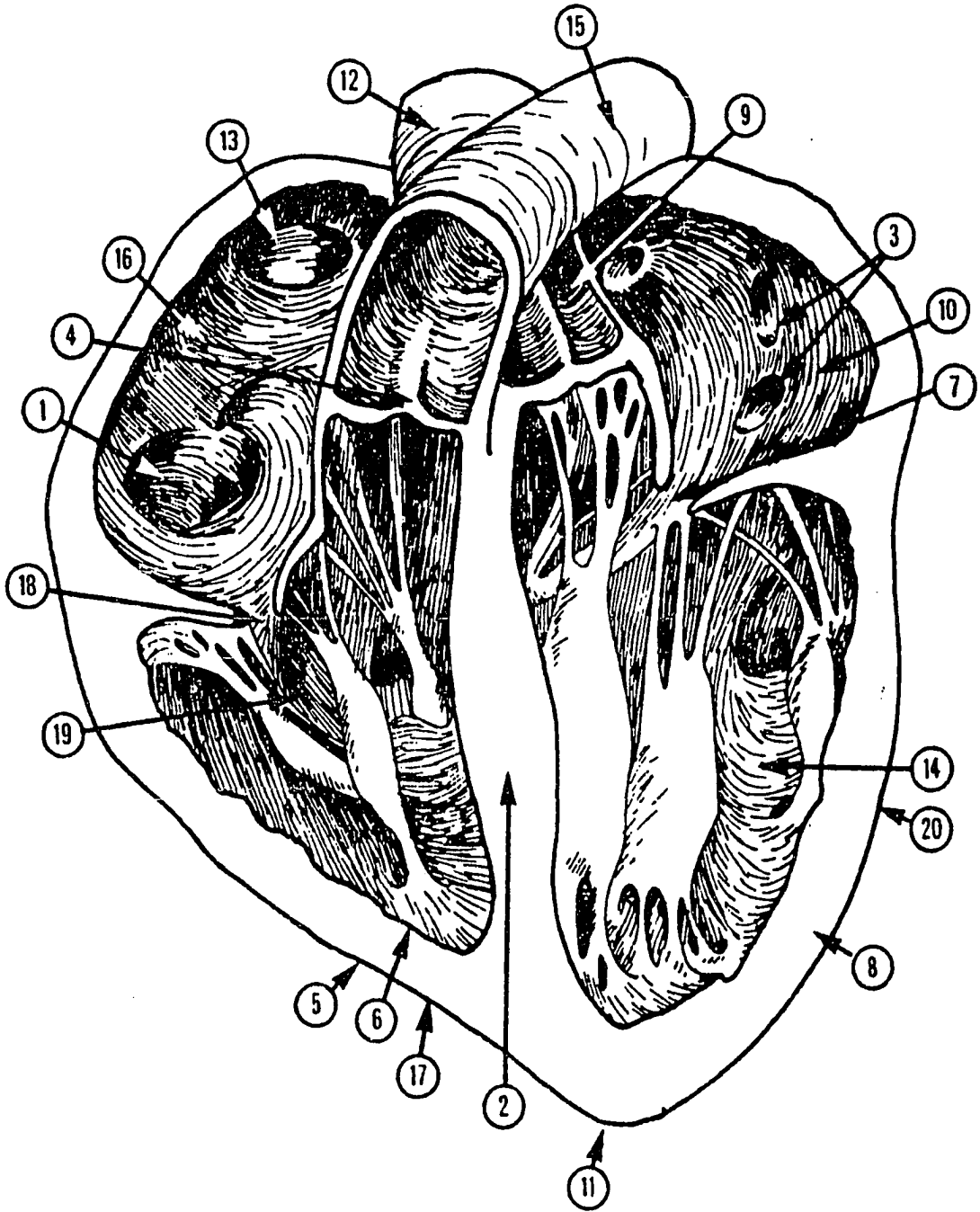
CORRECT ANSWERS TO THE PRETEST

1. d
2. b
3. a
4. b
5. b or d
6. b
7. c
8. a
9. d
10. b
11. c
12. c
13. b
14. c
15. b
16. d
17. b
18. c
19. a
20. d

APPENDIX E: POSTTEST

IDENTIFICATION TEST

See the following pages for test items.



POSTTEST

This test was programmed on the Apple II microcomputer. The subjects were asked to select the answers that best identifies the part of the heart indicated by the numbered arrows and type the corresponding letter on the computer keyboard.

1. Arrow number (1) points to the
 - a. aorta
 - b. mitral valve
 - c. superior vena cava opening
 - d. inferior vena cava opening
 - e. septum

2. Arrow number (2) points to the
 - a. pericardium
 - b. endocardium
 - c. septum
 - d. myocardium
 - e. pulmonary artery

3. Arrow number (3) points to the
 - a. inferior vena cava openings
 - b. superior vena cava openings
 - c. aortas
 - d. pulmonary veins
 - e. pulmonary arteries

4. Arrow number (4) points to the
 - a. pulmonary vein
 - b. pulmonary artery
 - c. aorta
 - d. tricuspid valve
 - e. mitral valve

5. Arrow number (5) points to the
 - a. myocardium
 - b. ectoderm
 - c. pericardium
 - d. endocardium
 - e. aortic base

6. Arrow number (6) points to the
 - a. endocardium
 - b. myocardium
 - c. pericardium
 - d. muscle
 - e. septum

7. Arrow number (7) points to the
 - a. venic valve
 - b. pulmonary valve
 - c. tricuspid valve
 - d. mitral valve
 - e. aortic valve

8. Arrow number (8) points to the
 - a. pericardium
 - b. endocardium
 - c. ectocardium
 - d. ectoderm
 - e. myocardium

9. Arrow number (9) points to the
 - a. superior vena cava opening
 - b. inferior vena cava opening
 - c. aortic valve
 - d. pulmonary valve
 - e. mitral valve

10. Arrow number (10) points to the
- right auricle
 - right ventricle
 - left auricle (left atrium)
 - left ventricle
 - pulmonary artery
11. Arrow number (11) points to the
- pericardium
 - myocardium
 - endocardium
 - endoderm
 - apex
12. Arrow number (12) points to the
- septum
 - aorta
 - pulmonary artery
 - pulmonary veins
 - none of these
13. Arrow number (13) points to the
- superior vena cava opening
 - right auricle
 - mitral valve
 - tricuspid valve
 - none of these
14. Arrow number (14) points to the
- right ventricle
 - left ventricle
 - left auricle
 - right auricle
 - pericardium
15. Arrow number (15) points to the
- pulmonary vein
 - aorta
 - pulmonary artery
 - aortic valve

16. Arrow number (16) points to the
- a. right ventricle
 - b. right auricle (right atrium)
 - c. left ventricle
 - d. left auricle
 - e. epicardium
17. Arrow number (17) points to the
- a. epicardium
 - b. pericardium
 - c. endocardium
 - d. myocardium
 - e. none of these
18. Arrow number (18) points to the
- a. aortic valve
 - b. pulmonary valve
 - c. mitral valve
 - d. tricuspid valve
 - e. septic valve
19. Arrow number (19) points to the
- a. left ventricle
 - b. right ventricle
 - c. right auricle
 - d. left auricle
 - e. vascular space
20. Arrow number (20) points to the
- a. myocardium
 - b. endocardium
 - c. ectocardium
 - d. epicardium
 - e. none of these

CORRECT ANSWERS TO THE POSTTEST

1. d
2. c
3. d
4. b
5. c
6. a
7. d
8. e
9. c
10. c
11. e
12. b
13. a
14. b
15. c
16. b
17. b
18. d
19. b
20. e

APPENDIX F: RAW DATA

Subject	Group	Pretest	Pretest Time	Posttest	Posttest Time	FD/FI	HSCR	Sex
01	1 ^a	14	202	17	188	15	19	M ^b
02	1	16	160	17	215	09	88	M
03	1	13	150	14	232	18	06	M
04	1	13	162	15	172	16	12	M
05	1	14	258	18	283	14	10	F ^b
06	1	16	304	15	356	08	88	M
07	1	13	103	15	133	08	03	F
08	1	13	164	13	188	09	19	F
09	1	13	170	16	172	15	24	M
10	1	16	132	08	158	09	01	F
11	1	13	212	13	163	16	08	F
12	1	08	134	06	159	12	39	F
13	1	14	220	17	206	12	09	F
14	1	14	183	16	250	18	02	M
15	1	07	206	02	302	12	99	M
16	1	13	191	17	165	17	10	F
17	1	14	183	11	183	11	51	M
18	1	12	163	14	218	11	30	F
19	1	07	400	16	264	17	30	F
20	1	14	230	15	249	16	14	F
21	1	16	178	17	226	16	06	F
22	1	13	200	09	200	13	20	F
23	1	09	145	12	217	16	05	F
24	1	07	179	08	162	07	71	F
25	1	13	152	09	162	07	41	F
26	1	17	183	16	218	15	14	M
27	1	12	179	18	210	17	40	M
28	1	16	181	07	254	17	34	M
29	1	11	176	14	183	14	37	F

Subject	Group	Pretest		Posttest		FD/FI	HSCR	Sex
		Pretest	Time	Posttest	Time			
30	2 ^a	14	311	12	250	01	44	F
31	2	13	116	13	204	17	27	F
32	2	18	230	12	247	13	24	M
33	2	11	223	14	313	13	71	F
34	2	14	140	16	125	14	19	F
35	2	10	252	16	258	11	88	M
36	2	09	209	08	195	13	45	F
37	2	11	257	12	200	12	33	F
38	2	11	198	11	203	11	12	F
39	2	14	160	05	170	14	88	M
40	2	15	160	18	248	10	24	M
41	2	11	202	09	256	17	99	M
42	2	11	197	16	181	16	56	F
43	2	12	241	15	234	01	34	F
44	2	13	185	06	209	11	35	F
45	2	14	196	09	216	07	47	F
46	2	14	299	17	200	16	06	F
47	2	13	208	12	282	12	23	F
48	2	09	188	15	200	09	34	F
49	2	15	270	10	325	16	99	M
50	2	11	262	15	264	08	43	F
51	2	16	281	16	249	09	88	M
52	2	07	239	07	195	10	11	M
53	2	13	180	06	216	08	88	F
54	2	14	155	17	189	18	09	M
55	2	11	367	09	388	05	12	M
56	2	19	134	18	259	14	01	F
57	2	17	120	18	180	18	01	F
58	2	12	178	16	188	18	11	F

Subject	Group	Pretest		Posttest		FD/FI	HSCR	Sex
		Pretest	Time	Posttest	Time			
59	3 ^a	13	267	13	352	18	04	M
60	3	13	131	13	247	18	18	F
61	3	13	134	11	264	18	01	F
62	3	19	104	17	160	18	99	F
63	3	18	181	18	233	15	13	F
64	3	14	150	08	218	15	19	M
65	3	11	280	11	350	05	39	F
66	3	12	129	06	208	16	01	F
67	3	09	215	06	240	17	14	M
68	3	12	129	10	175	14	36	F
69	3	10	121	13	230	16	12	F
70	3	19	155	11	205	17	11	M
71	3	19	161	18	278	18	03	M
72	3	13	130	05	210	14	26	F
73	3	09	231	04	263	10	18	F
74	3	14	180	03	206	13	08	M
75	3	12	143	07	200	05	37	F
76	3	15	170	02	212	18	27	M
77	3	15	162	09	276	08	07	F
78	3	13	283	05	305	12	06	F
79	3	11	146	08	320	15	45	F
80	3	12	284	04	277	14	37	F
81	3	14	170	08	260	09	57	M
82	3	18	147	18	284	01	32	F
83	3	09	191	10	203	18	20	F
84	3	13	132	10	242	11	88	F
85	3	13	187	17	318	17	02	M

1^a = Color treatment group, 2^a = Black and white group
 3^a = Control group, F^b = Female and M^b = Male

Total: M = 31, F = 54

RESUMÉ

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Nationality: Cameroon, West Africa

EDUCATION:

1. Iowa State University. Ph.D. in Curriculum Planning and Instructional Media, May 1984.
2. Indiana University. M.S. degree in Instructional Systems Technology, August 1973.
3. Moray House College of Education, Edinburgh (U.K). Diploma in Education (English), July 1969.
4. The University of Wisconsin - Stout. B.S. degree in Industrial Education and Sociology, June 1966.
5. Government Teacher Training College, Kumba - Cameroon. Teaching Certificate, 1960.

PROFESSIONAL EXPERIENCE:

1. 1980 - 1984, enrolled in the Ph.D. program at Iowa State University. Graduate Teaching Assistant at Iowa State University.
2. 1978 - 1980, lecturer at Ahmadu Bello University at Zaria, Nigeria. Taught Instructional Systems Technology

courses to undergraduate and graduate students. Acting director of the Center for Educational Technology.

3. 1973 - 1978, Media Coordinator and Head of the Audio-Visual Department of the Pan African Institute For Development in Cameroon.. Acting Director of the Institute on several occasions. Taught instructional media courses to Pan African Institute students.
4. 1972 -1973, enrolled at Indiana University (Bloomington) for the Master of Science degree in Instructional Systems Technology.
5. 1969 -1972, taught high school English at the "Lycee Technique de Douala", Cameroon.
6. 1968 - 1969, enrolled at Moray House College of Education (Edinburgh, Scotland) for a Diploma in Education.
7. 1966 - 1968, taught Secondary School English at the Government Technical College, Ombe Cameroon.
8. 1963 - 1966, enrolled at the University of Wisconsin - Stout for a B.S. degree in Industrial Education and Sociology.

RESEARCH INTERESTS:

1. Application of low-cost educational technology.
2. Curriculum and Instructional Media problems.
3. Preparation and utilization of instructional media.
4. Instructional application of microcomputers in Education.
5. Supervising students' theses and dissertations.
6. "The Relationship of Field Dependent/Field independent

Cognitive Styles, Stimuli Variability and Time factor on Student Achievement." A Ph.D. dissertation.

UNPUBLISHED WORKING PAPERS:

1. "A Proposed Closed-circuit Television System for Cameroon", Indiana University, Bloomington, 1973.
2. A handbook for Pan African Institute for Development students on "Developing Black & White roll Film", PAID, Buea 1973.
3. The theory and practice of communications in developing countries. Iowa State University, 1984.
4. Administration of Media Resources Centers in developing countries. Iowa State University, 1984.
5. "The relationship of field dependent/field independent cognitive styles, stimuli variability and time factor on student achievement". A paper delivered at the Association for Educational Communications and Technology, Dallas Texas, January 21, 1984.

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Atang, C. I. The relationship of field dependent/field independent cognitive styles, stimuli variability and time factor on student Achievement. In Simonson, M. R., & Lamb, A. (Eds.), AECT Research Proceedings. College of Education, Iowa State University, 1984.

PROFESSIONAL ORGANIZATIONS:

1. The Educational Institute of Scotland, 1969.

2. Pan African Institute for Development Association, 1974-1978.
3. Nigeria Audio-visual Association, 1978.
4. Iowa Educational Media Association, 1982.
5. Phi Delta Kappa, 1983.
6. Association for Educational Communications and Technology, 1973 to present.

PROFICIENCIES:

Experienced in all fields of Instructional Systems Technology, the use of micro-computer in education, educational television, teaching media courses, curriculum planning with emphasis in developing countries, consultation in educational media development, photographic and dark room techniques, organization of media centres, budgetting, personnel administration and procurement of media commodities. Good mechanical ability. Have visited almost all African Countries to attend conferences or tours related to educational media and technology. Speak French, several Cameroonian languages, and ofcourse, English.

CAREER OBJECTIVES:

Continuing service in the area of instructional media and technology, psychology and sociology as related to instruction, curriculum planning and behavioural sciences. Interested in research on cognitive styles, stimuli variability and time on task in student

learning. I enjoy administering a media centre, designing and producing visual aids for development projects, using instructional media in the integrated approach to development, and teaching media courses. I like opportunities for creative work, consultancy in Instructional Systems Technology and research in related areas.

REFERENCES:

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