To the Graduate Council:

I am submitting herewith a dissertation written by Duane Gordon Millslagle entitled "Visual Perception, Recognition, Recall, and Mode of Visual Search Control in Basketball Involving Novice and Experienced Women Basketball Players." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Physical Education.

Patricia A. Beitel

Patricia Beitel, Major Professor

We have read this dissertation
and recommend its acceptance:

Craig A. Wrisberg

Ralph E. Jones

Mark A. Hester

Accepted for the Council:

Lawrence Dowminkel

Vice Provost
and Dean of the Graduate School

VISUAL PERCEPTION, RECOGNITION, RECALL AND MODE OF VISUAL SEARCH CONTROL IN BASKETBALL INVOLVING NOVICE AND EXPERIENCED WOMEN BASKETBALL PLAYERS

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Prior to the onset of this research, utilization of human subjects to investigate the major objectives of this study was approved by the University Human Subject Review Committee and the Graduate College at the University of Tennessee, Knoxville.

ABSTRACT

The primary purpose of this study was to examine the visual search abilities of experienced and novice women basketball players utilizing a visual search paradigm. An attempt was made to: (a) compare the speed and accuracy of detection and recall ability between both types of players, and (b) compare the visual search performance of experienced and novice basketball players in structured and unstructured basketball situations. A secondary purpose of this study was to examine how experienced and novice basketball players control their visual search process (target or context) through the adoption of Prinz's et al. (1974) hurdle paradigm.

Thirty female college students consisting of 15 experienced and 15 novice basketball players served as subjects. Sport slides consisting of 32 structured and 32 unstructured basketball situations were used as the stimuli in this study. Sixteen of each situation, structured or unstructured, contained a target item (basketball). Sixteen of each situation contained a hurdle item (orange triangle). Each subject scanned the sport slide projected for a 5-second period. Speed and accuracy of ball detection were measured by the subject response to presence or absence of the target item (basketball) by depressing a yes or no key positioned in front of the subject. After the 5-second viewing, players recalled as many players as possible on a grid depicting the basketball court.

Two randomized repeated measures design ANOVA models were used as the basis for the analysis of the three dependent variables and the testing of the research hypotheses. The findings were that: (a) visual search performance of experienced players, their overall speed of target detection and player recall, were significantly superior than that of novice players, (b) the overall accuracy in detecting the target item was similar for both experienced and novice players, (c) both groups of players could accurately detect and recall a structured play better than an unstructured play, with the experienced player being superior in both situations, and (d) the speed of detection of both groups of players was not affected by the difference in structured and unstructured plays. The finding pertaining to the control of visual search was that the presence or absence of the hurdle item did not affect speed by experience level or accuracy of detection, indicating that the visual search of both experienced and novice players may have operated under target control.

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CHAPTER I

INTRODUCTION

A rapidly changing variety of information characterizes the visual display of the team sport player (Gentile, 1972). The player must quickly and constantly select relevant visual cues, while discarding or ignoring irrelevant cues, in order to select an adequate motor response. Perceptual decisions made in the game require the player to constantly search the visual display to identify the presence of the ball and his/her position and the position of other players in relation to the game situation. Researchers have attempted to explain visual search performance of participants in sport (Allard & Starkes, 1980; Allard, Graham & Paarsalu, 1980; Bard & Fleury, 1976; Bard, Fleury, Carriere & Halle, 1980; Starkes & Deaken, 1984; Allard & Barnett, 1985). From these studies three general conclusions may be drawn: (a) visual search can be used to assess the player's cognitive ability about the organization and timing of skills in the game; (b) search performance of experienced players differs from that of non-players; and (c) the visual search process is a key perceptual process in the game. It should be noted, however, that very few studies have been conducted in sport to examine whether or not searching performance of experienced players and non-players differs in the way in which they control visual search.

Visual search is a perceptual process used to locate objects in the visual field. This process is needed for total elimination of spatial uncertainty (Monk, 1984; Prinz, 1977). The visual search

paradigm that has been used to study searching in basic psychological experiments involves the presentation of a list of letters which includes a target item and distractors (contextual items). The observer is asked: (a) to indicate whether or not the target is present or absent; (b) to locate the target; and/or (c) to recall the position of the target. The interactions between the observer and the visual display are noted. Most visual search studies measure the subject's performance based on the rate or speed at which the target or field items are located.

Researchers (Neisser, 1967; Monk, 1984; Prinz, 1979a) have highly praised the visual search paradigm for three reasons. First, this paradigm provides a convenient means to study information processing theory under experimental conditions in relation to the natural characteristics of the task. Second, the paradigm tests a variety of theoretical problems in studying the perceptual recognition process. Third, the paradigm offers one means of explanation of the perceptual learning process of the observer involved in a visual search task.

A number of investigators (Allard & Starkes, 1980; Allard, Graham & Paarsalu, 1980; Allard, 1984; Bard & Fleury, 1976; Bard, Fleury, Carriere & Halle, 1980; Starkes & Deaken, 1984) have adopted the visual search paradigm in the study of sport. These investigators required subjects to visually search slides or a film and detect, recognize, or recall situations in a sport setting. The purpose of this line of research was to compare the perceptual recognition processes of expert and non-expert subjects across a variety of sport situations. Allard

and Starkes (1980) and Starkes and Allard (1983) found that experienced women volleyball players were skilled visual searchers in detection and recognition of the ball, but this search process did not extend to sport situations beyond the game of volleyball. However, the speed of search in detection of the volleyball for these players seemed to be developed to a high degree, and Allard and Starkes (1980) suggested that detection of the ball may be a key visual search strategy which coaches should emphasize.

The results of the study by Starkes and Allard (1983) were consistent with those from an earlier study by Allard and Starkes (1980) which revealed that in both non-competitive and competitive situations, the speed of visual search of both non-players and experienced players increased. The expert volleyball player responded significantly faster but made slightly more errors in detection of the ball than the inexperienced volleyball player.

In the sports of basketball and field hockey, experienced women players have been found to recall game situations with greater accuracy than non-players (Allard, Graham, & Paarsalu, 1980; Starkes & Deaken, 1984; Allard & Barnett, 1985). Researchers have, therefore, assumed that a relationship exists between the structure of the game and the level of experience of the players; that is, experienced basketball and field hockey players are assumed to have greater cognitive ability about the organization and the timing of the game.

Bard and Fleury (1976) found that the search pattern used by experienced male basketball players differed from that of non-players

and according to the types of skills in the game. Experienced players and non-players were presented slides depicting typical offensive patterns that differed in spatial organization in terms of proximity of distance of the viewer from other players. Subjects were instructed to decide whether to shoot, pass, dribble, or stay. Eye fixations were recorded by means of a cornea reflection recorder. Results indicated that experienced basketball players made fewer fixations to locate elements in the slide that pertained to the solution of the problem. A similar pattern of findings was reported by Bard, Fleury, Carriere, and Halle (1980) in a subsequent study involving women's gymnastics judges that differed in amount of experience. Both varsity basketball players and experienced gymnastics judges developed different search abilities determined by the type of task and the selection of the elements to be analyzed in the sport situation.

In studying visual search in sport, as well as the settings used in basic psychological visual search experiments, less attention has been paid to observer variables such as experience, sex, age, and eyesight, the latter of which may be the most important observer variable in a visual search task. Bloomfield (1979) has suggested that two aspects of eyesight are crucial to the observer: (a) visual acuity, and (b) how the observer controls his/her search over the display. Monk (1984) has further contended that future research should match subjects based on their level of visual acuity and/or level of experience with the task.

A considerable amount of psychological experimentation has been conducted dealing with how a person controls the visual search process (Neisser, 1967; Prinz, 1977; 1979a). Neisser (1967) proposed two theories to explain the control of visual search: target control theory and context control theory. Target control theory contends that visual search to detect a target is conducted under the control of a memory representation of the target. When a match occurs between the stimulus representation and the memory representation of the target, the learner detects the target. In contrast, context control theory contends that visual search is under the control of memory representations that are not sensitive to individual objects but to a larger portion of the display. Using this search process, the observer is said to be context controlled when the stimuli are matched against a memory representation of the context.

Research (Prinz, 1977, 1979a; Prinz & Atair, 1973; Prinz, Tweer, & Feige, 1974; and Neisser, 1967) has indicated that search control is different in early and later stages of skill development. The results of such studies suggest that without practice, a subject will operate under target control since the observer has not yet become familiar with the context. With practice, the subject develops memory representations that are sensitive to features which constitute a larger portion of the display. Practice should, then, increasingly favor context control, i.e., change the memory control of search from one of target control to one of context control. Gentile, Higgins, Miller, and Rosen (1975) and Beitel (1980) seem to concur with this notion and imply that the

attainment of motor skill calls for differing visual perceptual strategies that acknowledge both the environmental demands of the task and the abilities of the individual.

The hurdle technique is an experimental paradigm used in psychological visual search studies to determine under what mode of control the observer scans the visual field (Prinz et al., 1973, 1974, 1977, 1979b). The hurdle technique involves presentation of a stimulus (hurdle) within the display that is different from the target and field items. The subject is trained to detect the target but is required to recall any other stimuli that may be different from the target. Detection of the hurdle is assumed to occur if: (a) the subject can recall the hurdle, or (b) the speed of search is slower when a hurdle is present than when there is no hurdle present in the context. If the subject detects the target and the hurdle, it is assumed that the search is operating under contextual control (Prinz et al., 1973, 1974, 1977, 1979b).

Bard et al. (1976, 1980) suggested that the visual search strategies of experienced and inexperienced basketball players and gymnastics judges differed according to the skills required by each sport. Allard's (1983) assumption was that volleyball players focus attention on the ball and ignore the background information while basketball players take in as much of the environment as possible. The athlete, through practice and training, may develop a general underlying visual search strategy to be successful in a particular sport. Thus, it may be hypothesized that the inexperienced player, an unskilled

searcher, operates under target control, while the experienced player, a skilled searcher, operates under both target and context control. By employing the hurdle technique in a visual search paradigm, this assumption may be tested in a sport context. Moreover, investigation of the role of observer variables of experience and mode of visual control is also possible.

STATEMENT OF THE PROBLEM

The primary purpose of this study was to examine the visual search performance of female experienced and novice sport participants utilizing the visual search paradigm. In particular, an attempt was made to: (a) compare the speed and accuracy of the visual search performance of experienced and novice basketball players, (b) compare the recall ability of experienced and inexperienced basketball players, and (c) compare the visual search performance of experienced and novice basketball players in structured and unstructured basketball situations.

A second purpose of this study was to examine how experienced and novice participants control their visual search process in a sport context. In particular, an attempt was made to compare the visual search performance of experienced and novice basketball players when presented sport situations with and without a hurdle item.

The following research hypotheses were tested, the first three with respect to the visual search paradigm, and the last with respect to the visual search paradigm and the hurdle item.

1. There are no significant differences in the speed and accuracy of the visual search performance of experienced and novice women basketball players.

2. There are no significant differences in visual search performance between experienced and novice women basketball players in the recall of a sport situation.

3. There are no significant differences in the speed, accuracy and recall of the visual search performance between experienced and novice basketball players, in structured and unstructured basketball situations.

4. There are no significant differences between the visual search performance of experienced and novice women basketball players with or without presentation of a hurdle item in a sport situation.

DELIMITATIONS OF THE STUDY

The study was delimited to female college varsity and novice basketball players at Northern State College, Aberdeen, South Dakota.

ASSUMPTIONS

1. It is assumed that all subjects who participated in this study were naive to the experimental task.

2. It is assumed that the subjects attempted all tasks to the best of their ability.

3. It is assumed that the varsity basketball players were of similar physical ability and skill. It is assumed that the novice players were of similar ability and skill.

4. It is assumed that the varsity players were more highly skilled than the novice players.

DEFINITION OF TERMS

Distractor Items. Those inputs during a given trial that were not targets nor hurdle items. For this study, the presence of other players and officials served as the distractor items.

Experienced Player. A female player who had varsity college basketball playing experience and who was currently involved in formal coaching and practice in a collegiate setting.

Frame Time. The time from onset of a given frame to completion of the single-frame search task. A 5-second frame time was used in this study.

Hurdle Detection Trial. A search task where the hurdle item is present in the single frame search. Hurdle detection can be identified by detection on the recall task or by the subject's slower reaction time in the hurdle detection trial compared to the non-hurdle detection trial.

Hurdle Item. An input which belongs neither to the target category nor to the distractor category. In this study the hurdle item was an orange triangle within the key of the basketball court area (Figure 1).

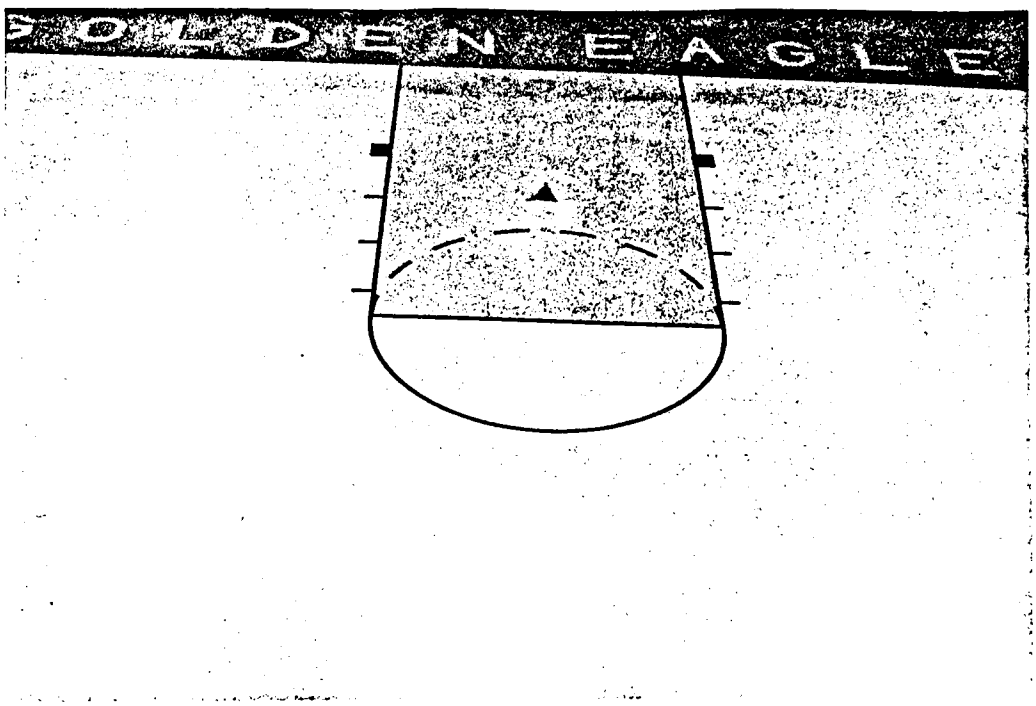


Figure 1. Hurdle Item

Inputs. A combination of target, hurdle and distractor items in a search task.

Novice Player. A female who had no experience in competitive basketball. Each subject had limited theoretical and practical knowledge verified in a preliminary interview and a pre-experimental session. In the preliminary interview, each subject was given a sport specific questionnaire which indicated her direct and indirect participation in basketball.

P(A). In signal detection theory, a nonparametric measure that quantifies an individual's ability to make perceptual decisions (McNicol, 1972). P(A) ranges from .5 to 1.0; a measure approaching 1.0 indicates little uncertainty as to whether the signal (in this study, a basketball) is present; a measure closer to .5 usually results when the subject is uncertain about presence or absence of the signal.

Signal Detection Theory. A statistical approach which provides a basis for quantifying a person's limitation in detecting signals, or stimuli labeled as signals. In this study, signal detection theory was measured by calculating P(A) (Appendix A) using the following criteria and response types (McNicol, 1972).

Correct Rejection. A subject responded by pressing the "no" key when no ball was present.

False Alarm. A subject responded by pressing the "yes" key when no ball was present.

Hit. A subject responded by pressing the "yes" key when the ball was present.

Miss. A subject responded by pressing the "no" key when the ball was present.

Negative Response. A subject responded by pressing the "no" key.

Negative Trial. A trial in which the ball (target) was not present.

Positive Response. A subject responded by pressing the "yes" key.

Positive Trial. A trial in which the ball (target) was present.

Single-frame Search Task. A visual search task in which all inputs were presented simultaneously. For this study, the target, hurdle, and distractor items were presented above threshold, and reaction time was the dependent variable. The frame tasks were slides of structured or unstructured basketball situations. A frame consisted of one structured or one unstructured basketball situation.

Structured Game Situation. An offensive basketball play in progress, positioned in the key area of the basketball court (Figure 2).

Target Item. The criterion item presented among a set of inputs on a given trial. For this study, the presence of the basketball in the single-frame task served as the target item.

Types of Search

Target-control Search. A search that was conducted under the control of a memory representation of the target item (Neisser, 1967; Prinz, 1979a). The search process is under the control of

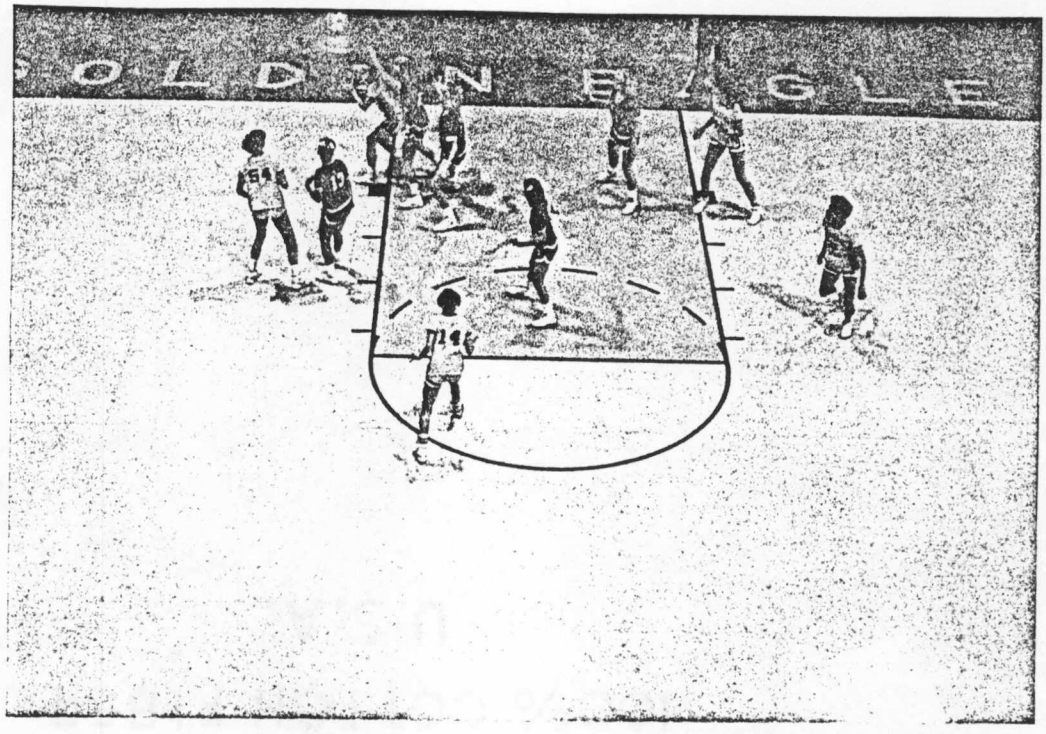


Figure 2. Structured Game Situation

recognizers that are sensitive to the target items but not to other inputs of the search task. In this study, subjects operating under target control search would be able to recognize the presence of the ball but unable to recall the contextual item (hurdle), and/or would have slower reaction times in hurdle detection trials compared to non-hurdle detection trials (Prinz, Tweer, & Roffeige, 1974).

Context-control Search. A search that is conducted under the control of a memory representation of both the target and context (non-target items) (Neisser, 1967; Prinz, 1979a). The search process is under the control of recognizers that are sensitive to features of larger portions of the display. The input information of the visual frame is tested against the representations of the context. Detection of target items under context control search can be demonstrated by subjects detecting the hurdle item they are not instructed to look for or by a subject's slower reaction time in a hurdle detection trial compared to a non-hurdle detection trial (Prinz, Tweer, & Roffeige, 1974). In this study, subjects operating under context control would be able to detect the presence of the ball, as well as the contextual item (hurdle).

Unstructured Game Situation. A transitional situation in basketball in which the ball has just changed possession or is in no one's possession. In this study, unstructured situations included turnovers, rebounds, and fastbreak initiations (Figure 3).

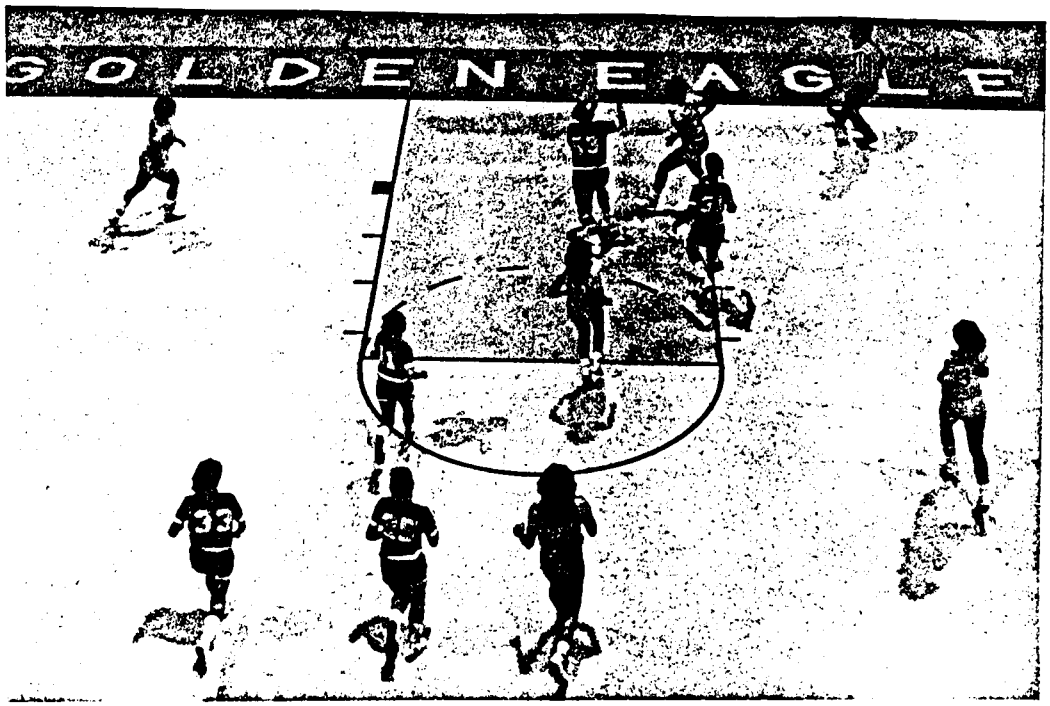


Figure 3. Unstructured Game Situation

Visual Search. Evaluating for the purpose of detecting the presence or absence of inputs in a given situation. For this study, the subjects were presented a single-frame search task. Detection of the inputs was required. Detection accuracy (percent P(A) of hits and/or percent of correct rejections) and reaction time were the dependent variables.

Visual Search Performance. Lies on a continuum from unskilled to skilled. Unskilled search performance is reflected by slow reaction time, inaccurate decisions, and inability to recognize presence or absence of a target and recall distractors and/or the hurdle item in a single-frame searching task. Skilled search performance is reflected by fast reaction time, more accurate decisions, and ability to recognize presence or absence of a target and recall distractors and/or the hurdle item in a single-frame search task.

Accuracy of Visual Search. In this study, accuracy of the visual search is measured by P(A), that is, percent of hits or correct rejections, and/or misses or false alarms in identifying the presence or absence of the target. Appendix A provides the rationale and definition for the nonparametric measure of P(A).

Recall in the Visual Search. The subject's ability to recall the contextual items, distractors, and hurdle item in the single-frame search task. In this study, each subject was allowed an unlimited recall period after each single-frame task. During this period, subjects were asked to copy the location of the offensive and defensive players, and any other contextual items

(i.e., hurdle item, officials) on a diagram of one-half of the basketball court. She was instructed to identify the position of offensive players (checkmarks) and defensive players (X's), and to mark any other items which attracted attention (0's) on the grid from the preceding single-frame search task. The subject's score was the number of contextual items correctly placed on the grid.

Speed of Visual Search. The time it takes the subject to identify the presence or absence of the target in the single-frame search task. In this study, speed of visual search is the subject's simple reaction time (RT) measured from the moment a slide appeared until the moment the subject pressed one of the two keys designated "yes" and "no." The "yes" key represented the presence of the ball and "no" represented the absence of the ball.

Visual Search Task. A detection task in which the items are presented above sensory threshold so that each is clearly identified (Neisser, 1967).

CHAPTER II

REVIEW OF LITERATURE

In this review of literature the following topics will be addressed: (a) sport and visual search, (b) control of the visual search process, i.e., target control, context control, and (c) the experimental paradigm used to determine the specific method used to control visual search. The first section includes studies which have examined the visual search processes of experienced and novice players in sport. The second section includes literature explaining target and context control and the effect practice has on visual searching. The third section of this review of literature describes the hurdle paradigm used to determine the mode of visual search.

SPORT AND VISUAL SEARCH

A series of studies conducted by Allard et al. (Allard, 1984; Allard & Starkes, 1980; Allard, Graham & Paarsalu, 1980) and by Starkes and Deaken (1984) investigated athletes' perceptions involving visual search in volleyball, basketball, and field hockey. The experimental paradigm adopted involved presentation of slides of structured and unstructured sport situations. Structured slides consisted of typical game situations, and unstructured slides consisted of non-game situations in each sport; i.e., volleyball, basketball, and field hockey. The subjects (women) in the volleyball studies were asked to determine whether or not the ball was present; in the basketball and

field hockey studies subjects were asked to recall the position of the players. The subjects differed in level of experience in each sport, and varsity players were compared to non-varsity players.

Subjects in the volleyball study (Allard & Starkes, 1980) viewed 80 randomly presented slides depicting structured and unstructured sport situations. The subjects responded verbally into a microphone which stopped a timer which had been started by the onset of the slide. In all the volleyball experiments, the dependent measure of search was voice reaction time, i.e., the time between the onset of a slide and the subject response. Accuracy of the search was also determined by a nonparametric analog, P(A) (McNicol, 1972). P(A) was used to measure the subjects' degree of visual sensitivity in recognizing the presence or absence of the volleyball.

When women varsity and inexperienced players were asked to identify the presence or absence of the ball (Allard & Starkes, 1980, Experiment 1), results indicated that the varsity players' speed of search was significantly quicker than that of the non-player for both structured and unstructured slides. The accuracy of the search between the groups was not significantly different for either type of slide. Allard and Starkes (1980) cited several methodological problems concerned with the volleyball structure in the slides presented that may have influenced these results. Thus, the players' speed of search may have only been a result of the player/structure interaction.

A second experiment (Allard and Starkes, 1980, Experiment 2), designed to control the effect of the structure of the game, was

conducted by presenting slides of structured and unstructured volleyball situations upside down. The experiment used different subjects viewing twice as many slides and verbally responding to the presence or absence of the ball. The voice response-time data indicated speed of search for both groups was slower and less accurate. The decrease in performance across both groups would seem to indicate that structure was not a possible rival hypothesis in the first experiment. Even when manipulations were controlled, rate of search results were identical and supported those of the first experiment for both the structured and unstructured slides. However, one difference did appear, ability to accurately detect presence or absence of the ball was significantly greater for varsity players than for inexperienced players.

Additional studies (Allard & Starkes, 1980, Experiment 3) attempted to determine if the speed of search for the presence or absence of the ball was a factor in the volleyball game. Women volleyball players were compared to athletes participating in different sports. Eighty volleyball slides were presented, 40 with a ball and 40 without a ball present. Volleyball players' rate of speed in detecting the ball was quicker than that of swimmers, basketball players, and field hockey players.

Subsequent experiments (Allard & Starkes, 1980) investigated whether volleyball players were simply: (a) fast deciders, or (b) fast processors of information. In one experiment, (Allard & Starkes, 1980, Experiment 4) 11 volleyball players viewed: (a) slides of game situations with the ball present or absent, and (b) slides depicting

country scenes with a barn present or absent. It was found that the players were able to detect a volleyball quicker than they could a barn. Thus, it was suggested that volleyball players may not simply be fast deciders, but are dependent on familiarity of the scene.

In another experiment (Allard & Starkes, 1980, Experiment 5) slides were presented to varsity players who were asked to detect the presence or absence of a ball and the presence or absence of a referee. A one-way analysis of variance revealed that the players detected the ball significantly faster than they did the referee. Thus, a volleyball player's perceptual skill was contingent on detection of the ball. If this was the case, it could be hypothesized that volleyball players are influenced little by the context or background information in detecting the ball.

Starkes and Allard (1983) attempted to reexamine the perceptual questions studied by Allard and Starkes (1980) through a competitive perspective. Women varsity and non-varsity volleyball players viewed slides of the Canadian National Volleyball Championships presented upside down. Subjects viewed 80 structured game slides and 80 unstructured, non-game slides. Each subject was instructed to detect the presence or absence of the ball. Heart rates were taken to assess the difference in stress level evidenced while viewing the slides. Tests were conducted over a three-day period. The first day was used to familiarize the subjects with the search task and to obtain a stabilized heart rate. The second day the subjects performed under a non-competitive situation similar to that of the Allard and Starkes

(1980) experiments. On the third day the subjects were led to believe they were competing against an opponent of like ability.

The results of Starkes and Allard (1983) supported those from the earlier studies by Allard and Starkes (1980) across the non-competitive situations. In a competitive situation, however, both search time and accuracy of detection decreased for both groups. This experiment clearly showed that a speed vs. accuracy trade-off occurred during a competitive situation. The expert volleyball players had a quicker response, but made slightly more errors in detection, than the inexperienced volleyball player.

Allard, Graham, and Paarsalu (1980) attempted to determine if skilled women basketball players recalled more information about structured and unstructured game situations. Structured situations in basketball consisted of offensive and defensive players centered around the key where one team was on the defensive. The unstructured situation was a transitional one in which the ball had just changed hands. The number of players in each picture varied, but the ratio of defensive to offensive players was controlled. Each subject was asked to recall the positions of the players in each slide on a magnetic board that represented one half of a basketball court.

Accuracy was measured by the number of basketball players placed over all the slides and by the location of players placed on the magnetic board that corresponded to each slide. An analysis of these accuracy measures revealed that: (a) defensive players in structured situations were recalled more accurately by both experienced and

non-experienced players, and (b) varsity players recalled and located the players in structured situations with greater accuracy than non-players. The Allard, Graham, and Paarsalu (1980) results indicated that experienced basketball players' recall of information resulted from an understanding of the structure of the game. Experienced basketball players' search ability may enable them to encode more information than inexperienced players.

Allard, Graham and Paarsalu (1980) also attempted to determine if the same skilled basketball players encoded information more deeply than the unskilled players. The same subjects viewed 80 basketball slides, 40 used earlier and 40 new slides, of structured and unstructured situations in basketball. The premise was that varsity level players should recognize the earlier slides with more success than the unskilled players. The analysis of the recognition data did not significantly differ between players and non-players. But a trend in the data did show that players recognized more structured slides than non-players. In a later paper, Allard (1984) indicated these results were exactly as expected, "basketball players recalled the position of players in structured slides more accurately than did control subjects while both groups of subjects were essentially equal in recall for non-structural slides" (p. 23).

Starkes and Deaken (1984) reported data from a similar recall task performed by field hockey players of different skill levels. The experienced group of hockey players consisted of the Canadian national women's field hockey team. The inexperienced group consisted of

undergraduate physical education majors and university varsity level field hockey players. As in the basketball study (Starkes & Allard, 1983), Starkes and Deaken showed their subjects slides of structured and unstructured game play. Structured game play consisted of play around the net and circle, while unstructured game play involved transitions from offense to defense. Slides were presented for eight seconds, and recall was performed by placing magnets on a schematic picture of the hockey field. National team players were superior to the control group in recalling structured slides only. Thus, field hockey players (Starkes and Deaken, 1984) and basketball players (Allard, Graham & Paarsalu, 1980) showed evidence of sensitivity to the pattern or structure of their game in a fashion similar to other experts.

Unlike Allard, Graham and Paarsalu's (1980) earlier recall task, Allard and Burnett (1985) used a five-second recall task to assess how much information could be chunked into a meaningful form by experienced and novice women basketball players. Allard and Burnett's (1985) subjects were eleven members of the Canadian National Women's Basketball Team and novice players were Ph.D. students in psychology. The subjects were presented a schematic diagram of a basketball play drawn on a piece of paper. They were allowed to study the play for five seconds at which time they turned over the paper and reproduced as much of the play as they could recall using a colored marker. The subjects then studied the play for another five-second interval, and marked the schematic diagram with a different colored marker. This experimental procedure continued until the subject recalled the entire play. The subjects were asked to

recall ten plays: (a) seven offensive plays, (b) two out of bounds plays, and (c) one stall or delay play. The results indicated that the experienced basketball players took significantly fewer looks ($\bar{X}$=2.42) than did the graduate students ($\bar{X}$=3.88) to complete the play. The number of elements recalled per look was larger by the experienced player ($\bar{X}$=4.93) than the inexperienced player ($\bar{X}$=3.81).

Bard and Fleury (1976) and Bard, Fleury, Carriere and Halle (1980) investigated visual search in association with solving basketball problems and gymnastic judging ability. Male basketball players (five experienced and five inexperienced) were presented slides that involved typical basketball situations. The types of solution required by each situation were to shoot, pass, dribble, or stay. Each slide represented a typical offensive pattern that differed in spatial organization in terms of proximity or distance from the center, left and right forward, and left and right guard.

Voice decision time and number and location of eye fixations were the dependent measures. Eye fixations were recorded by means of a cornea reflection recorder. When solving the offensive basketball situation, experienced basketball players' voice decision time did not differ from that of the inexperienced players. But a significant difference was found between the groups in the number and location of eye fixations. Non-players made more fixations than players. The spatial organizations and types of decision required by the slide did modify the voice decision time and visual patterns of eyes for both groups. These results suggested that a visual search profile of the

player and non-player can be determined by the type of task and the selection of the elements to be analyzed in the situation. Briefly stated, the experienced basketball players made fewer fixations to locate elements in the display that pertain to the solution of the problem.

Bard, Fleury, Carriere, and Halle (1980) investigated the visual searching patterns of novice and experienced gymnastics judges. Eye fixations and error detection were recorded by the same procedure used in the Bard and Fleury study (1976) with basketball players. Error detection measures were determined by a reference system developed by filming gymnastic routines. The films were judged by an expert judge and compared to judges who served as subjects.

A 16 mm film of four gymnastic routines, two compulsory and two optional, were viewed by four experienced and three inexperienced female judges. Expert judges had fewer eye fixations than novice judges. Compulsory routines required more eye fixations than optional routines. Interestingly, the location of fixations was markedly different for the two types of judges. Expert judges concentrated their fixations on the gymnast's lower body. As was expected, expert judges made fewer errors or missed fewer gymnastic mistakes than the novice judges.

The visual search performance of the novice judges required more fixations, differed in location, and made greater error in judging a gymnastic routine than the search performance of expert judges. The information load caused by a visual search is great when the subject is faced with immediate perception, and the ability of a novice judge to

process the load may be less than that of the expert judge (Bard et al., 1980). These results support those from Allard and Burnett's study (1985) in which experienced basketball players recalled more information in fewer looks at schematic basketball plays.

The research reviewed thus far has involved studies in which subjects visually searched a slide or film representing a visual field to detect, recognize, and recall situations in a sport setting. The purpose of this line of research is to uncover perceptual knowledge or ability which may be different between expert and non-expert athletes or judges in a specific sport. Results of studies with volleyball players (Allard & Starkes, 1980; Starkes & Allard, 1983) indicated that: (a) experienced volleyball players speed of visual search in identifying the ball was faster than that of non-players for both structured and unstructured slides; (b) the accuracy of recognition and identification was similar for both experienced and non-experienced players; (c) volleyball players' visual search performance was dependent on the familiarity of the scene; (d) in a competitive situation the experienced player was faster but made more errors in detection of the ball; and (e) experienced volleyball players were skilled visual searchers in detection of the ball, but this search process did not extend beyond the game of volleyball.

In basketball and field hockey, (Allard, Graham, & Paarsalu, 1980; Allard & Burnett, 1985, Starkes & Deaken, 1984) experienced players recalled game situations with greater accuracy than did non-players. According to Bard and Fleury (1976), an interaction of level of

experience with the structure of the game exists, i.e., experienced basketball players' cognitive and perceptual abilities about the organization of the game and timing of the skills in the game are more refined.

Bard and Fleury (1976) disclosed that the search pattern used by experienced basketball players differs from that of non-players and according to the structure of the task. This view is supported by results of the Bard et al. (1980) study with gymnastic judges differing in experience. Both varsity basketball players and experienced gymnastics judges have developed different visual search patterns specific to the sport or activity.

TARGET AND CONTEXT CONTROL THEORY

Neisser (1967) has explained skilled performance in visual search from a two-control memory component model: target control and context control. Briefly, visual search requires perceptual ability to learn the differences between the target object and the context objects in the visual field. A memory representation of the target is needed for the recognition of target and non-target items used in the control of search. A search governed by target control is dependent on a memory representation of the target. A search governed by context control is dependent on sensitivity or recognition of larger portions/patterns of the display rather than to individual items.

Neisser's (1967) two-control model of visual search postulates that the searcher uses a number of types of analyzers during the search

that test the visual input on different qualifiers. These analyzers work on different levels. The lowest are detectors which function to specify figural characteristics of the elements in the visual display. As soon as the detectors are successful in their search, they send an alarm and mobilize another analyzer which functions as a letter detector. According to Neisser, the visual search process operates through a system of hierarchical analyzers.

When the searcher observes a target, the analyzers become excited and transmit the information about the target deeper into the perceptual system. Neisser (1967) contended that early in learning the observer operates under target control because the qualifiers of the target are not developed. However, when the detectors become more sensitive and the qualifiers more refined through training to both the target and the context, the observer operates under context control. The analysis of the target and the context becomes immediate because the observer is under the control of pre-attentive processes that are developed from training and earlier process levels. The identification of the target then becomes more possible under context control (Neisser, 1967).

A line of research using multiple target search tasks was performed in the early 1960's in an attempt to determine the principles of target and context control. Neisser (1967) and Neisser, Novick and Lazar (1963) found that both male and female university students' speed of visual search with practice was the same when using multiple targets as it was when using one or two targets. The subjects in both studies scanned a list of letters consisting of a single column of 50 lines.

The target items were a specific letter or combination of letters randomly presented in the list. The observers in each study were to search the list for the target or targets as fast and accurately as possible. Each subject's speed and accuracy of visual search was recorded during each training session which lasted over several days. Neisser's (1963) results indicated that with practice, no more time was needed to examine the list for any of four targets than for two or one. Neisser, Novick and Lazar's (1963) results indicated that, with practice, observers searching for any of ten targets were not only as fast but also at least as accurate as subjects searching for only one item.

Both studies indicated that early in training the speed of search was slower and less accurate than in later stages of training. Neisser (1967) contended that after sufficient practice the observer was able to search efficiently and under context control by detecting targets that fail to match against a set of expected contextual stimuli. Early in practice, the observer's visual search analyzer presumably makes use of the representation(s) of the target(s). The detector recognizes only the target letter or letters. As long as no target letter(s) appear in the stimulus, the detector is silent and the search continues. When a match occurs between the stimulus representation of the letter or letters and the memory representation of the target(s), the detector is activated. The search is interrupted and an overt response is triggered.

Neisser (1967) assumed that practice operates to enhance the efficiency of memory representation of the targets, without affecting the organization of the memory comparisons. Neisser conjectured that for the unpracticed searcher, "a many-target task will be more difficult than a one-target task because the mere chance of detecting valid and distinguishing attributes will decrease as the complexity of the target category increases. When specific practice improves the efficiency of the memory codes, the absolute difference between both target and non-target items will become small" (p. 71).

Several investigations have been conducted since the original series of studies by Neisser et al. (1967, 1963, 1965) that have indicated support for the notion of visual search performance of the trained observer. Kristofferson (1972) replicated the Neisser et al. (1963) study with eight university student volunteers and found that early and late in training the subjects' visual search was similar to that reported by Neisser et al. (1963). Other studies involving different visual tasks or target(s) have produced similar results (Brand, 1971; Neisser and Stoper, 1965; Neisser, 1974).

CHANGES OF SEARCH CONTROL WITH PRACTICE

As shown in several multiple-target studies, the influence of the number of targets on speed of visual search is significantly reduced with practice. Prinz et al. (1977; 1979) proposed several visual search models that explain the stages of visual searching. Prinz (1977) states that, "without practice, a subject will be forced to operate under

target control since he has not yet become familiar with the context. Practice will then increasingly favor context control since the subject becomes acquainted with the context more and more, first at symbol level and then at the clusters of symbols after extended practice" (p. 449).

The model of visual search proposed by Prinz (1977) involves three stages of practice. In Stage 1, the observer starts the search under exclusive target control. This first stage is characterized by the recognition of target items without the recognition of nontarget items. After some practice, representations of some nontargets are formed. The nontarget items are used in search, though not exclusively. It is reasonable to assume that the observer remains under target control for some time. This leads the observer to scan-and-check between context and target items (Stage 2). Stage 2 passes to Stage 3, or context control, when the memory codes for context control have attained perfect efficiency which occurs when: (a) each location of the display that leads to a context mismatch contains a target, and (b) when each location that contains a target leads to a context mismatch (Prinz, 1977).

Prinz (1977) examined his own visual search model with six university psychology students. Each subject visually searched a list of letters over 20 sessions. Three conditions were formed, each condition differing in the number of targets: 2, 4, or 8. For three subjects the context was homogeneous, that is a simple context made of five symbols that never changed. The other three subjects visually searched for targets in a heterogeneous context, that is a complex

context made of ten symbols randomly ordered. The results tended to replicate the earlier multiple searching experiments indicating that practice served: (a) to facilitate the speed of the visual search, and (b) to reduce the effect of the size of the target set. These results supported Neiser's (1967) view that practice serves to improve the efficiency of the analyzers involved.

Results suggestive of three stages of visual search reported by Prinz (1977) indicated that early in practice both context and target complexity had a negative effect on the efficiency of visual search, but later in practice neither the context nor target complexity had an effect on visual search. These results supported Prinz's visual search model in Stages 1 and 3. But, Prinz's results also indicated that the transition from Stage 1 to Stage 2 was accomplished rather easily, since the performance of each subject after the fifth session of practice was virtually independent of target set size. It was concluded that target set size can affect the search performance of observers in the very early stages of practice.

Fitts and Posner (1967) designated and defined the three stages of learning in skilled tasks. In the cognitive, or early stage, performance is simply a reflection of experience and familiarity with the skill and the situation. In the associative, or intermediate stage of learning, performance patterns become more efficient and fewer errors are committed. In the autonomous, or final stage, performance is automatic.

An applied visual search study (Mourant and Rockwell, 1972) with experienced and inexperienced drivers examined visual search based on Fitts and Posner's (1967) stages of learning theory. Mourant and Rockwell (1972) recorded the visual search strategy performance of six novice drivers before they had any driving experience, when they were halfway through a driver education course, and just after they completed the driver education course. Four experienced drivers served as the control group. Both groups of subjects were tested on neighborhood and freeway routes. A television eye movement recording system was placed in the driver education car. The eye movement recording system measured the novice and experienced drivers' visual searching scan pattern over a wide range of driving subtasks.

The results of the Mourant and Rockwell study (1972) indicated that changes in the visual search process of novice drivers occurred over time. In the cognitive or early training stage, the novice driver's visual search was characterized by a long recognition stage and a large scan path. The novice driver made many fixations in order to learn which features were relevant in driving. At the end of the driving course, the novice driver's visual search involved a smaller range of fixations, but the scan pattern differed from that of the experienced driver. The experienced driver had a much smaller scan path and fewer fixations.

These applied visual search results of Mourant and Rockwell (1972) are similar to earlier sport research reported by Bard et al. (1976 & 1980). Bard and Fleury (1976) indicated that the visual scan pattern of

novice male basketball players was different and contained more fixations than that of experienced basketball players. Such findings were also obtained in the Bard et al. (1980) study with novice and experienced gymnastics judges.

Gentile, Higgins, Miller and Rosen (1975) developed a taxonomy that implied that motor skills call for differing visual-perceptual strategies in light of the environment, the task, and the performer's abilities. According to Gentile et al. (1975) a means of integrating other aspects of skilled performance with the task classification is through the visual processes associated with each task. The visual processes needed to perceive a wide range of cues in the environmental display and the ability to quickly extract and interrelate pertinent information from the environment are two of the visual-perceptual factors often related to motor task performance (Gentile et al., 1975).

Beitel (1980) conducted a study involving 80 females whose visual-perceptual abilities were related to the cognitive and associative stages of performance of a temporal-spatial and a spatial motor task. The temporal-spatial motor task was a modified soccer test which required the subject to move a soccerball through a fixed setting. Beitel concluded that early in the performance of a temporal-spatial motor task, execution of the task is related more to the moving object than to the features and location of the stationary objects. Beitel's (1980) results support the contention that early in learning more attention is associated with the ball or target than with the location or features of stationary objects in the field. The spatial task (no

ball) required the subject to move through a fixed setting as fast as possible. To be successful, the subject needed to extract information about the environment in which her body was moving. The spatial-visual relationship between the moving body and the environment was found to develop with practice.

HURDLE PARADIGM

The hurdle technique is an experimental paradigm that enables the researcher to determine the mode of visual search being used, i.e., context control and/or target control (Prinz, Tweer, & Roffeige, 1974; Prinz, 1979b). In typical visual search studies, a hurdle item, which belongs neither to the target or context category, is inserted into a word list. The hurdle technique allows for testing the hypothesis that skilled visual searchers performing a search under context control should detect a signal for which he/she has not been instructed to look. As indicated above that context control of search occurs in one of two ways: (a) by testing each stimulus sample for internal consistency, or (b) by comparing each sample with a memory representation of the context category (Prinz, 1977). Hurdle detection can be identified in two ways: (a) the observer may report the detection of a hurdle; and/or (b) the speed of visual search will decrease in lists with hurdle items.

Prinz et al. (1974) first implemented the hurdle technique in an attempt to determine in which stage an experienced searcher operated, i.e., target or context control. Seven university subjects visually searched two types of lists, one with no hurdle and one with a hurdle

inserted. The lists contained letter targets and each subject was instructed to search for one or a combination of eight targets. The hurdle item was a letter turned backwards. During the first four training sessions, subjects were not given the hurdle item but only searched for the target(s). In the fifth training session the subjects were given alternating blocks of trials containing hurdle and/or target items. Both accuracy in detecting the hurdle item and the speed of search were measured.

The test apparatus was a search board. The search list of letters was displayed behind a vertical window in the board. At the start of each trial, the subject pressed a button. Pressing the button served to release a mechanism which uncovered a list of letters in the window and at the same time started a time measurement by an electronic counter. The subjects visually scanned the list. Each subject moved a small stylus with the dominant hand. Upon locating the target, he/she pressed down the tip of the stylus, thus activating a microswitch which stopped the counter.

The results indicated that none of the subjects failed to pause at the first presentation of the hurdle item, thus indicating a rather strong degree of context control. The time of visual search increased for all subjects when presented with the hurdle item. A rather interesting relationship was found between trained subjects who were classified as fast or slow scanners and the effect the hurdle items had on their search performance. Subjects classified as fast scanners by their initial search rate tended to keep their speed of search

relatively constant. However, the performance of subjects classified as slow scanners by their initial search rate, was affected by the hurdle item. Prinz et al. (1974) cautioned researchers that the finding of differences in behavior between fast and slow scanners is very tentative because the study involved only two slow scanners.

In a subsequent study, Prinz (1979b), Experiment 1 attempted to determine how much practice is needed before the control of search can be taken over by context control. Twelve female university students searched a list of letters which contained one target at an unpredictable position. Three subjects were randomly assigned to four training conditions: (a) identify the target with a constant context with one hurdle item, (b) identify the target with a constant context with three hurdle items, (c) identify the target with a varied context with one hurdle item, and (d) identify the target with a varied context with three hurdle items.

Estimates of the delay caused by the hurdles were obtained by calculating differences between the regression coefficients for the hurdle and no-hurdle lists. Prinz's (1979b) results indicated: (a) that all subjects in the first two practice sessions paused at the hurdle items, but, later in practice, no overt detection responses occurred; and (b) that the speed of search showed no deterioration across the two hurdle lists differing in context or between the no-hurdle conditions. The rate of learning was faster with the search list in a constant context than in the varied context.

These experiments (Prinz et al., 1974; Prinz, 1979b) indicated that all subjects discovered the hurdles and/or were disturbed by them. During practice the hurdle item was detected only in a small number of trials. Prinz (1979b) indicates that these results confirm the principles of context control but the transition from target to context is apparently almost immediate or occurs with little practice. Prinz et al. (1974) does suggest that a more complex task should be used to determine if there is an immediate transition from target to context control.

SUMMARY

On the basis of the literature reviewed, the concepts of perceptual recognition and recall of structured and unstructured sport situations can be applied to measure visual-perceptual performance in human subjects. A visual search approach to analyzing the visual perceptual abilities of experienced and novice women's basketball players would serve to: (a) provide evidence of the sensitivity of visual perceptual processes in experienced and novice players; (b) allow determination of the extent to which experienced or novice sport players' ability to detect, recognize, and recall game situations is developmental in nature, and (c) allow investigation of the mode of visual control used by experienced and novice players. The present study utilized a visual search paradigm involving the hurdle technique to more clearly assess the visual perceptual abilities of recognition, recall, and mode of visual search for experienced and novice basketball players.

CHAPTER III

PROCEDURES

Procedures used to conduct this research included: (a) design of the study, (b) collection of the data, and (c) analysis of the data.

DESIGN OF THE STUDY

Design of the study included: (a) selection of subjects, (b) selection of the visual stimuli (slides), and (c) selection of test apparatus.

Selection of Subjects

Subjects were women basketball players differing in level of experience. This concept was selected on the basis of procedures utilized in previous sport studies (Allard, Graham, & Paarsalu, 1980; Allard & Starkes, 1983; Starkes & Deaken, 1984) because it allowed comparison of visual perceptual recognition and recall abilities between experienced and novice players within the sport of basketball. Literature relative to this area of study is scant and incomplete.

Thirty female students from Northern State College, Aberdeen, SD, served as subjects. The group of 30 consisted of 15 experienced and 15 novice basketball players. The experienced basketball players were members of the Northern State College women's varsity basketball team. The novice players were females who had no competitive basketball experience and who were not participating in basketball at the current

time. Both the experienced and novice players were selected by means of a preliminary interview in which each female completed a pre-experimental subject questionnaire (Appendix B). The questionnaire assessed: (a) whether or not the subject had any vision problems, (b) whether the subject was left or right handed, and (c) the subject's degree of involvement and/or playing experience in the game of basketball.

Three questions relating to visual health were used to determine if the subject had experienced any eye problems that would interfere with vision. Any person with a history of vision problems was not used as a subject in this study.

Degree of involvement in basketball was assessed by four pre-experiment questions which asked subjects: (a) how much they read about basketball; (b) how much they watched basketball; (c) how often they attended basketball games; and (d) if they physically participated in the game of basketball. These questions were designed to identify novice and experienced players' indirect participation in the game of basketball outside of varsity play. The novice basketball players selected for this study were persons who had indicated no involvement (reading about, watching, attending games, or physical participation) in the game of basketball. The experienced players indicated a high degree of involvement in the game of basketball.

Visual acuity was assessed by the use of a Snellen eye chart to ensure the experimenter that each subject had 20/20 vision. The Snellen eye chart had rows of randomized letters which decreased in size.

Correct identification of any row represented a level of visual acuity at a distance of ten feet. Each subject was asked to correctly identify the row of letters that corresponded to 20/20 visual acuity standing behind a line drawn ten feet from the chart which was taped on the wall at the subject's eye level.

Subjects selected for this study ranged in age from 18 to 22 years. The 15 experienced players had four to seven years varsity playing experience beyond junior high school. The 15 inexperienced basketball players selected for this study had no varsity playing experience beyond the junior high level. None of the subjects were paid for their services during the study. Each subject was given a written explanation of the purpose of the study and each signed an informed consent statement (Appendix C) before participating in the study.

Selection of the Visual Stimuli (Slides)

The visual search paradigm used required subjects to recognize a target item (basketball) and recall players and any other distractors on the court in a sport slide. Studies with athletes (Allard, Graham, & Paarsalu, 1980) have heretofore used a paradigm in which subjects only recalled the items in a sport slide. No research studies investigating visual perception and recognition of target items in a sport context and/or with sport participants were found to exist.

The stimuli used in this study were photographs of high school women's basketball games. Permission to photograph was solicited from the high school women and their parents, from the respective high school superintendents, and from the respective coaches. Each party received a

letter of explanation and was asked to sign an informed consent statement (Appendix D).

The photographs were obtained by using a 35 mm Minolta auto focus camera with 400 Kodacolor VR film, mounted on a tripod, positioned in the balcony of the Aberdeen (SD) high school basketball arena. The balcony permitted a downward angle on the players and the key area, including the free-throw line of the basketball court. According to professional sport photographers, this technique results in photographs that best represent and isolate the real life action involved in basketball (Time Life, 1983; Bill Board Publishers, 1983; and Zimmerman, Kauffman, & Leifer, 1975).

The experimenter mounted the tripod and photographed structured and unstructured basketball plays from the same location, distance, and angle for each basketball game. The use of slides depicting structured and unstructured basketball situations is a specific experimental procedure adopted from Allard et al. (1980) and a personal conversation with Allard (1985) to assess the type of information about the game of basketball that may be perceived differently between experienced and novice women players.

The use of a hurdle item was included in this study to examine the mode of control in the visual search of novice and experienced women basketball players. The hurdle technique has been used in several visual search studies (Prinz, Tweer, & Roffeige, 1974; Prinz, 1979) but never in a sport context. These earlier psychological visual search studies (Prinz, Tweer, & Roffeige, 1974; Prinz, 1979) had subjects scan

a list of letters for a target (letter) with a hurdle item (an item not belonging to either the context or the target) either present or not present. In this study, an orange, 2-foot equilateral triangle of Contac paper placed in the key area was used as the hurdle item. The selection of the orange triangle, larger but different in shape than the target item (basketball), is compatible with the operational definition of a hurdle item by Prinz, Tweer, and Roffeige (1974).

The orange triangle was placed on the court at the exact middle of a rectangle formed by the free throw line, the endline, and two sidelines of the key area. The base of the red triangle was positioned so the apex pointed toward the end line (Figure 1). The triangle was put in place an hour before the scheduled high school basketball game while the arena was empty.

A pilot study was conducted prior to the study to: (a) develop the photographic techniques used to isolate structured and unstructured play situations, including the presence or absence of the basketball and/or the hurdle item; (b) determine the selection of the type of 35 mm film; and (c) standardize the angle of view in each photo.

One hundred and thirty four photograph negatives were selected by the experimenter on the basis of play (structured or unstructured), the presence or absence of the target item (basketball), and the presence or absence of the hurdle item (orange triangle). These negatives were made into sport slides. To eliminate experimenter bias in the slide selection process, the 134 sport slides were then viewed separately by three experienced college basketball coaches (two females and one male).

Each rater evaluated the sport slide on the basis of play (structured and unstructured), the presence or absence of the target item (basketball), and the presence or absence of the hurdle item (orange triangle). Each rater based his/her decision of each sport slide on the operational definitions of this study which were provided by the experimenter prior to viewing. The three raters unanimously agreed on 84 sport slides indicating structured or unstructured play, the presence or absence of the ball, and the presence or absence of the hurdle. Sixty-four of these served as the visual stimuli in this study.

Selection of Test Apparatus

Apparatus in this study included: (a) visual search apparatus, and (b) recall apparatus.

Visual search apparatus. The stimuli used in this study consisted of slides of 32 structured and 32 unstructured basketball situations. Sixteen slides of each situation, structured and unstructured, contained the target item (basketball). Sixteen slides of each situation contained the hurdle item (orange triangle). All of the slides depicted action, both offensive and defensive, around and within the key area on the basketball court. All slides were of female high school varsity players. All slides were taken of games involving two women's teams playing at regular season contests. The players pictured in the slides were unfamiliar to the subjects in this study.

Structured game slides depicted set offensive basketball plays in progress, and an identifiable defensive (Figure 2). Unstructured game slides depicted transitional basketball situations, i.e., turnovers,

rebounds, and fastbreaks (Figure 3). The camera angle of each slide was the same. The number of players in each slide varied from seven to ten. The mean number of players within the structured and unstructured plays depicted in the 64 slides was identical ($\bar{x}$=9.3 players/slide). There was never more than one official visible in each slide.

Each slide was projected on a white screen by a Kodak autofocus slide projector (Model 850H) with a Lafayette Instrument's lens (Model No. 6350) in conjunction with an eight bank timer (Lafayette Instruments, Model No. 520) functioning as a taschistoscope. A taschistoscope is an apparatus used for the brief exposure of visual stimuli. The eight bank timer enabled the researcher to set a 3-second foreperiod before each trial and to control the shutter of the slide projector to a 5-second viewing period. The experimenter initiated each trial with a verbal "ready" signal, simultaneously flipping the manual projection lever on the eight bank timer. The triggering of the shutter initiated the reaction timer. Each subject positioned the palm of her dominant hand on a black hand-shaped spot in front of and an equal distance (5 inches) from two keys before the start of each slide presentation. The two keys were exactly nine inches apart. In front of the two keys were the words "yes" and "no" designating which key to depress in response to the presence or absence of the target item (basketball) in the slide being presented (Figure 4).

The shutter of the slide projector initiated an external reaction timer (Reaction/Movement Timer, Lafayette Instruments Model N. 63017) electronically synchronized with the presentation of the slide.

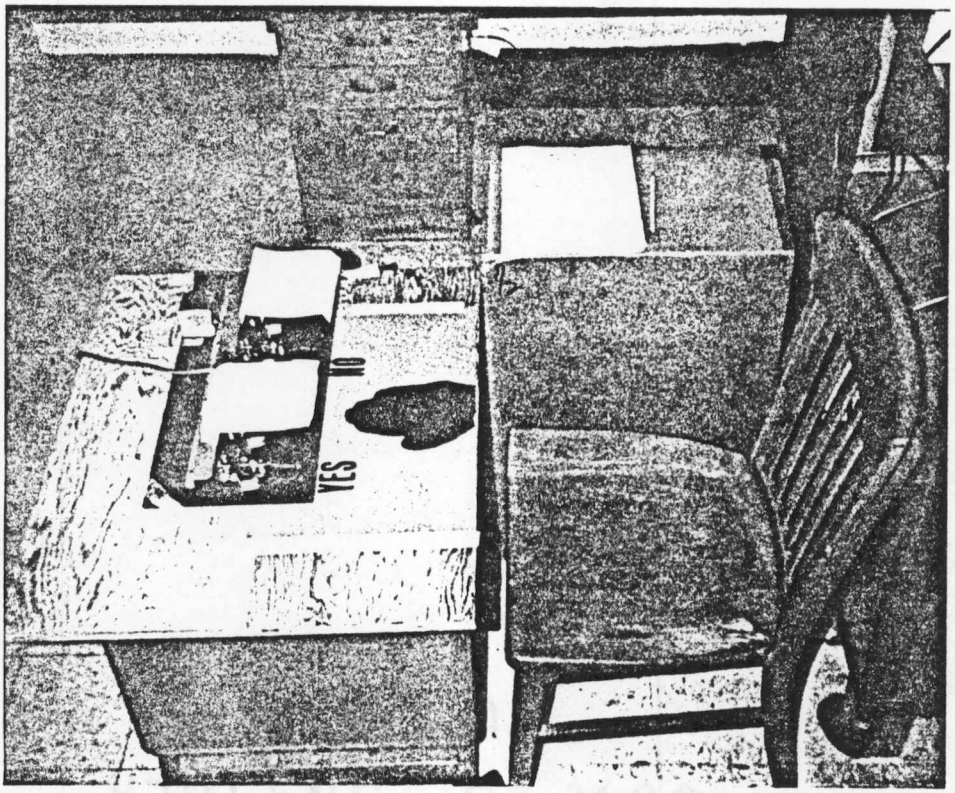


Figure 4. Response Key and Laboratory Organization

Depression of the right hand on either key stopped the reaction timer. The timer had two independently operated clocks connected to the stop keys which allowed the experimenter to record a yes or no response and the time required to make the response.

Recall apparatus. The recall apparatus that was used in this study is similar to the Allard, Graham, and Paarsalu (1980) magnetic basketball board. The subjects were provided an 8 1/2" x 11" sectored grid of one-half of the basketball court with the key area clearly outlined (Appendix E). The key area was drawn from the same perspective as depicted in the sport slide. Each sector on the grid was 1.5 cm X 1.5 cm and represented a scaled-down section of the court. The sectors of the grid were labeled A to M horizontally and 1 to 10 vertically. Sixty-four copies of the grid were marked by order of trial, and numbered to correspond with the play (structured or unstructured), presence or absence of the target item (basketball), and presence or absence of the hurdle item. The subjects were asked to identify the position of: (a) offensive players by placing a checkmark; (b) defensive players by placing an "X"; and (c) presence of any other items which attracted their attention by placing an "O", on the grid after each slide.

A master grid was developed for each slide which indicated the correct number and position of players in the respective slide. To eliminate any experimental bias in scoring the grids, each subject's 64 grids were scored by an adult female volunteer not associated with this research study. A subject's accuracy score was determined by the number

of marks on the grid that corresponded to the master grid for each slide presented.

COLLECTION OF THE DATA

Prior to the collection of the data, a pilot study was conducted to assure that the procedures were consistent and clear. After the selection of subjects through the use of the pre-experimental questionnaire, data was collected over a 5-week period. The 30 subjects were randomly tested. Each subject participated in a 70- to 80-minute testing session. The first 20-25 minutes were used to obtain subject consent (Appendix C), to deliver tape-recorded, pre-experimental intructions, to read the same instructions explaining the experiment and requirements of the subject (Appendix F), and to familiarize the subjects with the visual search and recall tasks. The subject was then positioned for testing and eight practice trials were administered. On each practice trial the subject responded to the presence or absence of the target item (basketball) and completed a recall grid indicating offensive players, defensive players, and any distractors.

After the eight practice trials were completed, the experimenter asked if the subject had any additional questions about the requirements of each task. Each subject was reminded to: (a) properly position the dominant hand before each trial, (b) continue to view the sport slide for the full 5-second period, and (c) recall the slide by marking the grid with a checkmark for for offensive players, an "X" for defensive players, and an "O" for any distractors on the court. Immediately after

the question/answer period and brief review of the instructions, the actual testing of the subject began.

Sixty-four different sport slides representing the 64 trials were presented to each subject. The 64 slides were organized into eight blocks of eight trials. Each of the eight different combinations of experimental conditions was presented once within each block. Those eight combinations consisted of: (a) an unstructured situation with the ball present and the hurdle item present; (b) an unstructured situation with the ball present but no hurdle item present; (c) an unstructured situation with no ball present but the hurdle item present; (d) an unstructured situation with neither the ball nor the hurdle item present; (e) a structured situation with the ball present and the hurdle item present; (f) a structured situation with the ball present but no hurdle item present; (g) a structured situation with no ball present but the hurdle item present; and (h) a structured situation with neither the ball nor the hurdle item present. Prior to testing, the eight blocks were randomly ordered for each of the 30 subjects.

A slide projector was placed on the top shelf of a 3-shelf metal cart 6 feet from the 60" X 60" white screen (Figure 5). The cart was elevated by wooden blocks so the slide projector was exactly 4 feet off the ground. The slides were projected directly over the top of the subject who was facing the screen. Each sport slide projected on the white screen produced a 15" X 22" rectangle. The eight bank reaction timer was placed on the second shelf so the experimenter could record and initiate each trial.

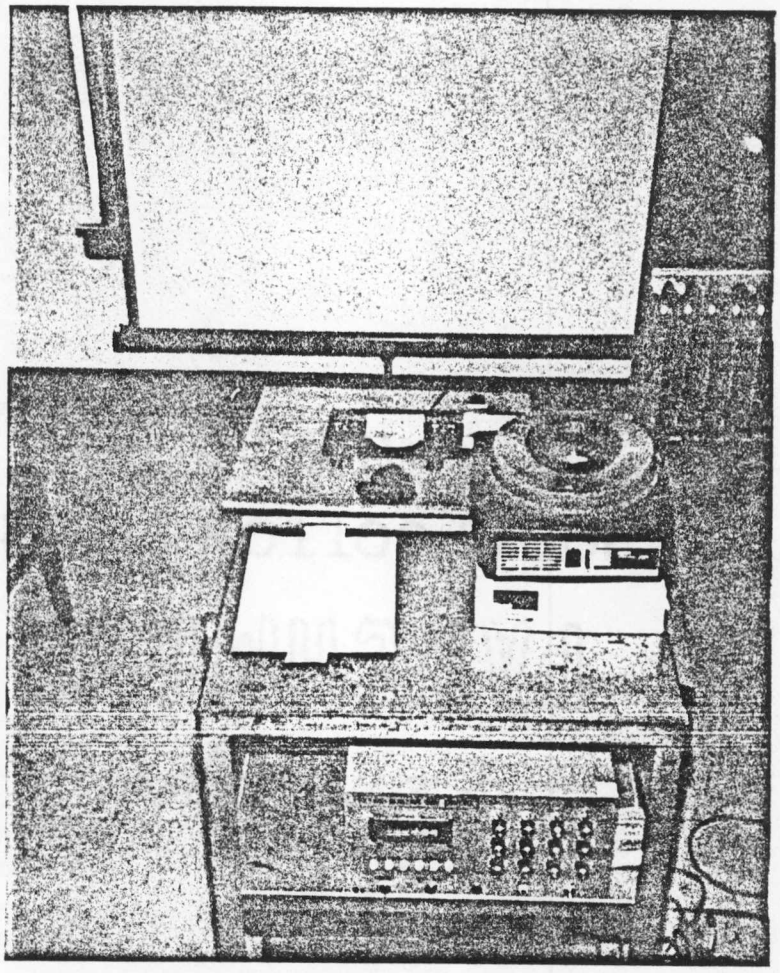


Figure 5. Slide Projector and Laboratory Organization

The subject sat in a chair 4 feet from the screen in front of a 27" high table upon which the stop keys were mounted (Figure 4). The subject could extend feet and knees under the table in a comfortable position. The subject's chair could be moved to afford a comfortable hand position in front of the stop keys. Before each trial the subject positioned her hand in the blackened area in front of the stop keys. The experimenter's chair was behind the cart and positioned so the experimenter could see the sport slide, the entire key board, the eight bank timer and the recall grids.

The recall grids for all the trials were placed on a 30" high table to the subject's immediate right (Figure 4). The subject needed only to move her shoulders slightly to the right and, with a No. 2 pencil, mark the recall grid. After the completion of each recall grid the subject placed it face down forming a pile next to the uncompleted recall grids. There was no limit to the time which could be used to complete each grid. When the recall grid was completed, the next trial was initiated by the experimenter with the "ready" signal. When 64 trials were completed, the subjects were debriefed, pledged to secrecy and dismissed.

ANALYSIS OF DATA

The purposes of this study were to investigate the speed and accuracy of ball recognition, accuracy of player recall, and mode of control in visual search of experienced and inexperienced women basketball players. The dependent measures used in this study were:

(a) the subjects' mean reaction time to measure the speed of ball recognition and mode of control in the visual search; (b) the subjects' mean P(A) score to measure the accuracy of ball recognition; (c) the subjects' mean number of accurately placed players on the basketball grid to measure the recall ability, and (d) the subjects' mean recall of the hurdle item recalled on the basketball grid. All the dependent measures except the subjects' recall of the hurdle item were measured on each of the 64 basketball sport slides containing the three within subject independent variables of: (a) basketball presence or absence, (b) structure and unstructured basketball plays, and (c) presence or absence of the hurdle item between the two subject groups differing by level of experience. Experience level, novice and experienced women basketball players, was the between subject independent variable.

The grouping of the dependent measures and the selection of the appropriate analysis of variance model were based on the following: (a) the specified hypotheses, (b) the method of calculating P(A), used in this study to determine accuracy of ball recognition (Appendix A), and (c) the data analysis of previous related sport studies involving the same dependent measures (Allard, Graham, Paarsalu, 1980; Allard & Starkes, 1980). Consequently, two different repeated measures ANOVA models were utilized as the basis for testing the specified hypotheses in this study: (a) two 2 X 2 X 2 X 2 ANOVA (experience X structure X ball X hurdle), were used to evaluate both mean reaction time and mean player recall, with subjects nested within experience with repeated measures on the last three factors (structure or unstructured play,

presence or absence of ball, presence or absence of the hurdle item), and (b) a 2 X 2 X 2 repeated measures ANOVA (experience x structure X hurdle) was used to evaluate P(A). In both models, subjects were nested within experience with repeated measures on remaining factors. All hypotheses were tested on the main effect or interactions of the specified hypotheses. Newman-Keuls' paired comparisons were calculated when appropriate, for significant interaction effects. In all of the hypothesis testing, the .05 level of probability was used.

CHAPTER IV

RESULTS

The purpose of this study was to contrast the visual search performance of women experienced and novice basketball players utilizing the visual search paradigm in order to test four specific hypotheses (Chapter 1, p. 7). The scores for representing the dependent variables of speed of visual search (mean reaction time) and recall in the visual search (mean recall) were evaluated using a 2 X 2 X 2 X 2 ANOVA (experience X structure X ball X hurdle) with subjects nested within experience. The structure of the play, the basketball's presence/absence, and the hurdle's presence/absence were all controlled as within subject variables. The scores representing the dependent variable of accuracy of visual search performance (mean P(A)) were evaluated utilizing a 2 X 2 X 2 ANOVA (experience X structure X hurdle) with subjects nested within experience. The structure of the play and hurdle presence/absence were controlled as within subject variables; and the dependent variable P(A) was calculated as a comparison of ball presence/absence (Appendix A).

Descriptive statistics were calculated for each dependent variable on the main effects and interaction effects of each model. The skewness, kurtosis, and homogeneity of variance of the distributions of each variable were evaluated prior to the analysis of variance (Winer, 1971; Nie, Hull, Jenkins, Steinbrenner & Bent, 1975 and Ray, 1982). The analysis of variance models were calculated utilizing SAS 82 (Ray,

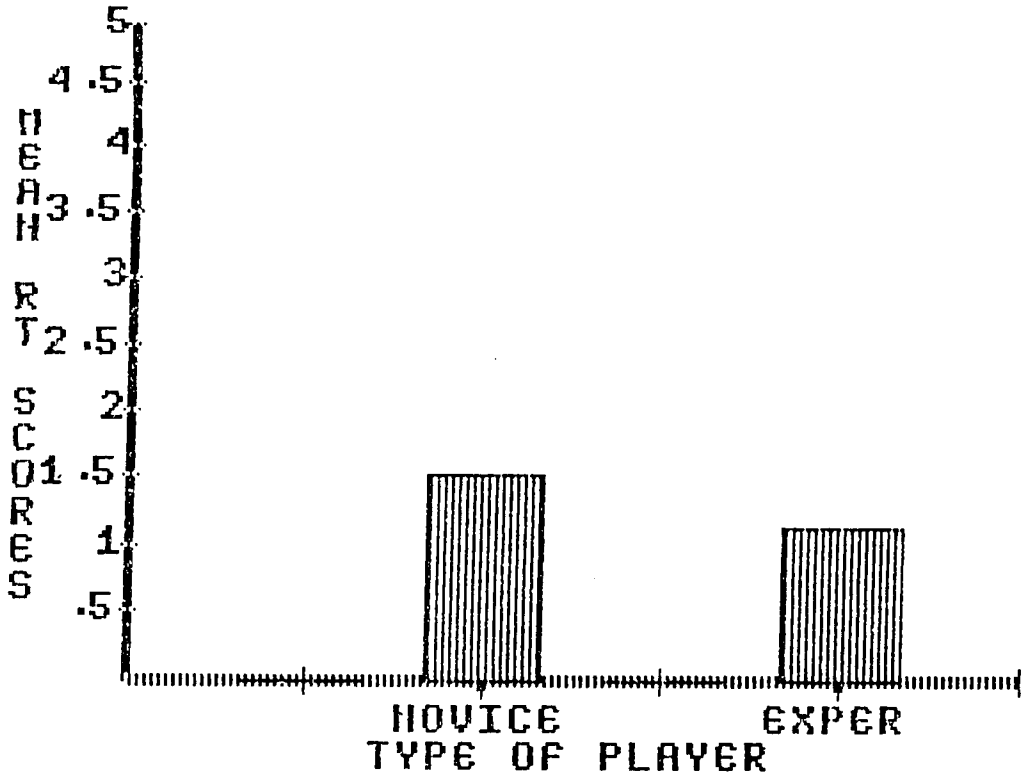
1982). Newman-Keuls' paired comparisons (Bruning & Kentz, 1977) were calculated when appropriate for significant interaction affects.

SPEED AND ACCURACY OF VISUAL SEARCH PERFORMANCE BETWEEN NOVICE AND EXPERIENCED BASKETBALL PLAYERS

The first hypothesis of the study (Chapter 1, p. 8) was that there are no significant differences in the speed and accuracy of the visual search performance of experienced and novice women basketball players. Mean reaction time scores representing speed of visual search and mean P(A) scores representing accuracy of visual search were each evaluated based on the calculation of the appropriate ANOVA model. The primary concern was the significance of the main affect of experience for both speed and accuracy of visual search.

Speed of Visual Search Performance between Novice and Experienced Basketball Players

The 2 X 2 X 2 X 2 repeated measures design ANOVA (Appendix G) produced a significant main effect for experience for the mean reaction time ($F_{1,28} = 16.35$, $p = .0004$). The experienced players' group reaction time for ball recognition when asked to determine the presence or absence of the ball was faster than the novice players' group reaction time (Figure 6).



	M(Sec)	SD
Novice (Nov)	1.47	.381
Experienced (Exper)	1.12	.216

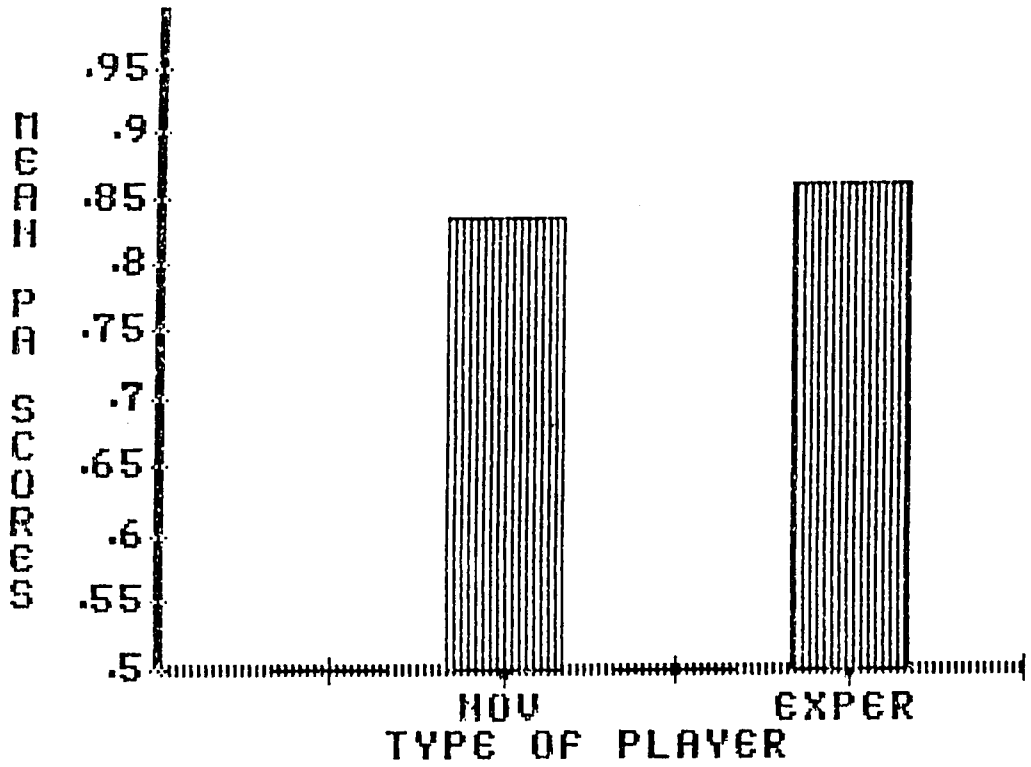
FIGURE 6: Mean reaction time for experience level of player including means and standard deviations for both groups.

Accuracy of Visual Search Performance between Novice and Experienced Basketball Players

No significant main effect for experience was found for the mean P(A) scores ($F_{1,28}$ = .61, p = .442) based on the 2 X 2 X 2 repeated measures design ANOVA (Appendix H). The accuracy of ball recognition measured by P(A) was similar for both groups (Figure 7).

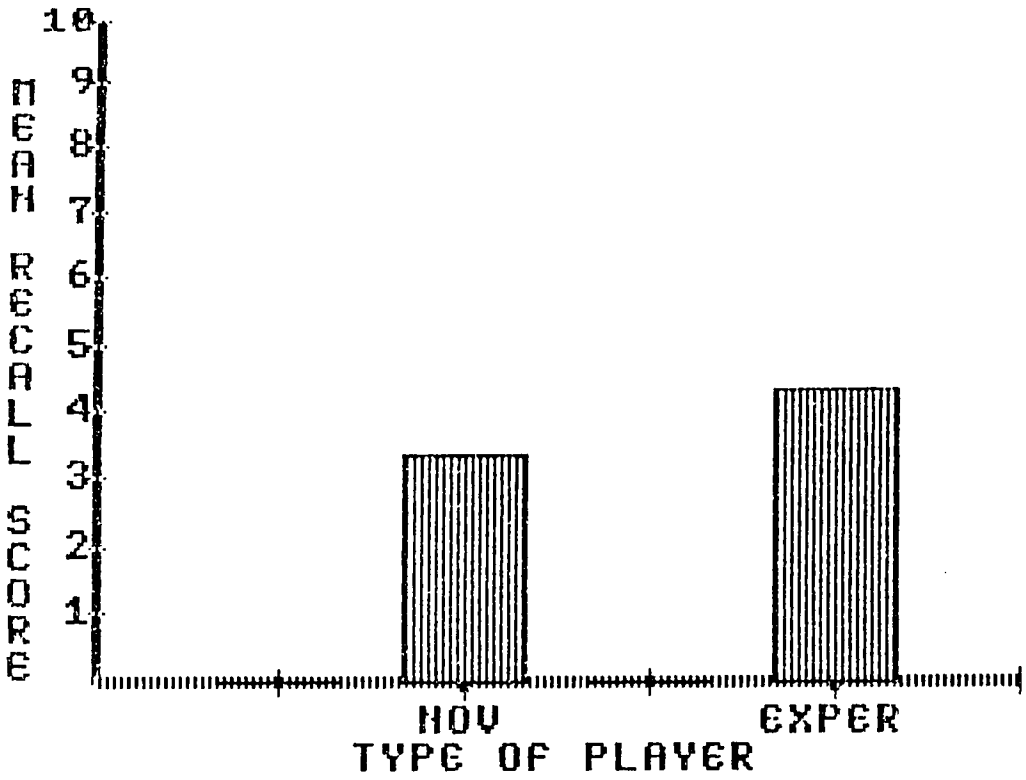
RECALL PERFORMANCE OF VISUAL SEARCH PERFORMANCE BETWEEN NOVICE AND EXPERIENCED BASKETBALL PLAYERS

The second hypothesis in this study (Chapter 1, p. 8) was that there are no significant differences in visual search performance between experienced and novice women basketball players in the recall of a sport situation. Mean recall scores representing recall of visual search were evaluated based on the calculation of the appropriate ANOVA model. The primary concern was the significance of the main effect of experience for recall in visual search. The 2 X 2 X 2 X 2 repeated measures design ANOVA (Appendix I) conducted on mean recall scores indicated a significant main effect of recall between novice and experienced player groups ($F_{1,28}$ = 26.99, p = .0001). The mean recall of experienced players was better than the mean recall of novice players (Figure 8).



	M	SD
Novice (Nov)	.835	.150
Experienced (Exper)	.858	.130

FIGURE 7: Mean recognition accuracy [P(A)] for experience level of player including means and standard deviations for both groups.



	M	SD
Novice (Nov)	3.25	.153
Experienced (Exper)	4.29	.888

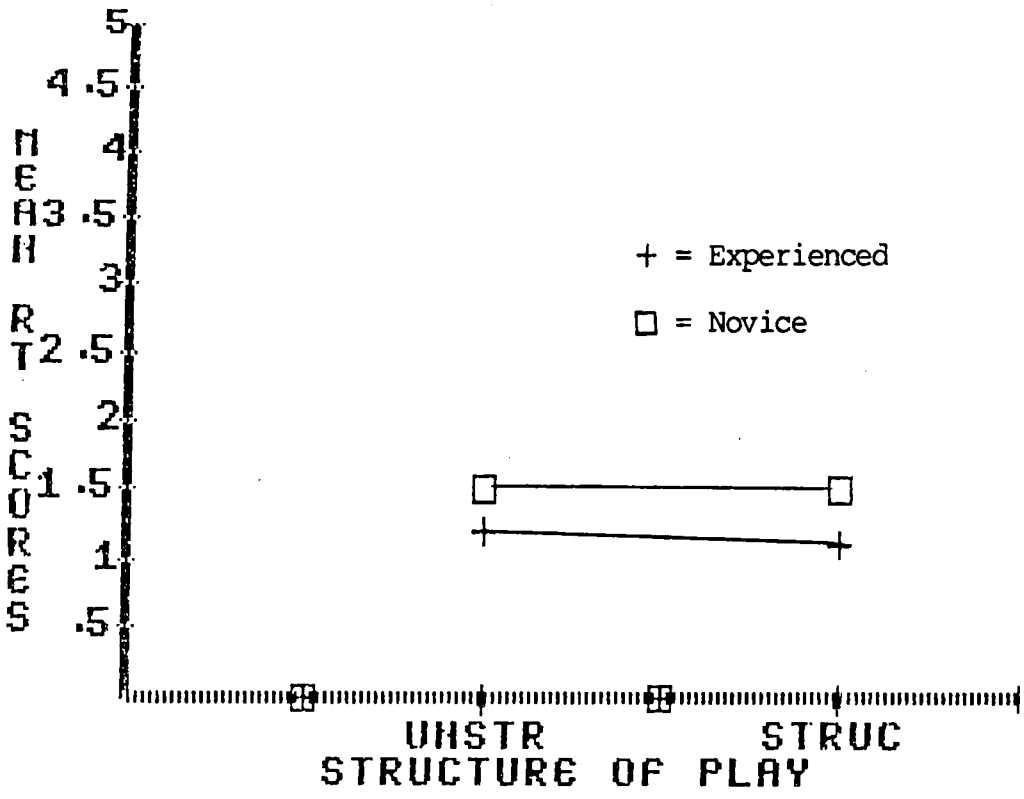
FIGURE 8: Mean player recall for experience level of player including means and standard deviations for both groups.

SPEED, ACCURACY, AND PLAYER RECALL OF VISUAL SEARCH PERFORMANCE FOR STRUCTURED AND UNSTRUCTURED PLAYS BETWEEN NOVICE AND EXPERIENCED BASKETBALL PLAYERS

The third hypothesis of this study was that there are no significant differences in the speed, accuracy and recall of the visual search performance between experienced and novice basketball players in structured and unstructured game situations (Chapter 1, p. 8). Mean reaction time scores representing speed of visual search, mean P(A) scores representing accuracy of visual search and mean recall scores representing recall performance of visual search were each evaluated based on the calculations of the appropriate ANOVA model. The primary concern was the significance of the interaction for level of experience by type of structured play for speed, accuracy and recall of visual search performance.

Speed of Visual Search Performance for Experience X Structure

To measure the speed of ball recognition in the visual search, the mean reaction time was analyzed based on the 2 X 2 X 2 X 2 repeated measures design ANOVA (Appendix G). The level of experience by type of structured play interaction for the subjects' mean reaction times was not significant ($F_{1,28} = .79$, $p = .38$). The novice and experienced players' speed of detection in visual search was not different for either structured or unstructured plays (Figure 9).



	Unstructured (Unstr)		Structured (Struc)	
	M(Sec)	SD	M(Sec)	SD
Novice	1.48	.390	1.46	.372
Experienced	1.15	.229	1.09	.200

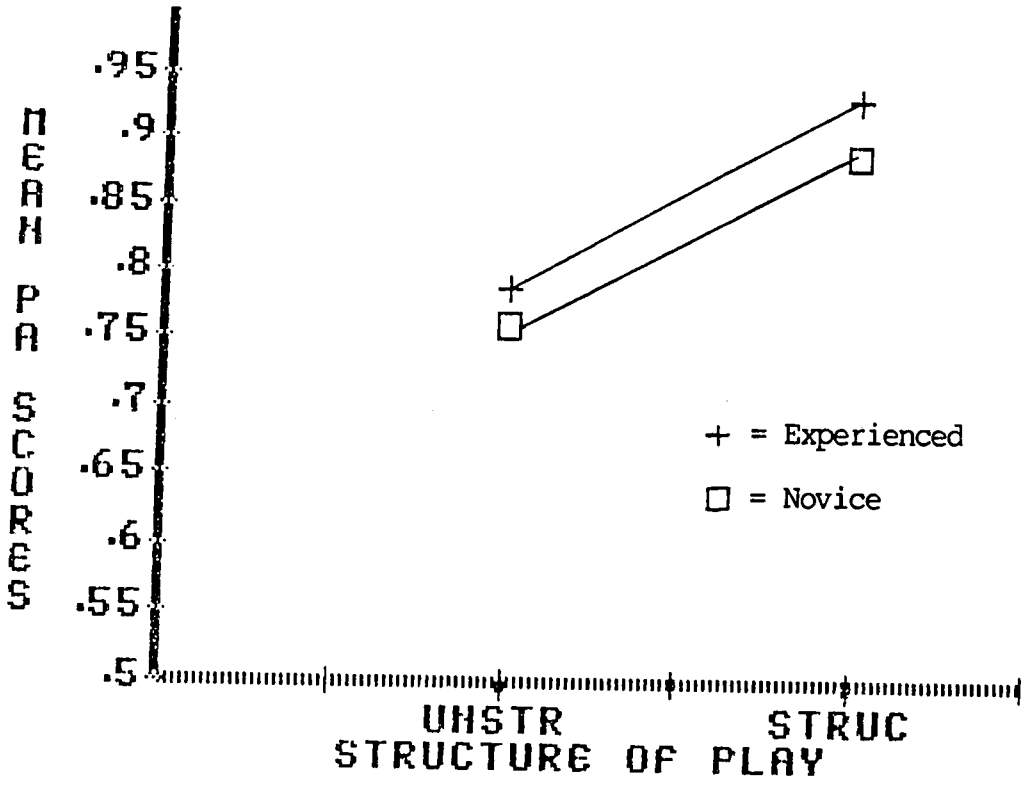
FIGURE 9: Mean reaction time for novice and experienced players for unstructured and structured slides including means and standard deviations.

Accuracy of Visual Search Performance for Experience X Structure

The mean P(A) scores of each subject were analyzed based upon the 2 X 2 X 2 X 2 repeated measures design ANOVA (Appendix H). The level of experience by type of structured play interaction for the subjects' mean P(A) was not significant ($F_{1,28} = .27$, $p = .60$). The novice, compared to the experienced, players' accuracy of detection in visual search was not different for either structured or unstructured plays (Figure 10). However, a significant structure main effect was found for the mean P(A) scores ($F_{1,28} = 37.03$, $p = .0001$). The combined mean P(A) scores for the experienced and inexperienced players was better for structured plays than for unstructured plays (Figure 10).

Recall of Visual Search Performance for Experience X Structure

The mean recall scores of each subject were analyzed based upon the 2 X 2 X 2 X 2 repeated measures design ANOVA (Appendix I). The level of experience by type of structured play interaction for the subjects' mean recall was significant ($F_{1,28} = 19.78$, $p = .0001$). A Newman-Keuls' multiple range test (Bruning & Kentz, 1977) was used to determine which of the differences between the recall means were significant and which were not, using the .05 level. Four comparisons were found to be significant: (a) experienced players' recall in structured plays was better than novice players' recall in unstructured plays, (b) experienced players' recall in structured plays was better than novice players' recall in structured plays, (c) experienced players' recall in unstructured plays was better than novice players'



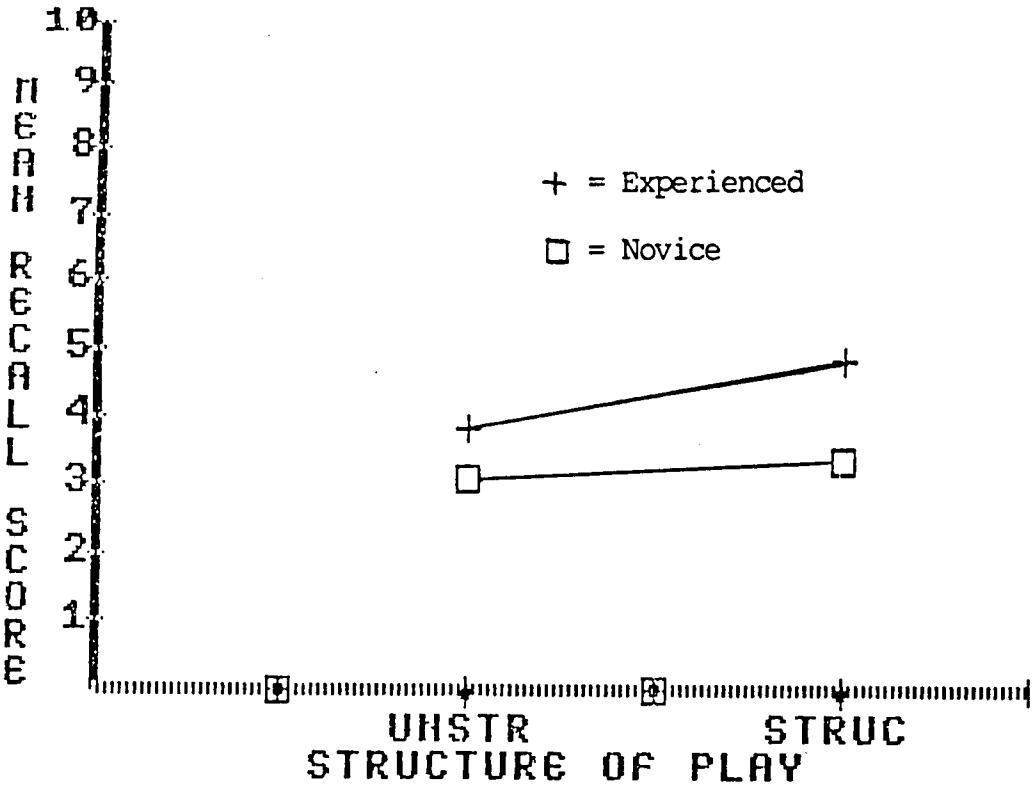
	Unstructured (Unstr)		Structured (Struc)	
	M	SD	M	SD
Novice	.776	.148	.894	.136
Experienced	.789	.123	.927	.097

FIGURE 10: Mean recognition accuracy [P(A)] for novice and experienced players for unstructured and structured slides including means and standard deviations.

recall in unstructured plays, and (d) experienced players' recall in structured plays was better than experienced players' recall in unstructured game plays (Figure 11). In addition, the main effect for structure was significant ($F_{1,28} = 56.48$, $p = .0001$). Player recall was better for structured plays than for unstructured plays.

THE MODE OF CONTROL IN VISUAL SEARCH PERFORMANCE BETWEEN NOVICE AND EXPERIENCED BASKETBALL PLAYERS

The fourth hypothesis of this study involved determining the mode of control in visual search through the hurdle paradigm. This hypothesis stated that there are no significant differences between the visual search performance of experienced and novice women basketball players with or without the presentation of a hurdle item in a sport situation (Chapter 1, p. 8). The determination of the mode of control in the visual search between the novice and experienced basketball players involved the subjects' mean reaction time and mean P(A) score when the hurdle item was present or absent in the 64 sport slides. The subject's mean reaction time for the hurdle item was used to determine the effect the hurdle item had on the speed of the visual search. The subject's mean P(A) score was used to determine accuracy of target (ball) recognition when the hurdle item was present or absent. The speed and accuracy of target recognition involving the hurdle item are critical in determining the type of visual search (Prinz, 1979a; Prinz, Tweer, & Roffeige, 1979).



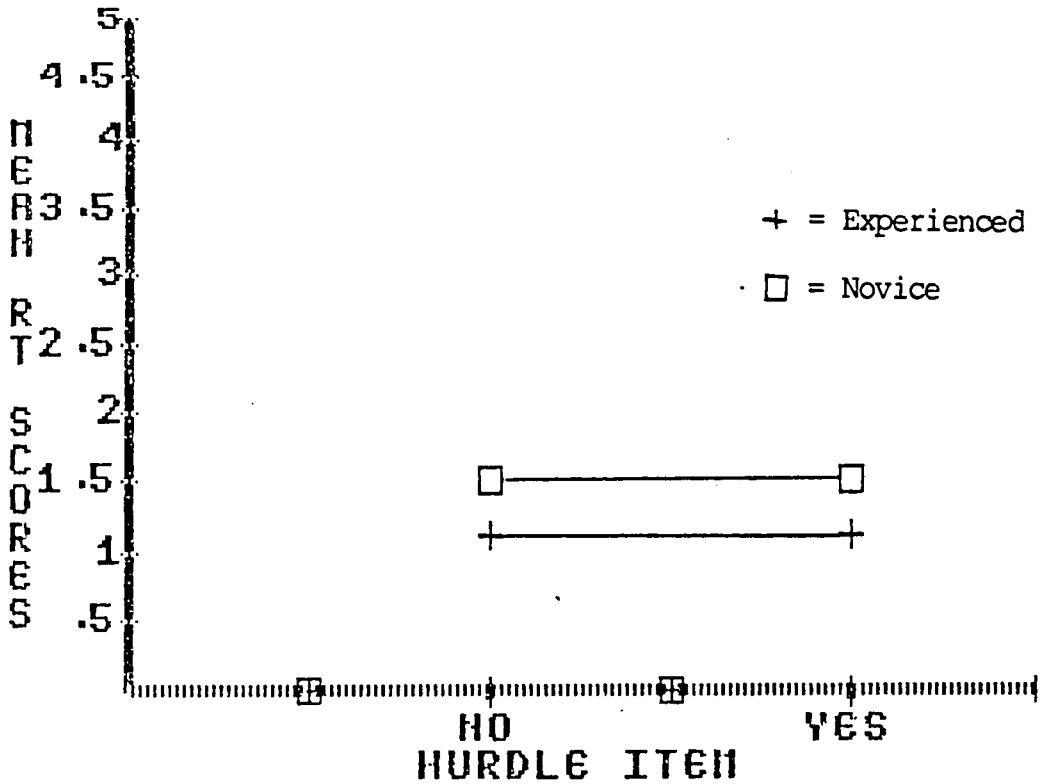
	Unstructured (Unstr)		Structured (Struc)	
	M	SD	M	SD
Novice	3.12	.663	3.38	.850
Experienced	3.78	.708	4.80	.752

FIGURE 11: Mean player recall for novice and experienced players for unstructured and structured slides including means and standard deviations.

Speed of Visual Search Performance for Experience X Hurdle

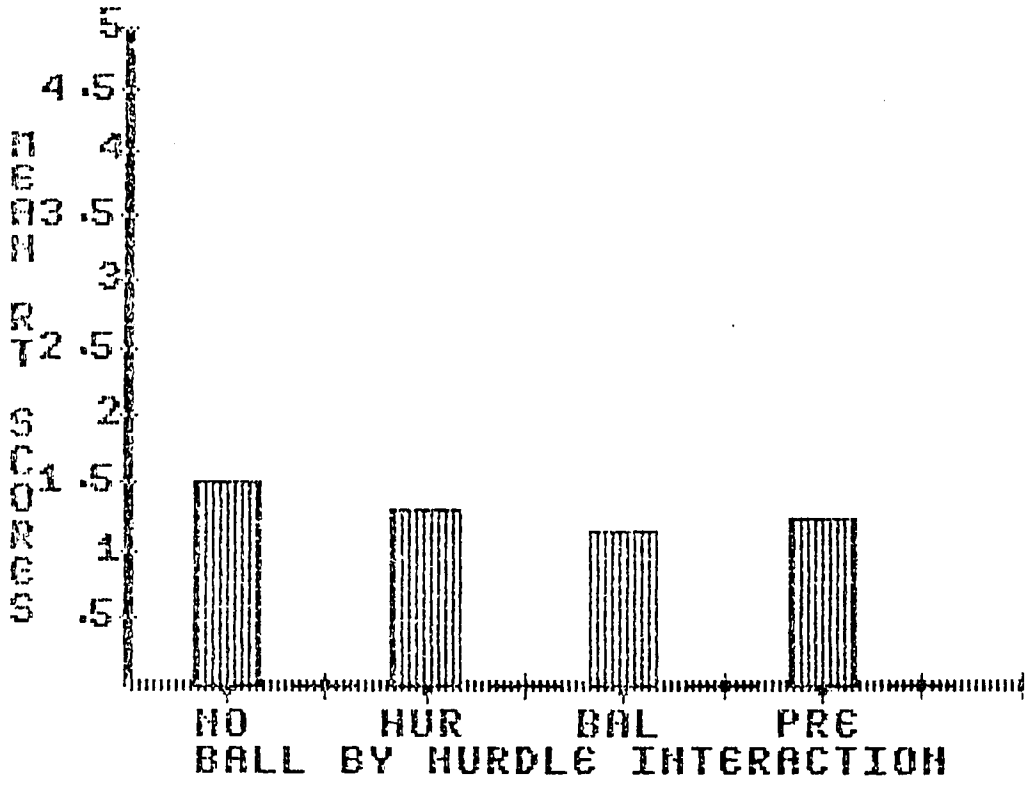
The 2 X 2 X 2 X 2 repeated measures design ANOVA on mean reaction time (Appendix G) examined the speed of visual search when the hurdle item was present or absent between the novice and experienced players. The interaction for level of experience by hurdle was not significant ($F_{1,28}$ = .41, p = .52). The mean reaction times were similar whether or not the hurdle item was present or absent for both novice and experienced basketball players (Figure 12).

A significant ball by hurdle item interaction was found for the combined subjects' mean reaction time ($F_{1,28}$ = 12.62, p = .001). A Newman-Keuls' multiple range test (Bruning & Klintz, 1977) was used to determine significant differences in mean reaction times using the .05 level. Four comparisons were found to be significant: (a) mean reaction time was better when both the ball and hurdle were present than when both were absent; (b) mean reaction time was better when the ball was present and hurdle absent than when both were absent; (c) mean reaction time was better when the hurdle was present and the ball was absent than when both were absent; and (d) mean reaction time was better when the ball was present and the hurdle absent than when the hurdle was present and the ball absent (Figure 13). However, a ball by hurdle item by experience level interaction was not significant ($F_{1,28}$ = .90, p = .34). The mean reaction times were similar for novice and experienced players when the ball, the hurdle, or both were present/absent.



	Hurdle Absent (No)		Hurdle Present (Yes)	
	M(Sec)	SD	M(Sec)	SD
Novice	1.46	.406	1.47	.358
Experienced	1.10	.212	1.14	.223

FIGURE 12: Mean reaction time for novice and experienced players for the hurdle item including means and standard deviations.



	M(Sec)	SD
Ball & Hurdle Not Present (No)	1.41	.325
Ball Absent/Hurdle Present (Hur)	1.32	.308
Ball Present/Hurdle Absent (Bal)	1.21	.206
Ball & Hurdle Present (Pre)	1.26	.311

FIGURE 13: Ball by hurdle interaction for the players' mean reaction times including means and standard deviations.

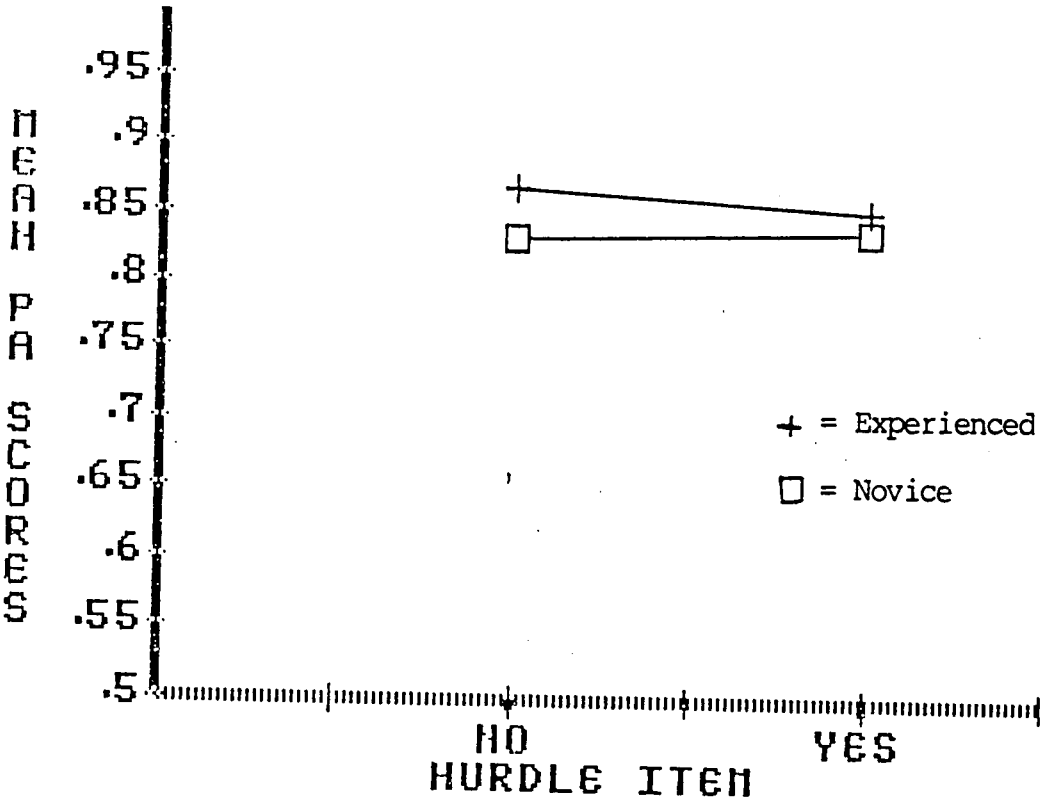
Accuracy of Visual Search Performance for Experience X Hurdle

The 2 X 2 X 2 repeated measures design ANOVA on the subjects' mean P(A) scores (Appendix H) examined target accuracy involving the hurdle item between the novice and experienced players. This comparison determined the effect the presence or absence of hurdle item had on the players' accuracy of ball recognition. The interaction for level of experience by hurdle item's presence was not significant ($F_{1,28} = .44$, $p = .51$). The mean P(A)'s were similar whether or not the hurdle item was present or absent for both novice and experienced basketball players (Figure 14).

SUMMARY

This study tested four null hypotheses surrounding visual search performance. The first, that there are no significant differences in the speed and accuracy of visual search performance of experienced and novice players, was partially rejected. There was no significant difference in accuracy of visual search performance between the two groups. There was a significant difference for speed of visual search performance between the two groups, that is, the experienced players identified presence or absence of the ball faster than novice players.

The second null hypothesis, that there are no significant differences in visual search performance between experienced and novice players in the recall of a sport situation, was rejected. A significant difference was found when recall was tested, that is, experienced



	Hurdle Absent (No)		Hurdle Present (Yes)	
	M	SD	M	SD
Novice	.832	.135	.838	.171
Experienced	.866	.126	.851	.135

FIGURE 14: Mean recognition accuracy [P(A)] for novice and experienced players for the hurdle item including means and standard deviations.

players' mean score for player recall was better than the mean score for novice players.

The third null hypothesis, that there are no significant differences in the speed, accuracy and recall of visual search performance between experienced and novice players for structured and unstructured plays, was partially rejected. There was no significant difference in the speed and accuracy of visual search performance between the two groups by type of game play. A significant difference was found between the groups for the recall of players by type of game situation, that is, the experienced players' mean recall score was significantly better than mean recall scores of novice players. Also, a significant main effect was found for the accuracy of visual search performance measured by mean P(A) scores, that is, the combined mean P(A) score for both groups was better for structured plays than for unstructured plays.

The fourth null hypothesis, that there are no significant differences between the visual search performance of experienced players with or without the presence of a hurdle item, could not be rejected. The accuracy and speed of target recognition involving the hurdle item were similar for both groups. However, a significant ball by hurdle item interaction was found for the combined subjects' mean reaction time, that is, the speed of visual search performance was better when the ball, the hurdle, or both were present than when neither was present. Further, speed of visual search performance was better when the ball was present and the hurdle absent than when the hurdle was

present and the ball absent. The hurdle by ball interaction between and among the two groups was not significant.

CHAPTER V

DISCUSSION

The findings of this study are discussed in relation to the specific literature reviewed. The discussion is organized in two sections: (a) sport and visual search, and (b) mode of control in the visual search process. The first section will examine the speed, accuracy, and player recall ability of novice and experienced women basketball players, and pertains to the first three hypotheses of this study. The second section, pertaining to the fourth hypothesis of this study, examines the findings surrounding mode of control in the visual search process which was examined through the use of the hurdle paradigm.

SPORT AND VISUAL SEARCH

Sport research suggests that visual perceptual differences exist between expert and non-expert players in their visual search performance in three areas: (a) speed, (b) accuracy of recognition, and (c) recall in a sport (Allard & Starkes, 1980; Starkes & Allard, 1983; Allard, Graham & Paarsalu, 1980; Allard & Burnett, 1985; Bard & Fleury, 1979). The findings of this study support the basic position that perceptual differences do exist between the expert and novice players' visual search performance. However, the findings do not agree totally with previously cited sport research. The similarities and differences of

these findings compared to previous research involving speed and accuracy of the visual search and player recall are discussed.

Speed and Accuracy of Visual Search Performance

In a series of studies, Allard and Starkes (1980) presented structured and unstructured game slides to varsity and non-varsity women volleyball players. Each subject was required to detect and recognize the presence or absence of the volleyball as rapidly as possible. The dependent measures for speed of volleyball detection and accuracy of ball recognition were voice reaction time and nonparametric analog, P(A). Allard and Starkes (1980) indicated that women varsity volleyball players' speed in detecting the ball's presence was quicker, but the accuracy of ball recognition for both the varsity and non-varsity women players was similar. A later but similar volleyball study by Starkes and Allard (1983) indicated additional support for the volleyball studies of Allard and Starkes (1980).

This study, similar in approach but involving the game of basketball, indicated support for both the Allard and Starkes (1980) and the Starkes and Allard (1983) findings. The experienced women basketball players' speed in detecting the basketball's presence or absence was significantly ($p = .0004$) quicker compared to novice basketball players; and the accuracy of basketball recognition was similar for novice and experienced basketball players. But Figure 7 (Chapter 4, p. 59) shows that both the experienced and novice players were highly accurate in detecting the presence of the basketball. These findings (experienced women basketball players were quicker in detection

of the ball but not more accurate) seem to rule against a possible speed and accuracy trade off explanation.

There were some differences between the findings of this study involving experienced and novice basketball players and the findings of both Allard and Starkes (1980) and Starkes and Allard (1983) involving varsity and non-varsity women volleyball players. When the speed and accuracy of ball recognition in structured and unstructured plays are considered, Allard and Starkes (1980) and Starkes and Allard (1983) indicated that the experienced women volleyball players' speed of volleyball detection was significantly quicker than non-varsity players for both structured and unstructured plays. In the present study no statistical difference ($p < .05$) was found between experienced and novice women basketball players' speed of basketball recognition for both structured and unstructured plays (Figure 9).

The findings of this study concerning accuracy of ball recognition in structured and unstructured game slides supported the findings of Allard and Starkes (1980) and Starkes and Allard (1983). In this study, a significant difference ($p = .0001$) was found between the structured and unstructured basketball plays for both the novice and experienced women basketball players' accuracy of ball recognition. Both the novice and experienced basketball players' accuracy of ball recognition was better for structured plays than for unstructured plays. These results indicated that both novice and experienced basketball players had a better time in identifying the basketball's presence or absence in structured plays than in unstructured plays.

The interaction involving the type of player by type of play for accuracy of ball recognition was not significantly different. These results are similar to the Allard and Starkes (1983) and Starkes and Allard (1983) findings involving varsity and non-varsity volleyball players. As reported by Allard and Starkes (1980) and Starkes and Allard (1983), and shown in Figure 10, (Chapter 4, p. 64) of this study, experienced or varsity players' accuracy of ball recognition was similar for novice or non-varsity players for both structured and unstructured plays.

This experiment shows that the structured plays affected the recognition accuracy for both experienced and novice players, but did not affect their speed of detection. The results support the assumption that the ball was more readily perceived in structured plays than unstructured plays by both the novice and experienced basketball players and that the experienced players were quicker in identifying a critical stimuli (basketball) than novice players when presented structured and/or unstructured game slides.

This study has indicated that the speed of basketball recognition was not superior for either type of player, but the perceptual sensitivity to the structure of the game was evident for both player groups. Basketball is a sport in which the players and the type of defense and offense constantly move or change. A basketball player that attends solely to the location of the basketball would be quickly deceived by other players, types of defenses or offenses during the game. The structure of play presented in the game of basketball,

however, may facilitate or hinder the players' speed in accurately locating the basketball. It would appear that playing experience in the game of basketball may not be a critical factor in the accuracy to detect the presence of the basketball.

This does not suggest that the speed of basketball recognition is not critical to the game of basketball, nor does it rule out the possibility that experienced and novice women basketball players differ in their perceptual abilities to detect the presence of the ball. The data tended to show (Figure 9) that the experienced women basketball players were quicker in basketball recognition.

Recall Ability of Visual Search Performance

A variety of sport research suggests that the recall ability of the experienced sport player is superior to that of the novice sport player. In basketball and field hockey, (Allard, Graham, & Paarsalu, 1980; Allard & Burnett, 1985, Starkes & Deaken, 1984) experienced players recalled game situations with greater accuracy than did non-players. According to Bard and Fluery (1976) in their study with experienced and inexperienced women basketball players, interaction with the structure of the game varies with the level of experience; i.e., experienced basketball players' cognitive and perceptual abilities about the organization of the game are more refined. These findings concerning the recall ability of the experienced sport player were supported by the performance of the experienced women basketball players in this study.

This study adopted the recall task used by Allard, Graham and Paarsula (1980) which required each subject to view structured and unstructured plays. The players were allowed a 5-second observation of each slide, and were then asked to recall the position of as many players as possible on the basketball recall task using the drawing of the basketball court. In this study and as shown in Figure 8 (Chapter 4, p. 60), the number of players recalled by the experienced basketball players ($\bar{X}$ = 4.29) indicated significantly (p = .0001) superior recall ability to that of novice players ($\bar{X}$ = 3.25). The data in Figure 11 (Chapter 4, p. 65) revealed that: (a) both experienced and novice players' recall was significantly (p = .0001) superior for structured plays compared to unstructured plays, and (b) that experienced women basketball players demonstrated a significantly superior (p = .0001) recall ability to that of the novice players between structured and unstructured plays.

The results of this study tend to support the assumptions by previous researchers (Allard & Burnett, 1985; Bard & Fluery, 1976; Allard, 1984; Allard, Graham, Paarsula, 1980; Starkes & Deaken, 1984) that: (a) the experienced player has developed a more refined perceptual system to recall the organization of the game, and (b) the experienced player more deeply encodes information than the novice player. Support for these assumptions was evident in the data from this study which indicated that experienced performers: (a) recalled more players for structured plays than unstructured plays; and (b) recalled more players in both structured and unstructured plays than novice

performers. In this study, the subject's level of experience could be one explanation for the difference found in recall ability.

Further observation of the data (Figure 11) indicated that novice players could recall more players in a structured play than an unstructured play. This may mean that the novice player was able to recognize structure within the game without prior experience in basketball; however, the depth to which the information could be processed within either structured or unstructured plays, indicated by the poorer recall of players compared to that of experienced players, is limited. The difference in player recall between structured and unstructured plays indicated that the subjects perceived these plays differently, and that experienced players have a more refined perceptual ability in recalling the different situations in a sport than a novice player.

MODE OF CONTROL IN THE VISUAL SEARCH PROCESS

Neisser (1967) explained skilled performance in visual search from a two-memory component model: target control and context control. Neisser (1967) contended that early in learning the observer operates under the target control and with training passes to the context control. A line of psychological studies (Neisser, 1967; Neisser, Novick and Lazar, 1963) in visual search required their subjects to scan word lists for the target(s) as fast and as accurately as possible. Each subject's visual search performance was recorded over training sessions lasting several days. These studies indicated that early in

practice the subject's speed of search was slower and less accurate than in later stages of training. Late in practice the visual search of the subject became faster and more accurate.

Neisser (1967) contended that an unpracticed searcher was faced with a visual field which was more difficult because the visual field was unfamiliar and complex. But practice enhanced the subject's memory representation of the targets which decreased the complexity of the visual field making the visual search more efficient. Several investigations (Kristofferson, 1972; Neisser, 1963 & 1965, Brand, 1971; and Neisser & Stopper, 1965) have supported Neisser's assumptions that practice enhances visual search.

Several researchers involved in the study of sport and motor skill learning have indicated that differences do exist in the stages of learning a motor skill (Fitts & Posner, 1967), and type of motor skills (Gentile, Higgins, Miller & Rosen, 1975; Beitel, 1980) between an unpracticed and practiced performer. As cited earlier, Neisser (1967) indicated that, for the practiced visual searcher scanning word lists was quicker and more accurate. In this study, experienced basketball players' speed in detecting the target item (Figure 6) was faster, and their ability to recall players (Figure 8) was more accurate than novice women basketball players. Thus, it can be assumed that the experienced players had developed a more efficient visual search than novice players. These findings support the previous research that visual search differences exist due to experience.

Prinz et al. (1977; 1979a) has attempted to explain the stages of visual search in relation to Neisser's (1967) two-component model. Prinz (1977) contended that early in practice the visual searcher operates under target control, and later in practice passes to context control. Target control is characterized by the recognition of target items without the recognition of non-target items. After practice, context control is characterized by the recognition of both target items and non-target items.

The hurdle paradigm involves insertion of an item which belongs neither to the target nor to the context of the visual field. According to Prinz et al. (1977; 1979b) the hurdle paradigm can provide evidence regarding which mode of control a performer utilizes during visual search. A skilled visual searcher under context control should detect the hurdle item (Prinz, Tweer, & Roffeige, 1974; Prinz 1979b). An unskilled visual searcher operating under target control would recognize the target item but not detect the hurdle item.

The detection of the hurdle can be identified in two ways: (a) the observer may report the detection of a hurdle; and/or (b) the speed of visual search will decrease when the hurdle is present. Data collected in several studies involving the hurdle technique (Prinz, 1974; Prinz 1979b) indicated that: (a) the time of visual search increased for all subjects when presented with the hurdle item; and (b) during practice the hurdle item was detected only in a small number of trials.

This study adopted the hurdle paradigm to determine the mode of visual search, target or context, among novice and experienced basketball players. Based on the operational definition of a hurdle item given by Prinz, Tweer & Roffeige, (1974), an equilateral orange triangle placed within the key area served as an item dissimilar to either the target item (basketball) or context (players and court) of the visual field. This study employed both hurdle detection techniques in data collection: (a) the subjects were instructed to mark a "O" on the basketball grid for any object that attracted their attention on the basketball slide, and (b) the target (basketball) detection times of subjects were recorded when the hurdle item was present and not present.

This study's findings pertaining to the hurdle paradigm indicated that: (a) no subject in this study detected the hurdle by recording the hurdle item on the grid, (b) neither groups' speed of detection for the hurdle item presence or absence was differentially effected by level of experience, and (c) the accuracy of target detection was not affected by the presence or absence of the hurdle (Figure 14) for either the novice or experienced players. It can be assumed from these results that in this task both novice and experienced players operated under target control because: (a) neither group detected the hurdle item, (b) target accuracy for both groups was unaffected by the presence of the hurdle item, and (c) the speed of detection by level of experience could not be differentiated.

It seems that the mode of visual control of experienced and novice basketball players characterizes the unskilled visual search performer

depicted by Prinz et al. (1974, 1977, 1979a). But this researcher is cautious in supporting such an assumption due to several observations. First, the Prinz, Tweer, and Roffeige (1974) study indicated that subjects' transition from target control to context control was almost immediate. The Prinz et al. (1974) study involved an extensive number of trials and the interpretation of the word immediate may have been misinterpreted by this researcher. Also, the hurdle item may have been ignored by the subjects in order to process more immediate information stated by the instruction. In the psychological visual search studies, the subject's scanning of the visual field for the target item, including the hurdle item, was not limited in time. The subjects in this study scanned the sport slide for only five seconds and may have attended only to players and the basketball (target item) which they were required to detect or recall.

While neither experienced nor novice players seemed to detect the hurdle item there was a significant ball by hurdle interaction for the combined subjects' mean reaction times. This interaction may support target control concept, or call for an alternative explanation (Figure 13). The subjects' speed of detection when either the ball, the hurdle, or both were present was better than when both were absent. In addition, the speed of detection was higher when the ball was present and the hurdle absent than when the hurdle was present and the ball present. These findings, that speed of detection appeared to be affected more by the presence of the ball than presence of the hurdle item, support the contention that the subjects operated under target

control. However, an alternative explanation could exist, that the uncertainty of visual search performance was greater when the hurdle, ball, or both were absent; than when the hurdle, ball, or both were present. This is evidenced in greater reaction times when neither the ball or hurdle item were present.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

SUMMARY

The purpose of this study was to examine the visual search performance of female experienced and novice sport participants utilizing the visual search paradigm. In particular, an attempt was made to: (a) compare the speed and accuracy of the visual search performance of experienced and novice basketball players, (b) compare the recall ability of experienced and inexperienced basketball players, and (c) compare the visual search performance of experienced and novice basketball players in structured and unstructured basketball situations.

The second purpose of this study was to examine how experienced and novice participants controlled their visual search performance in a sport context. In particular, an attempt was made to compare the visual search performance of experienced and novice basketball players when presented sport situations with or without a hurdle item. Thirty female students from Northern State College, Aberdeen, SD, served as subjects. The group of 30 consisted of 15 experienced and 15 novice basketball players. The experienced basketball players were members of the Northern State College women's varsity basketball team. The novice players were Northern State College women who had no competitive basketball experience and who were not participating in basketball at the current time.

The measures of visual search performance in this study were based on previous reported sport research which documented their role in assessing the visual search process of sport participants in a sport or sports. The measures to determine the sports participants' mode to control the visual search process were on the basis of previous psychological visual search studies. A visual search paradigm used in this study measured: (a) the speed and accuracy to detect a target item (basketball), and (b) the recall of players and any other distractors on the court in a sport slide. A hurdle technique developed by Prinz et al. (1977, 1979b) was used in this study to determine the sports participants' mode to control the visual search.

The stimuli used in this study consisted of slides of 32 structured and 32 unstructured basketball situations. Sixteen slides of each situation, structured and unstructured, contained the target item (basketball). Sixteen of each situation contained the hurdle item (orange triangle). Each subject scanned the sport slides projected on a screen for a 5-second period of time. Speed and accuracy of detection were measured by the subject's response to presence or absence of the target item by depressing a yes or no key position in front of her. A basketball recall grid was used to measure the player's accuracy to recall the players of each situation. The subjects' decision times and recall of the presence of the hurdle item was used to measure the subjects' mode of control in visual search.

Two randomized repeated measures ANOVA models were used as the basis for the analyses of the three dependent variables and the testing

of the research hypotheses. In all the hypotheses testing, the $p < .05$ was used. The selection and grouping of the dependent measures for the various analyses of variances and planned contrast comparisons were considered on the bases of: (a) each specified hypotheses, (b) the method of calculating P(A), the non-parametric measure used in this study to determine accuracy of ball recognition, and (c) the data analysis of prior sport and psychological literature involving the dependent measures.

The visual search performance of experienced women basketball players' speed of detection and ability to recall were found to be significantly better than the visual search performance of novice women basketball players. The experienced women basketball players were quicker and recalled more than novice women basketball players. But the experienced and novice players' detection accuracy was similar. The results partially supported previous research involving expert and non-expert volleyball players (Allard & Starkes, 1980; Starkes & Allard, 1983), and hockey players (Starkes & Deaken, 1984).

The structure of the basketball situation influenced the visual search performance of both the experienced and novice women basketball players. Both groups of players accurately detected and recalled better when presented structured plays than unstructured plays. But the speed of detection was unaffected by either structured or unstructured plays for both types of players.

These differences in visual search performance support the basic notion of other researchers (Allard & Burnett, 1985; Bard & Fluery,

1976; Bard, Fleury, Carriere & Halle, 1980) that an expert sports participant has a more refined perceptual system than a non-expert in a sport. The finding or results (i.e., experienced women basketball players are more accurate and recalled more but did not detect faster than novice players) support research (Allard, Graham & Paarsalu, 1980; Allard & Starkes, 1980; Starkes & Allard, 1983; Starkes & Deaken, 1984) that the perceptions of expert sport participants within a game is greater than inexperienced participants.

The hurdle technique of Prinz et al. (1977, 1979b) was utilized in this study to determine if there was a difference in the mode of control in the visual search process between experienced and novice women basketball players. This study found that presence or absence of the hurdle item did not differentially affect the experienced group's visual search for either structured or unstructured plays because the subjects in this study did not recall any hurdle item, nor was reaction time affected by the presence or absence of the hurdle item. The results may favor the contention that both experienced and novice players' mode of visual search operated under target control. The apparent ineffectiveness of the hurdle technique in the visual search may have been a result of: (a) a methodological misinterpretion by this researcher, and/or (b) the subjects' attending to the more immediate demands of the visual search task rather than to the hurdle item.

When contrasted with the novice players, the experienced women basketball players in this study: (a) had greater speed of visual search, (b) had approximately the same accuracy of recall, and (c)

recalled with more detail. This evidence shows that experienced players were more efficient in their visual search. These results support the psychological visual research (Neisser, 1967) and motor learning and skills research (Fitts & Posner, 1967; Gentile, Higgins, Miller & Rosen, 1975) indicating that differences exist between the unpracticed and practiced subjects in their visual search and perceptual-motor abilities, respectively. The difference in visual search performance between experienced and novice players in a sport may be due to practice or to experience in the specific context.

CONCLUSIONS

One purpose of this investigation was to examine the visual search performance of experienced and novice women basketball players. Another purpose of this investigation was to determine the mode of control in the visual search process of experienced and novice women basketball players. Based on the data obtained and its analysis, the following conclusions appear justified:

1. The experienced women basketball players' have: (a) significantly quicker speed of detection than novice women basketball players, (b) significantly better recall ability than novice women basketball players, and (c) similar accuracy of detection in the visual search to the novice women basketball players.

2. Speed of detection of both experienced and novice women basketball players in the visual search is not significantly different for structured or unstructured plays.

3. Accuracy of detection in the visual search for both experienced and novice women basketball players is significantly better for structured plays than for unstructured plays. However, the detection accuracy of the experienced basketball players in the visual search did not significantly differ from detection accuracy of novice players between structured and unstructured plays.

4. The recall performance of experienced women basketball players in the visual search was significantly better than that of novice players for both structured and unstructured plays. The recall performance of experienced players was significantly better than the recall performance of novice players for structured and unstructured plays.

5. There is no significant difference in speed or accuracy of the visual search between experienced and novice women basketball players whether the hurdle item was present or not present. However, a ball by hurdle interaction using the combined group mean reaction time for speed was significantly different.

IMPLICATIONS FOR FUTURE RESEARCH

This study demonstrated that a number of visual search differences exist between experienced and novice women basketball players. However, the experimental laboratory setting used to evaluate visual search performance may not be totally applicable to dynamics of the game of basketball. The suggested directions for future research involve a more

ecological methodology of sport investigation of visual search performance.

1. Examine the visual search performance through video-taped segments of the game which depict action in the game of basketball.

2. Examine the visual search performance across different sports or sport skills to determine the importance of structure on perception.

3. Study visual search performance with other perceptual abilities among experienced players in a sport differing by level of skill.

4. Develop a different technique for the implementation of the hurdle item to determine the player's mode of control in the visual search.

5. Reexamine the mode of visual search utilizing the hurdle technique over an extensive period of time and number of trials involving experts and non-experts within and/or across sport(s) or sport skill(s).

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APPENDICES

APPENDIX A

NON-PARAMETRIC MEASURE P(A)

NON-PARAMETRIC MEASURE P(A)

According to signal detection theory, this study is classified as a two-alternative (yes-no) experiment (Swets & Green, 1974; McNicol, 1972). The subjects will be presented a signal (slides of basketball situations) clearly above their perceptual threshold and will be instructed to select the signal trial or no signal trial. In this class of experiments the statistic, P(A) of percent correct response, is sufficient to summarize the yes-no test (Pollock & Norman, 1964; Pollock, Norman, and Galanter, 1964; Grier, 1971; and McNicol, 1972)

McNicol (1972) and Grier (1971) have provided explanation and calculation tables of the non-parametric measure, P(A). The P(A) is a non-parametric statistic in that no specific assumption is made about the form of the operator-recognition curve. There is no specific advantage that accrues by using the parametric statistics of d' or subject bias involving a two-alternative, yes-no experiment compared with P(A) (Pollock and Norman, 1964; McNicol, 1972; Allard, personal conversation, March 16, 1985).

The calculation of P(A) results in a numerical value that will fall on a scale from .5 to 1.0. A subject's P(A) score will be calculated by dividing the total number of hits by the total number of trials presented giving a hit probability or percentage. A false alarm probability will be derived by dividing the total number of false alarms by the total number of non-signal trials presented. These two probabilities will be matched on a table for P(A) values for a two-alternative, yes-no experiment (McNicol, 1972).

If the P(A) score approaches 1.0 the individual shows very little uncertainty in determining the presence of the signal, i.e., the basketball present in a slide. A low score of P(A) or .5, usually results in few hits or several false alarms. The mean of P(A) scores will serve as the subject's accuracy score in visual perceptual recognition of the basketball's presence or absence in the slide and can be used for further statistical procedures.

APPENDIX B

SUBJECT QUESTIONNAIRE

SUBJECT QUESTIONNAIRE

NAME _____ AGE _____ SEX _____

Visual Acuity (20/20)? Yes _____ No _____

Dominant Hand Right _____ Left _____

Answer the following questions with a "yes" or "no."

_____ 1. Are you aware of any current vision problem?

_____ 2. Do you experience brief or frequent episodes of blurred vision?

_____ 3. Have you had any problem with your eyes that has affected your vision?

Answer the following questions to describe your basketball knowledge and experience by indicating the number which represents your degree of involvement using the following scale.

1 2 3 4 5 6 7 8 9 10
Never Sometimes Very Frequently

_____ 4. Do you watch basketball on television?

_____ 5. Do you attend basketball games?

_____ 6. Do you read about basketball in magazines, books, or newspapers?

_____ 7. What is your current level of physical participation in basketball?

_____ 8. Have you ever participated in basketball at the varsity level in high school or college? _____ Yes _____ No

If you answered "yes" to question #8, complete the following.

_____ 9. How many total years of combined varsity high school and college basketball experience do you have?

_____ 10. What position did/do you play in basketball? _____

APPENDIX C

SUBJECT INFORMED CONSENT

Millslagle (1985)
Consent Form

I, _____, hereby volunteer to participate in a research study examining the perceptual abilities of recognition, recall and visual searching with college women basketball players.

I understand that I will view game slides projected on a screen. Once the slide is shown I will attempt to react as soon as possible to the presence or absence of the basketball in the game slide. After a 5-second viewing of the slide, I will attempt to recall as accurately as possible the players' position and other items which attracted my attention on a gridded scale of a basketball court.

Other details of the project have been explained and I have had an opportunity to have my questions answered. However, I have been told that I may raise any future questions or concerns with the experimenter (Duane Millslagle, 622-2488) and may expect clarification before continued participation.

I have been told that I am free to withdraw my consent and to discontinue participation in the project at any time without penalty. I understand that if I should participate, all my data will remain confidential.

Date _____ Participant _____

APPENDIX D

LETTER AND CONSENT FORMS

August 28, 1985

Dear Parents and Athletes:

Let me introduce myself. I am Duane Millslagle, Assistant Professor of Physical Education at Northern State College, and a doctoral student at the University of Tennessee. This fall I will be conducting a study in Aberdeen which will provide the data I need to write my dissertation. The purpose of the study is to assess the perceptual recognition, recall, and mode of visual search of novice and skilled college basketball players. This will be done by presenting slides of basketball situations.

This brings me to the purpose of this letter. The Aberdeen high school women's basketball coaches have agreed to let me take photographs of their local contests. Now, I am asking for your permission to do so. Will you please read the enclosed consent form, sign it and return it to me in the stamped, self-addressed envelope.

Thank you for your help in this matter.

Sincerely,

Duane Millslagle
Assistant Professor

Enc: Consent form
Envelope

Millslagle (1985)
Parental Consent Form

I, _____, give permission for Duane Millslagle to photograph my daughter, _____, while participating in several local high school basketball contests.

I understand the photographs will be of basketball situations common to the game of basketball, and that the photographs will be made into slides. The slides will be shown to novice and experienced women college basketball players in order to assess the perceptual recognition, recall and mode of visual search in novice and skilled players.

I understand that I may raise any questions and concerns with the experimenter (Duane Millslagle, 622-2488) and may expect clarification before continued participation by my daughter. I acknowledge that I am free to withdraw my daughter from participation in the project at any time without penalty. I understand that the slides used in the research project will remain confidential.

Date _____ Parent _____

High School Girl's Consent Form

I, _____, give permission to be photographed during several basketball contests. I understand the photographs will be made into slides to be used in a research project to assess the perceptual abilities of recognition, recall, and mode of visual search with novice and experienced college women basketball players.

Other details of the project have been explained and I have had opportunity to have any questions answered. Any future questions may be raised with the experimenter (Duane Millslalge, 622-2488) and I may expect clarification before continued participation.

I have been told that I am free to withdraw my consent at any time. I understand that the photographs and slides will be kept confidential.

Date _____ Participant _____

Millslagle (1985)
Coach's Consent Form

I, _____, give permission for Duane Millslagle to take photographs of my high school girl's basketball team. I understand that the photographs will be taken during several local high school contests and will be used to make slides. The slides will be shown to novice and experienced college women basketball players to assess perceptual recognition, recall, and mode of visual search between novice and experienced college women basketball players.

Other details of the project have been explained and I have had opportunity to have any questions answered. However, I have been told that I may raise any questions with the experimenter (Duane Millslagle, 622-2488) and may expect clarification before continued participation.

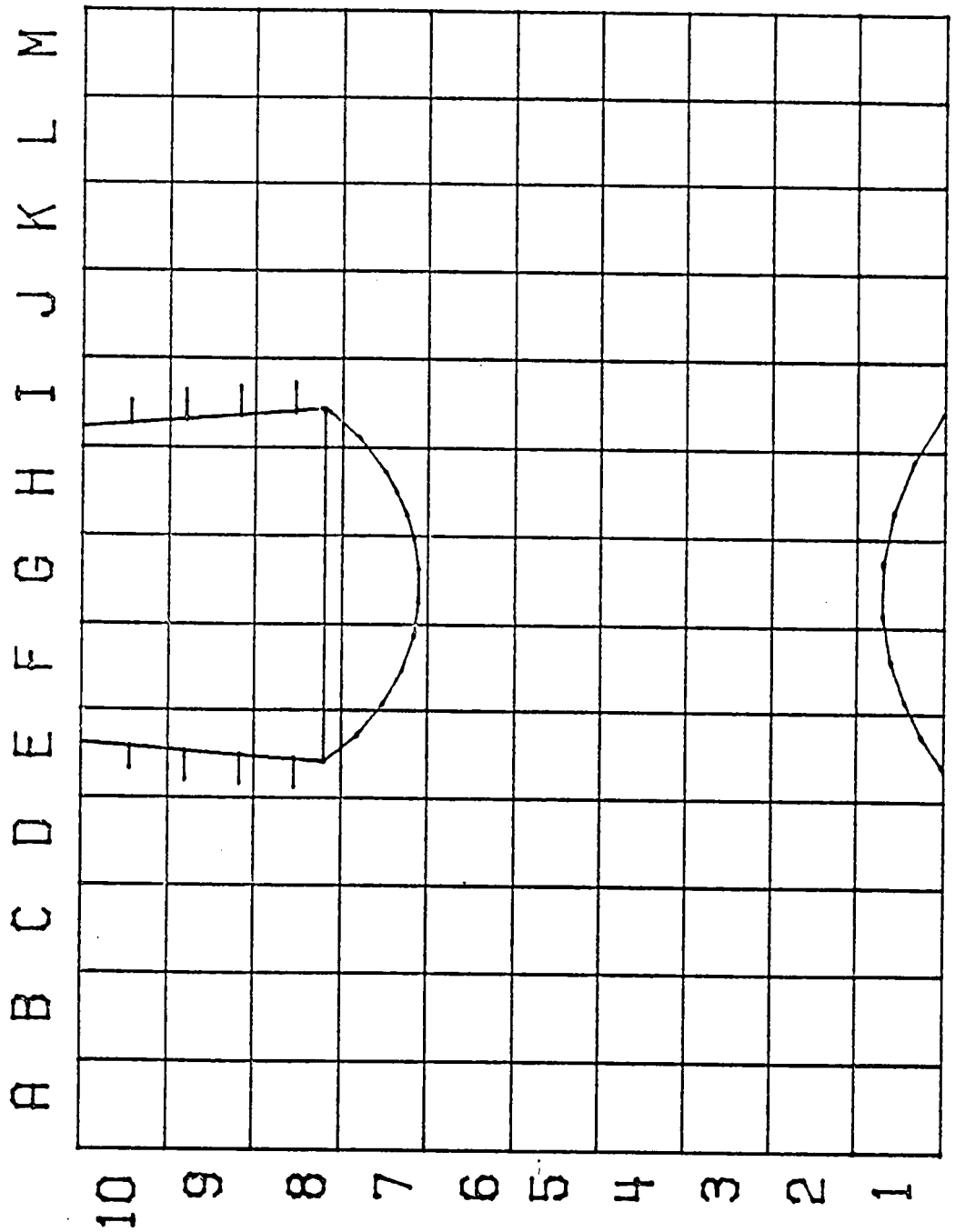
I understand that I am free to withdraw my consent at any time, and that the photographs and slides will be kept confidential.

Date _____ Coach _____

APPENDIX E

RECALL GRID

Recall Task



Scale: ½ in. = 1 in.

APPENDIX F

INSTRUCTIONS TO SUBJECTS

INSTRUCTIONS TO SUBJECTS

This is a visual searching study to assess your speed, accuracy, and recall of the basketball situation presented in each slide. You will be presented 64 slides in which you are to identify the presence or absence of the basketball. Then, you are to recall the number and location of players and any other items in the picture that attracted your attention. Each slide will be presented for 5 seconds.

In front of you are two response keys designated "yes" and "no." The "yes" key is depressed for slides in which the basketball is present. The "no" key is depressed for slides where no basketball is present. Your reaction will be measured from the moment the slide is projected on the screen until you identify presence or absence of the basketball by depressing the appropriate key. Depression of the key will stop the reaction time device and measure the accuracy and speed of your decision. Remember to continue viewing the slide for the entire 5-second period to aid in recall of players and other items. To begin, place your hand in the black area in front of the keys in preparation for the first slide.

After you have viewed the slide for the 5-second period, you are to recall and locate as many players and other items that attracted your attention on the 8 1/2 X 11 grid. You have 64 grids (one for each trial), each representing one-half of the basketball court. Place a checkmark for each offensive player; an "X" for each defensive player; and an "O" for any other item that attracts your attention in the corresponding square of the grid. You will be given as much time as needed after each trial to mark the location of the items that attracted your attention.

After you have completed the recall task, return your right hand to the black area in front of the keys in anticipation of another slide.

Just as a reminder, the researcher will provide you with a ready signal for the next slide. Respond as quickly as possible to the presence or absence of the basketball in the slide by depressing the appropriate key; continue viewing the slide for the entire 5-second period and then complete the recall task. In summary, the order of experimental procedures are: ready, presentation of slide and your response, recall the sport situation on the grid, and reposition your hand for the next trial.

APPENDIX G

2 X 2 X 2 X 2 REPEATED MEASURES DESIGN ANOVA FOR MEAN REACTION TIME

2 X 2 X 2 X 2 REPEATED MEASURE DESIGN FOR MEAN REACTION TIME

SOURCE	df	Sum of Squares	F	p
BETWEEN				
Exp	1	67.193	16.35	.0004*
S(Exp)	28	12.316		
WITHIN				
Play	1	.095	2.04	.164
Play X Exp	1	.037	0.79	.380
Play X S(Exp)	28	1.311		
Ball	1	1.054	12.42	.001*
Ball X Exp	1	.064	.76	.390
Ball X S(Exp)	28	2.377		
Hurdle	1	.032	.84	.367
Hurdle X Exp	1	.015	.41	.526
Hurdle X S(Exp)	28	1.076		
Play X Ball	1	.019	.63	.43
Play X Ball X Exp	1	.0003	.01	.92
Play X Ball X S(Exp)	28	.852		
Play X Hurdle	1	.071	2.23	.14
Play X Hurdle X Exp	1	.005	.15	.70
Play X Hurdle X S(Exp)	28	.898		
Ball X Hurdle	1	.347	12.62	.001*
Ball X Hurdle X Exp	1	.024	.90	.34
Ball X Hurdle X S(Exp)	28	.77		
Play X Ball X Hurdle	1	.25	5.39	.02
Play X Ball X Hurdle X Exp	1	.002	.04	.83
Play X Ball X Hurdle X S(Exp)	28	1.31		
TOTAL	239	30.139		

* $p < .05$ in ANOVA Analysis

APPENDIX H

2 X 2 X 2 REPEATED MEASURES DESIGN ANOVA FOR MEAN P(A)

2 X 2 X 2 REPEATED MEASURES DESIGN ANOVA FOR MEAN P(A)

SOURCE	df	Sum of Squares	F	p
BETWEEN				
Exp	1	.016	.61	.44
S(Exp)	28	.763		
WITHIN				
Play	1	.495	37.03	.0001*
Play X Exp	1	.003	.27	.60
Play X S(Exp)	28	.374		
Hurdle	1	.0006	.09	.76
Hurdle X Exp	1	.002	.44	.51
Hurdle X S(Exp)	28	.187		
Play X Hurdle	1	.051	2.88	.10
Play X Hurdle X Exp	1	.005	.33	.56
Play X Hurdle X S(Exp)	28	.495		
TOTAL	119	2.396		

* $p < .05$ in ANOVA Analysis

APPENDIX I

2 X 2 X 2 X 2 REPEATED MEASURES DESIGN ANOVA FOR MEAN RECALL

2 X 2 X 2 X 2 REPEATED MEASURES DESIGN ANOVA FOR MEAN RECALL

SOURCE	df	Sum of Squares	F	p
BETWEEN				
Exp	1	64.761	26.99	.0001*
S(Exp)	28	67.189		
WITHIN				
Play	1	24.479	56.48	.0001*
Play X Exp	1	8.574	19.78	.0001*
Play X S(Exp)	28	12.135		
Ball	1	2.89	7.45	.01*
Ball X Exp	1	.117	.30	.58
Ball X S(Exp)	28	10.871		
Hurdle	1	2.691	9.94	.004*
Hurdle X Exp	1	.064	.24	.630
Hurdle X S(Exp)	28	7.586		
Play X Ball	1	2.038	11.87	.001*
Play X Ball X Exp	1	.855	4.98	.03*
Play X Ball X S(Exp)	28	4.806		
Play X Hurdle	1	.527	2.38	.13
Play X Hurdle X Exp	1	.031	.14	.70
Play X Hurdle X S(Exp)	28	6.215		
Ball X Hurdle	1	.421	2.28	.14
Ball X Hurdle X Exp	1	.144	.78	.38
Ball X Hurdle X S(Exp)	28	5.178		
Play X Ball X Hurdle	1	.972	4.38	.04*
Play X Ball X Hurdle X Exp	1	.439	1.98	.17
Play X Ball X Hurdle X S(Exp)	28	6.219		
TOTAL	239	229.215		

* $p < .05$ in ANOVA Analysis

VITA

Duane Gordon Millslagle was born in Rapid City, SD, on October 1, 1950. He attended elementary schools in that city and graduated from Rapid City Central High School in June, 1968. That fall he entered Black Hills State College, Spearfish, SD, and graduated magna cum laude in May, 1973. Following graduation he began his teaching career with a position in the Sully Buttes Schools, Blunt, SD. In 1974, he went to North Platte, NE, where he taught until beginning his master's studies. Duane entered the Iowa State University in September, 1977, and received the Master of Science in Education degree in May, 1979. During those two years he was a teaching assistant and assistant track coach. He was awarded the Hilton Award for Outstanding Research (1979). Upon receiving the master's degree, he accepted a position as instructor of physical education and head men's and women's cross country and track coach at Northern State College, Aberdeen, SD. During 1984-85, Northern State awarded Duane a sabbatical leave to complete all coursework for the doctor's degree at the University of Tennessee, Knoxville. He did complete all coursework before returning to Northern State where he completed his study and wrote his dissertation. During that time, he was named "Doctoral Student of the Year" in the Division of Health, Physical Education and Recreation (1986). He will receive the Doctor of Education degree with a major emphasis in Motor Behavior/Sport Psychology in August, 1986.