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PETRAKIS, ELIZABETH
THE RELATIONSHIP BETWEEN FIGURE-GROUND PERCEPTION AND VIEWING TIME IN A BALL CATCHING TASK.

THE UNIVERSITY OF NORTH CAROLINA AT GREENSBORO, ED.D., 1978

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THE RELATIONSHIP BETWEEN FIGURE-GROUND PERCEPTION AND VIEWING TIME IN A BALL CATCHING TASK

by

Elizabeth Petrakis

A Dissertation Submitted to
the Faculty of the Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Doctor of Education

Greensboro
1978

Approved by

Gail M. Dennis
Dissertation Adviser

APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of the Graduate School at the University of North Carolina at Greensboro.

Dissertation Adviser Gail M. Hennis
Dr. Gail M. Hennis

Committee Members W. Hugh Hagaman
Dr. W. Hugh Hagaman

Rosemary McGee
Dr. Rosemary McGee

E. Doris McKinney
Dr. E. Doris McKinney

Celeste Ulrich
Dr. Celeste Ulrich

February 3, 1978
Date of Acceptance by Committee

February 3, 1978
Date of Final Oral Examination

PETRAKIS, ELIZABETH. The Relationship Between Figure-Ground Perception and Viewing Time in a Ball Catching Task. (1978)
Directed by: Dr. Gail M. Hennis. Pp. 111

The purpose of this study was to determine the relationship between figure-ground perception and viewing time in a ball catching task of male and female tennis players. Sub-problems were to investigate the effects of sex and tennis skill level on figure-ground perception, the ball catching task and the length of viewing time.

A total of 98 college students (49 males and 49 females) from five tennis classes at the University of Nebraska-Lincoln, as well as both the men's and women's tennis teams and the Nebraska Wesleyan University women's tennis team, volunteered to participate as subjects. The subjects were divided into three groups according to their skill level: (1) beginner, (2) intermediate, and (3) advanced tennis players. The non-varsity tennis players were given the Hewitt Revision of the Dyer Backboard Test to determine their skill classification, while the varsity tennis players were subjectively classified by observation of their playing ability and team rank.

To determine field dependence, the Group Embedded Figures Test (GEFT) was administered at five different times to accommodate the subjects. The Group Embedded Figures Test was scored by the total number of simple forms correctly traced, with the highest possible score being 18. To determine the degree of field dependence, the distribution was divided into four groups. The groups were defined as follows: field independent, scores of 18-17; moderately field

independent, 16-15; moderately field dependent, 14-12; and field dependent, 11-0.

The ball catching task was administered individually to each subject. The objective of the task was to catch the projected ball with one hand under five different light interval conditions, namely 0.1, 0.2, 0.25, 0.3, and 0.4 seconds. A trial, consisting of 20 balls preceded by three practice balls at a specific light interval, provided a sub-score designated as the viewing time score. The ball catching score consisted of the total score of all five trials. The highest possible ball catching score was 100.

The Statistical Package for Social Science Programs (SPSS) computer program was utilized to compute the Pearson Product-Moment correlations, one-way ANOVA, two-way ANOVA and the Scheffé post hoc test. In addition the Biomedical Computer Program P-Series (P2V-analysis of variance and covariance, including repeated measures) was used in the data analysis. Significant F ratios were subjected to the Scheffé test to determine where the differences existed. The level of significance was set at .05.

Results indicated that there was no relationship between figure-ground perception and viewing time in the ball catching task. There was no significant difference between males and females on the Group Embedded Figures Test or between tennis skill levels on the Group Embedded Figures Test. No significant difference was found between field-independent and field-dependent subjects on their ability in the ball catching task. On the other hand, statistically significant differences existed between the sexes on the ball catching task and between tennis skill levels on the ball catching task. When examining the effects of the length of viewing time, a significant difference was found between the sexes and between the skill levels. Significant differences existed between the following viewing times: .1 seconds with each of the other viewing times; .2 seconds with .3 seconds; .2 seconds with .4 seconds; and .25 seconds with .4 seconds. The conclusion can be drawn that the increased viewing time produced greater catching success.

ACKNOWLEDGEMENTS

I wish to express my sincere appreciation to my adviser, Dr. Gail Hennis, for her support, advice, and guidance throughout this study and graduate work. Special appreciation is extended to Dr. Hugh Hagaman, Dr. Rosemary McGee, Dr. Doris McKinney, and Dr. Celeste Ulrich for their constructive review of the study and advice during my graduate work.

Special thanks are due to Mr. Darryl Rivers, Mr. Howard Gatliff, and Mr. Elmer Navock for their technical knowledge in constructing the components of the ball throwing equipment. Thanks also go to Mr. Jeff Rehm for his aid in programming the statistics for this study.

To all my friends and colleagues at the University of Nebraska-Lincoln who generously gave of their time, patience, and support so that this research could be completed, thank you. I am grateful to the University of Nebraska Research Council for the grant that made this study possible.

My thanks go to the University of Nebraska students, men's and women's tennis teams and the Nebraska Wesleyan University women's tennis team for their wonderful cooperation in this project.

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CHAPTER I

INTRODUCTION

In the performance of sports or motor skills, the performer is confronted with a complex external environment. From this environment, specific information must be gathered via the receptors of the eyes and ears to enable the player to make decisions regarding the performance of the skill or task. Since vision is the sense through which most accurate information is gathered, the perceptual response to a visual stimulus may be a key factor in sport and motor learning.

Visual information must be extracted from the visual display to allow the subject to select and classify necessary cues for initiating appropriate responses. For example, a tennis player observes his/her opponent's racket, body position, the point of ball contact and the flight of the ball. This information helps the tennis player to initiate a response and to anticipate the future path of the ball. These visual cues may be affected by the background in the visual display. The background of the visual display (area surrounding the tennis court) may vary from homogeneous (wind screen) to variegated (sky, grass, trees) causing a series of perceptual reactions.

Gestalt psychologists have theorized that individuals see patterns or configurations in the sensory field. The individual views the visual display of his/her surroundings in two parts: the figure as the main object, and the background or the surrounding environment.

This view is referred to as figure-ground perception. This style of perception is reflected in degrees of field dependence or independence. In a field-dependent mode of perceiving, perception is dominated by the surrounding field. In field-independent perceiving, the main object dominates. Each individual develops his/her own perceptual style which is characteristic and consistent in his/her perceptual activities.

The uniqueness of each individual poses the problem of the visual stimuli being perceived differently. To direct the perception of appropriate visual stimuli, tennis authorities suggest that a player "keep his eyes on the ball." This practice should provide the player with necessary information concerning position, directionality, velocity and acceleration of the ball. Whiting (1965, 1970, 1973), Nessler (1973) and Hubbard and Seng (1954) investigated visual monitoring of a ball in flight. The results of these studies indicated that the longer the individual viewed the ball, the more successful he/she would be in catching or batting the ball. The more experience the player had in the task, the less viewing time was needed to predict the flight of the ball. The cited studies used subjects who were either experienced in ball handling skills or advanced players in that sport.

The perceptual style of athletes has been investigated in relation to success in skill performance. Studies involving tennis players were reported by Kreiger (1962), Enberg (1973) and Barrell and Trippe (1975). Kreiger found a relationship between figure-ground perception and spatial adjustment. Enberg's findings did not show a significant relationship between directionality and field dependence.

Barrell and Trippe found highly skilled tennis players to be more field dependent than moderately skilled players.

Figure-ground perception and visual attention in ball skills have been studied independently. It is reasonable to assume that there may be a relationship between perceptual style and visual attention in the performance of ball skills. Therefore, it was the intent of this study to investigate the relationship between figure-ground perception and viewing time in a ball catching task. The significance of this study lies in the contribution to the knowledge of figure-ground perception and viewing time in a ball catching task of male and female beginning, intermediate and advanced tennis players.

STATEMENT OF THE PROBLEM

The purpose of this study was to determine the relationship between figure-ground perception and viewing time in a ball catching task of male and female tennis players. Sub-problems were to investigate the effects of sex and tennis skill level on figure-ground perception, the ball task and the length of viewing time.

The study attempted to answer the following questions:

1. Is there a relationship between viewing time in a ball catching task and figure-ground perception for:

   a. tennis players?
   b. beginning tennis players?
   c. intermediate tennis players?
   d. advanced tennis players?
   e. male subjects?
   f. female subjects?

2. Is there a difference between the sexes and the tennis skill levels in figure-ground perception?

3. Is there a difference in figure-ground perception due to the interaction between sex and skill level?

4. Are field-independent subjects more successful at the ball catching task than field-dependent subjects?

5. Is there a difference between sexes and skill levels on the ball catching task? If so, where are the differences?

6. Is there a difference in performance on the ball catching task due to the interaction between sex and skill levels?

7. Is there a difference in length of viewing time due to the interaction between:

a. viewing time and skill level?
b. viewing time and sex?
c. viewing time and skill level and sex?
d. length of viewing time?

DEFINITIONS OF TERMS

The terms relating to this study are defined as follows:

Ball catching task is a task in which a projected ball is caught with one hand while viewing conditions are restricted.

Group Embedded Figures Test (GEFT) is a standardized psychological assessment tool used to determine the cognitive style of an individual. The task involves quick identification of a simple form from within a complex figure.

Cognitive styles "are characteristics, self-consistent modes of functioning which individuals show in their perceptual and intellectual activities" (Witkin, et al., 1971, 3).

Field-dependent is "perception which is strongly dominated by the overall organization of the surrounding field" (Witkin, et al., 1971, 4).

Field-independent is perception in which "parts of the field are experienced as discrete from organized ground" (Witkin, et al., 1971, 4).

Field-independent subject is a college female or male who scored 18 or 17 on the GEFT.

Moderately field-independent subject is a college female or male who scored 16 or 15 on the GEFT.

Moderately field-dependent subject is a college female or male who scored 14-12 on the GEFT.

Field-dependent subject is a college female or male who scored 11-0 on the GEFT.

Figure-ground perception is "a kind of perceptual organization in which some part of the field stands out as a unified object while the rest is relegated to the background" (Eysenck, et al., 1972, 376).

Figure is the main object.

Ground is the surrounding environment.

Viewing time is the length of time given to observe a ball in flight in order to catch or strike it.

Beginning level player is a college female or male student who scored 14 or below on the Hewitt Revision of the Dyer backboard test.

Intermediate level player is a college male who scored 14-19 or female who scored 14-17 on the Hewitt Revision of the Dyer backboard test or who was a member of an intercollegiate tennis team.

Advanced level player is a college male or female student who was a member of an intercollegiate tennis team or who scored 20 or above if a male and 17 or above if a female on the Hewitt Revision of the Dyer backboard test.

ASSUMPTIONS

The following basic assumptions govern this study:

1. Subjects were either free of visual defects or corrective measures had been taken.

2. Subjects were able to catch a ball.

3. The subject's performance on the test reflected a genuine effort.

4. All varsity tennis players were either intermediate or advanced tennis players.

SIGNIFICANCE OF THE STUDY

This study appears significant because it contributes to the knowledge of:

1. The role of figure-ground perception in motor skill performance.

2. The role of viewing time in motor skill performance.

3. Viewing time of beginner, intermediate and advanced tennis players as related to the ball catching task.

4. Perceptual styles of beginning, intermediate and advanced tennis players.

5. Male students compared to female students in their perceptual style and viewing time related to a ball catching task.

6. Catching ability of male and female college students.

CHAPTER II

REVIEW OF LITERATURE

CONCEPT OF FIGURE-GROUND PERCEPTION

In the early studies of perception, a sound foundation was established for the understanding of how man makes contact with his environment. The main emphasis was upon either the physical properties of the environment or the universal laws of perceptual response.

The first serious attempt to deal with perception as an integrated, organized system, instead of independent sensations, was advanced by Gestalt psychologists. Their assumption was that the modalities of sensation contributed to the perception of an object as a whole. Therefore, these psychologists looked for "wholes," "configurations," and "forms" in perceptual experiences. The Gestaltists theorized that in the world of sight, the perceiver's visual field is seen as objects on surfaces or as figures against a background. This phenomenon was referred to as the figure-ground principle.

Rubin (1958) first studied the different features of the figure-ground concept. He noted that when two fields have a common border, one is viewed as the figure and the other is viewed as the ground. The figure's characteristic has form or shape; whereas the ground is formless or shapeless. Because the figure appears to be object-like, it is more impressive and suggests meaning. On the other hand, the ground appears uniform and less definite. Even though the ground and figure are equidistant, the figure will dominate the visual field and will appear closer than the ground. If color is present, the figure becomes even more discernible and easier to identify.

After a period of viewing it was noted that the field may reverse itself. The reversal of positions between figure and ground may occur rapidly or over a prolonged period of time. If one of the fields is different, larger, or surrounding the other field, it will enhance the probability that the smaller field will be viewed as the dominant figure. If there are two homogeneously colored fields, the tendency will be to view either as the figure and/or the ground.

Hebb (1949) took exception to the Gestalt theory that perception depends on the excitation of specific cells in the central nervous system. He further disagreed with the concept that one perceives simple figures as distinctive whole figures. He believed that the perception of whole figures could not be achieved without the learning process functioning. In his neuropsychological theory, he distinguished between three aspects of the figure-ground relationship: (1) the primitive unity determined sensorily, (2) the nonsensory unity, affected by experience, and (3) the identity of a perceived figure, affected by learning and memory.

The primitive figure was viewed as one unified area separated from the background. It was a direct product of sensory excitation of the nervous system. This innate figure-ground mechanism is independent of learning and past experience. Thus, it was called "primitive unity" by Hebb.

The nonsensory figure was observed as one in which the boundaries of the figure are not determined by its outer contour. The perception of the figure occurs whenever the observer selectively focuses on a limited portion of a homogeneous area in the visual field. The perception of nonsensory figures may be affected by experiences and other non-sensory factors.

Identity, the third component of figural organization, referred to memory as a component of perception. Hebb suggested that identity falls into two categories: (1) the figure is perceived immediately when viewed either as similar to or dissimilar to other figures and/or (2) the object is perceived as being associated with other objects or with some action. Since identity may occur on the first exposure to the figure, it may be thought of as spontaneous association. Objects which are not rapidly recognized or recalled easily, may not possess identity. Therefore, identity is dependent on past experience and is learned as the situation demands.

Gottschaldt (1926), as cited by Woodworth and Schlosberg (1954), was interested in studying the importance that past experiences played in form perception. The common belief was that a familiar figure is easily seen. To test this belief, Gottschaldt developed a technique of concealing figures. The participants in his study then had to identify these concealed figures from their surrounding. His study concluded that when concealed, it was no easier to find a familiar than it was an unfamiliar figure. He did succeed in developing material in which a person could see a figure independently of its surroundings.

Studying individual differences of the perceiver, Witkin (1950) became interested in the manner in which people perceive an object in relation to its surroundings. Witkin used Gottschaldt's material but modified the hidden figures by adding color. He standardized the task by devising the "Embedded Figures Test." This test gave evidence of the ease with which a person could detect a simple figure from its embedded surroundings. The reliability was considered to be fairly high. The results obtained indicated that there was a range of differences among subjects. It was revealed that there was considerable difference between men and women in detecting the simple figures.

The result of Witkin's (1954) works clearly revealed that there was an important difference between sexes. The difference seems to arise from the perceptual approach used in analyzing the field. This approach was either field dependent or field independent. Field dependence is defined as a mode of perceiving in which parts of the field are viewed as "fused" and blend into the surrounding field, while field independence is defined as a mode of perceiving in which parts of the field are viewed as separate from the organized ground. Women tend to be more field dependent than men, because they find it more difficult to separate items from the prevailing visual field. Witkin concluded that women passively accept a new visual framework "as is," while men tend to actively analyze it. He concluded further that men are more attentive to sensation indicating body position; whereas, women are more concerned with the relationship between the body and its surroundings. He did state that when it is necessary, women have the ability to be sensitive to body position in the same manner as men. Other differences existed in performance. Women's performances tended to vary more under different conditions; whereas men's performances tended to be more consistent.

Most studies (Witkin, et al., 1974; Sherman, 1967; Vaught, 1965) agree that sex differences in field dependence are influenced by social-cultural factors. The woman's role has been one of dependence and passiveness. In contrast, men have been trained to be independent and active. In school men are channeled into subjects that require analytical abilities while women are placed in subjects that deal with the social amenities.

Sex differences at different age levels have also been reported. Witkin, Goodenough, and Karp (1959) reported sex differences as early as age 8. Studies of children below 8 years of age suggested sex differences may not exist in field dependence (Witkin, 1974; Bowd, 1976). Evidence presented by Schwartz and Karp (1967) suggested that above 60 years of age there may be slight or no sex differences in field dependence.

Witkin, Goodenough and Karp (1967), in a longitudinal study, indicated a clear age-related change in field dependence. An examination of the developmental curves from 8 to 24 years of age indicated a continuous trend towards increasing field independence. Between 8 and 15 years of age, there was a marked increase in independence. A plateau or leveling off was reached after 15 and up to 24 years of age. A return to field dependence was evident after 60 (Schwartz & Karp, 1967). The return to field dependence begins at some point between ages 24 and 60.

Studying individual differences of the perceiver, Witkin (1954) brought to light the relationship of the individual's personality to the process of perception. The different modes of perception are correlated with activity. The characteristic of attitude and behavior is represented by two types of performance: "passivity" which is associated with field-dependence and "activity" which is associated with field-independence.

With the emergence of the theory of cognitive styles, psychologists researched individual differences involving perceptual, intellectual, social-interpersonal and personality-defensive processes. Witkin, et al. (1974) considered the field dependence-independence theory to be an expression of articulated functioning. Individual differences in analytical functioning vary from one extreme of a global approach to the other extreme of articulated field approach. The field dependent person "tends to experience his surroundings in a relatively global fashion, easily conforming to the influence of the prevailing field or context" (Witkin, et al., 1972, 35). By contrast, the field-independent person "tends to experience his surroundings analytically, with objects experienced as discrete from their backgrounds" (Witkin, et al., 1972, 35). There is evidence indicating that articulated functioning in one area is related to expression in other areas.

Analytical persons tend to be analytical in other perceptual and problem-solving situations. They are able to impose an organization on unstructured stimulus field. They tend to have a sense of separated identity with internalized values and standards that permit them to function independently of the social field.

The global person takes the organization of the field in perceptual and problem-solving tasks as given. He/she tends to use external references in other situations as well as to rely on others for self-definition in social-interpersonal settings. Such persons are attentive to social stimuli.

FIGURE-GROUND PERCEPTION AS RELATED TO MOTOR SKILLS

The role of cognitive style as a factor in motor skill performance is a relatively recent area of research. The performer faces a perceptual task which requires constant cue discrimination in a dynamic field of visual-kinesthetic stimuli. A person's style of perceiving the world around him should find expression in his athletic performance.

Two different approaches have been used in studying the relationship between perceptual modes and motor performance. The first approach has compared success of athletes and their perceptual style. The second approach has related figure-ground perception to success in performing specific sport skills. This review of literature will investigate both approaches.

Miller (1960) explored the relationship between perceptual factors and success in sports. One hundred and sixty-two male and female subjects who were champions, near-champions, and low-skilled performers in volleyball, basketball, fencing, swimming, diving and gymnastics were administered a battery of perceptual measures. Five of the perceptual measures were paper and pencil tests; the remaining three measures (balance, depth perception and adaptability) were dynamic in nature.

Little difference was found between champions and near-champions in the eight tests. However, a significant difference was found between champions and low-skilled performers on balance, depth perception, block response and mutilated words. Men scored significantly higher than women on tests of spatial visualization and spatial orientation.

In a recent study, Deshaies and Pargman (1976) experimented with selected visual abilities of 40 male college football players. The groups tested on these visual attributes were varsity and junior varsity team members, composed of linesmen and backs, of both offensive and defensive players. The visual attributes measured were peripheral vision, horizontal and vertical fields of vision, depth perception and disembedding ability. No significant differences were found between any of the groups.

Williams (1975) studied the perceptual style of 25 male fencers: 14 classified fencers (highly skilled) and 11 unclassified fencers (moderately skilled), as rated by the Amateur Fencer's League of America. The results of the Hidden Figures Test suggested that fencers are field independent, but there was no significant difference between the classified and unclassified fencers.

An English team, Barrell and Trippe (1975), was interested in the different perceptual modes of high-level (county, international or professional) players and of medium-level (club) performers in the sports of tennis, soccer, cricket, track and field, and dance. High-level athletes, non-athletes and professional dancers were tested. To determine field dependence a version of Oltman's portable rod and frame apparatus was used. Dancers did not differ in perceptual mode from the highly skilled athlete and non-athlete. When comparing the highly skilled and the medium skilled players, no differences were found except in the tennis players. The top class tennis players were more field dependent than the medium ability players. The tennis players were more field dependent than the track and field athletes and non-athletes. No significant differences were found among the other sport groups.

Utilizing data from the Gottschaldt Embedded Figure Test, Bohlen (1961) compared 38 female dance majors and 70 female physical education majors. The results indicated that there was no significant difference between dancers and physical education majors in figure-ground perception. It should be noted that Bohlen failed to determine if one group was more field dependent than the other.

Gruen (1955) conducted a comprehensive study of dancers' personalities as they related to perception. Data were collected on the Rod and Frame Test, Tilting-Room-Tilting-Chair, Stabilometer and Embedded Figures Test. Personality assessment techniques used were Rorschach, Figure Drawing and Interviews. Thirty male and 30 female dancers from the New York Metropolitan area were compared to 46 male and 45 female non-dancers who were Brooklyn College students. No significant differences were found between the dancers and non-dancers in either the perceptual or personality tests. Dancers proved to be superior in balance performance under the conditions of stable visual field. Under conditions of a moving visual field there was no significant difference between the groups.

Using the Hidden Figures Test, Schreiber (1972), and Pargman, Schreiber and Stein (1974) studied the relationship between figure-ground perception and the selection of athletic team choice. One hundred and fifteen male college varsity athletes of seven sports, three of which were team sports (baseball, football, ice hockey) and four of which were individual sports (gymnastics, swimming, track, wrestling), were tested. The results indicated that team sport participants were more field dependent while individual sport participants were more field independent. The hypothesis that perceptual style does influence athletic team choice was supported. The researchers also compared playing positions to perceptual style but found no statistically significant differences.

In a second approach to studying perceptual mode, figure-ground perception was compared to success in skill performance of a specific motor task. Pargman, Bender and Deshaies (1975) investigated the relationship of successful basketball shooting to figure-ground perception. During mid-season the Group Hidden-Figure test was administered to 11 male and 9 female sophomore and junior college varsity basketball players. The test results were then correlated with the seasonal field-goal and free throw shooting efficiency of each subject. The results indicated that figure-ground perception and basketball shooting ability are not significantly related.

Several studies have used tasks from within a tennis game with tennis players as subjects when studying the effects of figure-ground perception. Kreiger's (1962) investigation utilizing beginning and intermediate tennis players (16 men and 8 women) involved figure-ground perception and its effect on spatial adjustment. Witkin's Embedded Figures Test and the Kreiger Spatial Adjustment Tennis Test were administered. A Pearson Product-Moment correlation coefficient of $r = .421$ was significant at the .05 level; a coefficient of $r = .549$ was significant for intermediate players. Results also indicated that the men were more field independent than the women. Thus, a significant relationship was found between spatial adjustment and perceptual style in tennis.

Enberg (1968) developed a film which assessed an individual's perception of directionality in tennis. The Tennis Directionality Test and Witkin's Embedded Figure Test (EFT) were administered to 63 college women classified as team players, beginning players and naive players. When comparing players on the EFT, the scores for the team and naive groups were significantly different. However, when comparing the Tennis Directionality Test results and EFT, the correlation coefficient was extremely low, $r = 0.58$.

An interesting aspect of the Enberg study was the reporting of subjective visual "cues." These cues were classified into 15 general categories. The team players reported more cues associated with body, racket and tennis ball than did the other groups. This area could be further investigated to compare the relationship of figure-ground perception to relevant visual "cues."

Pargman and Inomata (1976) studied the perceptual style of 18 women athletes and how displaced vision would affect motor performance. The Hidden Figures Test was administered to determine figure-ground perception. The subjects were then divided into two groups, nine field dependent and nine field independent. The motor task consisted of throwing tennis balls with the preferred hand at a target. To distort vision, prisms which reverse the visual field from right to left were placed in goggles. Goggles without prisms were used for normal viewing conditions. The results indicated that the performance of the field independent group was significantly higher than the field dependent group under displaced vision. Under the normal visual condition there were no distinct differences between the two groups.

Although Torres' (1966) research dealt with children of elementary school age, it is discussed here because of its relevance to figure-ground perception in relation to spatial adjustment during a ball-catching task. The ball-catching test measured the subjects' ability to make spatial adjustments necessary for successfully catching a ball from three different angles. The subjects were 56 children (28 ten-year olds and 28 thirteen-year olds) who were given the Witkin's Embedded Figure Test and the ball catching test. The results showed that there was not a significant relationship between figure-ground perception and spatial adjustments from angle one and angle three. There was a low positive correlation of $r = .271$ which was significant at the .05 level for angle 2. This study does not support Kreiger's finding of a relationship between figure-ground perception and spatial adjustment. When comparing the age groups, the thirteen-year-old boys and girls were significantly superior to the ten-year-old boys and girls, but there were no significant sex differences at either age on figure-ground perception. When analyzing the catching ability, it was found that the thirteen-year-old children were superior to the ten-year olds. The boys were superior to the girls at both age levels in ball-catching ability.

ATTENTION

Experimental psychologists such as Broadbent, Hebb, Moray, and Neisser surveyed the behavioral research in vision and hearing in an attempt to determine the function of attention. Although the word "attention" has varied meaning and applies to a wide range of phenomena, the concept was subdivided by Moray (1970). His categorization is as follows: (1) mental concentration (ability to solve problems mentally), (2) vigilance (ability to detect forthcoming events), (3) selective attention (ability to select the vital stimuli), (4) search (ability to thoroughly examine a set of stimuli for a subset or one stimulus), (5) activation (ability to be ready to respond to a stimulus), (6) set (ability to prepare to respond, either cognitively or overtly), and (7) analysis by synthesis (a process of identification). While "attention" has dissimilarity of tasks, at the same time, it has similarities which are overlapping.

Moray and Fitter (1973) suggested that the properties of attention are variable, therefore, not fixed. Attention adjusts to the requirements of the specific task and takes on the appearance of an acquired skill rather than the characteristics of a control system of the central nervous system.

The adoption of the information theory by psychologists, especially Broadbent's model (1958), has important implications for the understanding of attention. To apply information theory to attention, Posner and Boies (1971) divided attention into three components: (1) alertness, (2) selection, and (3) processing capacity. Alertness was defined as the ability of the central nervous system to be ready to receive and process information as a consequence of a warning signal. The ability to select information from one stimulus over another stimulus determines the selection process. Processing capacity is the ability of the central nervous system to process information at an optimal rate. The question arises as to the amount of information that can be processed per unit of time.

Stroud (1955) addressed the problem of how the variable physical time is handled by man with respect to the input-output relationship. He argued that the input-output relationship is identified by a different variable which he called psychological time. The inference is made that information is processed in distinct moments of time rather than continuously. The central mechanism absorbs the amount of information capable of being processed in a "perceptual moment." Stroud generalized that the "perceptual moment" occurs within the limits of .05 to .2 seconds with an average of .1 seconds. This variance depends on an individual's selective attention and processing capacity.

White and associates (1952, 1953, 1954, 1959, 1963) conducted a series of experiments which dealt with the presentation of visual, auditory and tactical stimuli. The results of these studies indicated that the limited perceptual rates of approximately 80 milliseconds per perceived unit were common for all three senses. White (1963) reported that, after the onset of visual stimulation, the perceptual moment lasted approximately 250-300 milliseconds. These findings support the hypothesis that some temporal process in the central nervous system tends to limit the perceptual input of the major senses.

Shallice (1964) reviewed the experimental data of loudness thresholds, brightness thresholds, and the perception of causality while comparing alternative theories with Stroud's (1955) perceptual moment hypothesis. He concluded that the perceptual moment hypothesis was superior to the other theories. While summarizing the findings, he noted that no agreement had been reached in the length of the "moment." He cited theorists who studied the alpha rhythm (Walter, Wiener, Murphree) and they considered the moment to be 100 milliseconds. White (1963) estimated the moment to be 80 milliseconds, based on subjects' estimates on the number of stimuli in a rapid sequence. Ansbacher, when using the Brown Circle Illusion and Michotte's data on the perception of causality, deduced the perceptual moment to be about 55 milliseconds.

Kay (1957) applied the information theory to the acquisition of skill. He suggested that both input and output in skill performance are interdependent. If a complex stream of events occurs rapidly or simultaneously, the player must learn to select the most significant events. Kay questioned the necessity of a skilled player watching the ball continuously. He theorized that skilled persons could predict the action of a ball from early information received and that additional information was redundant. Further, he noted that the speed of processing information would depend on the skill and experiences of the performer.

Hubbard and Seng (1954) studied professional batters using cinematographic analysis. This analysis pointed out that the batter's head was fixed and the pursuit movements of the eyes were used to track the ball. The results indicated that viewing was discontinued from 8 to 15 feet from the plate; therefore, the ball was not watched to the contact point. They suggested that further tracking was unnecessary for gathering additional useful information or that pursuit movements of the eyes were impossible to continue at such velocities. They also noted that the batter began his forward step as the pitcher released the ball and the swing began .04 seconds after the foot was planted.

Eastwood et al. (1968), as cited by Whiting (1969, 1970), conducted a reaction and movement time study in a cricket type situation. They substantiated the finding that it was not necessary to watch the ball continuously during the ball task in order to perform successfully. Eastwood et al. suggested that there may be a critical time factor of approximately 200 milliseconds for viewing the ball in flight.

In all sports the player directs his/her attention to identifying stimuli from various modalities so he/she may initiate the appropriate response and performance. Directing attention has been a commonplace task of teachers and coaches. The familiar saying of "keep your eyes on the ball" helps alert the player so that he/she may select the needed information, process this information and respond. The concept of attention will be further explored in relationship to viewing time in motor skills.

VIEWING TIME IN BALL SKILLS

To accomplish the task required in a ball game it is necessary for a person to view the ball in order to perceive its position, direction, velocity and acceleration. Visual information concerning ball tasks will be explored in this section. For the purpose of this study, viewing time or period (VT or VP) is defined as the length of time given to observe a ball in flight in order to catch or strike it.

The processing of visual information of ball flight has been categorized into three general areas by Whiting (1968): (1) Tracking of an oncoming ball with the intent of catching it by use of the hand(s) or an instrumental extension of the hand(s); (2) Tracking of an oncoming ball with the intent of immediately striking or propelling it towards a target; and (3) Striking or propelling a motionless ball towards a target.

In Whiting's early studies (1967, 1967, 1968, 1970), his experimental work was conducted in tracking and striking, using a continuous ball throwing and catching task. The task involved directing a ball on a chain toward a target. The apparatus was designed so that the researcher could illuminate only the ball, only the target, or both the ball and target simultaneously.

In 1967, Whiting (1969) conducted a pilot experiment in which players watched the ball during its entire trajectory under full-light conditions. The task utilized in this study was a ball throwing and catching skill. The players performed this task under a series of controlled light conditions including full light, target only, quadrant of flight and total darkness. The results of this experiment indicated that there was a transfer of learning from the training period to the actual experiment. It was possible to maintain performance at a similar level even though the reviewing time was restricted. Although performance decreased significantly in total darkness, the performance was reasonably good.

In the next experiment, Whiting (1968) gave this same ball throwing and catching task to 84 male university students under seven restricted light conditions. The range of conditions was from full illumination, to target illumination only, to target and ball illumination in segments of flight, to total darkness. The findings revealed that performance was the same under restricted light conditions as in full light. It was hypothesized that it was not necessary to view the ball during its entire flight to be successful in this task. This hypothesis was supported.

In a follow-up experiment using the same task, Whiting (1970) restricted 10 male subjects' view. They could view either the ball or the target, but not the two simultaneously. The researcher concluded that the subjects became more proficient in the task with practice and that they tended to transfer their attention from the ball to the target.

The evidence from Whiting's studies implies that as the performer becomes more proficient in the task, less time is needed to watch the ball in flight and, therefore, more attention is directed to the response or goal desired.

Whiting and his associates also explored viewing time of ball skills in category one--tracking of an oncoming ball with the intent of catching it with the hand(s) or an instrumental extension of the hand(s).

Whiting, Gill, and Stephenson (1970) simulated an actual catching situation in which a ball was dropped onto a trampoline bed which caused the ball to enter a parabolic flight path. The subjects (36 skilled male university athletes) were tested in a dark room so that viewing time could be restricted. The lengths of time for illuminating the ball were: .1 second, .15 second, .2 second, .25 second, .3 second and .4 second. The .4 of a second was considered full light. The subjects were required to catch the ball with one hand. Scoring for each lighting condition was the number of successful catches made out of 20 attempts. The results showed that watching the ball for a longer period of time tended to improve the number of successful catches. The findings indicated a significant difference between the mean scores of the successful catches at each light duration except those between .1 and .15 seconds and .15 and .2 seconds.

In a follow-up study Whiting, Alderson, and Sanderson (1973) simulated a catching situation using a ball-throwing machine. Forty-four male subjects (20 cricketers, 24 non-cricketers) were required to catch the ball with one hand under restricted light conditions of 100, 150, 225 and 300 milliseconds. Scoring was based on the number of successful catches at each time interval. The results supported the findings of Whiting et al. (1970) that catching performance improved as the viewing time lengthened. There was not a significant difference between cricketers' and non-cricketers' ability in this task.

Nessler (1973) simulated a catching situation by the use of a ball-throwing machine which projected a tennis ball to rebound off the front wall of a squash court. Subjects were 65 women physical education majors and varsity athletes. The experiment was conducted in a dark squash court with the room being illuminated by the use of fluorescent lights. The length of illumination was .5 second, .4 second, .3 second, .25 second, and .2 second. The findings indicated that there were significant differences among all the viewing conditions in terms of number of catches. Nessler noted that success in catching is related to the length of viewing time. Her findings are supportive of those of Whiting et al. (1970).

Williams and MacFarlane (1975) used a different approach to study ball catching. They were concerned with the effects increased ball velocity would have on reaction time (RT), movement time (MT), and catching ability in a ball task. They established a catching situation in which the velocity of ball throwing was manipulated. Balls (10 per trial) were projected at speeds of 57, 65, 84, and 123 miles per hour; trials occurred in that exact order. Measures of reaction time (RT) and movement time (MT) were collected from 30 male physical education majors as they caught the balls with two hands. The findings revealed that as ball velocity increased, MT remained relatively constant but

RT progressively decreased. As velocity increased, viewing time was restricted and ball-flight time decreased, causing catching ability to deteriorate. These findings are in agreement with those of Whiting, et al. (1970) and Nessler (1972).

The preceding studies conclude that tasks which require the tracking of a ball or object to be caught by the hand(s) necessitate following the ball as long as possible to achieve maximum performance.

In Whiting's latest studies, the question still arose as to whether it was necessary to view the ball during its entire flight to achieve maximum performance. He was interested in studying the effectiveness of viewing time and occlusion period (cut-off time after viewing time) in the success of ball catching.

Whiting and Sharp (1974) again utilized the simulated catching situation using 44 male university students as subjects. This investigation was to determine the importance of the occluded period (period of darkness) following the viewing period on the success of catching a ball. The task involved catching a tennis ball which was projected by a ball-throwing machine. The trajectory of the ball was divided into four phases: (1) total darkness (DP), (2) viewing phase (VP), (3) occlusion phase (OP) and (4) latency period (LP). Total flight time was held constant at 580 milliseconds while DP varied, VP remained constant at 80 milliseconds, OP varied between 0 and 320 milliseconds, and LP remained constant at 125 milliseconds. Five trials (occlusion periods of 320, 240, 160, 80 and 0 milliseconds) of 18 balls each were given. The scores for each trial were recorded as (a) a catch,

(b) located or (c) missed. The results suggested that the occluded period influences success in a ball-catching task. Performance declined when the occlusion phase was between 160-320 milliseconds. This result may be due to the inability of subjects to predict ball flight over this extended period of time. A curvilinear relationship was found between catching performance and occlusion phase with peak performance at 160 milliseconds. The explanation given for performance between 160-320 milliseconds was memory decay, while performance between 0-160 milliseconds was probably influenced by lack of time to process necessary flight information.

In a follow-up study, Sharp and Whiting (1974) gave 48 male university students the task of catching a tennis ball that remained in the dark during its flight except for brief periods of illumination. The velocity of the throwing machine remained constant while the between variable viewing periods (VP) were 20, 40, 80, 120 and 160 milliseconds and the within variable occlusion period (OP) were set at 0, 80, 160 and 240 milliseconds. The results indicated occlusion periods, viewing periods and their interaction were significantly different. Further analysis showed the significant differences existed between occlusion period and all levels of viewing period and between viewing period and all levels of occlusion periods except 240 milliseconds. The researchers noted that the total processing time (VP + OP) available is more important than the viewing period or occlusion period per se. Sharp and Whiting stated that it does not matter how viewing period and occlusion period each contribute to the total time; the conditions OP = 80, VP = 40 milliseconds and OP = 0, VP = 120 milliseconds both resulted in the same performance, as did OP = 80, VP = 80 milliseconds and OP = 0, VP = 160 milliseconds.

SUMMARY

The concept of figure-ground perception was first recognized by Gestalt psychologists. These psychologists theorized that an individual perceives his/her visual field as objects on surfaces or as figures against a background. To assess the ease with which a person can detect a simple figure from its embedded surroundings, the Embedded Figures Test was devised. This test measures the perceptual style of an individual in degrees of field dependence or independence.

The literature indicates that each individual develops his/her own perceptual style which is characteristic of and consistent with his/her perceptual activities. Women tend to be more field dependent than men, finding it more difficult to separate items from the prevailing visual field. Visual discrimination increases with age, stabilizes in young adulthood and then reverts back to dependence in old age.

Two approaches have been used to study the relationship between figure-ground perception and motor performance. The perceptual style of athletes has been investigated in relation to success in skill performance. The findings did not show a significant relationship between figure-ground perception and skilled performance in specific motor tasks. Investigations also have compared the perceptual style of skilled athletes and less skilled performers. The literature indicated that there is little or no significant difference between athletes and non-athletes when comparing perceptual style.

The concept of "attention" has numerous and varied definitions. Each definition of attention is operational in nature, reflecting the task to be accomplished. The adoption of the information theory by psychologists has led to the sub-division of attention. The three components of attention are (1) alertness, (2) selection, and (3) processing capacity. The perceptual moment hypothesis provided a basis for examining the amount and rate of information that can be processed per unit of time. No agreement has been reached on the length of perceptual moment. The assumption put forth was that the variance of the "moment" depended on some temporal process in the central nervous system that limited input of the major senses.

The concept of attention was explored in relation to viewing time in motor skills. The processing of visual information of ball flight was explored. Research indicates that tasks requiring the tracking of a ball or objects which will be caught by the hand(s) make it necessary to follow the flight of the ball as long as possible to achieve maximum performance. The evidence from studies of tracking an oncoming ball with the intent of propelling it toward a target implies that as the performer becomes more proficient in the task less time is needed to watch the ball.

CHAPTER III

PROCEDURE

The purpose of this study was to determine the relationship between figure-ground perception and viewing time in a ball catching task for male and female tennis players. The differences between sex and tennis skill ability on figure-ground perception, the ball task, and the length of viewing time were also investigated. Discussed in this chapter are the procedures utilized in the selection of the subjects, description of the measuring devices, testing procedures and treatment of data.

SELECTION OF THE SUBJECTS

The uniqueness of tennis requires players to rely upon cues from the external environment for successful performance. It is necessary for the player to discriminate and select the appropriate visual information, such as the opponent's body and racket position, to determine the future path of the ball. The faster a player gathers visual information, the sooner he/she can anticipate and respond effectively to the opponent. Thus, it seemed appropriate to study male and female tennis players of beginning, intermediate and advanced skill level with respect to figure-ground perception and viewing time in relation to a ball catching task.

To obtain the subjects, the researcher contacted the instructors who were teaching tennis classes at the University of Nebraska-Lincoln during the spring semester 1976-1977 to ask their permission to solicit subjects from their classes. In addition, the coaches of both the men's and women's 1976-1977 varsity tennis teams at the University of Nebraska-Lincoln were asked for their cooperation in contacting members of the tennis teams as potential subjects. In order to obtain additional women who were highly skilled, the coach of the women's tennis team at Nebraska Wesleyan University was also contacted.

During the first week of tennis classes, the Hewitt Revision of the Dyer Backboard Tennis Test was administered to the students by the tennis instructors. The students were classified as beginners, intermediates, or advanced players as a result of their scores on the classification test. The original norms established by Hewitt (1968) were used: a score from 5 to 10 for beginners, from 11 to 20 for intermediates, and 21 to 30 for advanced players.

Due to the delay of equipment construction, the tennis teachers were asked to retest the students during the eighth week of instruction. The data collected from the retest indicated that learning had occurred so that the original classification norms were no longer applicable. It was then necessary to modify the norms of the tennis test based on the scores of this sample of subjects. The norms were modified as follows:

Level	Female	Male
Beginner	7-14	10-14
Intermediate	14-17	14-19
Advanced	17-30	19-30

At the upper or lower ends of each level, the instructors subjectively classified the students who were borderline cases into one of the two levels. After the testing was completed and scores were tabulated, all the potential participants were classified by skill level. The experimenter selected and visited three beginning and two intermediate tennis classes, explained the project and asked for volunteers to participate in the experiment.

The potential subjects on the varsity tennis teams were subjectively classified as either intermediate or advanced tennis players by the researcher. This was done by observing the players' playing performance, his/her ability to make the tennis team, and the individual's team rank. All players on the University of Nebraska's tennis teams and one woman from the Nebraska Wesleyan University tennis team were classified as advanced tennis players. Seven women on the Nebraska Wesleyan tennis team were classified as intermediate players.

The researcher then contacted the players on both the men's and women's 1976-1977 varsity tennis teams at the University of Nebraska-Lincoln and the Nebraska Wesleyan University women's tennis team, explained the project and obtained the players' cooperation for the project.

In all, a total of 49 females and 49 males were participants in the investigation. Among the 98 subjects were 34 beginner (17 females and 17 males), 34 intermediate (17 females and 17 males), and 30 advanced (15 females and 15 males) tennis players. The subjects ranged in age from 18 to 28 years.

Because the tests were not completed by three beginners (males), two intermediates (1 female and 1 male) and two advanced (males) these subjects were dropped from the project. All subjects who volunteered and completed testing were included in this study. All subjects were requested to sign the Consent Form. A copy of this form can be found in Appendix A, page 90.

MEASURING DEVICES

Hewitt Revision of the Dyer Backboard Tennis Test

The Hewitt (1965) Revision of the Dyer Backboard Test was utilized for classifying subjects who were non-varsity tennis players according to tennis skill ability. This test quickly evaluates the player's general tennis ability from the beginning to the advanced player. The ease of administration of this test was also a factor in its selection. The reliability coefficients had been computed by test-retest method, $r = .93$ for the advanced group and $r = .82$ for the beginning group. The validity was established for both beginners and advanced players utilizing round robin tournament results as the criterion. RHOs ranged from .68 to .73 for beginners and .84 to .89 for advanced players (Hewitt, 1965).

The test consisted of rallying a tennis ball against the wall, using a forehand or backhand drive. At the signal "Ready? Go" the student serves the ball and then repeatedly hits the tennis ball against the wall for 30 seconds. One point is recorded each time the ball is hit from behind a 20-foot restraining line and above the net line (3 feet above the floor). All other hits are disregarded. One 15-second practice trial is given followed by three 30-second trials. The subject's final score is the average of the scores from the three 30-second trials.

Administration of Tennis Test

During the staff orientation week at the University of Nebraska-Lincoln of the Spring Semester 1976-1977, the experimenter contacted the instructors teaching the tennis classes to obtain their cooperation in the project. All instructors consented to allow their classes to participate. A briefing session was held with the instructors on how to administer the Hewitt Revision of the Dyer Backboard Tennis Test. Each instructor administered the test to his/her class(es). The tests were conducted in Room 313, Mabel Lee Hall.

The rebounding wall served as a backboard for the administration of this test. One-inch blue masking tape was used on the wall at a height of three feet from the floor to represent the net, and a restraining line 20 feet from and parallel to the wall was marked with one-inch white masking tape. To prevent loss of time in retrieval of balls out of control, extra balls were available to continue action.

The average class size was 24 and all were coeducational. There was adequate space to allow for four groups of students to be tested simultaneously. Students assisted in the testing; one student recorded the score, one student counted the number of hits above the three-foot line, one student observed foot faults over the restraining line, and the remaining students retrieved the tennis balls. Students rotated duties until all of the subjects had completed their three trials.

The verbal explanation for the tennis test was given by the instructor. A copy of the instructions and norms can be seen in Appendix B, page 92. The score card can be viewed in Appendix C, page 94.

Group Embedded Figures Test

The Group Embedded Figures Test (GEFT) was designed to determine field dependence and to be administered to large numbers of subjects in a group setting. It is an adaptation of Witkin's (1950) original Embedded Figures Test (EFT) which is administered individually to a subject.

The GEFT contains 18 complex figures. Seventeen of these figures were taken from the EFT. The test is divided into three sections: the first section is designed for practice and contains seven very simple items to be completed within a two-minute time interval; sections 2 and 3 each contain nine difficult items, with a time limit of five minutes per section. The GEFT is administered in a 20-minute testing session. Subjects respond directly on the GEFT test booklet. The test booklets were obtained from Consulting Psychologists Press, 577 College Avenue, Palo Alto, California 94306.

Administration of the Group Embedded Figures Test

The Group Embedded Figures Test (GEFT) was administered to each subject during the Spring Semester of the 1976-1977 academic year. To accommodate the students in the tennis classes, the Nebraska Wesleyan tennis team and the University of Nebraska-Lincoln tennis teams, the test was given at five different times. The first session was held at the Nebraska Wesleyan Physical Education Building on Monday, March 21, 1977, at 3:00 p.m. The test was given in classroom 228A at Mabel Lee Hall on the University of Nebraska campus on Monday, March 28, 1977, at 11:30 a.m. and 1:30 p.m. and again Wednesday, March 30, 1977, at 8:30 a.m. and 9:30 a.m. Subjects who could not attend one of the five meetings were tested in small groups or individually. This was administered by the researcher in her office in 207 Coliseum as follows: (a) small group as necessary (two to five subjects) or (b) to a single individual.

During the administration of the test the subjects were seated at a desk or table. Each was provided with a test booklet and a pencil. They were directed to listen to the tape-recorded instructions.

To standardize the instructions for the GEFT, they were recorded on a Sony Cassette Tape Recorder. To counterbalance the effects of role enactment due to having a female researcher, a male voice was used. A copy of the tape text appears in Appendix D, page 96.

Ball Catching Task

The ball catching task was designed to determine the effects of selected viewing times on the performance of a ball catching skill. In an adaptation of Whiting's (1970) ball catching test, the object of the task was to catch a projected ball with one hand under five different lighting conditions. The light intervals selected were 0.1, 0.2, 0.25, 0.3 and 0.4 seconds.

The test was divided into two parts. The first part familiarized the subject with the task. Each subject was given a practice trial of 10 balls under the full light condition. The second part of the test was conducted in a dark room. Five trials were given. A trial consisted of 20 balls, preceded by three practice balls, at a specific light duration of 0.1, 0.2, 0.25, 0.3 and 0.4 seconds. The light flashes on the peak of the ball's trajectory and the ball is visible only for that length of time. The interval between trials was the time it took the subject to count his/her score and return the balls. The test was administered individually to each subject. Total administration time for the five trials was approximately twenty minutes.

Equipment

Gravity drop ball throwing apparatus. The ball throwing apparatus was patterned after equipment used by Whiting, Gill and Stephens (1970). The laws of freely falling bodies serve as the basic principle for this equipment. A ball is dropped vertically onto a projection platform which causes the ball to enter a parabolic flight path. The equipment was designed by the researcher in cooperation with Darryl Rivers of Rivers Metal Products of Lincoln, Nebraska, who also constructed the apparatus.

The frame was constructed of two-inch steel with a base four feet square. An adjustable shaft allows the height of the equipment to vary from 5'5" to 10'10". The height used for this study was nine feet (from the floor to the release point of the ball).

A metal tennis racket head was attached to the steel frame. The racket head was used as the projection platform to project the ball into a parabolic flight path. The platform was adjustable so the height could vary from 40" to 70" above the floor. For this study the platform was set 40" above the floor. The angle of the racket head could be adjusted to 60 degrees, 65 degrees, and 70 degrees. The 65 degree angle or projection provided the desired trajectory for the catching task.

A spiral container capable of holding 24 tennis balls was attached to the top of the steel shaft. The container was 16 inches high with a ten-inch diameter. The spiral ramp within the container was angled to allow the balls to roll freely to the release point.

At the release point a six-inch chute was attached to guide the ball on its downward flight. The ball was mechanically released. The release device consisted of a stop pin placed in the passage of the chute. The release was activated electrically.

The entire ball throwing apparatus, with the exception of the tennis racket head, was spray-painted non-glare black. The ball throwing apparatus is shown in Figure 1, page 41.

Lighting apparatus. A pole seven feet in height held the photographic lamp holder which contained a 75 watt Blacklite Bulb #4145 made by Duro-lite Lamps, Inc. The angle of the lampholder was 45 degrees so that the light was focused on the peak of the ball trajectory. The lighting apparatus is shown in Figure 4, page 48.

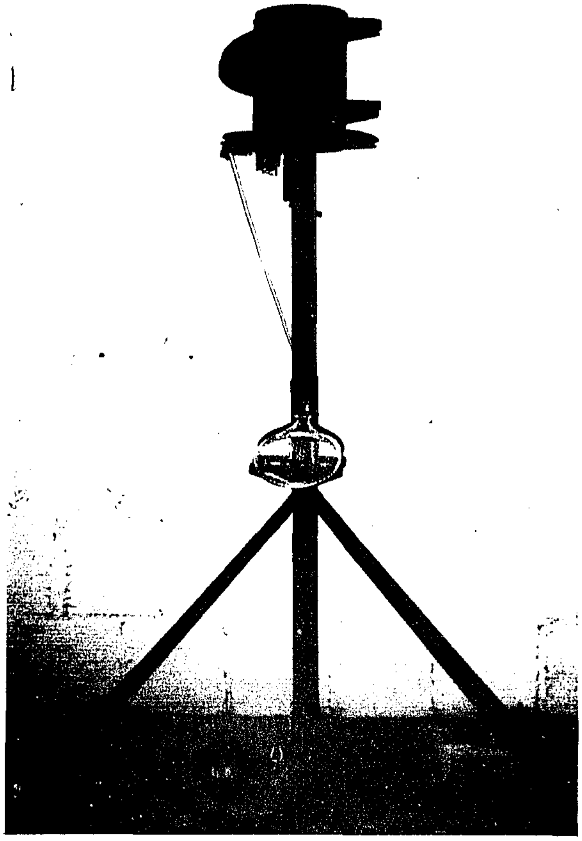

Figure 1

Ball Throwing Apparatus

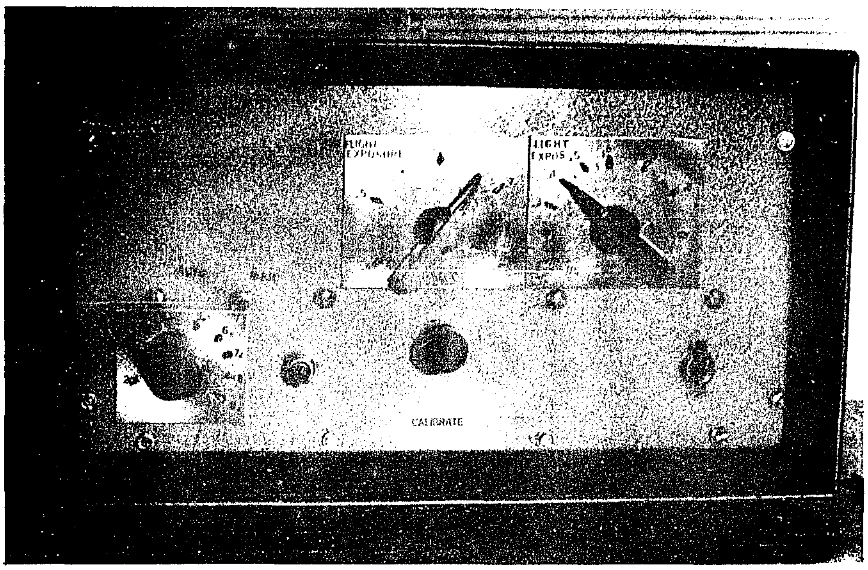

Figure 2

Control Console

<u>The control console</u>. This unit was specifically designed for use with the gravity drop ball throwing apparatus. It is a completely solid state instrument consisting of three major components: (1) light control, (2) flight control, and (3) ball initiation control.

The light exposure control is activated electronically to generate calibrated time intervals from 0.05 seconds to one minute with increments of 0.05 seconds. The time intervals used in this study were 0.1, 0.2, 0.25, 0.3, and 0.4 seconds.

The flight exposure control can be adjusted to the varying height of the throwing apparatus and to the trajectory of the ball by the amount of time necessary for the total flight of the ball. The time intervals may vary from .4 to .8 of a second. This control activates the lamp which illuminates the ball during its trajectory. The point of illumination may vary anywhere from the time the ball leaves the racket to the time the ball lands on the floor. For this study, the light was focused at the peak of the ball's trajectory with a time setting of .65 of a second.

The initiating control for the ball release can be triggered either manually or automatically. The time intervals between releases of the ball may vary from 0.05 second to 10.0 seconds. For this study, the ball release varied from 1.0 to 4.0 seconds. The control console is shown in Figure 2, page 41, and the electrical circuitry for the control console is included in Appendix E, page 99.

<u>Tennis balls</u>. New yellow Tretorn tennis balls were used. These pressureless tennis balls were selected because of their unchanging

quality and the consistency of their bounce. The yellow balls were brightly illuminated by the Blacklite. A total of 46 balls were used. These balls were divided into two sets of 23 each to allow rapid reload procedure for the throwing apparatus.

Due to the newness of the tennis balls, friction was created by the felt covers of the balls causing them on occasion to stick together in the ball container. To reduce the friction, the balls were sprayed periodically with "Static Guard," a product of the Alberto-Culver Company. This process resulted in the balls running smoothly down the spiral track of the ball container.

Pilot study to test equipment for the ball catching task. A pilot study was conducted to test the accuracy of the ball throwing apparatus, the trajectory of the ball, the placement of the target, the placement of the light, and to clarify the procedures for the ball catching task.

To establish the proper height of the apparatus and the flight pattern of the ball, 100 tennis balls were projected from the ball throwing apparatus. The reference point for the height of the machine was set from the floor to the ball's point of release. This distance was nine feet.

A tennis ball 2-1/2 to 2-5/8 inches in diameter was droppped onto the 65 degree angle racket head from a height of nine feet and was projected on a parabolic flight path a distance of 9'5" to the center of the target.

The flight accuracy of the ball was established by projecting 200 tennis balls and recording the landing distance from the throwing apparatus. The target was located 9'5" from the center of the racket head. The ball would land on the center of the target or within a 12 inch diameter of dead center of the target.

To reaffirm the accuracy of the throwing machine and to position the beam of light, 100 additional tennis balls were projected. The beam of light was focused at the peak of the ball's trajectory. The flight exposure dial on the control console was set at .65 seconds.

Six faculty members served as subjects during the pilot study. The first five subjects were assigned viewing time in a progressive order. Each subject was assigned a different time interval to counterbalance the residual effects of treatment.

Subject I - 0.1, 0.2, 0.25, 0.3, 0.4
Subject II - 0.2, 0.25, 0.3, 0.4, 0.1
Subject III - 0.25, 0.3, 0.4, 0.1, 0.2
Subject IV - 0.3, 0.4, 0.1, 0.2, 0.25
Subject V - 0.4, 0.1, 0.2, 0.25, 0.3

The sixth subject's viewing time exposures were randomized so that the times were 0.3, 0.1, 0.25, 0.4, 0.2.

The results revealed there was an apparent learning effect present in the progressive order of presenting viewing time. To reduce the possibility of a learning effect, the experimenter decided to randomize the light exposures for viewing time rather than to present them in a progressive order.

The subjects indicated that the instructions for the test were stated clearly and were easy to understand. The testing time per subject was approximately 20 minutes.

Research laboratory. The location of the visual perception research laboratory was in Room 16 of the Coliseum at the University of Nebraska-Lincoln. The dimensions of the room were 8'2" by 24'. A black stage curtain was placed behind the ball throwing equipment as a backdrop to provide a homogeneous visual field. This backdrop was ten feet in height and placed six feet from the front wall of the room. Another curtain was placed twelve feet from the ball throwing equipment to contain the balls in a limited area so they could be quickly retrieved.

A field archery target 25" by 25" was placed 9'5" from the ball throwing equipment. The target was used to ensure the consistency of the ball's flight and to make certain that the ball stayed within the prescribed limits. If the ball were allowed to drop to the floor it would land within the twelve inch diameter of the center of the target. The target was also used to standardize the subject's standing position; the subject was instructed to stand on the center of the target.

Next to the target was placed a grocery cart, 34" high and 36" long and 14" wide. The cart was used to retain the balls caught by the participants.

The lighting apparatus was placed twenty-two inches directly behind the target.

Located behind the ball throwing equipment and backdrop were the electrical controls for both the light and the ball throwing apparatus. The control console, a lamp, and the score sheets were placed on a table. Next to the table were located the electrical outlet and the light switch for the room illumination. A six-foot ladder was placed next to the backdrop. The height of the apparatus made it necessary for the researcher to use this ladder to reload the ball throwing apparatus. A diagram of the visual perception research laboratory can be viewed in Figure 3, page 47. A picture of the laboratory can be seen in Figure 4, page 48.

Administration of ball catching task. The ball catching task was administered by the researcher individually to each volunteer. The subjects selected their appointment time for the ball catching task. An appointment card was given to each person so that he/she would remember the date, time and place for testing. This form may be seen in Appendix F, page 101.

During the first week of testing, the subjects scheduled appointments from 3:00 p.m. through 9:30 p.m. Monday through Thursday. After the first week, appointments were scheduled at 10:30 a.m., 12:30 p.m. or from 2:30 p.m. through 6:00 p.m. Monday, Wednesday, and Friday. Appointments on Tuesday and Thursday began at 9:00 a.m. and continued until 6:00 p.m. Testing began Monday, March 14, 1977, and was completed Monday, April 25, 1977.

Since testing was conducted in a dark room, the subjects were shown the apparatus and were allowed to familiarize themselves with the task. Each subject was given a practice trial of 10 balls under full light conditions. Due to the fact that this study was based on the assumption that the subjects could catch a tennis ball, the researcher observed all subjects during the practice trial to assure

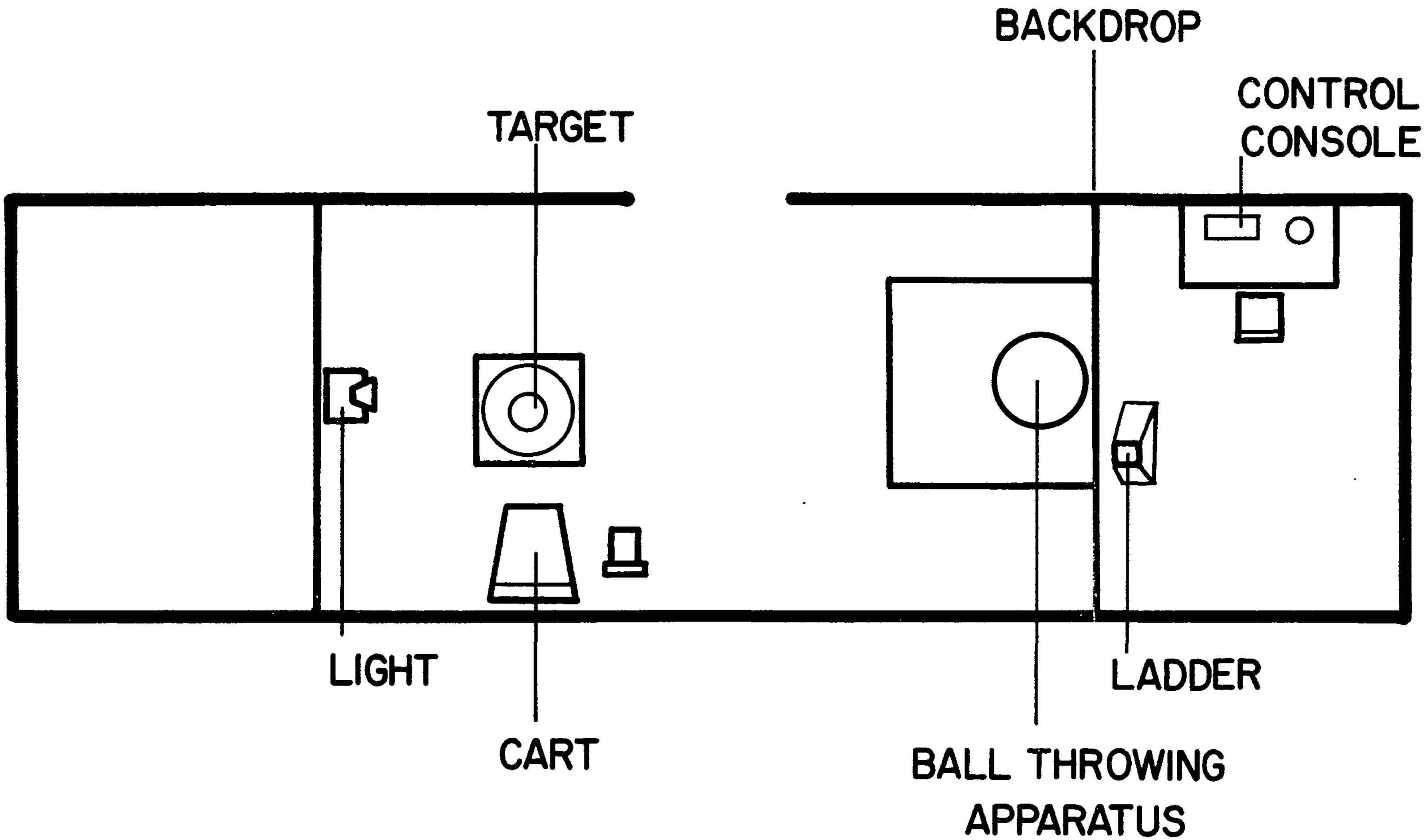

Figure 3

Diagram of Research Laboratory

Figure 4

Research Laboratory

that their catching ability was adept at the task. All subjects were successful at catching under the full light condition. Therefore all subjects were included in the study.

The object of the task was to catch the projected ball with one hand while viewing the ball under restricted lighting conditions. The five lighting conditions used throughout the experiment were 0.1 seconds, 0.2 seconds, 0.25 seconds, 0.3 seconds and 0.4 seconds. The light intervals were randomized to counterbalance the residual effects of treatment. One trial consisted of 20 balls preceded by three practice balls. This procedure was followed for each light exposure.

The interval between trials was the time it took the subject to count his/her score and return the balls. Meanwhile, the researcher recorded the score and reloaded the apparatus with the extra set of balls. Total administration time was approximately 20 minutes per subject.

A score sheet was devised to provide spaces for recording "Name," "Comments," "Time Exposures" and "Scores." The scores for five subjects were recorded per page. A copy of this sheet can be seen in Appendix G, page 103.

The following instructions were given verbally by the researcher to each subject prior to testing:

> E: "Please stand on the center of the target and face the throwing equipment. Notice that the balls will drop from the machine, bounce on the racket and rebound to you. Your task is to catch the ball with <u>one hand</u> and place it in the cart. If you miss the ball, let it go; do not recover it. In a minute you will try a practice trial with

the lights on. On the command 'Ready' a tennis ball will be projected to you. Do you have any questions? Let's go through the practice trial. 'Ready.'"

(Go through the practice trial projecting 10 balls, the examiner watching how the subject is catching the balls.)

E: "Would you please place the balls in the pail while I reload the machine? Now the room will be darkened. Notice the light behind you. The light is set to go off at a certain time for a certain duration. Your task will be to catch the ball with one hand as you did during the practice. The test will be given five times under different viewing conditions. Before each trial, you will be given three practice trials. During the practice, if you catch the ball, drop it on the floor. When the test begins, catch the ball with <u>one hand</u> and place it in the cart. Your score will be the number of balls in the cart. The command 'Ready' will be given during the three practice trials. The command, 'The test will begin, Ready' will be given before the test starts. Do you have any questions?"

Test I Begins

E: "Ready for the three practice balls? Make sure you catch the ball with one hand and drop it on the floor. Ready?"

(Give three practice balls)

E: "Now the test will begin. Ready?"

(Give 20 test balls)

E: "Please count the number of balls in the cart. What is your score? Please pick up the balls and place them in the pail. There should be 23 balls."

(E reloads the throwing machine and records the score.)

Test II Begins

E: "Are you ready for the three practice balls? Make sure you catch the ball with one hand and drop it on the floor. Ready?"

(Give three practice balls)

E: "Now the test will begin. Ready?"

(Give 20 test balls)

These procedures were followed for the remaining trials.

At the completion of the test, the subject was shown his/her score. The experimenter explained the use of the different light exposures and what would be done with the results.

COLLECTION OF DATA

All non-varsity tennis players were given the Hewitt Revision of the Dyer Backboard Tennis Test during their tennis class. The non-varsity tennis players who volunteered as subjects were also given the Group Embedded Figures Test (GEFT) during their tennis class. The participants were individually scheduled to complete the ball catching task.

The varsity tennis players, who were subjectively classified according to tennis playing ability, were given the GEFT during one of the five scheduled times or in small groups or individually. The participants were individually scheduled to complete the ball catching task. The individually tested varsity subjects were given the ball catching task immediately following the GEFT administration. The total time for both tests was approximately 40 minutes per subject. Testing began March 14, 1977, and was completed by April 25, 1977. The time lapse between administration of the GEFT and the BCT varied from one day to one week.

The Hewitt Revision of the Dyer Backboard Tennis Test is scored by totaling the number of times the tennis ball, hit from behind the 20-foot restraining line, contacts the wall above the three-foot marker. The mean score of the three trials is the subject's classification score. Classification norms were established to fit the circumstances of this study. The norms used were: advanced ability group for females--scores from 17-30, for males 19-39; the intermediate group for females--scores from 14-17, for males 14-19; for beginniners, females 7-14 and males 10-14. Students whose scores overlapped either the upper or lower ends of a level were subjectively classified by the instructor.

The Group Embedded Figures Test (GEFT) is scored as the total number of simple forms correctly traced in Sections Two and Three. A scoring key is provided with the Simple Form traced over each Complex Figure. The individual's degree of field dependence was determined by the number of correct answers on the Group Embedded Figures Test. The subject was classified as field independent when the score was 18-17; moderately field independent, 16-15; moderately field dependent, 14-12; field dependent, 11-0.

The ball catching task (BCT) score is the total number of successful catches of all the five trials. A sub-score for each of the five viewing times (0.1, 0.2, 0.25, 0.3, 0.4) is the number of balls caught at the specific light interval. The sub-scores are referred to as the viewing time (VT) score while the total number of balls caught during the five trials is referred to as the ball catching score (BCT).

STATISTICAL ANALYSIS

The analysis of data was derived statistically by a computer utilizing the Statistical Package for Social Sciences (SPSS) Programs. The programs used were Pearson correlation, one-way ANOVA, two-way ANOVA and Scheffé multiple range test. The second statistical package used was Biomedical Computer Programs P-Series (BMDF-Series). The specific program used was BMDP2V-analysis of variance and covariance including repeated measures.

The relationship between the ball catching task (BCT) and the Group Embedded Figures Test (GEFT) was determined by the use of the Pearson-moment coefficient of correlation. The Pearson-moment coefficient of correlation was used to assess the relationship between:

1. Viewing time and Group Embedded Figures test in male subjects
2. Viewing time and Group Embedded Figures test in female subjects
3. Viewing time and Group Embedded Figures test in all subjects
4. Viewing time and Group Embedded Figures test in beginning players
5. Viewing time and Group Embedded Figures test in intermediate players
6. Viewing time and Group Embedded Figures test in advanced players

An analysis of variance was used to assess the significance of the differences between:

1. Males and females on the Group Embedded Figures Test
2. Males and females on the ball catching task
3. Beginners, intermediates and advanced skill levels on the Group Embedded Figures Test
4. Beginners, intermediates and advanced skill levels on the ball catching task
5. Beginners, intermediates and advanced level tennis players, males and females, on length of viewing time (VT).
6. Field dependent and field independent subjects on the ball catching task

When a significant F ratio was found, the Scheffé test was used to determine which of the means differed significantly. The level of significance was established at the .05 level.

CHAPTER IV

RESULTS AND DISCUSSION

A ball catching task (BCT) designed for use in this study provided data for the comparison of differences resulting from variations in viewing time for male and female tennis players. The Group Embedded Figures Test (GEFT) was used to assess the field dependence of the subjects. The dependent variables GEFT and BCT were subjected to separate analysis of variance with sex, skill level and the length of viewing times as the independent variables. Relationship between the catching task scores and figure-ground perception of the subjects was statistically analyzed.

RESULTS

Ball Catching Task

The 98 subjects were administered the ball catching task under five randomized viewing conditions: 0.1, 0.2, 0.25, 0.3, and 0.4 seconds. The total score, referred to as the ball catching score, was composed of the successful catches on each of five trials with a maximum of 100 possible catches. Each specific viewing interval constituted the sub-score called viewing time score. A viewing time score included one trial (consisting of a maximum of 20 possible catches) under a specified light condition.

The ball catching scores ranged from 19-96 for women and from 60-93 for men. The mean score for women was 68.08 catches with a standard deviation of 16.87. The mean score for the men was 81.53 with a standard deviation of 7.77 (Table 1).

Table 1

Means and Standard Deviations of Age, Ball Catching Task, and Group Embedded Figures Test for All Subjects, Females, Males, Beginner, Intermediate and Advanced Tennis Players

	N	Age	SD	BCT	SD	GEFT	SD
All subjects	98	20.44	2.16	74.81	14.71	13.60	4.32
<u>Sex</u>							
Female	49	19.96	1.85	68.08	16.87	12.90	4.03
Male	49	20.92	2.35	81.53	7.77	14.31	4.52
<u>Tennis classification</u>							
Beginner	34	20.21	1.92	68.74	19.16	14.59	2.80
Intermediate	34	20.76	2.10	73.85	11.20	13.53	4.24
Advanced	30	20.33	2.48	82.77	7.32	12.57	5.56

A two-way analysis of variance was conducted to determine the differences between the sexes on the ball catching task. The F ratio of 33.612 for 1 and 97 degrees of freedom indicated a difference between the sexes was significant at the .05 level (Table 2).

Table 2

Two-way Analysis of Variance for the Ball Catching Task Utilizing Tennis Skill Level and Sex

Source of Variation	SS	df	MS	F
Level	3185.074	2	1592.537	12.079*
Sex	4431.437	1	4431.437	33.619*
Level x sex interaction	1245.314	2	622.657	4.723*
Error	12129.320	92	131.840	
Total	20991.145	97	216.404	

*$p < .05$ or significant at the .05 level of confidence.

For 2 and 97 degrees of freedom, the F ratio of 12.079 was significant at the .05 level, indicating differences between skill levels on the ball catching task.

When examining the mean score by skill level, it can be seen that the beginners' score was 68.74 with a standard deviation of 19.16; the intermediates' score was 73.85 with a standard deviation of 11.20; and the advanced players' score was 82.77 with a standard deviation of 7.32. The mean ball catching task scores increased as skill level increased and the deviation within the group decreased (Table 1, page 56).

To determine if each of these apparent increases was statistically significant, the Scheffé test for multiple comparisons was applied. The results of the Scheffé analysis revealed that significant differences did exist between all skill levels (see Table 3).

Table 3

Scheffé Test: F Values for Comparison of Skill Levels

Means in Comparison	df	$\bar{x}_1 - \bar{x}_2$		F
Beginners with intermediates	2/95	5.1200*	>	3.50
Beginners with advanced	2/95	14.0314*	>	3.50
Intermediates with advanced	2/95	9.1138*	>	3.50

*Significant at .05 level, F greater than 3.50.

The combination of variables of sex and skill level on the ball catching task resulted in a statistical interaction. This ordinal interaction in which the graphic lines do not cross provided a significant F ratio of 4.723 for 2 and 95 degrees of freedom (see Table 2, page 57).

Field Dependence

To determine field dependence, the Group Embedded Figures Test was used. The total number of simple forms correctly traced in Sections Two and Three of the GEFT determine the score. The highest possible score is 18. The scores ranged from 0 to 18 for females and from 1 to 18 for males. The mean score for men (14.31) was slightly higher than the mean score for women (12.90). The mean scores decreased as skill level increased, i.e., beginners, 14.59; intermediates, 13.53; and advanced, 12.57. The mean scores for sex and skill are presented in Table 1, page 56.

To determine if significant differences existed between the groups on the GEFT, a two-way analysis of variance was utilized to analyze the data. The F ratio of 2.648 obtained between the sexes was not large enough to be statistically significant, nor was the F ratio of 1.782 significant for differences among the three skill levels. Significant interaction between the skill levels and the sexes was also lacking. The summary of these data is presented in Table 4.

Table 4

Two-Way Analysis of Variance for the Group Embedded Figures Test Utilizing Tennis Skill Level and Sex

Source of Variation	SS	df	MS	F
Level	65.406	2	32.703	1.782
Sex	48.582	1	48.582	2.648
Level x sex interaction	9.287	2	4.643	0.253
Error	1688.197	92	18.350	
Total	1811.472	97	18.675	

To determine the degree of field dependence, the distribution of scores on the Group Embedded Figures Test was divided into four categories. The first group was categorized as field dependent (FD), the second as moderately field dependent (MFD), the third as moderately field independent (MFI) and the fourth as field independent (FI). The norms used to establish these categories were as follows:

Number correct on GEFT	
Field independent	17-18
Moderately field independent	15-16
Moderately field dependent	12-14
Field dependent	0-11

It should be noted that this categorization is applicable only to the subjects in this study. The mean scores and standard deviations are presented in Table 5.

Table 5

Means and Standard Deviations of the Ball Catching Task for Field Dependent and Field Independent Subjects

Group	N	$\bar{x}$	SD
Field independent	25	77.96	13.17
Moderately field independent	28	70.32	18.54
Moderately field dependent	23	74.00	14.07
Field dependent	22	78.00	10.48
Total	98	74.81	14.71

A one-way analysis of variance was calculated to determine if a difference existed between field independent and field dependent subjects' success on the ball catching task. For 3 and 97 degrees of freedom, the F ratio of 1.666 was not significant at the .05 level. The analysis is summarized in Table 6.

Table 6

One-Way Analysis of Variance of Ball Catching Task Utilizing Field Dependence and Field Independence

Source of Variation	SS	df	MS	F
Between groups	1060.336	3	353.445	1.666
Within groups	19930.980	94	212.031	
Total	20911.316	97		

Relationship between Ball Catching Task and Field Dependence

Using the Pearson Product-Moment method of correlation, the relationship between the ball catching task and the Group Embedded Figures Test was assessed. Coefficients were determined for all subjects, males, females, beginner, intermediate and advanced tennis players. The coefficient for males was $r = -0.0800$ which was not significant at the .05 level. While a statistically significant coefficient ($r = -0.2902$) was found for females, it should be noted that the degree of relationship was low. For all subjects combined, a coefficient of $r = -0.1003$ was found. Coefficients of -0.131, 0.0605, and -0.0280 were computed for beginner, intermediate, and advanced players respectively. None of these correlation coefficients was significant at the .05 level. The results are summarized in Table 7.

Table 7

The Relationship between the Ball Catching Task and the Group Embedded Figures Test for All Subjects, Males, Females, Beginner, Intermediate and Advanced Tennis Players

Subjects	N	r
All subjects	98	-0.1003
Sex		
Male	49	-0.0800
Female	49	-0.2902*
Tennis classification		
Beginner	34	-0.1310
Intermediate	34	0.0605
Advanced	30	-0.0280

*Significant at greater than .05 level

Differences in Length of Viewing Time (VT) by Skill Level (L) and by Sex (S)

A three-way repeated ANOVA was used to analyze the dependent variable, length of viewing time, by sex and by skill level. The F ratio of 12.04706 for 2 and 97 degrees of freedom for skill level and the F ratio of 32.01797 for 1 and 97 degrees of freedom for sex were significant at the .05 level. A significant F ratio of 4.7349 for the interaction between level and sex was also found. The mean scores are presented in Table 8 and the summary of the analysis of variance is presented in Table 9.

Table 8

Means and Standard Deviations on the Ball Catching Task for the Five Viewing Time Intervals for All Subjects, Males, Females, Beginner, Intermediate and Advanced Tennis Players

	N	.1	SD	.2	SD	.25	SD	.3	SD	.4	SD
All subjects	98	11.00	4.68	14.15	4.65	15.54	3.94	16.42	4.06	17.68	3.38
Sex											
Females	49	8.63	4.62	12.86	5.49	15.04	4.33	15.06	4.62	16.43	4.07
Males	49	13.33	3.43	15.45	3.19	16.04	3.47	17.78	2.87	18.94	1.83
Tennis classification											
Beginner	34	9.76	4.94	13.47	5.28	13.88	4.45	15.18	4.91	16.38	4.54
Intermediate	34	10.82	4.52	12.79	4.65	15.68	3.32	16.59	3.95	17.97	2.24
Advanced	30	12.53	4.25	16.47	2.81	17.27	3.24	17.63	2.57	18.83	2.39

Table 9

Three-Way Analysis of Variance on the Length of Viewing Time Intervals Utilizing Skill Level and Sex and Viewing Time

Source of Variation	SS	df	MS	F
Level	638.72754	2	319.36377	12.04706*
Sex	848.78638	1	848.78638	32.01797*
Level and sex interaction	251.04614	2	125.52307	4.73499*
Error	2438.89038	92	26.50967	
Viewing time	2559.89917	4	639.97461	60.59682*
Viewing time and level	105.17065	8	13.14633	1.24478
Viewing time and sex	161.97778	4	40.49445	3.83427*
Viewing time x level x sex interaction	59.92748	8	7.48969	0.70917
Error	3886.51880	368	10.56119	

*Significant at the .05 level

The interaction between length of viewing time and skill level was not significant. However, the interaction between length of viewing time and sex was significant at the .05 level. The obtained F ratio was 3.83427 for 4 and 97 degrees of freedom. The interaction between length of viewing time, level of skill and sex had a F ratio of 0.70917 with 8 and 97 degrees of freedom which was not statistically significant.

Where significant F ratios were obtained, the Scheffé test was used to determine which differences were significant. The results presented in Table 10 indicate that a significant difference existed between beginning and advanced tennis players with respect to the length of viewing time.

Table 10

Scheffé Test: Comparison between Length of Viewing Time and Skill Level

Mean in Comparison	df	F
Beginner with intermediate	2/95	0.346715
Beginner with advanced	2/95	2.5342365*
Intermediate with advanced	2/95	1.0114194

*Significant at .05 level, F greater than 3.09.

Summarized in Table 11 are the comparisons between level/sex with length of viewing time. A significant difference was found to exist between female subjects at the beginner and advanced tennis skill levels, between male subjects at the intermediate and advanced tennis skill levels, and between male and female subjects in the beginning stages of tennis.

Table 11

Scheffé Test: Comparison between Level/Sex with Length of Viewing Time

Means in Comparison	df	F
S_1L_1 with S_1L_2	5/93	.7298717
S_1L_1 with S_1L_3	5/93	4.7258017*
S_1L_2 with S_1L_3	5/93	1.8135630
S_2L_1 with S_2L_2	5/93	.9271687
S_2L_1 with S_2L_3	5/93	.1716990
S_2L_2 with S_2L_3	5/93	5.2312931*
S_1L_1 with S_2L_1	5/93	3.3023229*
S_1L_2 with S_2L_2	5/93	.8822789
S_1L_3 with S_2L_3	5/93	.1536220
S_1L_2 with S_2L_3	5/93	1.8135630

*Significant at .05 level, F greater than 2.35

Key: S_1 = Female, S_2 = Male
L_1 = Beginner, L_2 = Intermediate, L_3 = Advanced

The results presented in Table 12 indicate that a significant difference existed between beginning male and female subjects on the .1 second viewing time, between beginning male and female tennis players on the .2 second viewing time, and between intermediate male and female subjects on the .1 second viewing time. None of the other comparisons showed significant differences.

Table 12

Scheffé Test: Comparison between Length of Viewing Time and Sex with Level

Means in Comparison	df	F
Beginning Level		
S_1V_1 with S_2V_1	9/89	4.1637000*
S_1V_2 with S_2V_2	9/89	2.1833589*
S_1V_3 with S_2V_3	9/89	.7129328
S_1V_4 with S_2V_4	9/89	1.3478929
S_1V_5 with S_2V_5	9/89	1.5598414
Intermediate Level		
S_1V_1 with S_2V_1	9/89	2.2885597*
S_1V_2 with S_2V_2	9/89	.4706478
S_1V_3 with S_2V_3	9/89	.0003093
S_1V_4 with S_2V_4	9/89	.9023048
S_1V_5 with S_2V_5	9/89	.1117037
Advanced Level		
S_1V_1 with S_2V_1	9/89	.2749420
S_1V_2 with S_2V_2	9/89	.0056120
S_1V_3 with S_2V_3	9/89	.0000000
S_1V_4 with S_2V_4	9/89	.0592711
S_1V_5 with S_2V_5	9/89	.3819015

*Significant at .05 level, F greater than 2.00

Key: S_1 = Female, S_2 = Male
V_1 = .1 second; V_2 = .2 second, V_3 = .25 second, V_4 = .3 second, V_5 = .4 second

Significant differences between all viewing times existed except in three cases: (1) between 0.2 and 0.25 seconds; (2) between 0.25 and 0.3 seconds; and (3) between 0.3 and 0.4 seconds. The results of the Scheffé test are summarized in Table 13.

Table 13

Scheffé Test: Comparison between Viewing Times

Means in Comparison	df	F
.1 with .2	4/94	11.6813590*
.1 with .25	4/94	24.1317350*
.1 with .3	4/94	34.3105430*
.1 with .4	4/94	52.1318320*
.2 with .25	4/94	2.2338466
.2 with .3	4/94	5.9522326*
.2 with .4	4/94	14.4585280*
.25 with .3	4/94	0.8932404
.25 with .4	4/94	5.3260858*
.3 with .4	4/94	1.8569987

*Significant at .05 level, F greater than 2.47

DISCUSSION

Ball Catching Task

The results of this study indicated a significant difference between males and females in the ball catching task. The mean scores for females were as follows: beginner, 57.47, intermediate, 68.00, and advanced, 80.20; the mean scores for men were: beginner, 80.00, intermediate, 79.71, and advanced, 85.33. Men were more successful at ball catching than were females at all skill levels and at all viewing times.

These findings tend to support Torres' (1966) results although her study dealt with young children and ball catching. There seems to be a sex difference at all age levels in ball catching tasks; females as a group are less successful in ball handling than males. This difference may be due to the enculturation of women who have had less experiences in ball handling skills. When questioning the subjects with regard to other ball skills, it was found that the majority of men had played softball or baseball before they had begun to participate in tennis. Only a few of the women had acquired skills or had past experiences in softball. It is possible that such prior experience may have been responsible for the higher male scores.

When examining the differences between skill levels on the ball catching task, a statistically significant difference was found between all skill levels. The mean scores showed that the beginners' average was 68.74; the intermediates' average, 73.85; and the advanceds' average, 82.77. It is logical to assume that advanced players would be more successful because of their added experience in ball handling skills.

Whiting, et al. (1973) did not find a significant difference between male cricketers and non-cricketers when studying the differences in performance on ball catching. All of Whiting's subjects were males. It could be hypothesized that the non-cricketers had had experiences in other ball sports which could account for the absence of a difference.

A significant interaction between skill levels and the sexes on the ball catching task was present. According to Glass and Stanley (1970) when interaction is ordinal it can be assumed that when one group of subjects scores higher than another group this superiority exists for all of the test results. The following describes the ordinal interaction in this study:

1. Male subjects scored higher on the ball catching task than the female subjects at all skill levels. The mean ball catching task scores for males were 80.00 (beginner), 79.71 (intermediate) and 85.33 (advanced). The mean ball catching task scores for females were 57.47 (beginner), 68.00 (intermediate) and 80.20 (advanced).

2. Advanced tennis players were superior to intermediate tennis players and intermediate tennis players were superior to beginning tennis players.

Field Dependence

The male subjects appeared to have higher mean scores ($\bar{x}$ = 14.31) than the female subjects ($\bar{x}$ = 12.90) on the Group Embedded Figures Test.

However, a significant difference was lacking between the scores of the sexes. This finding is contrary to the findings of Witkins (1950, 1954, 1971), Kreiger (1962) and others who have observed a significant sex difference.

Mayo and Bell (1972) reported no significant sex differences between male and female art students. They were also surprised at their results because their findings were unlike those of previous studies. They speculated that women art students had higher spatial ability than most women. This study utilized as subjects tennis players who are active and rely on spatial ability in order to perform. The results of Kreiger's (1962) study found a relationship between spatial adjustment and perceptual style in tennis players. She found, however, a significant difference between the male and female subjects on figure-ground perception.

No statistically significant difference was found between the skill levels on the Group Embedded Figures Test. The finding is supported by Miller (1960) who studied champions and near champions in several sports and by Williams (1970) who studied highly skilled (classified) and moderately skilled (unclassified) fencers. On the other hand, Barrell and Trippe (1975) found top class tennis players to be more field-dependent than the medium ability tennis players. The mean scores of this study show that the advanced tennis players

($\bar{x}$ = 12.57) tended to be more field dependent than the intermediate tennis players ($\bar{x}$ = 13.53) and the beginning tennis players ($\bar{x}$ = 14.59) although the differences were not sufficient to be significant.

<u>Effects of Field Dependence on the Ball Catching Task</u>

An analysis was calculated to determine if a difference existed between the performance of field dependent and field independent subjects on the ball catching task. Norms were established to determine the degree of field dependence: field independent = 18-17; moderately field independent = 16-15; moderately field dependent = 14-12, and field dependent = 11-0. The norms were used when calculating a one-way ANOVA. Since an insignificant F ratio of 1.666 was found, it could be concluded that no difference existed between the performance of field dependent and field independent subjects on the ball catching task.

Pargman and Inomata (1976), when studying the effects of displaced vision upon a throwing task, found that field-independent subjects were more successful in the ball throwing task than field dependent subjects during visual displacement. No significant difference was found between field dependent and field independent persons during initial and final normal vision conditions in the ball throwing task. Under normal conditions in Pargman and Inomata (1976) and in the present experiment the visual display lacked contrast, making it unnecessary to extract the figure (ball) from the background.

Relationship between the Ball Catching Task and Field Dependence

The results indicated that there was no relationship between scores on the ball catching task and figure-ground perception for all subjects. The homogeneity of the environment may have affected the relationship of the ball to its background. Due to the simplicity of the visual display the viewers had little difficulty in selecting the relevant cues from the visual information.

It appears that the male subjects followed the pattern of the total group in that they were not affected by the environment. Therefore, there was no relationship between the ball catching task and the Group Embedded Figures Test for male subjects.

The women's scores resulted in a slight negative relationship ($r = -0.2902$) which was significant at the .05 level. This may have been caused by women being more affected by the environment and having less skill in the catching task.

The results also indicated that there was not a relationship between scores on the ball catching task and the Group Embedded Figures Test for either the beginning, intermediate or advanced tennis players. Again it appears that the homogeneity of the environment may have affected the relationship of the ball to its background.

Studies that have examined figure-ground perception in relationship to success in skill acquisition or performance have not found a relationship between the two. Pargman, Bender and Deshaies (1975), when studying male and female college varsity basketball players' shooting ability, did not find a significant correlation between visual disembeddness and basketball shooting. They suggested that the ability to disembed a static visual field may not be related to the dynamic visual field. Pargman (1974) did not find a significant relationship between visual disembedding and batting in baseball. It should be noted that these studies did not use perceptual tasks where it was necessary to disembed the figure from the background.

Length of Viewing Time (VT)

The results of this experiment showed that success in catching the ball increased as length of viewing time increased. The mean scores of the 98 subjects were as follows: viewing time of 0.1, 11.00; 0.2, 14.15; 0.25, 15.54; 0.3, 16.42; and 0.4, 17.68. Whiting, Gill, and Stephenson (1970), Nessler (1973), and Whiting, Alderson, and Sanderson (1973) support these findings. The statement often used by tennis instructors, "Keep your eye on the ball," tends to have merit because the longer the subjects viewed the ball the more successful they were in catching.

A statistically significant difference was found between males and females and between the skill level of the tennis players' catching success and length of viewing time. When examining where the differences did exist, the Scheffé test of multiple comparisons was used. The Scheffé test is a very conservative post hoc test; therefore, the significant differences may not be indicated because of its ultra conservatism. For example, the F ratio of 2.5342 between the beginning and advanced tennis players did not exceed the required F of greater than 3.09 at the .05 level of significance. The significant difference did exist between beginning and advanced tennis players on the five viewing times. The advanced tennis players will be more skillful in the ball catching task at all viewing times than beginning tennis players because of their greater experience in tennis.

When examining the differences between level and sex with the length of viewing time, a significant difference was found to exist: (1) between female subjects at the beginning and advanced tennis skill levels, (2) between male subjects at the intermediate and advanced tennis skill levels, and (3) between male and female subjects at the beginning level of tennis. This may be due to the greater experience of the advanced tennis players and their ability to concentrate on watching the ball. That male beginning tennis players had more experience than females in observing the reactions of balls was indicated from their past experience with other ball activities.

Several differences existed between sex and skill with specific lengths of viewing time. Differences were found between beginning male and female tennis players at 0.1 viewing time, between beginning male and female players at 0.2 viewing time and between intermediate male and female players at 0.1 viewing time. Again this may be due to male tennis players having had past experiences with other ball activities prior to their participation in the sport of tennis.

When examining the differences between the five viewing times, the results of this experiment showed that there were statistically significant differences between the following viewing times: 0.1 with

0.2, 0.1 with 0.25, 0.1 with 0.3, 0.1 with 0.4, 0.2 with 0.3, 0.2 with 0.4, and 0.25 with 0.4 seconds. Significant differences were lacking between 0.2 and 0.25, 0.25 and 0.3, and 0.3 with 0.4 seconds. The lack of significance for these viewing times may be attributed to the ability of the subjects to predict the flight of the ball from auditory cues derived from the ball release and to learning. Some of the subjects stated they would "get set" for the ball by focusing the eyes on the area where they expected the light to flash and would place their hand in a ready position to catch the ball.

Whiting (1970), using six light conditions (0.1, 0.15, 0.2, 0.25, 0.3, and 0.4 seconds) found a significant difference between all viewing times except between 0.1 and 0.15 seconds and 0.15 and 0.2 seconds. In the present study 0.15 seconds was not used. Whiting (1970) speculated that the lack of significance between the catches at 0.1 and 0.15 and 0.15 and 0.2 seconds may have been due to the time period being shorter than a perceptual moment. Stroud (1955) estimated that a perceptual moment occurred between .05 and 0.2 seconds. Kay (1957) suggested that a person could predict the action of the ball from early information received and that additional information was redundant. These theories could apply to the present experiment since the lack of significance was for times which were longer than the estimated perceptual moment (.05-.2 second); therefore, additional information (beyond 0.2 seconds) was redundant.

Nessler (1973) found a significant difference among all viewing conditions (.5, .4, .3, .25, .2 seconds). Whiting, Alderson and

Sanderson (1973), using four view conditions (100, 150, 225 and 300 milliseconds) also found all viewing conditions to be significant.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

The purpose of this study was to determine the relationship between figure-ground perception and viewing time in a ball catching task. The investigator hypothesized that a significant positive relationship would be found between figure-ground perception and viewing time for successful catches in a ball catching task. The sub-problems investigated differences between male and female tennis players of beginning, intermediate and advanced skill levels on the ball catching task, figure-ground perception and the length of viewing time.

A total of 98 college students (49 males and 49 females) from five tennis classes at the University of Nebraska-Lincoln, both men's and women's University of Nebraska-Lincoln tennis teams and the Nebraska Wesleyan University women's tennis team volunteered to participate as subjects. Age of the subjects was from 18 to 28 years. Subjects were divided into three groups according to their tennis skill levels: (1) beginner (17 male and 17 female), (2) intermediate (17 male and 17 female), and (3) advanced (15 male and 15 female). The non-varsity tennis players were given the Hewitt Revision of the Dyer Backboard Test to determine their skill classification. The varsity tennis players were subjectively classified by observation of their playing ability and team ranking into either the intermediate or the advanced category.

To determine field dependence, the Group Embedded Figures Test (GEFT) was administered at five different times to accommodate the subjects. If a subject could not attend one of the five meetings, he/she was tested in a small group or individually. The Group Embedded Figures Test is scored by the total number of simple forms correctly traced. The highest possible score is 18. To determine the degree of field dependence, the distribution was divided into four parts. The groups thus formed were defined as follows: field independent, scores of 18-17; moderately field independent, scores of 16-15; moderately field dependent, scores of 14-12; and field dependent, scores of 11 or below.

The ball catching task was administered individually to each subject. The objective of the task was to catch the projected ball with one hand under five different lighting conditions. The light exposures were set at 0.1, 0.2, 0.25, 0.3 and 0.4 seconds. The presentation of the light intervals was randomized to counterbalance the residual effects. One trial consisted of 20 balls, preceded by three practice balls at a specific light interval. This sub-score was designated the viewing time score (VT). The ball catching score consisted of the total of the sub-scores for each of the five trials. The highest possible ball catching score (BCT) was 100.

The Statistical Package for Social Sciences (SPSS) Computer Program was utilized to compute the Pearson Product-Moment correlation, one-way ANOVA, two-way ANOVA and Scheffé's post hoc test. A second statistical package used was Biomedical Computer Program P-Series (BMDP2V-analysis of variance and covariance, including repeated measures). Significant F ratios were subjected to the Scheffé test to determine where the differences existed. The alpha level of significance was set at .05.

The data were statistically analyzed through the application of the Pearson correlation, the analysis of variance technique and the Scheffé test. The dependent variables of the Group Embedded Figures Test and the ball catching task were subjected to separate analysis of variance with sex, skill level and the length of viewing times as the independent variables.

Results indicated there was not a significant relationship between figure-ground perception and viewing time in the ball catching task used in this study. There was not a statistically significant difference between males and females or between tennis skill levels on the Group Embedded Figures Test. On the other hand, significant differences did exist between the sexes on the ball catching task as well as between skill levels. When examining the effects of the length of viewing time, a significant difference existed both between the sexes and between the skill levels. Significant differences were found between the following viewing times: 0.1 and 0.2 seconds, 0.1 and 0.25 seconds, 0.1 and 0.3 seconds, 0.1 and 0.4 seconds, 0.2 and 0.3 seconds, 0.2 and 0.4 seconds and 0.25 and 0.4 seconds.

CONCLUSIONS

Within the limitations of this study and from the analysis of the data collected the following conclusions may be drawn:

1. There is no relationship between the ball catching task and figure-ground perception in all subjects.

2. Male and female tennis players do not differ in figure-ground perception as assessed by the Group Embedded Figures Test.

3. There is no difference between the performance of field dependent and field independent subjects on the ball catching task.

4. Male subjects are more successful at ball catching than are female subjects at all skill levels and at all viewing times.

5. The ball catching task does distinguish between skill levels (advanced > beginners).

6. Success in catching the ball increases as length of viewing time increases.

RECOMMENDATIONS

As a result of this study the following recommendations are suggested for further research.

1. Conduct a study using the ball catching task with a variegated background and the Embedded Figures Test with male and female beginning, intermediate and advanced tennis players.

2. Repeat this experiment using a dynamic method of assessing figure-ground perception (rod and frame).

3. Repeat this experiment decreasing the lengths of viewing times in the ball catching task.

4. Investigate the learning effect of viewing time on a ball catching task at various age levels, elementary, secondary and college students.

5. Investigate the relationship of viewing time in a ball catching task to reaction time, to movement time and to anticipation response.

6. Investigate the perceptual style of male and female advanced tennis players.

7. Develop procedures to study the selection of relevant cues in the sport of tennis as related to the subjects' perceptual style.

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APPENDIX A

Informed Consent Form

Informed Consent Form

Subject No. ______

The Relationships Between Figure-Ground
Perception and Viewing Time in a Ball Catching Task

I have been informed of the research procedures and methods of this experiment. I understand I will take two tests:

1. Group Embedded Figures Test is a perceptual test which determines field dependence.
2. Ball Catching Task tests the catching ability of the subject under five light conditions.

I am interested and willing to volunteer to be a participant in this experiment.

Signature ____________________

Present Address ____________________

Telephone ____________________

Age __________ Sex __________

Tennis classification score __________: B I A

Embedded Figures Score __________: D I

Ball Task Scores: .1___ .2___ .25___ .3___ .4___ Total ____

Order of Presentation: ____ ____ ____ ____ ____

APPENDIX B

Hewitt Revision of the Dyer Backboard Tennis Test

Hewitt Revision of the Dyer Backboard Tennis Test*

Purpose: Classification

Equipment and Materials:

A wall 20 feet high and 20 feet wide is needed.
Tennis racket, stop watch, a basket with at least a dozen new tennis balls.
Masking tape for marking lines.
A line one inch wide is marked on the wall at a height of three feet and 20 feet long to simulate the net. A restraining line 20 feet long and one inch wide is marked 20 feet from the wall.

Directions:

The subject starts with two tennis balls behind the 20 foot restraining line, and serves the ball against the wall. Any type of serve may be used. The watch is started when the served ball hits above the net line on the wall. The subject then rallies from behind the restraining line against the wall using any type of stroke. If the ball should get away from the student, he may take another ball from the basket. However, each time he takes a new ball, it must be started with a serve again. The hitting continues for 30 seconds. (One 15 second trial practice is given.) Three trials are given.

Scoring:

One point is counted for each time the ball hits above the three foot net line. No score is counted when the subject steps over the restraining line or for balls that hit below the net line. Balls that hit the line are counted. The average of the three trials is the score.

**Norms:

High-Good 21-30   Middle-Average 11-20   Low-Poor 5-10

*Research Quarterly, 1965, 36, 153-157.
**Research Quarterly, 1968, 39, 552-555.

APPENDIX C

Tennis Score Card

Tennis Score Card

TENNIS CLASSIFICATION TEST
Name ____________________
Address _________________
Telephone _______________
Tennis Class ____________
Grade: Fr. So. Jr. Sr. Gr.
TENNIS SCORE
Trial 1 _________________
Trial 2 _________________
Trial 3 _________________
Total score _____________
Average _________________
Classification:
Beg. Int. Advanced

APPENDIX D

Directions for the Group Embedded Figures Test

Directions for the Group Embedded Figures Test

Examiner says: Please fill in the information on the cover page, your name, sex, today's date, and birth date.

E says: Now start reading the directions, which include two practice problems for you to do. When you get to the end of the directions on page 3, please stop. Do not go beyond page 3.

(Stop tape; wait until everyone is finished.)

E says: Before I give the signal to start, let me review the points to keep in mind.

1. Look back at the simple forms as often as necessary.

2. ERASE ALL MISTAKES.

3. Do the problems in order. Don't skip a problem unless you are absolutely "stuck" on it.

4. Trace ONLY ONE SIMPLE FORM IN EACH PROBLEM. You may see more than one, but just trace one of them. (Pause)

   Turn now, to the back cover of your test booklet and examine the eight simple forms. (Pause)

5. The simple form is always present in the complex figure in the SAME SIZE, the SAME PROPORTIONS, and FACING IN THE SAME DIRECTION as it appears on the back cover of this booklet.

6. Trace all lines of the simple form. Examine Form "E." Include all the inner lines of the cube.

7. Be sure to erase all incorrect lines if you make an error.

Are there any questions about the directions? (E should pause to allow questions.) Raise your hand if you need a new pencil during the test.

E then says: When I give the signal, turn the page and start the first section. You will have two minutes for the seven problems in the first section. Stop when you reach the end of this section. Go ahead!

(Time: 2:00 minutes)

After two minutes
E says: STOP--Whether you have finished or not. When I give the signal, turn the page and start the second section. You will have five minutes for the nine problems in the second section. You may not finish all of them, but work as quickly and accurately as you can. Raise your hand if you need a new pencil during the test. Ready, go ahead.

(Time: 5:00 minutes)

After five minutes
E says: STOP--Whether you have finished or not. When I give the signal, turn the page and start the third section. You will have five minutes for the nine problems in the third section. Raise your hand if you need a new pencil during the test. Ready, go ahead.

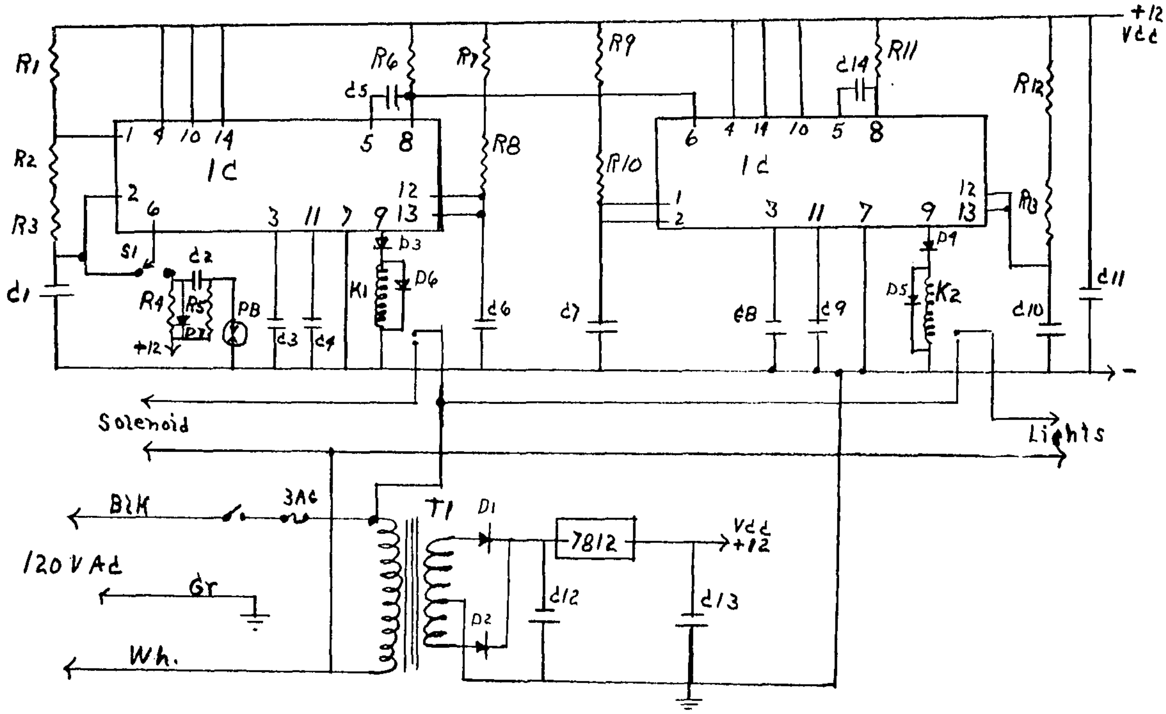
(Time: 5:00 minutes)

After five minutes
E says: STOP--Whether you have finished or not. Please close your test booklets. The test is over. Thank you for your help.

APPENDIX E

Electrical Diagram of Control Console

Electrical Diagram of Control Console



R1 – 4.7K
R2 – 680.K
R3 – 3 m. pot
R4 – 47K
R5 – 2.7K
R6 – 33K
R7 – 270K
R8 – 100K
R9 – 250K
R10 – 500K
R11 – 33K
R12 – 82K
R13 – 500K

C1 – 3.mfd (tant.)
C2 – .01 mfd (cer.)
C3 – .01 mfd (cer.)
C4 – " " "
C5 – .001 " "
C6 – 1 mfd (tant.)
C7 – 1 mfd (tant.)
C8 – .01 " (cer.)
C9 – .01 " "
C10 – 1. mfd (tant.)
C11 – .1 mfd (cer.)
C12 – 1000 mfd
C13 – 1000 mfd
C14 – .001 mfd (cer.)

S1 - man/auto. switch
PB - man. reset
T1 – Triad F54X transformer
D1-D2-D3-D4 — 1N5624
D5-D6 - 1N914 – D7 - 1N914
K1-K2 — PB 27E125 Relay
7812 – MC7812CP Regulator
3AG – 3A. Fuse
IC – 556 integrated circuit

R3 – Rate control
R8 – Ball drop (adj.)
R9 – calibrate adj.

R10 – Flight Exposure control
R13 – Light Exposure control

APPENDIX F

Appointment Card

Appointment Card

Ball Catching Task Appointment You are requested to return for an appointment at ________ M, on ________________________, 1977. Come to Room 16 Coliseum Elizabeth Petrakis Examiner

APPENDIX G

Ball Catching Task
Score Sheet

Ball Catching Task
Score Sheet

NAME ______________________ COMMENTS ______________________

Time						Total
Score						

NAME ______________________ COMMENTS ______________________

Time						Total
Score						

NAME ______________________ COMMENTS ______________________

Time						Total
Score						

NAME ______________________ COMMENTS ______________________

Time						Total
Score						

NAME ______________________ COMMENTS ______________________

Time						Total
Score						

APPENDIX H

Directions for the Ball Catching Task

Directions for the Ball Catching Task

E: Please stand on the center of the target and face the throwing equipment. Notice that the balls will drop from the machine, bounce on the racket and rebound to you. Your task is to catch the ball with one hand and place it in the cart. If you miss the ball, let it go; do not recover it. In a minute you will try a practice trial with the lights on. On the command, "ready" a tennis ball will be projected to you. Do you have any questions? Let's go through the practice trial. "Ready."

(Go through the practice trial projecting ten balls, the examiner watching how the subject is catching the balls.)

E: Would you please place the balls in the pail while I reload the machine? Now the room will be darkened. Notice the light behind you. The light is set to go off at a certain time for a certain duration. Your task will be to catch the ball with one hand as you did during the practice. The test will be given five times under different viewing conditions. Before each trial, you will be given three practice balls. During the practice, if you catch the ball, drop it on the floor. When the test begins, catch the ball with one hand and place it in the cart. Your score will be the number of balls in the cart. The command "Ready" will be given during the three practice trials. The command, "The test will begin, Ready?" will be given before the test starts. Do you have any questions?

Test I Begins

E: Ready for the three practice balls? Make sure you catch the ball with one hand and drop it on the floor. Ready?

(Give three practice balls)

E: Now the test will begin. Ready?

(Give twenty test balls)

E: Please count the number of balls in the cart. What is your score? Please pick up the balls and place them in the pail. There should be 23 balls.

(E reloads the throwing machine and records the score.)

Test II Begins

E: Are you ready for the three practice balls? Make sure you catch the ball with one hand and drop it on the floor. Ready?

(Give three practice balls)

E: Now the test will begin. Ready?

(Give twenty test balls)

These procedures were followed for the remaining trials.

APPENDIX I

Raw Data

Raw Data

Subject	Sex	Age	GEFT	.1	.2	.25	.3	.4	BCT	Presentation of VT
101	1	20	16	12	07	13	19	16	67	2 3 5 1 4
102	1	19	14	05	13	15	17	17	67	1 4 2 3 5
103	1	18	12	11	17	18	16	18	80	4 2 3 1 5
104	1	20	14	10	13	10	16	20	69	3 1 2 4 5
105	1	19	13	10	19	20	20	20	89	5 1 2 4 3
106	1	19	15	02	01	05	10	01	19	2 4 5 1 3
107	1	19	16	04	06	11	05	07	33	2 4 1 3 5
108	1	19	18	03	10	10	12	18	53	1 2 5 4 3
109	1	19	16	06	06	05	07	15	39	3 4 5 1 2
110	1	20	14	04	17	17	17	17	72	1 4 5 3 2
111	1	25	18	02	03	13	06	08	32	1 4 5 2 3
112	1	19	12	09	14	05	20	16	64	3 5 2 4 1
113	1	19	14	07	11	11	03	09	43	4 5 3 1 2
114	1	21	05	03	10	17	15	17	62	1 5 2 4 3
115	1	19	16	10	16	11	14	13	64	5 4 3 1 2
116	1	22	14	07	20	19	20	20	86	1 3 4 5 2
117	1	21	14	03	04	12	08	11	38	1 4 5 2 3
118	2	18	14	10	15	13	19	20	77	1 4 2 3 5
119	2	25	16	08	19	20	18	20	85	4 3 2 5 1
120	2	18	18	16	18	16	15	17	82	5 4 3 2 1
121	2	22	16	13	08	16	15	16	68	2 5 1 3 4
122	2	19	14	15	14	12	13	17	71	3 4 2 5 1
123	2	19	17	18	15	20	15	16	84	4 2 3 1 5
124	2	21	17	12	10	11	20	18	71	2 3 1 4 5
125	2	20	18	09	18	18	19	18	82	1 5 4 2 3
126	2	20	16	08	16	17	18	20	79	1 2 4 3 5
127	2	19	09	13	18	16	10	20	77	4 5 3 2 1
128	2	18	17	08	14	05	13	20	60	2 4 1 3 5
129	2	22	09	17	20	17	20	13	87	5 4 3 1 2
130	2	25	16	12	19	17	20	20	88	1 3 4 5 2
131	2	20	13	13	17	13	18	19	80	3 5 2 4 1
132	2	21	16	15	19	19	19	20	92	1 4 3 2 5
133	2	20	14	20	14	15	20	20	89	3 2 5 4 1
134	2	22	15	17	17	15	19	20	88	3 2 4 1 5

Level 1 = Beginner
2 = Intermediate
3 = Advanced

Sex 1 = Female
2 = Male

Presentation of VT
1 = .1
2 = .2
3 = .25
4 = .3
5 = .4

Subject	Sex	Age	GEFT	.1	.2	.25	.3	.4	BCT	Presentation of VT
201	1	21	15	12	06	09	14	15	56	2 3 4 5 1
202	1	23	16	10	14	14	04	15	57	4 1 5 3 2
203	1	21	11	04	16	19	16	20	75	4 3 2 5 1
204	1	22	16	12	16	14	18	19	79	2 5 4 1 3
205	1	20	09	08	10	17	19	19	73	2 5 1 3 4
206	1	19	12	15	11	18	19	15	78	5 2 4 1 3
207	1	19	16	15	20	20	20	18	93	5 3 2 4 1
208	1	20	08	10	16	17	11	12	66	4 1 5 2 3
209	1	19	12	07	10	10	12	15	54	2 3 4 1 5
210	1	22	10	08	09	17	19	18	71	2 1 3 5 4
211	1	20	16	02	00	17	18	20	57	2 1 3 5 4
212	1	20	06	13	12	18	19	19	81	3 5 1 4 2
213	1	18	11	06	19	11	15	19	70	4 1 3 5 2
214	1	18	13	03	17	15	19	17	71	5 1 3 4 2
215	1	18	10	01	11	19	10	18	59	4 2 3 1 5
216	1	18	15	09	08	14	10	17	58	2 4 1 3 5
217	1	19	15	06	03	17	12	20	58	2 1 4 5 3
220	2	21	17	08	11	18	12	20	69	4 1 5 2 3
221	2	19	18	15	11	19	20	18	83	5 2 3 4 1
222	2	22	16	15	10	06	14	19	64	3 5 4 2 1
223	2	20	18	17	17	15	19	20	88	5 4 2 1 3
224	2	25	15	12	15	14	18	17	76	2 3 5 1 4
225	2	23	02	16	16	16	20	18	86	3 2 4 1 5
226	2	22	16	14	20	17	20	19	90	3 2 1 5 4
227	2	20	02	12	12	10	20	20	74	3 2 5 1 4
228	2	20	17	12	09	18	20	19	78	2 5 1 3 4
229	2	20	17	17	15	15	15	20	82	4 2 5 1 3
230	2	24	16	16	16	14	19	19	84	3 5 4 2 1
231	2	20	14	14	17	18	18	20	87	3 4 2 5 1
232	2	22	18	11	12	18	20	14	75	5 3 2 1 4
233	2	21	16	11	09	20	20	19	79	2 1 5 4 3
234	2	25	15	06	18	14	16	13	67	1 5 4 3 2
235	2	19	14	14	17	17	20	20	88	2 1 5 3 4
236	2	26	18	17	12	18	18	20	85	4 2 3 5 1
301	1	17	17	09	14	18	14	20	75	4 5 1 2 3
302	1	18	10	05	14	10	16	20	65	3 1 2 4 5
303	1	22	08	13	17	20	17	20	87	4 2 5 1 3
304	1	19	13	07	20	09	16	20	72	3 4 5 1 2
305	1	19	13	12	17	19	18	12	79	5 1 4 2 3
306	1	20	07	19	19	19	19	20	96	5 1 4 2 3
307	1	22	17	05	18	20	14	18	75	1 4 2 5 3
308	1	26	00	17	19	19	16	17	88	5 4 2 3 1
309	1	18	14	11	19	20	19	19	88	1 5 4 2 3
310	1	20	16	18	14	17	17	20	86	2 3 4 1 5
311	1	20	16	15	09	15	19	19	77	2 3 1 4 5
312	1	22	17	11	19	20	17	19	86	4 1 3 2 5

Subject	Sex	Age	GEFT	.1	.2	.25	.3	.4	BCT	Presentation of VT
313	1	23	18	07	20	19	19	17	82	5 4 1 3 2
314	1	18	12	17	11	15	17	14	74	5 2 4 1 3
315	1	19	02	08	15	19	20	11	73	5 3 1 2 4
316	2	20	18	09	18	17	20	19	83	1 3 2 4 5
317	2	23	17	16	14	18	19	20	87	2 1 3 4 5
318	2	20	17	15	16	20	20	20	91	1 2 4 5 3
319	2	19	09	11	15	13	19	20	78	3 5 2 1 4
320	2	28	18	14	17	19	20	20	90	5 3 2 1 4
321	2	19	08	15	14	19	20	20	88	2 1 5 3 4
322	2	19	08	14	19	20	20	20	93	1 4 2 5 3
323	2	23	17	17	16	19	17	20	89	4 5 1 2 3
324	2	19	04	09	14	12	20	20	75	3 4 1 5 2
325	2	22	01	15	19	20	18	20	92	5 2 1 4 3
326	2	19	16	15	19	16	09	20	79	4 3 1 5 2
327	2	21	16	15	13	20	19	20	87	2 4 3 5 1
328	2	19	13	13	18	17	13	20	81	4 3 1 5 2
329	2	18	18	19	17	11	17	20	84	3 4 5 1 2
330	2	18	17	05	20	18	20	20	83	1 5 2 3 4