AN INVESTIGATION OF THE PREDICTION OF SUCCESS IN WOMEN'S FIELD HOCKEY

by

Nancy L. Chapman

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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

Committee Members Sarah M. Robinson

Rosemary McGee

[signature]

[signature]

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The purpose of this study was to determine what, if any, predictive qualities could be identified in a group of skilled women field hockey players. The specific areas investigated were anxiety, visual perception, manual dexterity, ball control, and dynamic balance. Years of experience and playing position served as a secondary focus in the study.

A total of 106 women field hockey players served as subjects. They were grouped according to the level of selection each achieved as a participant in the international selection and training camps sponsored by the United States Field Hockey Association during the summer of 1978. Players who entered one of the Level C camps (Lancaster, Pennsylvania) but were not selected to participate at the Level B camp (State College, Pennsylvania) were classified as the least successful group of skilled players. Those players who were selected from the Level B camp to participate in Level A camp were identified as the most successful group of field hockey players.

The results from five tests, selected on the basis of a pilot study, supplied the data for analysis. The Sports Competition Anxiety Test (SCAT), a brief paper-and pencil test, provided an anxiety measure. A modified

version of Herkowitz's Moving Embedded Figures Test (MEFT) was used to assess visual perception. Manual dexterity was determined by the Two-Hand Turning and Placing Test of the Minnesota Rate of Manipulation Test (MRMT). The Chapman Ball Control Test (CBCT), a test designed by the investigator, was employed to assess skill in stickwork. Dynamic balance was measured by the Scott Sideward Leap Test (SSLT).

The Statistical Package for Social Sciences (SPSS) Computer Programs was utilized to compute a multiple discriminant function analysis to identify those variables which discriminated between the groups of selected camp participants. A second subprogram of the SPSS, a one-way analysis of variance, was employed to assess the differences between groups of players according to their playing positions. The Sheffé post hoc test was applied when a significant F ratio indicated that differences existed. The Pearson correlation technique was utilized to determine the relationship between some selected predictor variables. The alpha level of significance was set at .05 for all data in the study.

Results indicated that dynamic balance, ball control, and anxiety were the discriminating variables for the groups of selected women field hockey players. Visual perception and manual dexterity, as measured in this study, did not discriminate between successful and less successful field

hockey players. Years of playing experience was not an important factor in group classification. Significant differences did exist between ball control skills of goalies and field players. Classification of subjects determined by the stepwise discriminant function analysis indicated that on the basis of the three discriminating variables correct group membership could be predicted 78.95 percent of the time, provided the goalies' ball control skills were analyzed separately from those of the forwards and backs.

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CHAPTER I

INTRODUCTION

The recent widespread opportunity for girls and women to participate in sports has greatly increased the number of sports participants. This increase in numbers of participants enhances the difficulty one faces as a coach in the task of player discrimination for the purpose of team selection. The highly competitive programs that culminate with championship tournaments in our high schools and colleges imply an emphasis on excellence and compound the problem of player selection.

It is believed that sports competition offers unique experiences to those who participate, and opportunities for these are usually of high regard. The outcome of player selection could have long-lasting effects on individuals who aspire to become involved. Thus, the coach, in the role of player selector, becomes highly accountable to those desirous of competitive sport experiences.

While the superior athlete is easily detected, others who will comprise the team are not so readily identified. Often, this latter group of players possess varying levels of skill and previous experiences. In some parts of the country, it is not atypical to find persons desirous of learning a new sport at the college level.

Thus, it behooves the coach to make decisions on the basis of observable individual differences, as well as to speculate on individual potentiality. In a sport such as field hockey, where eleven individuals must mold together to perform well during the short preseason period, little time is provided for long deliberations over decisions on player selection.

Successful performance in sports is dependent upon a number of underlying dimensions of human behavior. In the team sport of field hockey, complexity of the sport environment becomes an additional factor that can contribute to a player's effectiveness. Research is limited, however, in determining the specific attributes a field hockey player should possess.

It has been assumed that the most valid measure of total playing ability in a team sport is the judgment of several qualified persons (Baumgartner & Jackson, 1975, p. 232). Safrit (1973) states that in some situations, tests are used to determine initial team membership of an athletic squad but such tests are usually supplemented by the coach's subjective judgment. Although the prediction of final performance from predictive test batteries has been unsuccessful to date, Schmidt (1975) states that a need exists for test batteries that can be administered before training that are predictive of performance after training. With our understanding of human performance, it

should be possible to identify specific factors that contribute most toward effective play.

Statement of the Problem

The purpose of this study was to determine what, if any, predictive qualities could be identified in a group of skilled women field hockey players. In the attempt to make this identification, groups of players selected for participation in the various levels of international training camps for field hockey were compared according to their performance on five tests. The specific areas of performance investigated were: (1) visual perception, (2) anxiety, and (3) the selected physical qualities of dynamic balance and manipulative skills.

Definition of Terms

Prediction - To foretell or know the outcome of a happening or an event prior to its occurrence.

Selection - A process employed by a group or an individual for the purpose of identifying specific persons to constitute a team.

Anxiety - ". . . a pervasive apprehension of threat of danger" (Harriman, 1966, p. 12).

State Anxiety - ". . . the emotional response that is evoked in an individual who perceives a particular situation as personally dangerous or frightening for him, irrespective of the presence or absence of a real

[objective] danger" (Spielberger, 1971, p. 267). Literature in psychology refers to state anxiety as A-state.

Trait Anxiety - "A motive or acquired behavioral disposition that predisposes an individual to perceive a wide range of objectively non-dangerous circumstances as threatening, and to respond to these with state anxiety reactions disproportioned in intensity to the magnitude of the objective danger" (Spielberger, 1966b, p. 17). Literature in psychology refers to trait anxiety as A-trait.

Competitive Trait Anxiety - ". . . a tendency to perceive competitive situations as threatening and to respond to these situations with feelings of apprehension or tension" (Martens, 1977, p. 23).

Perception - ". . . the organism's maintenance of contact with its environment, its internal state, and its postures and movement" (Day, 1969, p. 1).

Visual Perception - ". . . the capacity to interpret or give meaning to what is seen" (Butenica, 1968, p. 16).

Figure-Ground Perception - ". . . 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 & Wurzburg, 1972, p. 376).

Dynamic Balance - ". . . the type of balance that is concerned in keeping one's equilibrium in motion, or

while changing from one balanced position to another" (Bass, 1939, p. 33).

Manipulative Skills - Abilities requiring the coordination of eye, hand, and arm movements for the purpose of maneuvering one or more objects.

United States Field Hockey Association - An organization that promotes women's field hockey, and that has been designated by the United States Olympic Committee as the sports-governing body responsible for the development and control of women's amateur international participation for this country.

Level A Camp - The highest level of international selection and training camps sponsored by the United States Field Hockey Association, July 18-25, 1978, at Pennsylvania State University, State College, Pennsylvania. The number of players selected to attend this camp was 52.

Level B Camp - The intermediate level camp sponsored by the United States Field Hockey Association in its international selection and training camp program. This camp was held July 9-16, 1978, at Pennsylvania State University, State College, Pennsylvania and was opened to nearly 90 players, 60 of whom were selected from the various Level C camps held around the country. The remainder of the group was comprised of those previously selected and trained as international level players.

Level C Camp - The lowest level of camps sponsored by the United States Field Hockey Association in its international selection and training camp program. There were five Level C campsites located throughout the country, each open to approximately 60 women field hockey players who were desirous of becoming international players. These camps were held June 28-July 7, 1978.

Significance of the Study

The significance of this study lies in the possible identification of some specific performance qualities that may lead to the prediction of success in play in the sport of field hockey. Identification of these qualities could allow for a more objective means of player selection for team participation. Finally, should it be possible to predict the success of field hockey players as determined by outcomes of these prescribed tests, it might also be possible to detect players who possess the potential for high level development regardless of whether or not they may have had prior experience in the sport.

CHAPTER II

REVIEW OF RELATED LITERATURE

This review of literature is presented in two parts. Part I is concerned with studies related to the prediction of success in sports performance. Part II includes information more specifically related to this investigation. Attention is given to the areas of performance being studied, and the means by which these areas have been researched.

Prediction in Sports Performance

Included in the research pertaining to the prediction of success in sports are studies conducted for the purpose of identifying common relationships or the making of comparisons between various performance elements in physical activity. The first section of this review is limited to those studies that specifically purport to predict success in a particular sport or group of sports through: (1) their title, (2) their purpose, or (3) their treatment and analysis of the data.

Most prevalent in the literature in the prediction area are studies involving men's team sports, particularly basketball. Seven studies were reviewed in this category. Four investigators (Edgren, 1932; Boyd et al., 1955;

Stroup, 1957; Plinke, 1966), centered their research on college-age male performers while the other three (Pierce, 1961; Ellenburg, 1970; Childress, 1972) tested high school varsity players. All seven studies included basketball type performance tests and general ability tests. Height was a variable in the studies of Pierce (1961), Ellenburg (1970), Plinke (1966), and Childress (1972). Both height and weight were measures included by Pierce (1961), Ellenburg (1970), and Childress (1972). In addition, Pierce (1961) and Ellenburg (1970) included age as a variable, and Childress (1972) measured hand span of his subjects.

Edgren (1932), the earliest of the researchers, found a high correlation between individual and total basketball playing ability and such general ability tests as speed, agility, coordination and endurance. This finding supported Edgren's belief that general ability tests serve as a good predictive measure for potential playing ability.

Boyd et al. (1955) administered the Knox Basketball Test to determine its validity as a predictor of basketball ability. The Knox battery consists of four tests: (1) speed dribble, (2) wall bounce, (3) dribble and shoot, and (4) "penny-cup" test. Five items: (1) Knox Basketball Test, (2) coaches' preseason rankings, (3) coaches' post-season rankings, (4) average number of minutes played per

game, and (5) total points compared with number of minutes played, served as the five variables that were correlated using the rank correlation technique. While the Knox Basketball Test appeared to be a predictor for basketball squad membership, statistical evidence of the test's capability to distinguish between levels of ability among team members was lacking.

Pierce (1961) used a pilot study to determine the test items to be included in his study. Reducing the original 20 test items to ten, and then combining those with five personal factors which included grade level and number of years of experience, he developed a Basketball Classification Index (BCI). A composite score was computed by ranking from one to ten, a boy's score on each of the 15 variables with his other nine teammates' scores. Each boy's rank values were totaled to determine his BCI, a score which could range from 15 to 150. Predictions were made from the BCI scores. The coach's selection of first and second squads was the validating criteria. It was found that boys with the lowest scores on the BCI were those who were selected as the first team members in 85.6 percent of the cases. The researcher emphasized that there was also a need to measure an athlete's desire, determination, and team value.

Plinke (1966) classified subjects according to one of two height categories, under 6 feet or 6 feet and over.

Existing tests which measured agility, balance, coordination, jumping power, quickness, speed, and touch were identified. Sixteen tests were selected from those developed by other investigators, through a process defined as logical analysis. After all raw scores had been transformed to T scores, these were summed to produce a composite T score. Multiple regression techniques were employed using this composite T score as the criterion. As a result of a stepwise regression analysis, a three-item battery was determined for each classification.

Ellenburg (1970) also utilized the multiple regression techniques to formulate a five-item battery. He concluded that the half-minute shooting test used in the study was the most reliable predictor for performance. The researcher admitted that one of the weaknesses of the test was that it did not measure such factors as determination, desire and leadership.

Stroup (1957) also designed a five-item battery of basketball tests. The items were selected from previous batteries. In addition, he measured the subject's binocular vision in the temperal meridian to a maximum range of 220^{o}. The instructor's rating of the subject's basketball ability served as the criterion for comparison with the five-item battery and the field of motion test. Correlation coefficients were significant at the .01 level between each of the five items and the ability ratings;

however, the correlation between the motion perception score and the ability ratings was significant only at the 10 percent level. Multiple correlation coefficients were computed from Betas derived by the Doolittle method as tests were combined. Results suggested that if more precise basketball prediction tests are to be constructed, performance items with low intercorrelation plus items measuring attributes other than physical skill will need to be included. Stroup concluded that although the field of motion test made a relatively high contribution to the forecast efficiency of the test battery, it was a variable that was difficult to measure reliably.

Childress (1972) attempted to determine through factor analysis whether test items could be identified that would best measure selected physical components of high school basketball players. And, if so, whether the technique of functional discriminate analysis would combine such test items to classify basketball players into two populations identified as successful or unsuccessful. Prior to the administration of the 24 selected test items, coaches of the players who were to serve as subjects subjectively evaluated each boy's seasonal performance and categorized him as successful or unsuccessful. The intercorrelations of the 24 experimental variables were factor analyzed according to the principal axes method with a varimax criterion for rotation. This process determined

the test items which best measured the selected physical components of high school basketball-playing ability. A discriminant function was constructed through the use of the seven test items loading highest on each of the rotated factors as independent variables. A second discriminant function was comprised of those test items identified as the most practical for use at the high school level and which significantly discriminated between successful and unsuccessful groups. When compared with coaches' classification of successful or unsuccessful, the seven factors correctly placed 74.6 percent of the subjects classified as successful basketball players and 68.1 percent of those classified as unsuccessful. The second discriminant function constructed of test items most appropriate for practical use at the high school level correctly placed 76.27 percent of the subjects classified as successful and 72.34 percent of those classified as unsuccessful. It was suggested that future factor analytic studies be conducted to determine the unaccountable variance through the investigation of additional components not included in this study.

Leilich (1952) conducted a similar study on prediction in basketball using female subjects. By applying the Thurstone method of multiple factor analysis to her data, Leilich proposed to identify the primary factors of 28 selected tests or measures. She further proposed to

determine the relationship of these factors to the test elements and then analyze the factorial composition of each test to form combinations of items which would offer high multiple correlation coefficients with factors specific to basketball ability. Treatment of the data isolated six factors identified as follows: Factor I, Kinesthesis; Factor II, Speed; Factor III, General Motor Ability; Factor IV, Ball Handling with Accuracy in Goal Shooting; Factor V, Ball Handling Involving Passing Accuracy and Speed; Factor VI, Flexibility. Leilich also found that the majority of the basketball tests studied correlated significantly with Factor III, General Motor Ability. Regression equations were not developed since the combining of test items to predict the factors specific to basketball ability was found to be but slightly more effective for use as a predictive device than was the single test item that correlated most significantly with that factor. Leilich stated that the investigation was an exploratory attempt and recommended further study in the area of basketball motor ability in order to determine what other components the tests might be measuring.

In studies involving football, Allen (1965) focused on the collegiate level of play and Talton (1972) focused on high school athletes in the sport. Both researchers studied many measures of physique, motor ability, and psychological characteristics. In addition, Allen

included items on mental traits. The two studies differed in that Allen solicited playing ability ratings from coaches on each of their players. The rating scale included the items: (1) conditioning level, (2) aggressiveness, (3) perserverance, (4) team play, (5) attitude towards coaches, (6) playing position, (7) blocking, (8) tackling, and (9) football know-how. Test scores on the 44 experimental variables and the coaches' rating scores were intercorrelated and coefficients were factor analyzed according to the principal axes method. Talton, on the other hand, had coaches classify their players as either successful or unsuccessful and subjected the data to factor analysis techniques. In neither case did the analysis identify a single or general predictive variable for the football-playing ability of the participants in the studies.

Allen reported that of the eight principal factors identified, football intelligence had the highest loadings on the coaches' rating, i.e., .440. While statistically significant, it was not high enough to warrant its use for prediction. The factor analysis of Talton's data selected two combinations of variables, one a Short-Test Battery of nine items and the other a Long-Test Battery of 18 items. The Short-Test Battery consisted of the following variables: (1) age, (2) right grip strength, (3) Roger's Arm Strength Score, (4) elbow flexion strength, (5) trunk

extension strength, (6) 10-yard dash, (7) 60-yard agility run, (8) emotional stability, and (9) sociability. Talton further organized his subjects into five different groupings. These were: (1) all athletes, (2) eleventh-grade players, (3) twelfth-grade players, (4) football linesmen, and (5) football backs, and had a discriminant analysis statistic computed with each of the five groupings using both batteries. Analysis of the data revealed that each battery was capable of correctly classifying members in four of the five groupings of personnel. It was concluded, however, that neither the Short- nor the Long-Test Battery achieved significant levels of discrimination in classifying football backs. Talton suggested that motivational variables could be useful in an investigation of characteristics of football players.

In prediction studies in baseball, Everett (1952) and Hooks (1959) both tested college men and utilized multiple regression techniques for the purpose of analysis. Everett compared coaches' ratings of the playing abilities of 30 players to their scores on tests of ten qualities selected to represent those considered essential to proficient baseball players. These items tested motor ability, and motor capacity as well as visualization of spatial relationships, quick decision making, judging distance, and the ability to relax properly. Multiple correlations computed by the Doolittle Method indicated that the best

combination to predict baseball ability was the Sargent Jump Test, the Thurstone "S" Test (visualization of spatial relationships), and the Block's Test of Multiple Response. A multiple regression equation was computed for the criterion in T-score units by using these three tests.

Hooks (1959) was interested in the relationship of body strength and structure to predicting success in baseball playing ability. When 19 selected measures were compared to the criteria of: (1) hitting, (2) running, (3) throwing, (4) fielding, and (5) total ability, the correlation coefficients were low and the measures contributing to the predictive equations were generally insignificant. Hooks recommended the consideration of other contributing factors such as depth perception, agility, and eye-hand coordination.

Shondell's (1971) study investigated the relationship of selected physical and anthropometric traits to successful volleyball performance. The investigator compared 23 items to scores obtained from a jury of four judges who rated overall volleyball performance of males. Reliability and validity coefficients were determined and multiple regression analysis techniques were applied. It was found that the medicine ball toss was the single test that correlated the highest with the criterion. A four-item test battery of the medicine ball toss, 30-yard dash, wall catch, and zig-zag run correlated .708 with the

criterion. The jump and reach plus body weight raised the multiple R to .732. Due to the ease in administration of these two items, they were added to the battery. Shondell's recommendations did not include suggestions for the alterations of test items; however, he did recommend that a study be conducted using women as subjects.

In addition to the work in basketball by Leilich (1952), two other studies in the literature focused on women's team sports. Both involved field hockey. Strait (1960) constructed a single test for the purpose of predicting game-playing ability. Subjects included college age, club, and sectional level players. Strait found that in terms of reliability and validity, the test could be used satisfactorily for measuring performances of members of groups of general playing ability but not for individuals within highly skilled groups of players. The test was equally satisfactory for the evaluation of attack and defense players. Although her test required the execution of a variety of skill tactics while moving and under time pressures, Strait cautioned of the real difficulty one faces in the actual measurement of game-playing ability due to the complex sport environment that exists in team sports.

Wharton (1961) investigated a measure of potentiality for field hockey as a means of classifying senior high school girls within a class to provide for

individualized instruction. The American Alliance (then Association) for Health, Physical Education and Recreation Youth Fitness Test battery was administered to 107 students who had had no previous experience in the sport of field hockey. At the close of the instructional unit the Smithals-French three-item battery of Achievement Tests in Field Hockey was administered to the same group of girls. Results from the two batteries were studied through a comparison of composite T scores. It was reported that for high school girls in this study, the National Youth Fitness Test served as a measure of predicting field hockey skill achievement, significant at the .01 level.

A review of previous research on the prediction of success in sport produced a few more studies in the individual sports area using only women subjects than those involving men. In archery, Hart (1955), investigated arm and shoulder girdle strength, motor ability, steadiness, eye-hand dominance, and attitudes toward activity preference in 117 college women. The results indicated that the factors selected as possible contributors to success did not bear the degree of relationship necessary to warrant their use as predictive instruments in foretelling archery skill. Pankonin (1966), and Hoth (1969) both reported studies performed in tennis using college-age women as their subjects. While Pankonin studied the relationship of ten measurements of height, strength, balance

and motor ability, to tennis ability, Hoth compared only one item from Scotts' Motor Ability Test, the basketball throw for distance, to investigate its potential as a valid measure of tennis playing ability. Both investigators found positive correlations in their test's predictive capacity for performance in the sport of tennis. Hoth concluded, however, that interest and motivation can often be factors related to successful tennis performance, even in cases where individuals have scored low on the basketball throw for distance. Pankonin used the Doolittle method to compute multiple correlation for the six items she found related to tennis ability, then employed multiple regression techniques to determine the best combination of these items to form a predictive equation. It was found that a battery composed of agility (measured by N.C. Fitness Test #1), balance as measured by McCloy adaptation of Bass Stick Test, and shoulder girdle strength measured by the basketball throw for distance, was the most economical time-wise to predict tennis success.

The most recent work reviewed was in gymnastics. Basler et al. (1974), studied 18 female college gymnasts to investigate the relationship between gymnastic performance and several variables, namely gymnastic skill ability, pulse rate and Palmer Sweat Index as measures of arousal, and state and trait anxiety representing the subject's anxiety proneness. A stepwise multiple regression analysis

was employed. The outcome of the treatment indicated that the best predictor of gymnastic performance was knowledge of prior performances. Pulse rate, Palmer Sweat Index and Trait Anxiety measures added only minimally to the predictability. These researchers concluded:

> Any attempt to predict athletic performance without taking into account the skill ability of the performer would be folly. One cannot separate the individual from his or her performance. Arousal and anxiety measures relate to an individual's upcoming performance but not to the extent of taking into account skill ability or past performance (p. 8).

The two studies reporting prediction of success for men in individual sports were presented by Wettstone (1938), in gymnastics and tumbling, and Malsimur (1966), in tennis. Wettstone's study included 22 top male gymnasts of college age. His intent was to compile a list of the innate and acquired qualities of a good all-around gymnast and then devise tests to measure the degree and amount of each quality within an individual. Finally, he wanted to develop a working formula that could be used to predict gymnastic performance. Twenty-five gymnastic experts assisted in the formulation of the list of qualities a gymnast should possess. The list consisted of 11 anthropometric measurements and 10 items relating to such traits as interest and determination, physical courage, coordination, quickness and precision of movement, motor rhythm, timing, strength, flexibility and motor

educability. Coaches also rated their gymnasts according to their potential in many of these traits. Zero order correlations were computed between each variable and the criterion score of overall gymnastic ability ratings. For those variables which indicated what Whettstone referred to as a fair correlation (.34 to .71) with the criterion score intercorrelations were computed and a regression equation was formulated. Although a multiple correlation of .79 was produced, Whettstone indicated that the test should not be used for the purpose of cutting down the size of a squad, but rather might be used as a device for screening those who should try the sport.

Malsimur (1966) examined those physical characteristics that seemed to be related to 23 young adult male Junior Davis Cup players in tennis. He attempted to determine what physical elements serve as prerequisites to successful tennis performance. Success criteria were: (1) ratings by six experts, (2) outcomes of tournament competition, (3) Junior National Championship seeds and national rankings, and (4) a composite of measured test items as established by weighted scores. The Pearson Product Moment method of correlation was utilized to compute correlation coefficients for the indicated variables. Although Malsimur found no meaningful relationship between measurements on the test items and tennis success, some findings were worthy of note. Dynamic balance and agility

were meaningfully related. Also, Junior National Championship seedings and National rankings were good indicators of success and ability ratings by experts were excellent indicators of success.

Malsimur recommended that, because the study was concerned primarily with physical factors and no significant relationships were found, further research involve the area of psychological factors that might influence success. He suggested investigation of such characteristics as determination, aggressiveness, emotional control, patience, pride, and confidence.

Some studies have been performed on more than one sport with regard to the prediction of success and for differing reasons. DiGiovoni (1943) included 102 male athletes of college age in his study, to determine structural and functional measurements to success in each of the sports. Participants in basketball, football, baseball, gymnastics, tennis, track and field, and shot and discus were studied as well as 836 male college students who were not athletes. Results of the study supported the common claim that factors of body weight, muscular strength, and explosive power were associated with athletic success. The results also indicated that there was a tendency for each sport to have its own unique pattern of success and that although substantial differences existed to distinguish athletes from nonathletes, no

substantial differences existed within the nonathletic group.

Steitz (1963) investigated measures from 196 male college football, soccer, cross-country, basketball, baseball, wrestling, tennis, track and swimming athletes. He used a Hale Reaction Timer to measure 16 separate and combined hand and foot reaction, movement, and performance times. Additional test items were the 30-yard dash, Sargent jump, and a Physical Fitness Index. Prediction indices were computed and multiple regression equations for each of the nine criteria were determined. The following results were reported: (1) reaction time was a significant measure in baseball, basketball, and tennis, as were hand movement times in basketball and baseball and foot movement times in tennis, (2) height on the Sargent Jump Test was significantly correlated to success in soccer and cross-country, (3) time on the 30-yard dash correlated significantly with success in football and soccer, (4) hand movement times in wrestling and swimming were significantly related variables, and (5) none of the variables were related to success in track.

Miller (1960) studied 162 men and women subjects in both team and individual sports to determine if certain spatial visual and related abilities which seemed to be associated with success in sports do in fact possess such a relationship. Her subjects were classified into three

groups: (1) champion performers, (2) near-champion performers, and (3) low-skilled performers. Various parts of the Guilford-Zimmerman Aptitude Survey were used to test each subject's perceptual speed, spatial orientation and spatial visualization. The Mutilated Words Test, Hidden Figures Test, the McCloy Blocks Test of Multiple Response and the Bass Stick Test of Static Balance were other items administered. Depth perception was measured using the Keystone Telebinocular Multi-Stereo Professional Performance Tests. A comparison of the scores for each of the groups indicated that there were measurable differences in the visual perceptual ability of performers of varying levels of skill in sports. To determine the usefulness of certain tests of visual perception as possible predictors of potential success in sports, correlation coefficients were computed for four of the most promising tests and skills. Intercorrelations were also computed. The three most significant tests were then selected to establish a measure of predicting skill. A coefficient of multicorrelation was computed and regression equations were prepared. A battery consisting of the Bass Stick Test of Static Balance, the Block Response, and the Depth Perception Tests was recommended, although the single test of static balance was found to be sufficient. Miller stated, "Whatever elements are involved in these tests, visual or otherwise, they are somewhat related to successful

experiences in performances of an athletic nature" (p. 175). The researcher further suggested that future studies should be undertaken to develop a test that more clearly simulates the sports environment as it would be a distinct asset in the predictive ability to perceive spatial relationships in sport situations.

Summary

Based on the evidence in this review, it can be concluded that many studies have been undertaken for the purposes of seeking out effective means of identifying the successful sports performance. It is also apparent that of the various factors studied, most common have been those that are most easily observed and measured, the physical characteristics of body structure and motor performance. Although it is evident that some research efforts have attempted to reveal relationships of the less discernible human traits to successful sports performance, the results remain inconclusive. It was this lack of evidence for a common understanding of what specific factors are most contributive in the prediction of successful sports performance that promoted this investigation.

Selected Qualities in Successful Sports Performance

There is extensive literature about qualities that can be identified in successful sports performers. This section of the review is limited to those qualities under

investigation in this study and the specific means by which these may be assessed. The specific qualities being studied are: (1) anxiety as a psychological factor affecting the outcome of sport performance, (2) visual perception as it relates to movement performance, and (3) the physical qualities of manual dexterity, ball control, and balance as these contribute to proficiency in skill productivity. To the extent possible, studies on the predictive aspect of successful sport performance regarding these areas of study are included.

Anxiety

Anxiety, defined as "a pervasive apprehension of threat of danger" (Harriman, 1966, p. 12), has been assigned a central role in many personality theories over the past two and a half decades. Moreover, experimentalists, situationists and most recently interactionists have viewed this role from within the context of differing beliefs of anxiety constructs. The term anxiety can refer to either a normal reaction to a particular situation or to a form of neurosis. Anxiety denotes a signal of danger to the organism which leads to a protective defense. The terms anxiety and fear are often used synonymously in psychological research (Singer, 1975). It is from within this broad context that psychologists have constructed evaluative tools to provide further insight in the

understanding of this human phenomenon.

Taylor (1953) reported on the construction of the Manifest Anxiety Scale (MAS). This instrument, based on Hull's drive theory, was developed and used exclusively for the selecting of subjects for experimentation in human motivation on the basis of extreme scores achieved. Use of the scale for this purpose was based on the assumptions that: (1) variations in drive level of the individual related to the level of internal anxiety or emotionality, and (2) that the intensity of this anxiety could be determined by a paper-and-pencil test that contained items previously referred to as overt or manifest symptoms of this state. The MAS consisted of items drawn from the Minnesota Multiphasic Inventory (MMPI) that were judged by clinicians to be indicative of manifest anxiety. Given the innocuous title Bibliographical Inventory, the final revision consisted of 50 of those statements judged most discriminating, supplemented by 225 "buffer" statements nonindicative of anxiety. Scores for groups of normal individuals and psychiatric patients were then compared to ascertain the possible relationship between the MAS scores and manifest anxiety as defined and observed by the clinician. Until recently, this test was the most popularly used tool in research undertaken in the area of anxiety (Singer, 1975).

Cattell and Scheier (1961) reported extensive work in the area of the assessment of anxiety through the development of the IPAT 8-Parallel-Form Anxiety Battery, a direct associate of the 16 Personality Factor Questionnaire. Test construction resulted from a series of replicated researches which "(a) established anxiety as a second order factor in questionnaire items, (b) established anxiety as a first order factor in objective tests, and (c) matched these factors as being the same and found them related to the consensus of clinical ratings of anxiety" (Cohen, 1965, p. 262). Hundreds of variables of diverse kinds that were applied to thousands of subjects of varying age, clinical status, and background formed the basis for the derivation of the eight equivalent forms developed through factor analysis. At one time the test was regarded as the only objective means of studying the aspect of anxiety fluctuation. For truly effective test usage considerable familiarity with the Cattellian system is required (Cohen, 1965).

Spielberger (1972) reported that most advances in the assessment of personality characteristics occurring over the past twenty years were in the measurement of personality traits rather than in the evaluation of psychological states. Trait anxiety (A-trait) is the general disposition to react or respond to psychological stress

in a specified manner with some predictable regularity, whereas state anxiety (A-state) refers to a relatively unique emotional condition or reaction that may vary and fluctuate over time (Spielberger, 1972).

This view of anxiety as two distinct concepts prompted the development of the State-Trait Anxiety Inventory (STAI) (Spielberger et al., 1970). This relatively brief self-report type tool provides a reliable means for measuring both A-state and A-trait on two separate scales. Individual items for the STAI A-trait scale were selected on the basis of significant correlations with other widely accepted anxiety scales that measured individual differences in A-trait, e.g., the Taylor Manifest Anxiety Scale, and the IPAT Anxiety Scale. Individual A-trait items were also expected to be unaffected by situational stress and to remain relatively stable over time (Spielberger, 1972).

A study in gymnastics by Basler et al. (1974), already reported in this review, used this test. Another study (Maloy, 1976) on the prediction of successful motor performance within a sport also reported the use of this evaluative psychological tool. Maloy attempted to identify personality and psychomotor variables which would discriminate the successful goaltender from within a group of ice hockey players. A total of 100 professional league, college, and high school players served as subjects. A battery of tests consisting of the Eysenck Personality

Inventory, the STAI, a pursuit rotor device, and a multiple choice reaction time test was administered to all subjects. Comparisons were made between goaltenders at all three levels of play and within goaltenders, successful versus less successful players. Multivariate analysis and discriminate analysis techniques were employed. Differences between successful and less successful goaltenders and differences between high school, college, and professional league players yielded significant multivariate F values. A discriminant function was produced to enable the classification of goaltenders as either successful or less successful, based solely on the individual scores for the selected variables. Results also indicated that the goaltenders researched were not significantly different from goaltenders as a group on a multivariate basis. Significant differences were found in stability and trait anxiety. General conclusions were: (1) personality traits and athletes are demonstrably linked as shown by the significant differences derived from stability and anxiety, (2) the concept of an integrated performance model, comprised of a statistically sound mixture of personality and psychomotor variables is reasonable and probable, but is subject to further refinement, and (3) a coach can gain greater probability of success in athlete selection if psychological and motor criterion are developed through task analysis and then applied by testing to

seek out qualified potential athletes, rather than attempting to develop individuals through random selection.

The Sports Competition Anxiety Test (SCAT) (Martens, 1977) is a newly developed psychological evaluation tool designed for research on anxiety constructs with specific regard for sport competition. It was constructed on the premise that the assessment of competition A-trait, as a unique and situation-specific form of trait anxiety, will enhance the ability to predict state anxiety in a competitive sport environment. Early psochological research lends support to the situational specificity (Mischel, 1968, 1973; Mandler & Sarason, 1952), which prompted the STAI (Spielberger et al., 1970). Bowers (1973) and Endler (1973) presented an interactionist model which, when placed within the context of sport and psychometrics, bears credence for the examination of an individual's reaction to the specific sport competition setting. The work by Martens and his associates in developing SCAT (Martens, 1977) reflects an interaction paradigm.

To construct the inventory, Martens developed some of the items and selected others from available anxiety scales. These latter were modified to relate to sports competition, specifically. A total of 75 items were then reviewed and evaluated by six judges to establish face validity and grammatical clarity. Twenty-one items were retained. In an attempt to despel reactivity to anxiety

assessment, Martens added nine spurious items that were directed toward other elements of sports competition. The 30-item inventory was a self-administered tool. Responses to each of the items were recorded as: (a) hardly ever, (b) sometimes, and (c) often. For scoring purposes the responses on the 21 anxiety items were scores from one to three. The range of scores for the inventory was from 21 to 63. A low value indicated low competitive A-trait and high values corresponded to high levels of A-trait.

The initial inventory was administered to both male and female populations of differing ages, and was subjected to continual modification and revision. Through the processes of item analysis, triserial correlations, and discriminant function analysis, item discrimination was determined. Two final inventories were developed, one for children (SCAT-C) and the one for adults. Each consisted of 15 items, only 10 of which were to be scored. The inventories were then given the obscure titles, Illinois Competition Questionnaire Form A for adults, and Illinois Competition Questionnaire Form C for children (Martens, 1977).

The statistical treatment used to determine item discrimination indicated that the items for both forms of SCAT were beyond the normal criteria for discriminability. Item analyses for the high competitive A-trait persons yielded a mean of .61 and for the low competitive A-trait

persons, .67 for all 10 items. A coefficient of .64 was reported for the mean triserial correlation across all 10 items. The mean discriminant function coefficient was 1.01.

For the purpose of determining reliability, the test-retest method was employed with two samples of differing ages of the children's populations. Results produced a reliability of .77 for both samples combined. Analysis of variance techniques employed on only one of these sets of scores yielded a reliability of .81. This same procedure produced a .85 reliability on scores achieved by the sample of 153 adults used for the final item analyses (Martens, 1977).

Internal consistency for SCAT was determined by obtaining a mean interitem correlation coefficient from calculations of a correlation matrix formed among the 10 items for each of six samples. A Kuder-Richardson formula was then applied to obtain the six different internal consistency coefficients. These ranged from .95 to .97 (Martens, 1977).

To determine concurrent validity, scales of other personality constructs and general anxiety scales or inventories were correlated with SCAT. Moderate correlations with the other tools measuring general anxiety and trait anxiety were hypothesized, with lower correlations expected on most of those measuring other specific personality

dispositions. In nearly all cases, the hypothesized relationships were confirmed (Martens, 1977).

Martens and Simon (1976) reported on studies examining concurrent and construct validity of SCAT. The investigators correlated coaches' subjective ratings of player A-traits with SCAT scores from collegiate women's volleyball players. A strong relationship was hypothesized; however, a very low correlation was obtained. To examine the reason for the low correlation a second study was conducted using high school girl basketball players, to determine the ability of SCAT and the coaches' ratings to predict A-state just prior to competition. Spielberger's general A-trait scale was also administered. The criterion measure was an A-state scale, a modified version of Spielberger's A-state scale. It was hypothesized that SCAT was the best predictor of precompetitive A-state. The results indicated that Spielberger's A-trait inventory was a moderate predictor of A-state ($r = .30$). SCAT was, as hypothesized, a considerably better predictor of precompetitive A-state ($r = .65$). It was found that the coaches were unable to predict reliably precompetitive A-state of their players ($r = .12$). Findings did concur with previous research in which situation specific A-trait instruments had been found to be better predictors of behavior than general A-trait inventories and did support the predictive and construct validity of SCAT.

Thus, there is substantial evidence to support the construct validity of SCAT from both experimental laboratory studies and field studies. And, to a substantial degree, SCAT, along with the short form of the SAI was able to predict anxiety levels of persons anticipating sports performance. Using hypothetical competitive situations, SCAT increased its ability to predict A-states as the threat in the competitive situation increased. However, it was found that SCAT, and SCAT with the associated A-states were unable to reliably predict subjects' motor performance (Martens, 1977).

Spielberger (1971) stated that the future of research on anxiety and movement behavior would seem to depend upon the understanding on how task difficulty varies for various motor tasks. Martens (1977) indicated that he, Spence, and Spielberger all concur that better theories of movement behavior are needed. He further contended that the major obstacle preventing the making of predictions about response hierarchies with motor responses lies in our difficulty in measuring arousal (Martens, 1977).

Visual Perception

In the study of human behavior, perception is regarded as "the organism's maintenance of contact with its environment, its internal state, and its posture and movements" (Day, 1969, p. 1). According to Ittleson (1960)

"the function of perception is to bring us into contact with the world outside of ourselves." Vision is regarded as one's primary source of sensory perception. Visual perception then, can be identified as "the capacity to interpret or give meaning to what is seen" (Butenica, 1968, p. 16).

Various aspects of visual qualities have been studied in relation to sports performance. Researchers interested in the prediction of successful performance in a specific sport have studied among other factors, the visualization of spatial relations, decision making and ability to judge distance in baseball (Everett, 1952), eye dominance and eye-hand coordination in archery (Hart, 1955), the periphery of binocular vision in basketball players (Stroup, 1957), and depth perception in tennis (Malsimur, 1966).

Miller (1960) studied many different visual aspects on the assumption they might relate to success in the various sports investigated. These were: perceptual speed, spatial orientation and spatial visualization, measured by Part IV and Part V of the Guilford-Zimmerman Aptitude Survey; a type of visual perception known as Closure I and Closure II, measured by the Mutilated Words Test and the Hidden Figures Test, respectively; the quickness in response and adaptability to changing situations, measured by the McCloy Blocks Test of Multiple Response; and depth

perception as measured by the Keystone Telebinocular Multiple Stereo Test. Through this extensive study on visual perceptual factors and the degrees of success realized by sport performers, Miller found that outstanding sports performers demonstrated significantly better abilities on tests of Depth Perception than did low-skilled performers.

Although Miller (1960) found no significant differences between highly skilled champions and low-skilled performers in results from the Hidden Figures Test she had employed to measure a type of visual perception organization referred to as "closure," this aspect of visual perception has gained some additional attention in movement research since that time. The importance of "whole" organization, to which closure is related, is one of the main tenets of the Gestalt school of perception (Dember, 1960). Gestaltists also devoted attention to the central figure experience that has come to be known as figure-ground organization. Basic to this conceptual organization of visual perception was the separation of the perceptual field into two parts, one dominant which was the focus of attention (the figure) and one homogeneous (the field or background).

Witkin et al. (1954) cited work by Gottschaldt (1926) who developed a test to determine the role that past experiences played in form perception. Gottschaldt's test technique of concealing figures was extended by Witkin et al.

(1954), when he devised the Embedded Figures Test. This test was to determine whether a given degree of ability to deal with an item independent of its surroundings was a pervasive character of a person's perception (Witkin et al., 1954).

The Embedded Figures Test (EFT) is a paper-and-pencil test in which the subject's task is to find a particular simple figure within a larger context figure. The simple figure is "hidden," to a greater or lesser degree by being concealed in the pattern of the larger figure. The standard test is comprised of 24 complex figures in which a simple figure is embedded. The mean time required by the subject to find the simple figure within each of the complex ones represents the subject's score. According to Witkin et al. (1954), the test provides a measure of the extent to which the subject's perception is influenced by the context in which the item occurs. A short form reported by Jackson (1956), was developed to reduce the time required of Witkin's original test. This 12-item test yielded high correlations with the longer form. Two different cross-validation processes resulted in coefficients of .96 and .98 for both men and women subjects (Jackson, 1956).

Of late, literature in psychology reflects the linkage of this evaluative tool with the further refinement in Witkin's work, as he associated two extreme cognitive styles of functioning to this figure-ground relationship

in visual perception. Through a hypothesized concept of differentiation, he identified one mode of perception as analytical and one as a global mode of perception. Witkin's theory allows for the classification of individuals into either of these two cognitive perceptual models, depending upon how each visually perceives his environment. According to Witkin's theory, those individuals who tend to experience items discrete from their background are field independent, and are more analytical by nature, while those persons who tend to perceive their surroundings from within a more global context are considered field dependent (Witkin et al., 1962).

Movement behavior research has reflected much interest in this psychological theory with a particular concern for the association of these human functional characteristics and the outcomes of sport performance. Two studies in tennis (Kreiger, 1962; Enberg, 1968) reported use of the EFT. Kreiger (1962) utilizing 24 men and women beginning and intermediate tennis players studied the effects of figure-ground perception on spatial adjustment. She reported a significant relationship between ease of perception of embedded figures and tennis-playing ability. In a study on directionality, Enberg (1968) compared 63 college women divided into three groups: tennis team members, beginning tennis players, and naive subjects. Scores on the EFT were significantly different between

team members and naive subjects. For use in her study, Enberg (1968) developed a film showing portions of the swing of a tennis forehand during various ball contact points. Subjects were to judge where the ball would most likely land, using as a scoresheet, a scaled grid of a tennis court. An extremely low relationship of r = .058 was found between EFT scores and the film test results. It was concluded by the investigator that the two tests measured separate kinds of perceptual ability, or at least, these two particular tasks appeared distinctly different.

A number of more recent studies involving the relationship between figure-ground perception and sports participation have been reported by Pargman and associates (1974, 1975, 1976). In each case, the EFT was utilized. Pargman, Schreiber, and Stein (1974) studied 65 varsity male athletes engaged in seven different team and individual sports. Results indicated that team sports participants were more field dependent, while individual sports participants were more field independent. However, of the three team sports studied, football, ice hockey and baseball, it was found that the football players' scores accounted for most of this difference. A 1975 study reported by Pargman, Bender and Deshaies involved 11 male and nine female varsity collegiate basketball players. Results of the EFT and each player's seasonal field goal and free throw records were compared. It was indicated

that the ability to disembed a static visual field is not a variable of concern in the understanding of the dynamic visual properties which relate to basketball shooting. A further study (Deshaies & Pargman, 1976) compared scores of 40 male college football players of varsity and junior varsity level in horizontal and vertical peripheral vision, depth perception, and disembedding abilities. For the treatment of the data, the two levels of players were subdivided into linemen and backs. No significant differences were found between any of the groups. It was suggested that assessment of the ability to interpret visual cues which are situation-specific may permit better discrimination among players than the measurement of the types of abilities investigated in this study (Deshaies & Pargman, 1976).

Arrighi (1974) utilized the EFT with 44 women field hockey coaches, club players and college players. Her specific intent was to determine through their verbal responses in the analysis of filmed game play, whether these 44 subjects could be categorized according to their classification--coach, club player, college player. Correlations revealed that the variables which influence an individuals' observations differ and are dependent upon the group classification. All subjects were considered field independent on the basis of their scores on the EFT. Somewhat surprising to the investigator, however, was the

finding that visual perception was not a significant factor in the observation of game strategy for any of the groups. It was stated that the negative results could possibly be attributed to the fact that the test for visual perception was not an appropriate tool for this particular study. As game play is primarily movement oriented, and the EFT is of a static nature, the researcher felt that dynamic play situations might require a set of visual operations completely different from those of static situations.

An attempt to resolve some of the concerns prompted by the inconclusive results of research in the field of movement behavior was reported in a study by Herkowitz (1971). In reference to the EFT, Herkowitz stated:

> One must ask if such tests (as well as other tests dealt with in the literature) are appropriate and adequate measures of figure-ground perceptual ability within the context of movement behavior research. None of them takes into account the affect of movement of either the figure or ground, or both the figure and ground. All are stationary tests, in the sense that they require subjects to respond to static situations. Yet, in most physical activities, subjects are required to respond to moving figures against stationary ground (Herkowitz, 1971, p. 5).

Herkowitz's study involved the refinement of a previously designed film (Herkowitz, 1968) developed to evaluate figure-ground perception of elementary school-aged children. The Moving Embedded Figures Test (MEFT) was a 16 mm. animated film with sound track of 20 minutes duration. On each of the 27 test items, the subject's task

was to identify which of four possible figures (ship, plane, boat or car) was embedded within a background. The refinement process involved an alternate method in test administration from the original design. In the revised version, the subject was required to identify the correct figure that was moving from the stationary background as quickly as possible. Each item was displayed in a static form for four seconds. During the following six seconds, the figure appeared to move toward the subject. The subject's score resulted in the total of timed latency of responses, measured by the use of a push-button device. Items answered either incorrectly or beyond a 15-second duration were assigned a score of 15-seconds latency. A single factor repeated measures ANOVA on item latencies for all 80 subjects produced an estimated reliability measure for the 27 MEFT items of .94. This same statistical treatment yielded an estimated reliability of a single test item of .35. This low positive intercorrelation indicates that the 27-MEFT test items do not measure to a great extent any single unitary trait.

To determine test validity, Herkowitz developed a stationary counterpart of the MEFT and administered it to 40 subjects between the ages of five and twelve. Through test-retest techniques, it was determined that performance on a stationary version of the MEFT was not the same as performance on the regular MEFT. The differences for

subjects of each age group were significant at or beyond the .01 level. Results indicated that the stationary version of the MEFT was a more difficult test than was the regular film version of the MEFT. It was concluded by Herkowitz (1971), that the MEFT was a reliable test measuring figure-ground perceptual ability, that it was appropriate for use with elementary school-aged children, and that it was easier than a stationary counterpart.

The revised version of Herkowitz's MEFT, as used in her study, provides a covariate measure of each subject's form recognition, form differentiation, and movement response time. Although movement response time may well be an important factor in the skills performance process, a modification in test administration (e.g., audio-taping verbal responses) could provide opportunity to measure more accurately perhaps, the two specific components of visual perception, form recognition and form differentiation. Additional modification of the film (e.g., the removal of the four seconds of static embedded figure Herkowitz included in each item in this child's version of the MEFT), could further allow the more precise measurement of these properties of visual perception, under pure dynamic conditions. As no apparent ceiling was reported in Herkowitz's (1971) study, it is conceivable this test has merit for use with adult subjects. The stabilization of scores from

an adult population could well support the viability of this test as a valuable tool in the assessment of visual perceptual attributes as they relate to successful sports performance.

Selected Physical Qualities of Manual Dexterity, Ball Control, and Balance

Physical qualities are those attributes of the human organism that contribute to efficient and effective motor performances. Some of these attributes are classified as abilities while others are considered to be skills. Fleishman and Rich (1963) provided the distinction: "Briefly, the term ability, as used here, refers to a more general, stable trait of the individual which may facilitate (transfer to) performance in a wide variety of different tasks" (p. 7). The term skill is more specific, referring to level of proficiency on a specific task or limited group of tasks (Fleishman & Rich, 1963; Fleishman, 1967).

> As we use the term skill, it is task oriented. When we talk about flying an airplane, in operating a turret lathe, or in playing basketball, we are talking about a specific skill. Thus, when we speak of acquiring the skill of operating a turret lathe, we mean that this person has acquired the sequence of responses required by this specific task. The assumption is that the skills involved in complex activities can be described in terms of more basic abilities. For example, the level of performance a man can attain on a turret lathe may depend on his basic abilities of manual dexterity and motor coordination. However, these same basic

> abilities may be important to proficiency in other skills as well. Thus, manual dexterity is needed in assembling electrical components and motor coordination is needed to fly an airplane (Fleishman, 1967, p. 351).

Proficiency or skill may be dependent on one or a combination of abilities.

The selected physical qualities of manual dexterity, ball control, and balance are more extensively reviewed as each may contribute to the proficiency of skill productivity in the sport of field hockey.

Manual Dexterity. In a factor analytic study on fine manipulative tests, Fleishman and Ellison (1962) administered 22 printed and apparatus tests to 760 subjects. Three factors were identified: (1) Manual Dexterity, (2) Finger Dexterity, and (3) Speed of Arm Movement. In an earlier study, Fleishman and Hempel (1962) defined manual dexterity as the ability to make skillful, controlled arm-hand manipulations of objects at a rapid rate. Throughout Fleishman's extensive research on human abilities, he employed (among others) two of the five subtests that comprise the battery of the Minnesota Rate of Manipulation Test (MRMT). In the MRMT, the subject is provided with a large board containing 60 holes and 60 cylindrical blocks. The subject is timed throughout the various tests, each of which requires different manipulative tasks of placing, turning, or displacing the blocks in relation to

the holes. The skillful movement involved in this factor are more gross than those involved in the finer finger-controlled manipulative movements required by some other tests (Fleishman & Hempel, 1954).

Although the first two tests of the five-item battery are the most popular, developers of the MRMT test feel that the latter three may be better predictors of success in certain situations. Moderate intercorrelations of the five tests indicate that related, though somewhat different, information is obtained from each (American Guidance Service, 1969). The MRMT is one of the better known tests on manual dexterity and has been used to select workers for office and factory jobs where speed of hand and finger manipulation is important (Fleishman, 1954; Tuckman, 1944). Ghiselli (1949) reported "It would seem the test is a wholly adequate instrument for selecting basketball teams" (Ghiselli, 1949, p. 663). Teegarden stated, "Few tests give so clear a picture of two-hand coordination as does the second part of the Minnesota Rate of Manipulation Test" (Teegarden, 1941, p. 438).

Childress (1972) included the MRMT in his battery of 24 selected test items to measure the components of basketball-playing ability in high school boys. Following a factor analysis, the seven test items loading highest on each of the rotated factors were determined. The MRMT was identified under Factor VII, described as manual dexterity.

The Johnson field goal test also loaded high on this factor. When compared with coaches' ratings of boys who were classified as successful or unsuccessful, the seven factors correctly placed 74.6 percent of the subjects classified as successful basketball players and 68.1 percent of those classified as unsuccessful.

The sport of field hockey demands quickness in the turning of the wrists, hands and arms in order to manipulate the stick to play the ball. Test five of the MRMT may well provide for the assessment of this physical ability identified by movement researchers as manual dexterity, for the prediction of success in field hockey. Named the Two-Hand Turning and Placing Test, the test requires the subject to use both hands simultaneously to remove the cylindrical blocks from the surface of one board, turn and place the two blocks in the holes of an adjacent board, repeatedly. The speed of these gross motor movements combined with the demands for quick manipulative maneuvers of the fingers, hands and wrists could be an underlying ability that contributes to the development of skillful stick manipulation and thus ball control in field hockey.

Jurgensen (1943) correlated time on first and second trials and then corrected these correlations with the Spearman-Brown formula to determine reliability on this test. A coefficient of .94 was reported. Ratings of

three supervisors of men working in a pulp and paper factory were converted to T scores. The sum of the three T scores was used as the success criterion to determine test validity. A validity coefficient for this test was reported at r = .39, corrected for attenuation.

Ball Control. Knapp (1963) defined skill as:

> the learned ability to bring about predetermined results with maximum certainty, often with the minimum outlay of time or energy or both. . . . The predetermined results may be in terms of speed, precision, power, quality, difficulty or any combination of these (Knapp, 1963, p. 4).

Thus, ball control in field hockey must be regarded as a learned skill. Speed and precision of stick manipulation must be timed and coordinated with the proper amount of force application to achieve the desired speed and direction of ball flight. Practice is necessary to develop the understanding of the nature and size of muscular contraction as predicted by the performer on each execution (Poulton, 1957).

Strait (1960) and Wharton (1961) in studies on the prediction of success in field hockey reported the use of skill tests specific to the sport. Strait (1960) designed a test which incorporated a dribble, a hit to a rebound board, fielding of the rebounded ball, and some dodging techniques. Wharton (1961) used scores on a three-item battery developed by Schmithals and French. Similar to

the test designed by Strait (1960), test one included a dribble, dodge, circular tackle, and drive. Test two involved goal shooting while test three required fielding and a drive.

On the selection of items for a predictive type test, McCloy and Young (1954) cautioned that it is important to choose or devise items not specific to the sport in question to eliminate differences due to training and experience in the sports, implying what Ferguson (1956) referred to as "culture-free tests." Because human abilities themselves are not culture free, the concept of culture-free tests is a misconception (Ferguson, 1956). Thus, the inclusion of a test designed to assess ball control in field hockey may be deemed appropriate for this investigation.

Balance. Balance is referred to as the ability to maintain body position and is regarded as a quality necessary for successful performance of sports skills. Two distinct categories of balance can be identified. Static balance is that type of balance necessary to maintain equilibrium in a steady position. In contrast, dynamic balance is that which is involved in keeping one's equilibrium while in motion or while changing from one position to another. Dynamic balance demands body orientation in off-balance situations. Tests have been developed to

determine ability in both types of body balance. High positive relationships between the two types of balance have not been found (Singer, 1975).

A variety of tests have been designed that require balance tasks of varying degrees of difficulty. Equipment utilized in these tests range from floor markings, balance sticks, and balance beams to such sophisticated instruments as stabilometers and ataxiameters. Bass (1939) studied both static and dynamic balance, using tests requiring little equipment and time for administration. A total of 19 tests were factor analyzed. Results showed that dynamic balance is particularly important to sports, and while some of the factors involved in dynamic balance are the same as those in static balance, others are more complex and perhaps of a different type. An additional finding was that of the number of different factors or components of which balance is composed, one is obviously concerned with the function of the eyes in balance performance. Also, it was determined that as these components function only when the eyes are opened, it could further be concluded that there are probably several functions of the eyes in balance.

Studies reported earlier on the prediction of success in sport that included tests of balance were Wettstone (1939) in gymnastics, Plinke (1966) in basketball, Pankonin (1966) and Malsimur (1966) in tennis, and Miller

(1960), a multi-sport study. Plinke (1966) experimented with a one-foot balance item, which because of low correlation coefficients was not included in the final battery. Pankonin (1966) found that static balance, measured by the Bass Stick Balance Test, was an important element in tennis playing ability. Malsimur (1966) reported a meaningful relationship between dynamic balance and agility using the stabilometer to assess balance. No reference was made to the balance item or the outcome of this test in Wettstone's (1938) study. Miller (1960) used two of the Stick Balance Tests designed by Bass and concluded that static balance alone provides a valuable predictive measure for distinguishing between different levels of sports ability. Greater relationships were found for gymnasts, swimmers and divers, and fencers in contrast to volleyball and basketball players.

Greenlee (1958) studied both static and dynamic balance in college women enrolled in bowling classes. The researcher used the Balance on Stick Test by Bass to evaluate static balance and Scott's Sideward Leap Test to measure dynamic balance. Other tests items assessed subjects' leg, grip and shoulder girdle strengths, and kinesthesis of wrist extension, rotary position of the forearms, and the forward weight shift. Bowling performance was determined by the averaging of six games rolled during the last three weeks of the instructional unit.

Dynamic balance was found to be the only factor significantly correlated at better than the .01 level of confidence. None of the eight factors selected for study in relation to bowling performance revealed a degree of relationship high enough to be used as a predictive device for bowling performance (Greenlee, 1958).

A study on the prediction of success in one specific event within a sport was reported by Sanborn and Wyrick (1969). The researchers studied the relationship among standardized and modified balance tests, discrepancy scores, balance speed tests, and an Olympic Balance Beam Skill Test to predict balance beam performance. To determine the effect height would have on balance, the Bass Stick Test and Scott's Sideward Leap Test were modified by being raised to a height of 3'11" above the floor. A total of 17 tests were administered to 94 college women students enrolled in beginning and intermediate gymnastic classes. The results of the study support previous findings that no one test of balance is appropriate for the assessment of balance. The most effective combinations of predictors of balance beam skill were the Sideward Leap Test and the Modified Sideward Leap Test.

Scott's (1959) Sideward Leap Test of dynamic balance requires the subject to leap sideward from one mark to another and immediately bend forward to remove a small object from its position on the floor that is 18 inches in front

of the landing mark. The subject is then required to maintain balance on the landing foot for up to a maximum of five seconds. Three trials are performed on each leg and then the test is repeated. Subjects in Scott's original study were 116 college students. Reliability was computed by using a series of ten trials stepped-up by the Spearman-Brown formula. A coefficient of .88 was reported.

The Scott Sideward Leap Test requires movements similar to those of the field hockey player in action. Effective use of this test in other studies on the prediction of successful sports performance strengthens the proposed value of the test in this study.

Summary

The literature reviewed implies a considerable interest in the integrative aspects of the personality, visual, and physical qualities that could be related to successful sports participation. Various methods have been utilized to investigate the role of these separate dimensions of human performance as they may relate to the successful sports performer. Collectively, the five tests selected represent a battery of performance measures that the investigator believes will assess the appropriate human dimensions that could identify predictive qualities of skilled women field hockey players.

CHAPTER III

PROCEDURES

The purpose of this study was to determine what, if any, predictive qualities could be identified in a group of skilled women field hockey players. The subjects consisted of women who tried out for and were selected by the United States Field Hockey Association to train for international level play and those who tried out but were not selected for the international squad. The specific areas being investigated were: (1) anxiety, (2) visual perception, and (3) the selected physical qualities of balance, manual dexterity and ball control. The procedures for this study involved three processes; the preliminary preparation, the collection of data, and the treatment of the data.

Preliminary Preparation

The preliminary preparation for this study included the selection of tests, the selection of the subjects and test sites, the arrangements for physical accommodations, equipment and supplies, and the selection of a research assistant.

Selection of Tests

A pilot study was conducted by the investigator to aid in test selection. During the spring of 1978 eleven tests were administered to 23 members of the two 1977 women's intercollegiate field hockey teams at Illinois State University. The eleven tests consisted of the Sports Competition Anxiety Test (known as the Illinois Competition Questionnaire), Herkowitz's Moving Embedded Figures Test (with modifications in the testing procedures), two tests of the five-item battery of the Minnesota Rate of Manipulation Test (Two-Hand Turning, and Two-Hand Turning and Placing), the Bass Stepping Stone Test and the Scott Sideward Leap Test for balance, the Edgren Shuffle Slide Test (modified to allow for a cross-over step), the Sargent Vertical Jump, and three tests designed by the investigator--the Obstacle Run, Obstacle Run with Ball Control, and the Chapman Ball Control Test. Test-retest techniques were employed for all original tests and those tests with modifications of their original source.

Five of the test items were selected for further investigation. The criteria for test selection were: (1) the apparent value each test offered to the potential battery in measuring the performance quality being investigated, and (2) administrative economy. An overall consideration in test selection for the final battery was the necessity for minimizing time and effort demands on each

subject. The five tests and rationale for their selection were:

1. Sports Competition Anxiety Test (SCAT) - This test is a brief, 15-item paper-and-pencil test, designed to measure a predisposition to respond with varying levels of anxiety in competitive sports situations (Martens, p. 89) (see Appendix A). The test has item discrimination, reliability, internal consistency and concurrent validity. The SCAT was selected to test competitive A-trait (anxiety-trait) because of its applicability to this study, its availability, and the practicality of administration to large groups in a very short period of time.

2. Moving Embedded Figures Test (MEFT) - The MEFT is a 16 mm. black and white sound motion picture film of 27 test items developed by Herkowitz for use in movement behavior research. It was used by Herkowitz to reliably assess elementary school-aged children's perception of four characteristic shapes (car, boat, train, plane) as embedded figures that appear to move toward the subject, and at the same time away from stationary backgrounds of differing densities (see Appendix A). Treatment of the test-retest scores achieved by adult-aged subjects in the pilot study produced a reliability coefficient of .84.

The film was originally designed to test a single subject using a push-button device to time subject responses. The task of the subject was to push one of the four

buttons, each marked to correspond to the figures used in the test. A modification of this procedure was utilized in the pilot study to investigate the feasibility of testing three subjects simultaneously. Three separate but identical cassette tape recorders were used to record the verbal responses of each subject for all 27 test items. The three subjects, seated an equal distance apart and away from the screen, were instructed to use low tones or whispers to record their responses as quickly and as accurately as possible into the condenser microphone of their individual cassette recorder (see Appendix A). A stopwatch was then used to transcribe the lapsed time for correct response to each item beginning with the subaudible tone that accompanied the initial appearance of each test item. Total accumulation of the latency of correct response for all test items provided the score for each subject. Pilot study subjects later attested to the appropriateness of this modified testing technique in that no sound disturbances seemed to be produced by others being tested.

As a result of the pilot study, the need for one other modification of this test became apparent. Because each of the 27 items was first presented on the screen in a statically embedded state for four seconds, many of the adult-aged subjects responded so quickly that the opportunity to measure discrimination time for the correct detection of the moving embedded figure simply did not

exist. Authorization to alter the film was granted from the original film producer (see Appendix C). A copy of the film was purchased from the Purdue Media Center. The four seconds of static embedded figures were edited out of each of the five example items and the 27 test items to allow for the viewing of each item only for the six seconds the object appears to be moving. A copy of this portion of the altered film was then reproduced to provide a back-up copy (in case of breakage) for use in the major study.

There being no other moving embedded figures test available that reportedly measures visual perception related to figure-ground perceptual abilities in movement behavior, this test, with modifications and alterations, was selected primarily for its overall contribution to the total test battery.

3. Two-Hand Turning and Placing - This is the fifth test of the five-item battery of the Minnesota Rate of Manipulation Test (MRMT), designed to measure manual dexterity. The test was selected because of the gross motor patterns of the arms and the precision of muscle coordination in manipulative control that is required of the test performer. It was thought that these were comparable to movements often demanded of the field hockey player when attempting to play the ball. It was an intuitive feeling of the investigator that performance on this test might have some relevancy to the prediction of successful

performances in field hockey. Within the broad limitations of the pilot study, results of the test performances of the subjects seemed to indicate that there could be some truth to this assumption.

4. Chapman Ball Control Test - This test is one of the three original tests designed by the investigator. It was designed to assess one's ability to combine quickness in wrist action needed to manipulate the stick with ability to control the force element when contacting the ball (see Appendix A). Scores from subjects in the pilot study when submitted to t tests revealed a statistical difference between the means of scores of members of the two teams. The difference was significant at the .01 level. Based on this evidence, the test was selected as one of the five items in the final battery.

5. Scott Sideward Leap Test - Scores on the two tests of dynamic balance included in the pilot study were significantly correlated ($r = .56$) at the .005 level of confidence. On the basis of the criteria for test selection stated previously, the Scott Sideward Leap Test for balance was selected for inclusion in the study (see Appendix A). Greater familiarity with this test through pilot study testing convinced the investigator of its apparent value in the search for success factors in the prediction of field hockey players. Again, the simulation of movement demands placed on the test performer when compared

to those required of the player attempting to play the ball, or retrieve the ball from an opponent, or move defensively in a low-crouched position with stick in hand, greatly influenced the investigator's decision to include this test in the final battery.

Other tests utilized in the pilot study but not included in the test battery, were the Two-Hand Turning Test, the Obstacle Run, Obstacle Run with Ball Control, the Sargent Vertical Jump and the modified Edgren Shuffle Slide. Scores on the Obstacle Run with Ball Control Test yielded a high correlation with the Chapman Ball Control Test designed by the investigator and for this reason alone was not given further consideration for inclusion in the final test battery. A relationship was also noted between the Two-Hand Turning Test and the other test involving stickwork and ball control, but did not seem to be as valid a factor in the prediction of successful field hockey players as the Two-Hand Turning and Placing Test. The remaining two tests (Sargent Vertical Jump and the Edgren Shuffle Slide, modified), revealed some relationship to either one of the balance tests and to each other. It was also noted that the mean scores for each of the two teams on each of these tests were nearly identical. Thus, it was concluded that because all players at the intercollegiate level are athletically inclined to some degree, tests for these rather common performance qualities of explosive

leg power and speed and agility failed to produce significant differences in scores between groups of varsity players. It was therefore speculated that these particular tests would not differentiate significantly between players who were in contention for the international level of selection and training.

Selection of Test Site

Basic to the design of the study was the testing of the highest level of women field hockey performers in our country today. The newly developed international selection and training program that was to be implemented throughout the country during the summer of 1978 by the United States Field Hockey Association provided the possibility of having subjects of that caliber available. This program, to be initiated at five Level C campsites across the United States, would yield a substantial number of subjects who within a three-week period would be classified as either successful or unsuccessful candidates for a pre-Olympic training program.

A memorandum was sent to members of the Executive Committee of the United States Field Hockey Association requesting their cooperation and permission to test players at their camps June 28 through July 16. Subsequent communication from the Executive Secretary of the organization indicated the Committee's approval with the reservation that the final decision would rest with the National

Coaching Staff involved at the various campsites. Close contact was kept with Sports Consultants, Incorporated, the organizing agency for all camp arrangements. It was through this contact that appropriate camps were identified to best satisfy the needs of the study with respect to obtaining an adequate number of subjects, consistency in facilities and other facilitative needs. One month prior to the opening of the Level C camp programs, final approval to conduct the research was granted the investigator by the coaching personnel in charge of the Level C camp at Franklin and Marshall College, Lancaster, Pennsylvania, and at the Level B campsite at Pennsylvania State University, State College, Pennsylvania (see Appendix C).

Arrangements for Physical Accommodations, Equipment and Supplies

During the process of preliminary preparation the following arrangements were made:

1. Site coordinators were contacted to arrange for in-camp housing for two persons (the investigator and an assistant) at the Level C camp, Lancaster, Pennsylvania, and at Level B camp, State College, Pennsylvania.
2. Facilities needed for data collection were requested from and assigned by the site coordinators.
   A. One classroom equipped with a movie screen and a 16 mm. projector.

B. An adjacent or nearby room, or office, available at the same time as the classroom.

C. A small area (either a portion of a gymnasium or other area) with wooden flooring.

3. Two hundred copies of each of the following forms were produced (see Appendix A).

A. Subject consent forms (required by UNC-Greensboro).

B. Personal Data Sheet (developed by the investigator).

C. Illinois Competition Questionnaire Form A (Martens, p. 93).

D. Scorecards developed for recording of raw data on the Chapman Ball Control Test and Scott Sideward Leap Test, as well as the scores from the SCAT, MEFT, and MRMT.

4. Three identical cassette tape recorders (Realistic, Model CTR-39) and corresponding AC adapters were purchased.

5. Thirty-six cassette tapes (Realistic C-30) were purchased.

6. Six copies of Test Information for Moving Embedded Figures were prepared and placed in plastic protective covers (see Appendix A).

7. A scoresheet for the transcription of timed responses on the MEFT was developed and duplicated.

8. A 16 mm. Kodak Pageant movie projector (manual load) was obtained to be taken to both test sites, along with extra projector bulbs.
9. A MRMT board was obtained to be taken to each test site.
10. Three yards of orange colored self-adhesive plastic (Con-Tact A-21) were purchased for use in the construction of floor targets for the Chapman Ball Control Test ard floor markings for the Scott Sideward Leap Test at each test site.
11. Two stopwatches (Junghans, three dial) to be used by the investigator for the transcription of timed responses to the nearest tenth of a second in the MEFT were obtained. Four additional stopwatches (Aristo, Appollo Shock Resistant) were obtained for the timing of trials to the nearest second in the MRMT, and the Chapman Ball Control Test by both the investigator and the research assistant.
12. One hundred pencils, two clipboards, one heavy-duty extension cord and wall-jack adapter, four household extension cords, film splices, a tape measure, scissors, black India marking pens, a compass, protractor and ruler, typing paper and a typewriter, four official hockey balls

(Chingford Red Seal) and eight badminton bird corks were collected and taken to the campsites.

In general, the equipment and supplies that were gathered and transported to the campsites were prepared in abundance to insure against loss, breakage, or some other unforeseen circumstances that could interrupt or unnecessarily detain the data collection process. Every attempt was made to anticipate any eventuality that could result in prolonged and/or inconvenient delays for subjects which might result in loss of subject participation.

Selection of Research Assistant

The services of a research assistant to expedite the data collection process during the limited hours that players would have free from scheduled camp activities was considered essential. Primarily, the assistant's role was to administer the MRMT, time trials for the CBCT, and demonstrate and administer the SSLT.

The criteria for selection of this assistant were: (1) availability and willingness to assist during the period of June 28-July 16, (2) the qualities of competence, efficiency, objectivity and congeniality, and (3) an interest in and knowledge of field hockey and the research process in general. The investigator was fortunate to obtain the services of a young woman meeting these criteria. The assistant was trained by the investigator to administer the MRMT, the SSLT and to time the CBCT.

Collection of Data

The collection of data included the introduction of the study for the purpose of selecting subjects, the administration of tests, and the compilation of the data.

Introduction of the Study--Subjects

An opportunity to introduce the study was provided at the close of the first evening camp session for each new group of camp participants. Following a brief overview of the study and a general description of what player involvement would entail, subject consent forms (see Appendix A) and pencils were distributed. Time and encouragement were provided for the careful reading of these forms prior to the request for their signing. Personal Data Sheets (see Appendix A) were then distributed to those who had signed consent forms. At the Level C camp, 84 subjects indicated their willingness to serve as subjects for the study; an additional 59 subjects were solicited from the Level B camp participants. The periodic cut sessions implemented at the Level C camp provided an attrition rate of players so that data were collected on only 60 of the 84 persons who originally consented to serve as subjects. At the Level B camp, time, as affected by changes in the scheduled camp activities, allowed for data to be collected from 46 of the 59 subjects previously solicited.

Administration of Tests

Administration of the five tests occurred on three separate occasions. One test was administered in a large group setting, two tests during a 30-minute period with three subjects scheduled during that time, and the other two tests during a 15-minute period which involved subjects being scheduled in pairs. The sequence of tests was as follows:

1. Sports Competition Anxiety Test - Prior to the close of the 30-minute session in which the study was introduced, copies of the Illinois Competition Questionnaire, Form A (see Appendix A), were distributed as Personal Data Sheets were collected. As these were completed and returned, subjects were informed where testing schedules would be posted regularly on a day-by-day basis (see Appendix B).

2. Moving Embedded Figures Test - This test was administered during evenings following a full day of play. Subjects using eye correction during play were instructed to wear this same correction for the viewing of this filmed test. Players were scheduled to arrive at the test site in groups of three. Seated at desks on which the tape recorders were placed, subjects were instructed to read the Test Information for Moving Embedded Figures (see Appendix A). Verbal instructions were then given for the use of the tape recorders and some additional instructions

for the test were offered (see Appendix A). During the projection of the film the investigator manually increased the volume prior to each of the five examples and 27 test items to insure the recording of the subaudible tone that accompanied these items as they initially appeared on the screen. Following this 10-minute test, subjects were directed to the location of the research assistant to complete the second test that was scheduled during that session.

3. Two-Hand Turning and Placing - This test immediately followed the MEFT and was administered in a room adjacent or nearby the previous test location. Chairs were placed outside the area for subjects to await turns for testing. Each subject was given instructions and scored on this test by the research assistant. Approximately three minutes were required for the completion of three trials by each subject. Upon conclusion of the testing session, the subject was asked to select a testing time for the remaining two tests on the following day. Periods of 15-minute duration were made available during the intervals that followed meals and the subsequent activity sessions (see Appendix A). Subjects were also informed of the test-site location and instructed to wear gym shoes and to bring their own field hockey stick to that test session (see Appendix B).

4. Chapman Ball Control Test - The investigator introduced this test to a pair of subjects through demonstration and discussion of scoring techniques (see Appendix A) at one of the two practice targets that were marked on the floor. A maximum of three minutes of practice time was then allowed each subject at either of the two circles. As players alternated their three 15-second trials, the player resting was seated and visually screened from view of the test circle. Due to the difficulty in scoring this test, the research assistant timed the trials and gave the command to stop while the investigator counted the correct score.

5. Scott Sideward Leap Test - Following the Chapman Ball Control Test, both subjects were given the instructions for this test by the investigator while the research assistant demonstrated the various techniques necessary for proper test execution (see Appendix A). Two test areas were marked on the floor. Both subjects were tested at the same time with one of the two data collectors testing at each of the two test stations.

Tester reliability was determined through the comparison of scores on the first five subjects engaged in the test. An item-for-item comparison yielded a percentage of agreement score of 92 percent. A ranked correlation of differences of sets of subscores produced a reliability coefficient equal to .98.

Throughout the data collection process, serious attempts were made to maintain a consistency in test conditions for all subjects. Although the two locations differed somewhat, most situations did provide similarity in the testing environments. These similarities were achieved through the standard procedures employed in : (1) the communication with subjects, (2) the scheduling of subjects and tests, (3) test sequencing, (4) test administration, and (5) providing the physical arrangement of test facilities.

Compilation of the Data

Subsequent to the collection of data at each test site was the compilation and storage of all scores in preparation for future treatment. The following steps were taken:

1. A scoring template for the SCAT was prepared according to test booklet instructions (Martens, p. 91), and all tests were scored by the investigator. Following a recheck of the scores by the research assistant, these were transcribed onto the score cards used to record scores for trials of the ball control and the balance test (see Appendix A).

2. Verbal responses for each item of the MEFT were timed by the investigator and recorded onto the score sheets designed for this purpose. Scores for the 27 items

were then totaled. These figures, before being transferred onto the individual score cards, were checked by the research assistant. Each day (following the first) that tapes were transcribed, the investigator performed a reliability check with scores obtained on the next to last tape that was transcribed on the previous day. The transcription of raw data from the tapes did not occur unless an $r = .95$ or better could be achieved.

3. The number of seconds recorded for the last two trials in the MRMT were summed following the close of each evening test session. The following day, scores were checked and then transferred to the individual subject's score card.

4. Procedures similar to those stated above for the MRMT were used in the compilation of the CBCT and the SSLT with all scores for each test being summed and then checked on each score card.

At the termination of each of the two camp sessions, scores from the score cards were placed on a master score sheet (see Appendix D) to provide a complete alphabetical listing of subjects, their selection status and a summary of the raw data.

Treatment of Data

Two subprograms of the Statistical Package for Social Sciences (SPSS) Programs were employed to analyze

the data. These subprograms were a stepwise discriminant function analysis and a one-way ANOVA.

A stepwise discriminant function analysis was utilized to determine whether criterion groups could be distinguished from each other using the primary set of five variables; that is, anxiety, visual perception, manual dexterity, ball control, and balance. The criterion groups were formed on the basis of individual players' selections to the various levels of camp participation. Years of playing experience and playing position served as secondary considerations for investigation in this study. A one-way ANOVA was employed to assess the significances of differences between groups of players designated as forwards, backs, and goalies for each of the five variables under primary investigation. The Pearson Product Moment Correlation Coefficient was utilized to assess relationships between some selected predictor variables. The .05 level of significance ($p < .05$) was established as the critical level for all data in this study.

CHAPTER IV

PRESENTATION AND DISCUSSION OF DATA

Presentation

Scores on five tests, selected for use in this investigation, provided the data for the comparison of subjects categorized into different groups according to field hockey playing ability. The five tests were the Sports Competition Anxiety Test (SCAT), Moving Embedded Figures Test (MEFT), Minnesota Rate of Manipulation Test (MRMT), Chapman Ball Control Test (CBCT), and Scott Sideward Leap Test (SSLT). Level of camp participation, determined by player selection based on subjective evaluation of field hockey playing ability, served as the criterion measure in the study. In addition, test results were compared to playing positions--forwards, backs and goalies. Years of playing experience also served as a secondary focus in the analysis.

Data were collected from 106 subjects who participated in the international selection and training camps sponsored by the United States Field Hockey Association during the summer of 1978. Sixty of these subjects were tested at a Level C camp that was conducted in Lancaster, Pennsylvania and 46 others were tested at a Level B camp

site, State College, Pennsylvania. The obtained data were then analyzed statistically by multivariate analysis, multiple discriminant function analysis, and a one-way analysis of variance. The Pearson Product Moment Correlation Coefficient was used to assess relationships between selected predictor variables.

Multiple Discriminant Function Analysis

The intent of this investigation was to determine if results derived from the five predictor variables would correctly classify individual performers into groups identified as successful in contrast to less successful field hockey players. The multiple discriminant function analysis determines whether groups can be distinguished from one another on the basis of a set of measures. The analysis takes into account the relationships between all variables, the variability of group means and the variables, and individual variability about group means on all variables. An important feature of this technique involves the consideration of a set of measures as a whole rather than as separate, independent factors (Kroll & Peterson, 1965). Separation of the groups is maximized through the formation of the functions. The maximum number of functions to be formed is either one less than the number of groups or equal to the number of discriminating variables, if there are more groups than variables. Once these have been derived, it is possible to pursue the two

research objectives of this technique: analysis and classification (Klecka, 1975).

The analysis aspects of this technique provide statistical tests for measuring the success with which the discriminating variables actually discriminate when combined into the discriminant functions. The classification aspect of this technique follows the initial computation that identifies a set of variables which provides satisfactory discrimination for cases with known group memberships. A set of classification functions can then be derived which will permit the classification of new cases with unknown membership (Klecka, 1975).

Raw data for each of the 106 subjects included scores on the SCAT, MEFT, MRMT, CBCT, SSLT, and group classification of players as Level A camp participants, Level B camp participants and Level C camp participants. These data were subjected to a stepwise multiple discriminant function analysis using the Statistical Package for Social Sciences computer program. This subprogram allows for each of the independent variables to be selected for entry into the analysis on the basis of their discriminating power. The stepwise procedure begins by selecting the single variable which has the highest value on the selection criterion. One at a time then, this initial variable is paired with each of the other available variables, and the selection criterion is computed. The second variable

selected to "enter the equation" is the one that produces the best criterion value when placed in conjunction with the initial variable selected. This stepwise process of locating the next variable that would produce the best criterion score, given the variables already selected, continues until all variables are selected or no additional variable provides sufficient contribution to the discriminant analysis. Thus, use of a stepwise process results in the selection of an optimal set of variables from which the classification functions are derived (Klecka, 1975).

The discriminant analysis subprogram also: (1) indicates for each group, the number of cases classified into the respective groups and the percentage of correct classifications for the known group memberships, and (2) plots a graphical illustration that indicates the dispersion of group members about the group centroids (mean discriminant scores for each group on the respective functions)(Klecka, 1975).

The findings of the stepwise discriminant function analysis are reported in Table 1. The value of the F statistic represents the discriminatory power of each variable. The minimum value necessary for entry into the equation is 1.00. These results indicate that dynamic balance is the single most discriminating variable among the three groups. Ball control was also an important discriminating variable and anxiety has some but lesser

importance in the distinction of group membership. Manual dexterity and visual perception failed to provide sufficient contribution to the discriminant analysis.

Table 1

Stepwise Discriminant Function Analysis of Three-Group Classification (N = 106)

Step Number	Variable	Value of F Statistic
1	Dynamic Balance (SSLT)	11.29
2	Ball Control (CBCT)	7.14
3	Anxiety (SCAT)	1.84

Table 2 summarizes the classification of all subjects on the predictor variables and reports the number and percentages of correctly classified members in each of the groups of Level A, Level B, and Level C camp participants. Examination of this summary reveals that although 65.7 percent of Level A and 71.4 percent of Level C camp participants were correctly classified, there is still a considerable amount of overlap in group composition. A report of 58.49 percent of correctly classed cases supports this observation.

Table 2

Number and Percentage of Classification of Predicted Group Membership, Three-Group Analysis (N = 106)

		Subject Classification		
Group	No. of Cases	A Camp Participants	B Camp Participants	C Camp Participants
A Camp Participants	41	27 (65.7)	5 (12.2)	9 (20.0)
B Camp Participants	30	10 (33.3)	10 (33.3)	10 (33.3)
C Camp Participants	35	5 (14.3)	5 (14.3)	25 (71.4)

Note. Percentage of grouped cases correctly classified = 58.49.

Figure 1 provides a spatial summary of the treated data. The letters represent individual cases of group membership, and correspond with Levels A, B, and C camp participation. This scatterplot reveals an interspersion of groups by membership. The group centroids, represented by an asterisk (*), are the mean discriminant scores for each group on the respective function and summarize the group locations in the (reduced) space defined by the discriminant functions. The position of each group centroid represents the most typical location of a case from that group in the discriminant function space (Klecka, 1975). Observation of the position of the group centroids in

Figure 1 illustrates a lesser distinction between Level A and Level B camp participants than between Level B and Level C camp participants or Level A and Level C camp participants.

A sixth variable, years of experience, was included as a secondary focus in the discriminant analysis. Although this procedure did not alter the results of the original stepwise analysis, the variable was entered into the equation on Step 4 of the discriminant function analysis with an F value of 1.20. This indicated that years of playing experience had some discriminating power, in the distinquishing among the three groups. This variable, however, contributed even less than anxiety. The addition of the years of experience variable also had a slight effect on the composition of the groups and the percentage of cases correctly classified. These findings are presented in Table 3.

Table 4 reports the standardized functions constructed from the discriminant analysis. Values reported reflect the order of weights each variable contributed in forming each function; that is, in the formation of the first function, dynamic balance contributed the most, followed by ball control, anxiety, and years of playing experience, respectively. Years of experience was the variable that had the greatest influence in the formation of the second function, followed by ball control, anxiety,

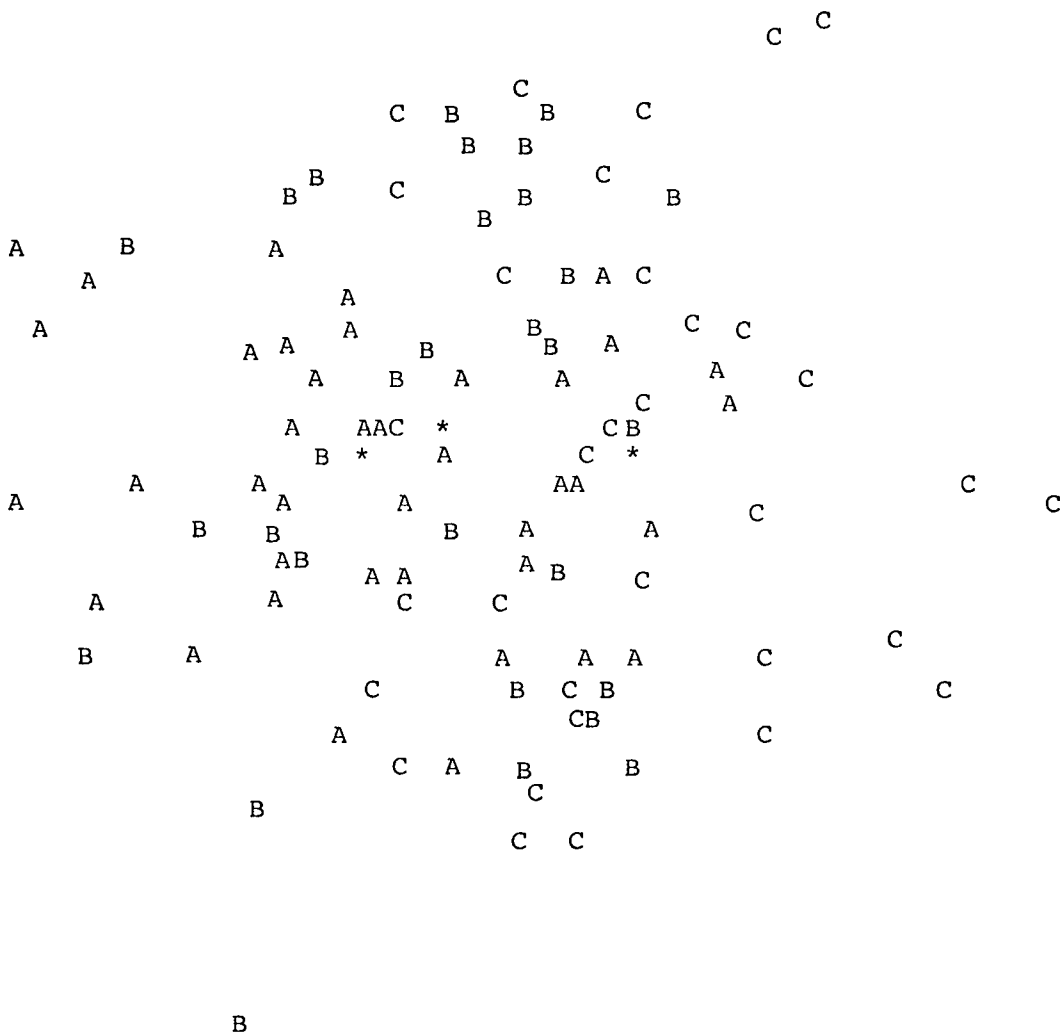

Figure 1. Plot of discriminant scores, three-group analysis.

Table 3

Number and Percentage of Classification of Predicted Group Membership, Including Years of Playing Experience (N = 106)

		Subject Classification		
Group	No. of Cases	A Camp Participants	B Camp Participants	C Camp Participants
A Camp Participants	41	26 (63.4)	7 (17.1)	8 (19.5)
B Camp Participants	30	9 (30.0)	11 (36.7)	10 (33.3)
C Camp Participants	35	6 (17.1)	5 (14.3)	24 (68.8)

Note. Percentage of grouped cases correctly classified = 57.55.

and then balance, in that order. The canonical correlation that is reported is an index of how closely the function and the "group variable" are related (Klecka, 1975).

The means and standard deviations for the three groups are reported in Table 5. In the SCAT, MEFT, and the MRMT, low figures represent the better performances, whereas in the CBCT and the SSLT, the better performances are represented by the larger values. An examination of these data reveals that the subjects in the Level A camp group appear to score higher than those in Level B and C groups on the CBCT and SSLT. The scores of Level A group subjects on the SCAT also appear to be lower than those for the Level B and C groups.

Table 4

Standardized Discriminant Function Coefficients, Three-Group Analysis (N = 106)

Source	Function 1	Function 2
Anxiety (SCAT)	.29	.36
Ball Control (CBCT)	-.46	.67
Dynamic Balance (SSLT)	-.60	.01
Years of Experience	-.16	-.94

Note. Canonical correlation, Function 1 = .558.
Canonical correlation, Function 2 = .127.

That this was indeed the case is supported by the data presented in Table 6. The univariate F values represent the significance of differences between group means when each of the variables is considered as a separate, independent factor (Klecka, 1975). It is interesting to to note that although years of experience was entered into the equation as a discriminating variable in the construction of the functions, the variable failed to achieve an F sufficiently high enough to indicate a significant difference between group means.

Table 5

Means and Standard Deviations of Sport Competition Anxiety Test, Moving Embedded Figures Test, Minnesota Rate of Manipulation Test, Chapman Ball Control Test, Scott Sideward Leap Test and Years of Playing Experience for All Subjects, A Camp Participants, B Camp Participants, and C Camp Participants (N = 106)

	A Camp Participants N = 41		B Camp Participants N = 30		C Camp Participants N = 35		Total Group N = 106	
Variable	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Anxiety (SCAT)	17.83	2.79	18.83	4.17	20.29	4.03	18.92	3.76
Visual Perception (MEFT)	32.65	6.66	34.59	8.09	34.65	7.81	33.86	7.46
Manual Dexterity (MRMT)	75.22	8.73	76.60	7.30	75.49	6.38	75.70	7.57
Ball Control (CBCT)	78.41	18.16	74.57	14.67	60.89	16.68	71.54	18.28
Dynamic Balance (SSLT)	43.29	7.98	40.43	11.01	32.71	10.82	38.99	10.80
Years of Experience	8.56	2.79	7.57	2.81	7.23	2.41	7.84	2.72

Table 6

Univariate F Ratio, Three-Group Analysis
(N = 106)

Source	df	F
Anxiety (SCAT)	2/103	4.30*
Visual Perception (MEFT)	2/103	.88
Manual Dexterity (MRMT)	2/103	.30
Ball Control (CBCT)	2/103	11.03**
Dynamic Balance (SSLT)	2/103	11.29**
Year of Experience	2/103	2.55

*p < .05 = 3.09.

**p < .01 = 4.82.

To further analyze the data, a stepwise discriminant function analysis was also performed using only two groups. These groups were Level A and Level C camp participants. Results of this analysis are reported in Table 7. Observation of the data indicates that the same three variables were entered into the equation and in the same order as in the three-group analysis; that is, dynamic balance was the single most discriminating variable in forming the function, followed by ball control and anxiety, successively.

Table 7

Stepwise Discriminant Function Analysis of Two-Group Classification (N = 76)

Step Number	Variable	Value of F Statistic
1	Dynamic Balance (SSLT)	23.96
2	Ball Control (CBCT)	9.09
3	Anxiety (SCAT)	3.29

Table 8 summarizes the classification of subjects in the two groups on the predictor variables and reports the numbers and percentages of correctly classified members in each of the two groups of camp participants. The data reveal that the percentage of cases correctly classified was increased from 58.49 percent achieved in the three-group analysis to 75 percent.

Inclusion of a sixth variable, years of playing experience, did not alter the results of the classification of the original two-group discriminant analysis, nor was the variable entered into the equation to form the function. The composition of predicted group membership also remained the same as that reported in Table 8. Figure 2 graphically illustrates, in the form of a histogram, a linear plot of group membership. The standardized

Table 8

Number and Percentage of Classification of Predicted Group Membership, Two-Group Analysis (N = 76)

	Subject Classification		
Group	No. of Cases	A Camp Participants	C Camp Participants
A Camp Participants	41	31 (75.6)	10 (24.4)
C Camp Participants	35	9 (25.7)	26 (74.3)

Note. Percentage of grouped cases correctly classified = 75.00.

discriminant function coefficients for the two-group analysis are presented in Table 9.

A summary of the separate univariate F ratios for each of the six variables is presented in Table 10. This analysis reveals that the two groups differed significantly in each of the following variables: anxiety, ball control, dynamic balance, and years of playing experience. This analysis indicated that the Level A group of players were less anxious, had greater ball control, greater dynamic balance and more years of experience than those players in the Level C group of players.

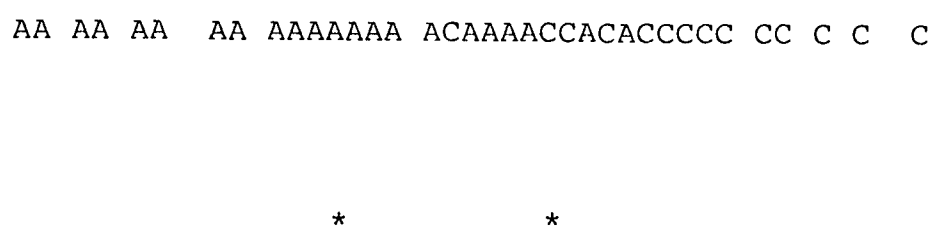

Figure 2. Plot of discriminant scores, two-group analysis.

Table 9

Standardized Discriminant Function Coefficients, Two-Group Analysis (N = 76)

Source	Function
Anxiety (SCAT)	.31
Ball Control (CBCT)	-.41
Dynamic Balance (SSLT)	-.62

Note. Canonical correlation = .598.

One-Way Analysis of Variance

A secondary focus in the analysis of the data was a comparison of scores achieved on the five predictor variables and subject's playing position; that is, forwards, backs, and goalies. Raw data for each of the 106 subjects and subjects' playing positions were subjected to a one-way ANOVA to determine whether goalies, forwards and backs differed with respect to scores on the SCAT, MEFT, MRMT, CBCT, and SSLT. The means and standard deviations are reported in Table 11. When examining the mean scores by position, it can be seen that forwards, backs, and goalies scored relatively the same on each of the five predictor variables, with the exception of the ball control test. It can be noted that those who play goalkeeper did not perform

Table 10

Univariate F Ratio, Two-Group Analysis
(N = 76)

Source	df	F
Anxiety (SCAT)	1/74	9.77**
Visual Perception (MEFT)	1/74	1.45
Manual Dexterity (MRMT)	1/74	.02
Ball Control (CBCT)	1/74	18.95**
Dynamic Balance (SSLT)	1/74	23.96**
Years of Experience	1/74	4.86*

*p < .05 = 3.98.

**p < .01 = 7.01.

as well in this test. The smaller standard deviation indicates that this lower performance level in the ball control test is more typical of the group of goalies, when compared to the performances of forwards and backs.

Results of the one-way ANOVA are presented in Table 12, Table 13, Table 14, Table 15, and Table 16. The low F values reported in Tables 12, 13, 14, and 16 indicate that no significant differences existed between groups of players (forwards, backs, and goalies) in anxiety, visual

Table 11

Means and Standard Deviations of Predictor Variables by Playing Position
(N = 106)

	Forwards N = 54		Backs N = 40		Goalies N = 12	
Variable	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Anxiety (SCAT)	18.87	3.42	18.85	4.06	19.42	4.44
Visual Perception (MEFT)	33.49	8.26	33.98	6.43	35.13	7.29
Manual Dexterity (MRMT)	74.43	6.41	76.55	8.46	78.58	8.66
Ball Control (CBCT)	74.54	18.97	72.43	17.14	55.08	8.44
Dynamic Balance (SSLT)	40.54	9.77	38.20	11.87	34.67	10.89

perception, manual dexterity, and balance. The F ratio reported in Table 15 indicates a significant difference between groups at the .01 level. The Sheffé Test was used to determine which differences in means were significant. The results presented in Table 17 reveal that a significant difference existed between scores achieved by goalies when paired with both forwards and backs. No significant differences were detected between scores achieved by forwards and backs.

Discriminant Function Analysis Using Dummy Variable

A feature of the discriminant analysis subprogram of the Statistical Package for the Social Sciences computer program is the opportunity to develop a "dummy variable" by providing an alternate intercept for the analysis of a prescribed portion of the data input. Based on the information obtained from the one-way ANOVA, this feature was employed to allow for the original statistical model to fit a different function of ball control for the goalies. The utilization of this technique in a two-group stepwise discriminant analysis produced an increase in the percentage of successful prediction of group membership to 78.95. This information is summarized in Table 18. The results of the stepwise discriminant function analysis are presented in Table 19, and the standardized coefficients are listed in Table 20. Observation of the information in Table 20 reveals that the dummy variable created for

Table 12

One-Way Analysis of Variance of Playing Position Utilizing Sport Competition Anxiety Test

Source of Variance	df	SS	MS	F
Between Groups	2	3.30	1.65	.12
Within Groups	103	1478.10	14.35	
Total	105	1481.40		

Table 13

One-Way Analysis of Variance of Playing Position Utilizing Moving Embedded Figures Test

Source of Variance	df	SS	MS	F
Between Groups	2	27.11	13.55	.24
Within Groups	103	5813.30	56.44	
Total	105	5840.41		

Table 14

One-Way Analysis of Variance of Playing Position Utilizing Minnesota Rate of Manipulation Test

Source of Variance	df	SS	MS	F
Between Groups	2	216.31	108.16	1.92
Within Groups	103	5798.01	56.29	
Total	105	6014.32		

Table 15

One-Way Analysis of Variance of Playing Position Utilizing Chapman Ball Control Test

Source of Variance	df	SS	MS	F
Between Groups	2	3766.18	1883.09	6.19*
Within Groups	103	31311.95	304.00	
Total	105	35078.14		

*$p < .01 = 4.82$.

Table 16

One-Way Analysis of Variance of Playing Position Utilizing Scott Sideward Leap Test

Source of Variance	df	SS	MS	F
Between Groups	2	378.53	189.26	1.64
Within Groups	103	11860.44	115.15	
Total	105	12238.96		

Table 17

Results of Sheffé S-Test Applied to Data from Chapman Ball Control Test and Playing Position

Group	Mean	II	III
I Forwards	74.54	.17	6.36*
II Backs	72.43		4.72*
III Goalies	55.08		--

*Significant at .05 level ($S \geq 3.51$).

goalies performances on the ball control test made a greater contribution to the formation of the function than did anxiety, measured by the Sports Competition Anxiety Test. Dynamic balance and ball control are still the highest contributors.

Pearson Product Moment Correlation Coefficient

Of interest to the investigator in the prediction of successful performance in field hockey is the assessment of the relatively new and inexperienced players and their possible potential for development in the sport. Therefore, the subprogram, Pearson Product Moment Correlation of the Statistical Package for the Social Sciences computer program was employed to determine if the one predictor variable specific to field hockey, ball control, correlated with the manual dexterity measure (Two-Hand Turning and Placing Test of the MRMT), and/or years of playing experience. The results of these comparisons are summarized in Table 21. It can be noted that significant correlations (although quite low) existed between years of experience and ball control and years of experience and manual dexterity. The relationship between ball control and manual dexterity was not statistically significant. The means and standard deviations for these comparisons are presented in Table 5.

Table 18

Number and Percentage of Classification of Predicted Group Membership, Two-Group Analysis, Using Dummy Variable (N = 76)

	Subject Classification		
Group	No. of Cases	A Camp Participants	C Camp Participants
A Camp Participants	41	33 (80.5)	8 (19.5)
C Camp Participants	35	8 (22.9)	27 (77.1)

Note. Percentage of grouped cases correctly classified = 78.95.

Table 19

Stepwise Discriminant Function Analysis Including Dummy Variable, Two-Group Classification (N = 76)

Step Number	Variable	Value of F Statistic
1	Dynamic Balance (SSLT)	23.95
2	Ball Control (CBCT)	9.09
3	Ball Control-Goalies (CBCT)	5.01
4	Anxiety (SCAT)	4.24

Table 20

Standardized Discriminant Function Coefficients Using Dummy Variable for Goalies' Ball Control Scores
(N = 76)

Source	Function
Anxiety (SCAT)	.32
Ball Control (CBCT)	-.43
Dynamic Balance (SSLT)	-.64
Ball Control-Goalies (CBCT)	-.36

Note. Canonical correlation = .638.

Table 21

Correlation Matrix of Minnesota Rate of Manipulation, Chapman Ball Control Test, and Years of Playing Experience
(N = 106)

Variable		2	3
Manual Dexterity (MRMT)	1	-.12	-.22*
Ball Control (CBCT)	2		.31**
Years of Experience	3		

*p < .05 = .20.

**p < .01 = .25.

Discussion

The criterion groups in this investigation were determined by the selection of individual players based on their playing performance at two of the international selection and training camps sponsored by the United States Field Hockey Association during the summer of 1978. Five Level C camps were held throughout the country during the period of June 28 through July 7. Any woman interested in being selected and trained for international play was permitted to enter one of the Level C camps.

All of the data for Level C camp participants in this study were collected at the Lancaster, Pennsylvania camp site. This group was comprised of those subjects who attended the camp, but were not selected to go on to the Level B camp. The single Level B camp was held July 9-16 at State College, Pennsylvania. Players who participated in that camp program were all of the Level C camp participants selected at the various five sites, in addition to a group of previously selected players who had been training with the United States Squad Program over past years. (These players, approximately 25 to 30, were permitted automatic entry into the camp program at the B Level.) In this study, the group of subjects who attended the Level B camp, but were not selected for further training were identified as Level B camp participants. The group known as Level A camp participants was comprised of the women

field hockey players who were selected for the United States international training program.

Throughout the selection process, a strong emphasis was placed on the need to prepare for a possible berth in the 1980 Olympics, and at the same time, to attempt to strengthen our "Twenty-three and Under" youth development program at the international level. (Only those 21 years of age and under were considered for future involvement in this program.)

Group Classification

Examination of the values of the F statistic in Table 1 clearly indicates that dynamic balance, measured by the Scott Sideward Leap Test, was the single most discriminating variable among the groups. Ball control was also a strong contributor, whereas anxiety contributed much less in the discriminating process. Table 2 refers to the group classification using the data on all three groups in the discriminant function analysis. These figures indicate that Level A and Level C camp participants are somewhat more clearly defined as groups, whereas the B Level camp participants show little distinction of their own. Of the 30 players comprising the group of Level B camp participants, 10 had characteristics of the Level C camp participants, while another 10 most clearly resembled those subjects in the Level A camp group. It is the opinion of the investigator that the lack of a more clear group

distinction, particularly in the case of the Level B camp participants, could possibly be attributed to two factors: (1) selection standards could have varied at the five Level C camps, and (2) some of the United States Squad players who had been training and participating at the international level and had entered the camp program at the Level B camp had reached their prime, so to speak, and were not selected to go on to the Level A camp. The latter factor along with other time and age-related concerns for the development of the sport in our country all seem contributive to the lower percentage of correctly classified cases reported in Table 3 when years of experience was included as a variable.

Figure 1 visually depicts the dispersion of individual group members about the three-group centroids (means). The two centroids for Level A and Level B camp participants are more closely aligned to one another than are the Level B and Level C group centroids. It can be interpreted that there is lesser distinction between Level A and Level B camp participants than there is between Level B and Level C camp participants. Again, this could be attributed to the points brought out by the foregoing discussion related to years of experience and the possible lack of clear cut selection standards at the various Level C Camps.

The similarity of Level A and Level B camp participants when compared to Level B and Level C camp

participants can also be supported by examination of the means reported in Table 5, when performances in the two most discriminating variables (balance and ball control) are noted. One might surmise that previously selected squad players who were no longer retained in the program were able to perform well on these two tests even though it was judged by others that their playing days at the international level were perhaps limited.

The second discriminant function analysis using two groups in the treatment, the most successful group of selected field hockey players and the less successful group of not selected players, produced an increase in the percentage of correctly classified cases from 58.47 to 75 percent. This, in the opinion of the investigator, can be clearly attributed to the amount of confounding information contained within the results of Level B camp participants discussed earlier. The addition of number of years of playing experience as a variable did not change the composition of groups nor did it affect the percentage figure for correctly classified cases. This might have been expected, as there is very little difference in the number of years of experience between these two groups, as reported in Table 5. These results are supportive of the reason stated for improved prediction of successful and less successful cases. A summary of the results of the second discriminant function analysis is found in Table 8.

The histogram presented in Figure 2 visually illustrates the more clearly defined group memberships that exist between Level A camp participants and Level C camp participants.

Although Table 7 reports that the outcome of the second discriminant analysis resulted in the same three variables (dynamic balance, ball control and anxiety) making relevant and sufficient contributions to the construction of the function, it can be observed that the discriminatory power of all three variables increased. It is logical to assume that the removal of the middle group would provide for greater discriminating power of the variables. Supportive of this also is the information on the two-group analysis reported in Table 10. When the univariate F ratio values are compared to the values of corresponding information for the three-group analysis found in Table 6, it is evident that values reported on the three discriminating variables were all significant at the .01 level. The values reported in Table 6 disclose that only in the case of the balance and ball control variables were the differences significant at the .01 level. The anxiety variable difference was significant at the .05 level.

The finding that dynamic balance was the single most discriminating variable that distinquished between groups in both the three-group and the two-group analysis

tends to be supportive of the results from other studies found in the literature. Greenlee (1957) and Sanborn and Wyrick (1969) studied dynamic balance in relation to sports performance, using the Scott Sideward Leap Test as their means of assessment and college women as their subjects. Greenlee found that dynamic balance was the only factor that significantly correlated with successful bowling performance. Sanborn and Wyrick found that the most effective combinations of predictors of balance beam skill were the Scott Sideward Leap Test and their modification of that test (performed on a platform raised 3'11" from the floor).

The statistical difference found between selected groups of successful and less successful field hockey players and anxiety appears to be contrary to the literature. Martens (1977) reported that the Sports Competition Anxiety Test alone did not reliably predict subjects' motor performances. Perhaps the source of this contradiction lies in the general level of performance of Martens' subjects in contrast to that of the subjects used in this study.

The fact that visual perception, as measured in this investigation, failed to discriminate between the groups of selected field hockey players warrants comment. Mean scores for the MEFT shown in Table 5 indicate a slight ordinal pattern from low to high (scores in number of seconds). This could mean that the modified version of

the MEFT does test properties of visual perception under pure dynamic conditions, but it would be more appropriate for use with adults if some items were made more difficult.

Analysis by Playing Position

A one-way ANOVA was performed to determine if a difference existed between the performances of subjects by playing positions (forwards, backs, and goalies), and the five predictor variables. From the results reported in Tables 12, 13, 14, 15 and 16, it could be concluded that only in the ball control test did their performances differ significantly. To examine where the differences did exist, the Sheffé post hoc test of multiple comparisons was employed. It was found that goalies differed significantly in their performance when compared with forwards and backs. It would be a logical assumption that this difference could exist due to the nature of the skills required for the successful goalkeeper as compared to the players in the field positions. The only legal way to maneuver the ball on the field is with the stick. The goalie, however, may use her body to play the ball. Thus, goalkeepers are coached to use primarily their legs and feet within the goal area. Use of the stick is encouraged only as a last resort.

The assumption that goalies would not possess as good ball control skills with stick usage is supported by the information presented in Table 17. Creation of a

"dummy variable" for use in further treatment of the data for goalies' ball control scores raised the level of successful prediction of correctly classed subjects to 78.95 percent.

Relationship Between Ball Control, Manual Dexterity, and Years of Experience

The results indicated that there was no statistically significant relationship between scores on the CBCT and the MRMT for all subjects. Years of experience however, was significantly related to the MRMT and the CBCT at the .05 and .01 level, respectively. These results could be interpreted to mean that both of these tests assess skill ability that can be acquired through practice and experience over a period of time.

Childress (1972) in his study on the prediction of successful male basketball players found through factor analysis that two variables, field goal shooting and manual dexterity, were identified as factors that distinguished successful high school basketball players from those classified as less successful players. Childress employed the MRMT as the means for measuring manual dexterity. Thus, the findings on manual dexterity and ball control in this investigation on women field hockey players do not support those that resulted in the prediction among male basketball players.

Failure of the MRMT to significantly discriminate between groups of subjects classified as successful and less successful players in this study as contrasted with the findings by Childress (1972), may indicate that the appropriate use of this test has some limitations. Childress used high school-aged male basketball players as his subjects. It may be that the test discriminates best with performers of a lesser level of skill ability than it does with the more highly skilled.

An additional consideration in regard to the overall results of the test in this study is that perhaps the sport of field hockey attracts those persons who possess greater qualities of manual dexterity, and thereby more readily develop the ball control skills required for successful participation in the sport. When comparing total group means ($\underline{N}$ = 106) to the test norms, it is found that the achieved mean is at the 88th percentile. Closer observation of the raw data reveals that of the 106 subjects, only four individual scores were reported lower than the 50th percentile. It is of further interest to the investigator that of these four scores, two of the scores were acquired by goalies.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to determine what, if any, predictive qualities could be identified in a group of skilled women field hockey players. The specific areas of performance investigated were anxiety, visual perception, manual dexterity, ball control, and dynamic balance.

A total of 106 women field hockey players served as subjects. Subjects were grouped according to the level of selection each achieved as a participant in the international selection and training camps sponsored by the United States Field Hockey Association. Players who entered one of the Level C camps (Lancaster, Pennsylvania) but were not selected to participate at the Level B camp (State College, Pennsylvania) were classified as the least successful group of skilled players. Those players who were selected from the Level B camp to participate in Level A camp were identified as the most successful group of field hockey players.

Data were collected during a period from June 28-July 16, 1978. All tests were scheduled and administered by the investigator and a qualified research assistant.

Each of the tests was encountered in the same sequence by all subjects. Uniform test conditions were established at each of the two test sites.

The Sports Competition Anxiety Test (SCAT) served to assess anxiety. This short paper-and-pencil test was administered to all subjects on the first evening of camp participation. Scores could range from 10 (indicating a low competitive anxiety trait) to 30 (indicating a high competitive anxiety trait). These subjects' scores ranged from 12-28.

Visual perception was tested using a modified version of the Herkowitz Moving Embedded Figures Test (MEFT). Subjects were scheduled during evening hours in groups of three to view this filmed test. Responses to the 27 test items were recorded onto cassette tapes. The test was scored later by transcribing the length of each timed response. Timing began at the sound of a subaudible tone that accompanied the beginning of each item and ended when the subject correctly identified the moving embedded figure. Maximum length of time for any of the 27 items was six seconds. Scores on all items were totaled to provide an individual score for each subject. These scores ranged from 22.1 seconds to 59.1 seconds.

To determine manual dexterity, the Two-Hand Turning and Placing Test of the Minnesota Rate of Manipulation Test (MRMT) was administered to each of the subjects

following the MEFT. The subject's score was the total number of seconds it took to complete the task of transferring the 60 cylindrical blocks from one board to the other, turning and placing them two at a time, in a systematic order. Three trials were given, but only scores on the last two were recorded. Total number of seconds ranged from 57 to 112.

The skill of ball control was evaluated by a test designed by the investigator. Each subject was administered the Chapman Ball Control Test (CBCT) individually. The test requires quick controlled movements of the arms and hands to tap the ball with the stick into and out of a circular target that is marked on the floor. Each subject was timed for three 15-second trials. The total of correct taps for all three trials served as the score. Scores ranged from 33 to 113.

Dynamic balance was measured by the Scott Sideward Leap Test (SSLT) and was administered to each subject individually immediately following the CBCT. The test requires that the subject leap sideward from one foot onto the other to a one inch square marked on the floor. The distance to be leaped corresponds to the length of the subject's leg. Immediately upon landing the subject must bend forward to displace a small object from its position on the floor 18 inches in front of the subject, and remain balanced on the landing foot for a maximum of five seconds.

Each subject was given a series of three trials on each foot and then the series was repeated for a total of 12 trials. A maximum score of 60 could be achieved on this test. Subjects' scores ranged from 12-60.

The Statistical Package for Social Sciences (SPSS) Computer Programs was utilized to compute a multiple discriminant function analysis. This statistical technique identified those variables which discriminated between the groups of selected camp participants. A second subprogram of the SPSS, a one-way analysis of variance was employed to assess the differences between groups of players according to their playing positions. The Sheffé post hoc test was applied when a significant F ratio indicated that differences existed. The Pearson correlation technique was utilized to determine the relationship between some selected predictor variables. The alpha level of significance was set at .05 for all data in the study.

Results indicated that dynamic balance, ball control, and anxiety were the discriminating variables for the groups of selected women field hockey players. Visual perception and manual dexterity, as measured in this study did not discriminate between successful and less successful field hockey players. Years of playing experience was not an important factor in group classification. Significant differences did exist between ball control skills of goalies and field players. Classification of subjects

determined by the stepwise discriminant function analysis indicated that on the basis of the three discriminating variables correct group membership could be predicted 78.95 percent of the time, provided the goalies' ball control skills were analyzed separately from those of the forwards and backs.

Conclusions

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

1. Dynamic balance, ball control and anxiety distinguish the most successful field hockey players from less successful field hockey players.

2. Visual perception and manual dexterity, as measured in this investigation, are not significant factors in the prediction of successful field hockey players.

3. There are no significant differences in the performances of forwards, backs, and goalies in anxiety, visual perception, manual dexterity, and balance.

4. Goalies' performances in ball control (stickwork) differ significantly from performances of forwards and backs. The goalies' performances were lower.

5. Years of playing experience is not a significant factor in distinguishing between the most successful field hockey players and less successful field hockey players.

Recommendations

On the basis of results from this investigation, the following recommendations are suggested for future research:

1. Conduct similar studies using the Sports Competition Anxiety Test to assess anxiety levels of highly successful performers in other sports.

2. Conduct studies in movement behavior of children, using the Moving Embedded Figures Test, as modified.

3. Further develop the Moving Embedded Figures Test as modified by increasing the degree of difficulty of some test items in order to continue the investigation of visual perception and its role in successful sports performances at the adult level.

4. Conduct a longitudinal study to determine the nature of the relationship between years of playing experience, ball control as measured by the Chapman Ball Control Test, and manual dexterity as measured by the Two-Hand Turning and Placing Test of the Minnesota Rate of Manipulation Test battery.

5. Develop a tool to assess goalie footwork ability.

6. Replicate this study using the same set of selectors to determine group membership of Level C, Level B, and Level A camp participants.

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APPENDIX A

Tests, Test Descriptions, Scoring and Personnel Forms

Sports Competition Anxiety Test

The test is a 15-item paper-and-pencil test (also known as the Illinois Competition Questionnaire, Form A) designed for measuring a predisposition to respond with varying levels of anxiety in competitive sport situations (Martens, p. 89). Five of the 15 items are spurious and are not scored. Each of the 10 remaining items results in a score of either a one, two or three. The total of the 10 scored items thus ranges from 10 (indicating a low competitive anxiety trait) to 30 (indicating a high competitive anxiety trait).

ILLINOIS COMPETITION QUESTIONNAIRE

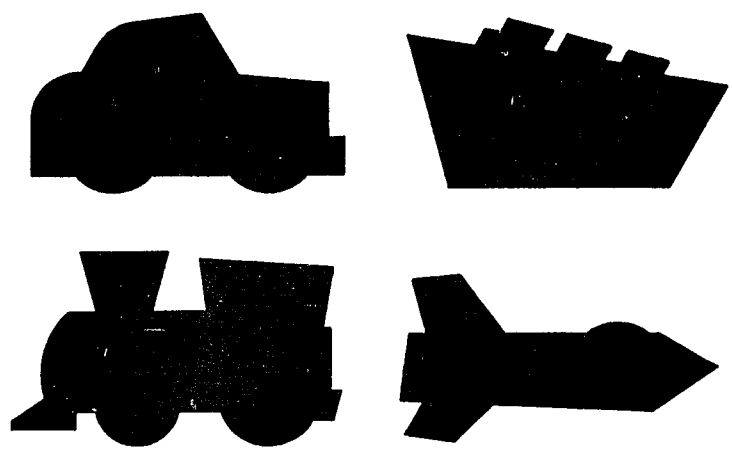
Form A

Directions: Below are some statements about how persons feel when they compete in sports and games. Read each statement and decide if you HARDLY-EVER, or SOMETIMES, or OFTEN feel this way when you compete in sports and games. If your choice is HARDLY-EVER, blacken the square labeled A, if your choice is SOMETIMES, blacken the square labeled B, and if your choice is OFTEN, blacken the square labeled C. There are no right or wrong answers. Do not spend too much time on any one statement. Remember to choose the word that describes how you usually feel when competing in sports and games.

		Hardly-Ever	Sometimes	Often
1.	Competing against others is socially enjoyable.	A ☐	B ☐	C ☐
2.	Before I compete I feel uneasy.	A ☐	B ☐	C ☐
3.	Before I compete I worry about not performing well.	A ☐	B ☐	C ☐
4.	I am a good sportsman when I compete.	A ☐	B ☐	C ☐
5.	When I compete I worry about making mistakes.	A ☐	B ☐	C ☐
6.	Before I compete I am calm.	A ☐	B ☐	C ☐
7.	Setting a goal is important when competing.	A ☐	B ☐	C ☐
8.	Before I compete I get a queasy feeling in my stomach.	A ☐	B ☐	C ☐
9.	Just before competing I notice my heart beats faster than usual.	A ☐	B ☐	C ☐
10.	I like to compete in games that demand considerable physical energy.	A ☐	B ☐	C ☐
11.	Before I compete I feel relaxed.	A ☐	B ☐	C ☐
12.	Before I compete I am nervous.	A ☐	B ☐	C ☐
13.	Team sports are more exciting than individual sports.	A ☐	B ☐	C ☐
14.	I get nervous wanting to start the game.	A ☐	B ☐	C ☐
15.	Before I compete I usually get up tight.	A ☐	B ☐	C ☐

Test Information for Moving Embedded Figures

What you are about to see is a film that tests your visual perception. In the film, you will see outlines of figures (shapes) as they move toward you through varying densities of backgrounds. The four figures used in the film are depicted below:



In this test, it is important to see how quickly and accurately you can detect just which of the four figures shown above is being presented in each of the test items. There are 27 items in this test.

Originally, this test was developed to be used by a single subject with a push-button device to time the quickness of responses. As this equipment is not available, cassette tape recorders will be used to record your verbal responses. For each test item, you will need to identify the shape as quickly as you can by saying into the condenser microphone, either of the words, "car," "boat," (or ship), "train," or "rocket."

Instructions will now be given for the proper use of the tape recorder.

Verbal Instructions to Subjects for the Moving Embedded Figures Test

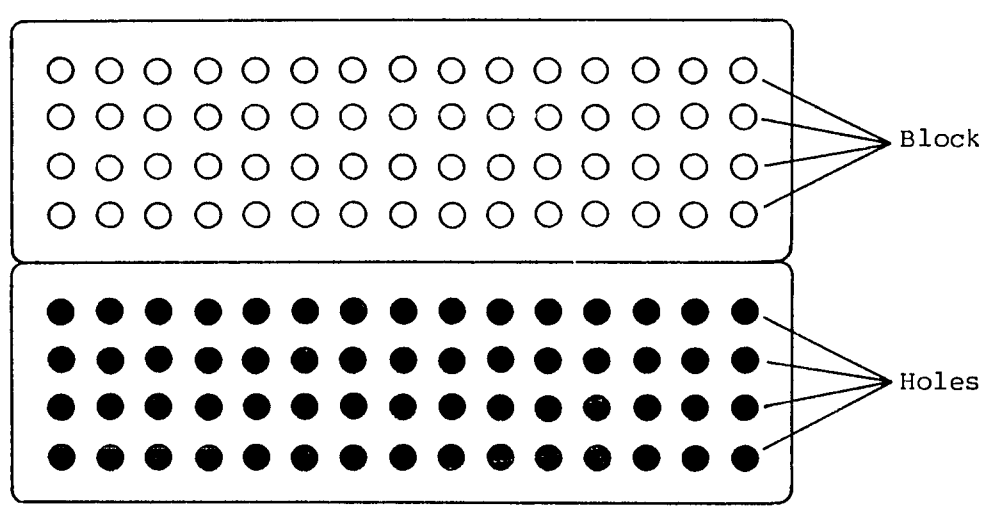
The test is approximately 10 minutes long. Five practice items precede the 27 test items. We will practice recording responses to these, although these items will not be scored. It will, however, provide the opportunity for you to practice speaking both quickly and quietly into the condenser microphone that is located in the upper left-hand corner of your recorders.

Once we begin to play the recorders, we will not stop them until the film ends. Although the voice that accompanies this test for instructive purposes speaks of pressing a button, you are to disregard this and merely prepare to respond with a soft voice or a whisper into the recorder microphone as soon as you detect which figure is moving. Should you realize you have made an incorrect response, you are permitted to correct yourself. As this is a timed test, it is important that you do give a proper response as often as possible, to avoid losing full credit for an item.

If there are no questions, take one more close look at the four possible test-item responses, and then turn your test information sheet face down. We will begin the test by putting the tape recorders into record position by pressing down firmly on the two buttons marked "Play" and "Record."

Minnesota Rate of Manipulation Test, the Two-Hand Turning and Placing Test

The test is the fifth in the Minnesota Rate of Manipulation Test battery, and is designed to measure manual dexterity. A board containing sixty circular blocks arranged in four rows of fifteen blocks each is used to test the speed with which the subject can simultaneously remove two blocks from one board, turn and place them in two holes in an adjacent board, following a systematic order. The required movement pattern is one of reaching, and then bringing the blocks toward the body while turning to then place them. Three trials, including the practice trial requires approximately three to four minutes for test administration. The score is the result of totaling the number of seconds required to complete the task in the two test trials.



Starting position for the Two-Hand Turning and Placing Test, viewed from above.

Verbal Instructions to Subjects for the Two-Hand Turning and Placing Test

We want to see how quickly you can put the blocks back into the holes, bottom side up, two at a time, using both hands. You do it like this--(demonstration).

You start on your right; put the two bottom blocks, one with each hand, into the top two holes, bottom side up; the next two blocks into the next two holes, and so on, right down the board (replace blocks).

Remember, you pick them up in this order, (tap from bottom row of blocks upward) and you put them down in this order (tap from top two vacant holes downward toward subject). Before you finish, be certain every block is all the way down.

Your score is the number of seconds it takes you to do this several times. When you finish one trial, wait until the signal to start the next.

Now put your hands on the bottom two blocks on your right. Ready? Go!

That trial was for practice. Put your hands on the blocks to begin again. Ready? Go!

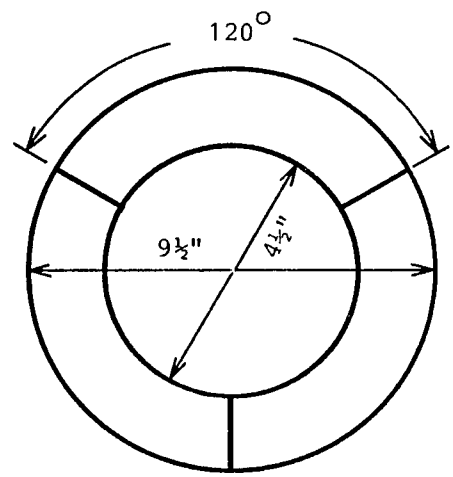
This is your last trial. Do it as fast as you can. Ready? Go!

Chapman Ball Control Test

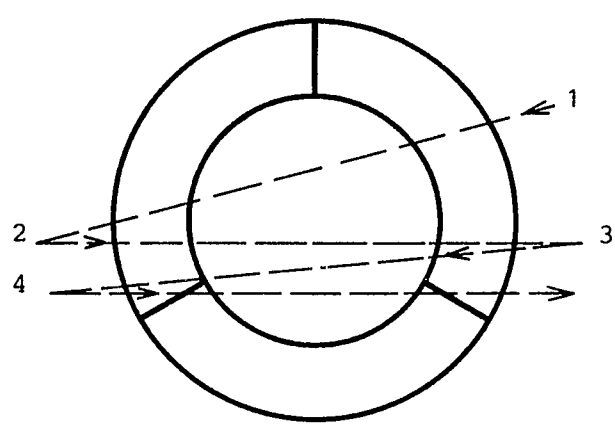
This test is designed to assess the subject's quickness and control in ball manipulation. It requires the use of an official field hockey ball, a field hockey stick, and a ring-like pattern described on the surface of the gymnasium floor. The pattern, made of self-adhesive plastic measures 9½" in diameter, with a second circle measuring 4½" removed from its center. Before removing the second circle, the larger circle should be divided into three equal segments of 120°. Lines 1/8" in width originating in the center of the circle and extending to its outer edge are marked on the target to define the boundaries of these segments. It is suggested that the ring-like pattern be of a color that gives some contrast to both the hockey ball and the gymnasium floor. Orange was selected as an appropriate color to best provide the necessary contrast. (See diagram on following page.)

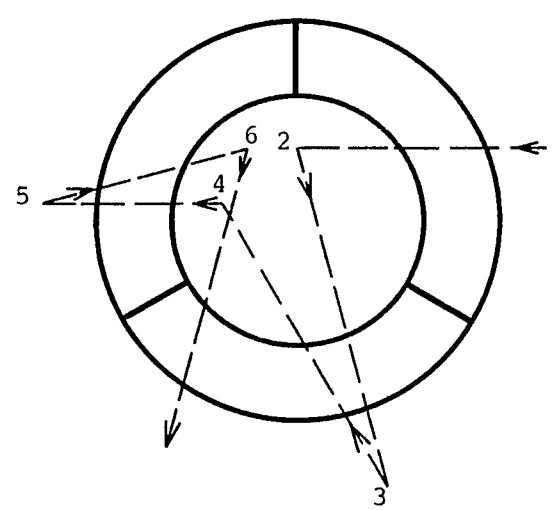
The test is a timed test in which the subject is required to send the ball into and out of the center circle by tapping it with the stick. A point is scored each time the ball is clearly tapped into the center circle and each time it is tapped outside the larger circle, provided it is sent out through a segment different from that which it entered. No point is awarded for a ball that is tapped,

(1) while it is in the orange area, or (2) with the rounded side of the stick. A total of three 15-second trials represents the subject's score. A brief practice period is provided with rest between all trials.



Target Measurements

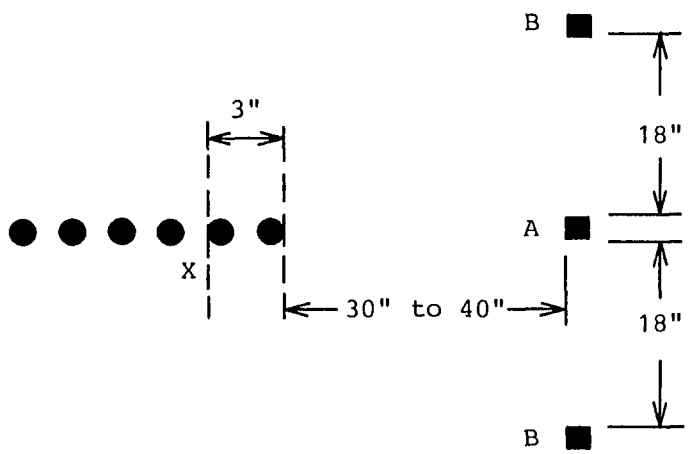




Examples of basic scoring techniques (one point for each correct tap).

Scott Sideward Leap Test

The test measures balance. The floor is prepared by marking three one-inch square spots in a straight line 18 inches apart. Additional marks are placed on the floor in a line at right angles to the previous line. These marks should be three inches apart and range in distance from 24 to 40 inches according to the age and height of the subjects. (See diagram below.) (Scott & French, p. 321)



Floor markings for sideward leap balance test

X = Starting point.

A = Point of landing on sideward leap.

B = Point for finger contact, upper B for leap to right, lower B for leap to left.

Note. Black India ink pens were used in this study to darken the squares made of the same material for ball

Place a small cork or other light object on spot B. (The cork may be cut off the bottom of an old badminton bird.) The length of the subject's leg is measured from the hip-joint to the floor. The area on the floor which corresponds in distance from A most closely to leg length is then selected as the point from which the subject must leap to land on A. The subject is given three trials on each foot to leap sideward, land on A and immediately lean forward and push the cork off spot B, and to then hold a balanced position (either forward or erect) for a maximum of five seconds. No score is awarded if the subject: (1) steps, rather than leaps, (2) fails to cover A on the leap, or (3) fails to lean forward immediately and move the cork from B. A point is awarded for each second (up to a maximum of 5) the balance is held without: (1) moving the supporting foot once the subject has landed, (2) removing the foot from A, and (3) resting the hand or other foot on the floor at any time. The series of three trials on each foot is repeated for a total of 12 trials. The maximum score for this test is 60. Test administration will require approximately three to four minutes.

---

control test for A and B. The numbers 30", 32", 34", 36", 38" and 40" were marked on the orange adhesive to indicate distances from A to correspond with subjects' leg lengths.

THE UNIVERSITY OF NORTH CAROLINA AT GREENSBORO
SCHOOL OF HEALTH, PHYSICAL EDUCATION & RECREATION

SCHOOL REVIEW COMMITTEE

Informed Consent Form

I understand that the purpose of this study/project is:

to investigate performance levels in women's field hockey.

I confirm that my participation is entirely voluntary. No coercion of any kind has been used to obtain my cooperation.

I understand that I may withdraw my consent and terminate my participation at any time during the project.

I have been informed of the procedures that will be used in the project and understand what will be required of me as a subject.

I understand that all of my responses, written/oral/task, will remain completely anonymous.

I understand that a summary of the results of the project will be made available to me at the completion of the study if I so request.

I wish to give my voluntary cooperation as a participant.

Signature

Address

Date

PERSONAL DATA SHEET

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

Brief Hockey History

1. At what age did you begin playing field hockey? _____

2. At what level was your last season of play?

   a. School _____

   b. College _____

   c. Club _____

   d. Association _____

   e. Sectional _____

   f. National _____

3. In how many total seasons of play have you participated? _____

4. What is your current position?

   Front Attack _____

   Middle Fielder _____

   Defending Back _____

   Goalkeeper _____

5. How long have you played this position? _____

6. During your playing career, what other positions have you played, and for approximately how long?

_____

_____

Sample Scorecard

Name _____ ID ____ ____ ____

Scott Sideward Leap		1	2	3	Total
LL:	1. Left				
	1. Right				
	2. Left				
	2. Right				
	Grand Total				
Chapman Ball Control					

SCAT	
MEFT	
MRMT	

APPENDIX B

Examples of Testing Schedules

Date: Monday, July 3

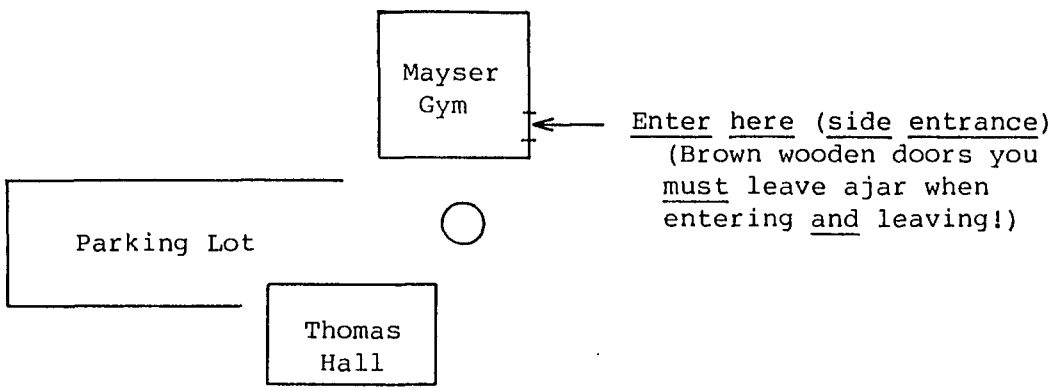
Testing Schedule for this Evening

Will the following people please report to Room 206 Mayser Gymnasium at the scheduled times:

8:30 P.M.	8:50 P.M.	9:10 P.M.
Heidi Berman	Karen Weaver	Tania Huber
Karen Burrell	Candy Zientek	Nancy Hahn
Hali Cohen	Kathryn Kline	Leslie Weber
9:30 P.M.	**9:50 P.M.**	**10:10 P.M.**
Carol Lusignea	Denise Westcott	Elizabeth Almeter
Greta Nicholson	Jane Shaw	Nancy Deal
Chris Sailer	Janice Alberti	Jean Fissinger

Please have with you for this evening's session, any eye correction you wear in game play

Map of the General Area



You need to be at the test site at the scheduled time to keep others scheduled after you from having to wait to be tested. (Try to remind the others in your group to be on time.)

Thank you!

Nancy Chapman

Testing Schedule for Monday Evening

The following players have been scheduled for this evening's testing that will take place in the 9th Floor Study Lounge in the dormitory where we are housed:

9:45 P.M.	10:05 P.M.
Sue Marcellus	Nancy White
Julie Staver	Diane Moyer
Barb Doran	Gwen Cheeseman
10:25 P.M.	**10:45 P.M.**
Karen Shelton	Robin Cash
Nancy Stevens	Sharon Holtschneider
Ann Keating	Pam Hixon

Please have with you any eye correction you wear for game play. Also, note the others scheduled with you and try to arrive at the test site together at the scheduled time. (We can't begin a 20 minute filmed test until all three are present.) Should evening play extend past 9:30 dismissal, the entire schedule will adjust to that dismissal time, that is, the first group of players will report immediately upon arrival from the field following play; the second group, 20 minutes after arrival back from the field; the third group, 20 minutes later, etc.

I greatly appreciate your cooperation in this endeavor, and again, I thank you.

Nancy Chapman

PLEASE SIGN YOUR NAME BY THE TIME SLOT YOU WISH TO COMPLETE THE LAST TEST SESSION TOMORROW (15 minutes):

NOTE: BRING YOUR OWN STICK AND WEAR GYM SHOES.

After Breakfast —

8:00 1. _____
2. _____

8:15 1. _____
2. _____

After Dinner —

6:00 1. _____
2. _____

6:15 1. _____
2. _____

After Lunch —

12:30 1. _____
2. _____

12:45 1. _____
2. _____

1:00 1. _____
2. _____

1:15 1. _____
2. _____

If you are delayed in serving line -- come anyway. We'll wait for you.

SEE MAP FOR TEST SITE.

INTRAMURAL BUILDING - GYM 3.

APPENDIX C

Correspondence

December 14, 1977

Dr. Jacqueline Herkowitz
Physical Education Department
Pomerene Hall
The Ohio State University
Columbus, Ohio 43200

Dear Dr. Herkowitz:

In reference to our phone conversations on November 17 and November 21, I wish to thank you for the cooperation you have extended in sharing with me some ideas relevant to the use of your Moving Embedded Figures Test with adult subjects. I am a bit alarmed, however, that the film you said you would send to my school address has not arrived. Being somewhat concerned that this film may have been lost in the U.S. mail system, I am also understanding that a busy schedule may have prevented your finding the time to package and send it to me.

Whatever the case, I am still very interested in having the opportunity to talk with you in regard to your test and would like to find some time to meet with you in Columbus over the forthcoming holidays as we discussed. Do you still plan to be in central Ohio most of the time during that period? If so, when would it be convenient for me to drive up from Cincinnati? I plan to be there from December 23 through January 3 or 4. Would you please address any future correspondence to me, c/o Mary Chapman, 614 Floral Avenue, Terrace Park, Ohio 45174.

Thank you again for your expressed interest in my research activities. I look forward to hearing from you soon.

Sincerely,

Nancy Chapman

PURDUE UNIVERSITY
DEPARTMENT OF AUDIO-VISUAL PRODUCTION
WEST LAFAYETTE, INDIANA 47907

April 7, 1978

Nancy Chapman
212 McCormich
Ill. State Univ.
Normal, Ill. 61761

Dear Ms. Chapman,

The film you inquired about - THE MOVING EMBEDDED FIGURES TEST - authored by Herkowitz, has been located in our vault.

We can furnish you with a print for $135.00 delivered.

Please address your request along with purchase order number to Jim Ratliff, Audio-Visual Production, Room 54 STEW - Purdue Univ. W. Lafayette, IN 47907.

Sorry for any inconvenience we have caused you.

Sincerely,

Jim Ratliff
Lab Supervisor

JR:mo

April 19, 1978

Mr. Jim Ratliff
Audio-Visual Production
54 Stewart Center
Purdue University
West Lafayette, Indiana 47907

Dear Mr. Ratliff:

Please send me one copy of the film "The Moving Embedded Figures Test," authored by Jacqueline Herkowitz. As discussed with you over the phone, this request is for the purpose of conducting personal research, not departmental. Therefore, I have no purchase order to submit with this request. However, I will pay you upon delivery the price quoted, $135.00.

Thank you in advance for your immediate attention to this matter.

Sincerely,

Nancy L. Chapman,
Assistant Professor

May 1, 1978

Dr. Jacqueline Herkowitz
The Ohio State University
1760 Neil Avenue
Columbus, Ohio 43210

Dear Jackie:

This past Thursday, my committee granted me full approval of the proposal for my study "An Investigation of the Prediction of Success in Field Hockey."

While I was in Greensboro, the copy of your filmed test "Moving Embedded Figures," previously ordered from the Purdue University Media Center arrived. To make any further progress toward the implementation of your test into the proposed study, it will be necessary that I have a letter granting me permission to alter the film as we discussed (removing the four seconds of static embedded figures from each test item), and then to have the altered film copied.

Thank you in advance for your attention to this matter.

Sincerely,

Nancy Chapman

OSU

The Ohio State University

School of Health, Physical Education, and Recreation
1760 Neil Avenue
Columbus, Ohio 43210
Phone 614 422-2615

May 5, 1978

Ms. Nancy Chapman
Department of Women's Physical Education
University of North Carolina at Greensboro
Greensboro, North Carolina 27412

Dear Nancy:

You have my permission to remove the four seconds of static embedded figure presentation from the Moving Embedded Figures Test, and have the altered film copied.

My continued hope that your efforts will be fruitful.

Sincerely,

Jackie

Jacqueline Herkowitz, Ph.D.
Associate Professor

JH/bb

May 1, 1978

Miss Vonnie Gros
857 Westtown Road
West Chester, Pennsylvania 19380

Dear Vonnie:

Last week when I was in Greensboro, North Carolina, my doctoral committee granted the approval of my proposed research study, pending cooperation of the United States Field Hockey Association.

Because I know what a busy time of year this is, I realize it may have been impossible for you to have given any thought to my request prior to now. However, at this time, I am wondering if you might be able to offer some attention to this matter within the next week or two. Should your busy schedule prevent getting some word to me by May 10 or May 11, I would like to plan to give you a call at which time you could give me some indication of your receptiveness to the overall plan of my proposal for data collection.

Thank you in advance for your consideration of this matter.

Cordially,

Nancy L. Chapman

June 2, 1978

Miss Bea Toner, President
United States Field Hockey Association
20 Wendell Street
Hempstead, New York 11550

Dear Bea:

My purpose for writing you is two-fold. First, I wish to express my appreciation to you and the other Executive Committee members for granting in principle, approval of my March 27 request for cooperation of the United States Field Hockey Association to collect data at the international selection and training camps this summer. Ruth Tergesen informed me of this action on April 7, when I called her to inquire of the Executive Committee's decision. At that time, Ruth also informed me that my request had been forwarded to Vonnie Gros, National Coach, for a final decision.

Secondly, I wish to follow-up with a report to you on the further communications I have had with Vonnie regarding this request. On April 20, when I called Vonnie to inquire as to whether or not she had as yet received the request from Ruth, she said that she had, although she had not had an opportunity to read through it yet. Following my return from Greensboro when I presented my proposal, I wrote Vonnie a letter on May 2, to inform her that the proposal had in fact been approved, and that should I not have a response from her within a week or ten days I would call again. Not hearing from Vonnie by May 11, I phoned her to see if she had at that time, any reaction to my request. Vonnie said that she had not received my letter, nor had she found the time to read through the papers sent her, but she would do so during the next two weeks, and could I wait until she returned from a two-week trip to hear from her on May 26?

During this conversation, I expressed to Vonnie, the importance that I know something sooner, if possible, as I had to locate a research assistant, acquire housing and necessary facilities at each site, and should she <u>not</u> approve the request, I would find it necessary to redesign the entire proposal. When pressed, Vonnie felt that it would be appropriate that I be at the Level B camp, as I had talked with her in Denver during the national tournament as to the feasibility of doing the sort of data

collection I wished to propose. She did say that I should check with the coaching personnel at the Lancaster site to ascertain that it meet with their approval as well.

I have since checked with Barb Longstreth by phone, May 15, and Lois Klatt who both see no reason for me not to be present at the Level C camp in Pennsylvania. Coaching personnel at both camps have stated that time will be provided for me to meet with the group of participants at each site to introduce my study and to request their further cooperation. Vonnie, Lois, Barb, and I, as well, all realize that the purpose for my being in camp is not in any way to dictate the camp schedule of activities. However, with my actually being in camp, I will be able to remain flexible to adjust to whatever a fluctuating camp schedule may demand, insofar as collecting data is concerned.

Housing arrangements have been made for me and a research assistant through Sandra McCullough (Lancaster), and Gillian Rattray (State College). Subsequent arrangements have been made through Dottie McKnight to have me billed for the expenses incurred for this by the USFHA. Both Sandra and Gillian have been extremely cooperative in providing on-site facility needs.

Thank you again for initially granting me the opportunity to collect data for my dissertation. I am looking forward to this experience.

I suppose that at this time you are looking forward to the close of another school year and hopefully a well-deserved rest. Perhaps I will have the opportunity to see you during some of the summer camp sessions.

Sincerely,

Nancy Chapman
Graduate Student
UNC-Greensboro

June 25, 1978

Dottie McKnight
Sport Consultants, Incorporated
Barlow Building, Suite 1455
5454 Wisconsin Avenue
Chevy Chase, Maryland 20015

Dear Dottie:

This is to confirm with you the arrangements that have been established for my attendance at the Level C and B International Selection and Training Camps during the next few weeks.

Sandy McCullough and Gill Rattray have both been contacted and have arranged to provide housing for me and a research assistant at each site. It is their understanding that I will be billed for these services by the United States Field Hockey Association through your office, as we had previously discussed. Sandy and Gill are aware of my needs in regard to facilities necessary for the data collection process. These are:

1. A fairly good sized classroom that can be darkened for the purposes of showing and viewing a film, and preferably is equipped with a movie screen.
2. An adjacent or nearby room, not necessarily as large, but that will be available at the same time as the classroom.
3. A small area in a gymnasium with wood flooring.

Although coordinators at both sites have offered to provide a 16 mm. projector, I have planned to bring one with me.

Thank you for sending me the information regarding the arrangements for Level C camp attendance, its location and the campus map. I look forward to getting this information on Level B camp when it becomes available at Franklin and Marshall College. Your helpfulness continues to be greatly appreciated.

Sincerely,

Nancy Chapman
Graduate Student
UNC-Greensboro

cc: McCullough
Rattray

APPENDIX D

Raw Data

Raw Data

Subject No.	Position and No. of Years	SCAT	MEFT	MRMT	CBCT	SSLT	ID Code	Status
			C Camp Subjects					
1	B/10	16	34.5	63	95	39	C-4-1A	A
2	F/9	23	43.4	85	67	34	C-3-1L	C-3*
3	B/8	26	29.3	70	76	17	C-3-2C	C-3
4	F/5	20	44.5	69	38	21	C-2-1G	C-2
5	F/5	21	35.1	74	35	47	C-2-1H	A
6	B/5	17	28.7	76	86	37	C-2-2C	A
7	F/9	17	28.6	70	109	51	C-4-1K	A
8	F/4	18	27.0	76	41	28	C-3-1A	C-3
9	F/6	22	30.4	85	88	35	C-5-1E	B
10	B/14	18	32.6	79	88	34	C-3-1C	B
11	F/10	15	38.6	72	81	36	C-4-1J	A
12	F/5	14	40.9	85	60	33	C-2-1A	C-3
13	F/10	25	46.6	72	79	39	C-2-1J	C-2
14	B/6	22	36.0	66	56	39	C-3-1E	C-3
15	B/9	27	38.3	84	61	41	C-3-2A	C-2
16	F/6	13	37.0	84	100	34	C-5-1A	B
17	G/3	19	26.6	85	44	28	C-3-2E	C-3
18	F/7	19	31.2	75	75	44	C-2-1F	C-2
19	F/6	14	30.2	75	54	31	C-2-1C	C-2

Raw Data (Continued)

Subject No.	Position and No. of Years	SCAT	MEFT	MRMT	CBCT	SSLT	ID Code	Status
20	F/4	23	30.5	66	51	34	C-2-1D	C-2
21	G/8	17	41.2	90	58	34	C-1-1C	A
22	B/12	13	26.1	82	88	29	C-5-1G	C-3
23	F/8	21	23.9	69	43	54	C-2-1B	C-3
24	B/8	23	27.0	81	80	30	C-3-1G	C-3
25	G/5	28	27.4	74	62	31	C-2-2A	C-2
26	B/6	16	50.6	80	55	50	C-2-2B	C-2
27	F/8	14	29.3	61	53	37	C-3-1D	C-2
28	B/7	22	32.1	78	36	46	C-1-1B	C-1
29	B/7	17	34.1	72	58	53	C-2-1K	C-2
30	B/5	15	40.2	76	61	29	C-2-2D	C-2
31	B/11	22	28.4	75	85	43	C-5-1K	C-3
32	B/10	19	35.9	76	61	20	C-3-1J	C-2
33	F/9	23	44.8	72	33	15	C-2-1E	C-2
34	B/7	23	29.5	74	89	42	C-2-1L	C-3
35	B/15	23	46.9	77	59	52	C-4-1H	A
36	F/4	15	25.0	68	82	46	C-5-1D	A
37	F/9	18	29.9	77	60	40	C-4-1G	A
38	F/9	18	27.7	72	69	54	C-5-1J	B
39	B/4	21	25.5	83	63	18	C-3-1H	C-3

Raw Data (Continued)

Subject No.	Position and No. of Years	SCAT	MEFT	MRMT	CBCT	SSLT	ID Code	Status
40	F/12	23	32.3	71	74	42	C-4-1I	B
41	F/7	21	25.9	85	58	39	C-5-1H	C-3
42	F/10	24	34.5	76	71	41	C-4-1C	B
43	B/10	18	32.4	74	95	36	C-5-1F	A
44	F/8	21	46.8	75	64	31	C-2-1I	C-2
45	B/9	23	49.9	77	70	43	C-3-1K	C-2
46	F/8	19	29.4	69	80	22	C-4-2A	A
47	F/8	17	28.9	69	101	32	C-5-1L	C-3
48	F/5	23	37.9	81	59	28	C-3-2B	C-2
49	B/7	23	34.4	82	37	19	C-1-1D	C-3
50	F/8	17	22.1	70	104	57	C-4-2B	A
51	G/7	18	37.0	71	42	12	C-1-1E	C-3
52	F/11	18	30.9	70	81	42	C-4-1B	A
53	G/6	16	37.7	80	58	31	C-5-1C	B
54	B/12	17	28.9	64	83	17	C-4-1E	B
55	G/8	26	48.5	83	59	38	C-3-1B	B
56	B/5	24	43.9	76	53	36	C-3-1I	C-2
57	F/12	20	30.8	67	82	46	C-4-1D	A
58	G/7	16	26.3	95	62	36	C-3-2D	B

Raw Data (Continued)

Subject No.	Position and No. of Years	SCAT	MEFT	MRMT	CBCT	SSLT	ID Code	Status
59	B/14	13	28.8	65	78	19	C-3-1F	C-3
60	F/10	18	33.7	82	68	35	C-4-1F	A
			B Camp Subjects					
61	B/10	17	33.8	83	74	36	B-4-1G	B
62	B/6	16	29.9	68	52	40	B-2-1G	B
63	F/5	23	59.1	80	84	52	B-3-1G	B
64	B/5	24	35.9	86	74	60	B-5-1C	B
65	F/13	20	23.0	68	82	55	B-1-1I	A
66	G/13	20	29.1	67	62	39	B-1-1B	A
67	B/7	12	27.9	81	73	48	B-4-1B	B
68	F/11	19	35.6	87	85	47	B-4-1D	A
69	F/12	13	25.5	73	108	53	B-1-1J	A
70	F/6	16	39.1	85	91	38	B-4-1A	B
71	F/6	21	35.0	71	69	50	B-3-1F	B
72	B/3	20	36.8	79	85	25	B-3-1J	B
73	F/5	17	29.0	71	59	40	B-3-1K	A
74	F/7	26	37.3	69	65	47	B-2-1B	B
75	F/10	25	36.7	80	75	47	B-2-1J	B
76	F/7	18	58.0	77	107	50	B-2-1K	B

Raw Data (Continued)

Subject No.	Position and No. of Years	SCAT	MEFT	MRMT	CBCT	SSLT	ID Code	Status
77	G/4	12	35.5	72	50	60	B-3-1B	B
78	B/12	18	41.0	72	91	48	B-1-1F	A
79	B/7	25	31.9	76	57	44	B-1-1G	A
80	F/8	19	30.5	70	63	60	B-4-1F	A
81	F/4	19	31.6	74	82	47	B-3-1A	A
82	F/9	15	52.2	80	65	49	B-1-1H	A
83	B/8	17	33.6	88	113	54	B-5-1A	A
84	F/5	17	34.2	76	67	32	B-5-1E	B
85	F/6	15	29.9	77	92	39	B-2-1I	A
86	B/14	14	28.7	69	61	24	B-3-1E	B
87	F/7	23	27.5	73	86	30	B-2-1A	B
88	F/10	16	29.9	76	76	42	B-2-1C	A
89	G/4	23	45.1	74	54	33	B-3-1I	A
90	F/10	19	35.8	81	98	43	B-5-1B	A
91	B/5	13	32.7	67	87	56	B-2-1E	B
92	F/10	19	25.8	66	83	27	B-3-2B	B
93	B/6	14	33.3	80	80	52	B-2-1D	A
94	B/8	20	29.0	72	67	46	B-4-1E	A
95	G/4	19	35.5	70	67	33	B-1-1K	A
96	B/5	22	26.1	112	44	43	B-3-1H	A

Raw Data (Continued)

Subject No.	Position and No. of Years	SCAT	MEFT	MRMT	CBCT	SSLT	ID Code	Status
97	G/6	19	31.6	82	43	41	B-3-1C	B
98	B/9	17	45.5	75	77	40	B-1-1E	A
99	F/9	14	29.5	72	103	46	B-2-1F	A
100	F/7	15	24.8	77	93	41	B-5-1H	A
101	B/6	16	28.4	68	84	53	B-3-1D	B
102	F/12	14	28.6	57	89	55	B-1-1A	A
103	B/10	13	36.7	82	70	33	B-4-1C	A
104	F/8	21	24.2	80	68	36	B-2-1L	A
105	B/7	18	34.1	74	95	37	B-1-1D	A
106	F/8	21	28.0	77	75	35	B-3-2A	B

*Indicates when subject was cut; 1st, 2nd, or 3rd cut session.