To the Graduate Council:

I am submitting herewith a dissertation written by Jolynn S. Kuhlman entitled "The Relationships among Gender, Gender Identity, Competitive Athletic Experience, Degree of Lateralization, Spatial Visualization Ability, and Performance on a Temporal/Spatial Task." 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 Philosophy, with a major in Physical Education.

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THE RELATIONSHIPS AMONG GENDER, GENDER IDENTITY, COMPETITIVE ATHLETIC EXPERIENCE, DEGREE OF LATERALIZATION, SPATIAL VISUALIZATION ABILITY, AND PERFORMANCE ON A TEMPORAL/SPATIAL TASK

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Jolynn S. Kuhlman

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To my Parents

Paul and Mary Kuhlman

whose support, encouragement,

and confidence made this possible.

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ABSTRACT

The purpose of this study was to explore an integrated approach to the investigation of gender related individual difference variables and the performance/experience with temporal/spatial tasks. The gender related individual difference variables were: (a) gender identity, Bem Sex Role classification; (b) spatial visualization ability, DAT Space Relation Test score; and (c) degree of lateralization, the log-odds ratio of dot enumeration test scores. The performance/experience variables were: (a) skill level, either skilled (current intercollegiate athlete in temporal/spatial sport) or unskilled (never participated in organized competitive athletics, temporal/spatial or spatial) and (b) performance of the Coincidence-Anticipation Accuracy Microcomputer Diskette, with regard to absolute, constant, and variable error. Participants were 119 college students aged 17-25, 59 males and 60 females. A 2 x 2 MANOVA (Wilks' Lambda, $p = .05$) was used to investigate the relationships between gender and/or skill level. The Bonferroni multiple comparisons method ($p < .008$) was used to evaluate all possible pairwise comparisons. Pearson product-moment correlation technique was used to determine the relationships between the dependent measures. The pattern of difference among gender, skill level, and gender identity was computed by a Chi-Square statistic.

The multivariate and univariate results indicated that: (a) skilled and unskilled males had better coincidence anticipation performance than unskilled females, (b) skilled males and skilled females did not differ, (c) degree of lateralization did not differ across gender and/or skill level, (d) unskilled males exhibited the best temporal and/or spatial performance overall, and (e) the unskilled females had the poorest performance overall. With respect to gender identity: (a) unskilled females were categorized mostly as feminine, (b) skilled females had the largest percentage of androgynous subjects, and (c) males had no significant gender identity pattern. Taken together, the major findings provided the strongest support for the theory of socialization. However, specific contributions of nature and nurture were not determined; therefore, it was concluded that an integrated approach continues to be necessary for the investigation of the complex concept of temporal/spatial task performance/experience.

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CHAPTER I

INTRODUCTION

Theories of lateralization (Davidoff, 1977; Hughes, Wilson-Derose, & Kiely, 1980) and socialization (Friedman, Catalano, & Lombardo, 1985; Wrisberg, Paul, & Ragsdale, 1979) have been offered as explanations for the differences in learning and performance of tasks. Verbal, spatial, and mathematical abilities have been the focus of both theoretical areas of research (Maccoby & Jacklin, 1974) with spatial ability producing the largest and most robust differences from within each framework (Halpern, 1986).

The organizational structure of the brain is described as functional brain asymmetry (Springer & Deutsch, 1981). In general, language functions are specialized in the left cerebral hemisphere; and structure, perception, and hard-to-verbalize stimuli are specialized in the right cerebral hemisphere (Doyle, Ornstein, & Galin, 1974; Galin & Ornstein, 1972; Kimura, 1961, 1964, 1966, 1973; Milner, 1962, 1971). More specifically, the right cerebral hemisphere is specialized for synthesizing, analyzing, and simultaneous processing of parallel sources of visual, spatial, tactile, and nonlinguistic stimuli in a holistic gestalt-type strategy (Gazzangia, 1978; Nebes, 1973; Ornstein, 1972). In contrast, the left cerebral hemisphere is specialized for analyzing, abstracting, and verbally labeling informational stimuli through sequential processing (Cohen, 1973; Kimura & Durnford, 1974). Spatial perception and processing strategies of the right cerebral hemisphere are important to dance, art, music, and athletics (Ornstein, 1972).

Lateralization theory (Levy, 1972, 1974) suggests that males are more lateralized than females. Regarding cognitive abilities, females are bilateralized with language functions represented in both hemispheres, while males are more lateralized with language functions represented only in the left hemisphere. This greater lateralization for males permits more specialization of the right hemisphere for processing of spatial tasks, and, thus, is one explanation for the superior spatial task performance of males as compared to females (Bakan & Putman, 1974; Davidoff, 1977; Kimura, 1973; McGlone & Davidson, 1973). Dichotic listening tasks (Kimura, 1964, 1967; Lake & Bryden, 1976) and tachistoscopic visual procedures (Bryden, 1965, 1966, 1976; Kimura, 1966; Levy & Reid, 1976; McGlone & Davidson, 1973) have been used to determine the degree of lateralization. Clinical studies (McGlone, 1977, 1978; McGlone & Kertesz, 1973) have also provided support for the gender differences in lateralization: (a) the speech of right-handed males was more dramatically affected by left side lesions than by right side lesions; (b) spatial deficits were more predominant for right side lesions that left side lesions for both males and females; (c) right side lesions produced greater deficits in performance of spatial tasks by males than by females; and (d) the occurrence of aphasia was three times greater for males than females with left hemispheric lesions. Further support has come from investigations of neurologically normal subjects who were tested with EEG instrumentation. Specifically, females were found to have similar

EEG activity for spatial and verbal tasks while males had higher EEG activity in the right hemisphere for spatial tasks and higher left hemispheric activity for verbal tasks (Baken & Putman, 1974; Galin & Ornstein, 1972; Ray, Morell, Frediana, & Tucker, 1976; Ray, Newcombe, Semon, & Cole, 1981; Tucker, 1976). Through the comparison of the results of clinical studies and the findings of studies utilizing neurologically normal people, support for the lateralization theory can be construed (McGlone, 1980).

Socialization theory (Sherman, 1967) suggests that differential childhood experiences influence an individual's spatial ability. According to this theoretical explanation, differential childhood experiences appear to be related to the gender identity of the individual (Green, Williams, & Goodman, 1982; Harris, 1974). The fundamental beginning of one's future gender identity occurs at the time of birth (Rubin, Provenzano, & Luria, 1976) and, by the age of six years, individuals are able to identify themselves according to the appropriate gender role (Maccoby & Jacklin, 1974). American society has typically held that the appropriate gender role for males is masculine and for females feminine (Bem, 1975). The process by which individuals develop their gender identify is known as gender role socialization and parents are major agents of socialization (Lewko & Greendorfer, 1978). Parents shape the child's gender identity by their interactions with the child and their reinforcement of the behaviors of the child that they deem appropriate according to the standards set by society (Block, 1973, 1979; Kelly & Worell, 1976; Orlofsky, 1979). The masculine gender role stereotype implies that a person is active, aggressive, rule-governed, competitive, goal-oriented, organized, and instrumental; while the feminine gender role stereotype is that of a person who is passive, submissive, idiosyncratic, cooperative, chaotic, disorganized, and expressive (Oglesby, 1984). More behavioral limits are imposed by the feminine gender role stereotype than by the masculine stereotype (Lever, 1976), especially in the area of sport participation (Berlin, 1974; Birrell, 1983).

The majority of athletic activities, especially competitive athletics, has been classified as masculine, and participation in these activities has often been considered by society as inappropriate for females (Colley, Roberts, & Chipps, 1985; Duquin, 1978; Snyder & Spreitzer, 1978; Sutton-Smith, Rosenberg, & Morgan, 1963). Since the expressive orientation of the feminine gender role stereotype conflicts with the instrumental orientation of competitive athletics (Zoble, 1976), it is predicted that the majority of females and individuals with a feminine gender identity will refrain from participating in such activities (Duquin, 1978). Lack of participation in such activities, because of the stigma of gender inappropriateness, may result in the failure to learn behaviors associated with those activities (Bem, 1975). Therefore, gender role stereotype characteristics may not only affect participation in vigorous competitive athletics, but also proficiency in other cognitive tasks such as mathematics (Nash, 1979). According to Sherman (1967), cultural gender role stereotyping may provide males and individuals with masculine gender identity more opportunities to practice temporal/spatial skills. Therefore, it might be hypothesized that the psychomotor abilities associated with specific activities will not be as highly developed in females or in individuals with a feminine gender identity as they are with males or individuals with a masculine gender identity. If this is true, males or individuals with masculine gender identity would be expected to have more spatial ability and perform better on tasks with temporal/spatial demands than females or individuals with a feminine gender identity (Friedman et al., 1985).

Socialization theory has been supported by the following findings: (a) female spatial ability scores have been found to improve following training in spatial tasks (Liben, 1978; Stericker & LeVesconte, 1982); (b) significant correlations have been found between participation in activities with spatial demands and performance on spatial ability tests (Hansen, Jamison, & Signorella, 1982; Lunneborg & Lunneborg, 1984; Newcombe, Bandura, & Taylor, 1983); and (c) higher performance on the spatial ability tests have been observed for individuals with masculine gender identity as compared to feminine, androgynous, and undifferentiated gender identity (Hansen et al., 1982; Jamison & Signorella, 1980; Popiel & DeLisi, 1984; Signorella & Jamison, 1986). The data used for a meta-analysis of gender differences in cognitive abilities (Rosenthal & Rubin, 1982) was a reevaluation of the data analyzed by Hyde (1981), and the results revealed a trend of decreasing gender differences for the cognitive areas over the past 20 years.

Spatial ability is a component in the learning and performance of many motor tasks (Whiting, 1969). Information processing theories (Bernstein, 1967; Welford, 1972; Whiting, 1969) describe human motor performance as an integration of environmental input through the processes of perception, translation, and effection. Spatial ability is directly related to the process of perception; that is, the organization and attaching of meaning to the stimuli received through the sensory system. The information concerning the movement of objects in the environment provided by vision is essential in the development of the corresponding motor response and performance of the motor task (Gentile, 1972; Poulton, 1957; Schmidt, 1982). Gentile, Higgins, Miller, and Rosen (1975) have classified tasks as: (a) spatial, no movement in the environment; or (b) temporal/spatial, movement in and/or of the environment.

Numerous researchers in the field of motor control/motor learning have focused their attention on the component of motor skills known as coincidence anticipation (Dorfman, 1977; Dunham & Glad, 1985; Petrakis, 1985; Wrisberg, Hardy, & Beitel, 1982; Wrisberg et al., 1979). The term was coined by Belisle (1963) and has been defined by Schmidt (1968) as the ability to anticipate the moment a stimulus will arrive and to respond coincident with that moment of arrival. Stadulis (1971) suggested that coincidence anticipation is an underlying factor of various gross, as well as fine, motor skills.

Poulton (1957) defined three types of anticipation. The first, effector anticipation, dealt with prediction of the length of time needed for the movement to reach the intercept point. The second, receptor anticipation, involved the determination of the amount of time required for the moving object to arrive at the intercept point. The third, perceptual anticipation, referred to the subject's ability to predict the position of the object at the completion of the movement.

As described, coincidence anticipation is a visuospatial task with temporal/spatial environmental demands requiring perceptual anticipation.

In coincidence anticipation studies, the variable of gender has produced inconsistent results with female performers either equal, inferior to and, for one study, superior to male performers (Dorfman, 1977; Dunham & Glad, 1985; Haywood, 1980; Wrisberg et al., 1982; Wrisberg et al., 1979). Spatial ability investigations have also reported conflicting results that follow the same pattern of the coincidence anticipation results in regard to the variable of gender (Friedman et al., 1985; Olson & Elliot, 1986; Popiel & Delisi, 1984; Sherman, 1974; Stericker & LeVesconte, 1982). Explanations for these findings have followed either a nature or nurture framework; both have weaknesses and are singularly inadequate (Halpern, 1986). Recent reviewers (Halpern, 1986; Harris, 1981; McGee, 1979; McGlone, 1980; Newcombe, 1982; Sherman, 1978) have concluded that the issue is not either/or answer in regard to nature and nurture, but instead an integration of socialization theory and the various biological theories, of which lateralization is one.

Statement of Purpose

The purpose of the present study was to explore an integrated approach to the investigation of gender related individual difference variables and the performance/experience of a temporal/spatial task. The following gender related variables were considered: (a) degree of lateralization, (b) spatial visualization, and (c) gender identity.

The following temporal/spatial performance/experience variables were considered: (a) coincidence anticipation measures and (b) skill level.

The following subproblems were studied to determine whether:

1. There were multivariate differences by gender, skill level, and/or gender by skill level for spatial visualization ability, coincidence anticipation performance, and degree of lateralization.

2. A significant negative relationship existed between spatial visualization ability and coincidence anticipation performance.

3. A significant negative relationship existed between spatial visualization ability and the degree of lateralization.

4. A significant positive relationship existed between coincidence anticipation performance and the degree of lateralization.

5. A significant interaction existed among gender, gender identity, and depth of skill.

Definitions of Terms

The following theoretical and operational definitions were used consistently throughout the text.

Coincidence Anticipation Performance--A component of motor skills that: (a) is the ability to predict the moment and position of stimulus arrival and to respond coincident with the moment of arrival at the predetermined position (Schmidt, 1968) and (b) has temporal/ spatial environmental demands (Gentile et al., 1975). Coincidence anticipation ability was demonstrated by the performer as he/she attempted to depress a computer key simultaneously with the arrival of a cursor moving across the computer monitor at a predetermined point and was represented by absolute error, constant error, and variable error.

Absolute Error (AE)--A quantified measure of the magnitude of the deviation from the target, regardless of direction, that was represented by using the absolute mean value for the error on each trial, thus averaging across 20 trials provides the mean absolute error.

Constant Error (CE)--A quantified measure of the deviation from the target, indicating both the direction and magnitude of the performer's bias, was determined by using the mean algebraic value of the error for each trial averaged across 20 trials.

Variable Error (VE)--A quantified measure of the magnitude of deviation of one's responses in relation to the algebraic mean (CE) of the individual's responses; also referred to as the standard deviation of the constant error for the 20 trials.

Gender Identity--Perception of one's self on masculinity and femininity dimensions as measured by responses on the Bem Sex Role Inventory (Bem, 1974). Gender identity categories are androgynous, feminine, masculine, and undifferentiated.

Androgynous--The gender identity of an individual who exhibits both masculine behaviors (e.g., instrumental, competitive, and aggressive) and feminine behaviors (e.g., expressive, cooperative, and passive) as dictated appropriate by the situation (Bem, 1975). The classification of an individual who scored above the total group median on both the masculinity and femininity scales of the Bem Sex Role Inventory (Bem, 1974).

Feminine--The gender identity of an individual whose behaviors are limited to behaviors characterized as feminine (e.g., expressive, cooperative, passive, and nurturant) (Bem, 1975). The classification of an individual who scored above the total group median on the femininity scale and below the median on the masculinity scale of the Bem Sex Role Inventory (Bem, 1974).

Masculine--The gender identity of an individual whose behaviors are limited to behaviors that are characterized as masculine (e.g., instrumental, competitive, aggressive, and independent) (Bem, 1975). The classification of an individual who scored above the total group median on the masculinity scale and below the median on the femininity scale of the Bem Sex Role Inventory (Bem, 1974).

Undifferentiated--The gender identity of an individual whose behavior does not have consistent patterns to match situational requirements (Spence, Helmreich, & Stapp, 1975). The classification of an individual who scored below the total group median on both the masculinity and femininity scales of the Bem Sex Role Inventory (Bem, 1974).

Gender Role Stereotype--The psychological traits and societal expectations that are considered appropriate for male and female behavior (Birrell, 1983).

Lateralization--The representation of specific functions to one cerebral hemisphere, with language functions to the left and spatial functions to the right, as measured by performance of a tachistoscopic task. A log-odds ratio is utilized to represent the degree of lateralization (Bryden & Sprott, 1981).

Skill Level--The degree or extent of competitive experience, represented by two levels of competitive experience (temporal/spatial tasks).

Skilled--An individual with extensive competitive athletic (temporal/spatial task only) experience (i.e., a current member of an organized collegiate basketball, tennis, or volleyball team).

Unskilled--An individual with no competitive athletic experience (i.e., a university student that has never participated in any type of organized competitive sport program (neither temporal/spatial nor spatial).

Environmental Demands--Constraints in the world external to the performer that must be matched by the movement in order to successfully complete the task (Gentile et al., 1975).

Spatial Task--A task in which there is no movement in and/or of the environment.

Temporal/Spatial Task--A task in which there is movement in and/or of the environment.

Spatial Visualization Ability--The spatial ability to mentally manipulate or rotate a three dimensional object as measured by the Spatial Relation Subtest of the Differential Aptitudes Test (DAT) (Bennett, Seashore, & Wesman, 1982).

Assumptions Underlying the Research

The conduct of the present study was made under the following assumptions:

1. All subjects were naive to all the tasks.

2. All subjects were able to comprehend the requirements of each task.

3. Each subject performed each task to the best of their ability.

4. All subjects had no uncorrected vision problems.

5. The Spatial Relations Subtest of the Differential Aptitudes Test is a valid and reliable measure of spatial visualization ability (Bennett et al., 1982).

6. The Bem Sex Role Inventory is a valid and reliable measure of gender identity (Bem, 1974).

7. The Coincidence-Anticipation Computer Diskette is a valid and reliable measure of coincidence anticipation ability (Kluka & Zimmerman, 1985).

8. The tachistoscopic task is a valid and reliable measure of the degree of lateralization (Kimura, 1966; McGlone & Davidson, 1973).

Delimitations

The following were delimitations of the present study:

1. Subjects were students at The University of Tennessee, Knoxville.

2. Subjects were between the ages of 17 years and 25 years of age.

3. Subjects were either current collegiate athletes or had no competitive athletic experience at all.

Significance of the Study

Researchers (Halpern, 1986; Harris, 1981; McGee, 1979; McGlone, 1980; Newcombe, 1982; Sherman, 1978) have proposed an integrated approach for the study of gender related differences in spatial ability. Individual studies, to date, have attempted to assess the following relationships: (a) gender identity with differential childhood experiences (Colley, Roberts, & Chipps, 1985); (b) lateralization with gender (McGlone & Davidson, 1973); (c) spatial visualization with temporal/spatial task performance (Beitel, 1980, females only); (d) gender with temporal/spatial task performance (Wrisberg et al., 1979); (e) temporal/spatial task performance and background experience (Petrakis, 1985); and (f) various combinations of three of the above mentioned variables (Hult & Brous, 1986; Newcombe, Bandura, & Taylor, 1982). A study has not been reported in the literature that has integrated all of the factors of differential experiences, gender identity, lateralization, and spatial visualization in an attempt to provide an explanation of gender related differences in the performance of a temporal/spatial task. Therefore, this study represents an integrated approach toward developing a more complete understanding of the role of gender to performance and related abilities.

CHAPTER II

REVIEW OF THE LITERATURE

Gender difference research has been conducted based upon either a nature or nurture framework, but recently an integrated approach has been advocated (Halpern, 1976). The focus of this study was the integration of the nature based theory of lateralization and the nurture based theory of socialization in the investigation of gender differences in spatial ability and temporal/spatial task performance. This review is organized into five sections: lateralization, socialization, spatial ability-spatial visualization, temporal/spatial task performance, and the interaction of these variables.

Lateralization

Lateralization theory (Levy, 1972, 1974) suggests that males are more lateralized than females. Regarding cognitive abilities, females are bilateralized with language functions represented in both hemispheres, while males are more lateralized with language functions represented only in the left hemisphere. This greater lateralization in males permits more specialization of the right hemisphere for spatial tasks and thus is one explanation for the superior spatial task performance of males as compared to females (Bakan & Putman, 1974; Davidoff, 1977; Kimura, 1973; McGlone & Davidson, 1973). Dichotic listening tasks (Kimura, 1964, 1967; Lake & Bryden, 1976) and tachistoscopic visual procedures (Bryden, 1965, 1966, 1976; Kimura, 1966; Levy & Reid, 1976; McGlone & Davidson, 1973) have been used to determine the degree of lateralization of an individual. Clinical studies (McGlone, 1977, 1978; McGlone & Kertesz, 1973) have also provided support for the gender differences in lateralization: (a) the speech of right handed males was more dramatically affected by left side lesions than by right side lesions; (b) spatial deficits were more predominant for right side lesions than left side lesions for both males and females; (c) right side lesions produced greater deficits in performance of spatial tasks by males than by females; and (d) the occurrence of aphasia was three times greater for males than females with left hemispheric lesions.

Further support for lateralization theory has come from investigations of neurologically normal subjects who were tested with EEG instrumentation. Specifically, females were found to have similar EEG activity for spatial and verbal tasks while males had higher EEG activity for the right hemisphere for spatial tasks and higher left hemispheric activity for verbal tasks (Bakan & Putman, 1974; Galin & Ornstein, 1972; Ray et al., 1976; Ray et al., 1981; Tucker, 1976). Through the comparison of the results of clinical studies and the findings of studies utilizing neurologically normal subjects, support for the lateralization theory was construed (McGlone, 1980).

The measurement of the degree of laterality has been addressed by Bryden and Sprott (1981). They suggested that a laterality index is necessary to compute comparisons between the degree of laterality and the performance of certain behaviors. The problem with previous methods was that observations were treated as a single observation instead of n observations. The log-odds ratio [Lambda = ln Pr (1-Pl)/ Pl (1-Pr)] that Bryden and Sprott (1981) proposed was calculated with regard to n independent observations. The number correct for the right visual field is represented by Pr, while Pl represents the number correct for the left visual field. Statistical analyses that utilize the index of laterality determined by this method are computed on group as well as individual data to determine tests of significance and confidence intervals (Bryden & Sprott, 1981).

Tachistoscopic visual procedures involve presentation of stimuli for a brief exposure time. Stimuli, verbal or nonverbal, are simultaneously presented to either one or both of the visual fields. According to Sergent (1983, p. 483), "the appropriateness of using tachistoscopic presentations to study hemispheric asymmetries is based upon the anatomical property of the visual system whereby temporal hemiretinea project contralaterally." Consequently, stimuli presented to the right of a fixation point are initially processed by the left cerebral hemisphere while stimuli presented to the left of a fixation point are initially processed by the right cerebral hemisphere. Sergent (1983) contended that to prevent eye movement and to guarantee the presentation is confined to a specific visual field the exposure time should be 150 msec or less. In addition, Sergent (1983) suggested that the stimuli should be presented to the left or right of a fixation point.

Lateralization theory has been investigated by numerous methods: dichotic listening (Lake & Bryden, 1976; Kimura, 1967); EEG instrumentation (Baken & Putman, 1974; Ray et al., 1981; Tucker, 1976); and tachistoscopic presentations (Bryden, 1976; Kimura, 1966; McGlone & Davidson, 1973). The tasks incorporated within each of the methods have been extremely varied, including the following: (a) dot detection, enumeration, or localization; (b) word recognition; (c) face recognition; (d) letter; (e) names; and (f) figures. Research has been conducted with clinical subjects as well as normal subjects. For the purpose of this review, only studies conducted with normal adult subjects that measured laterality through the specific task of dot enumeration for tachistoscopic presentations were discussed.

Kimura (1966) investigated functional asymmetry of the brain through the tachistoscopic presentation of verbal and nonverbal stimuli. Subjects totaling 28 undergraduates (13 females and 15 males) performed the following four tasks: (a) nonsense figures, (b) dot enumeration, (c) large letters, and (d) small letters. The subject was seated and the presentation was approximately 24 in. (60.96 cm) from the subject's eyes. For the dot enumeration test, the cards contained between 3 to 10 dots that were arranged so the visual angle to the outer edge of the array was 3° 50'. The presentation of the stimuli was random with equal representation for both the left and right fields. The dots were presented for 80 msec, and, after the presentation, the subjects verbally indicated how many dots they had detected. A significant ($p < .02$) visual field effect was reported with more accurate enumeration for the left visual field. The small and large letter tasks produced a significant ($p < .02$) right visual field advantage. No significant gender effects were obtained.

In a second experiment, Kimura (1966) administered the nonsense figure test and the dot enumeration test that had been used in the previous experiment to 17 right-handed nurses. Similar to the previous experiment (Kimura, 1966), a significant ($p < .05$) left visual field advantage was reported for accuracy on the dot enumeration test. Based upon these two experiments, Kimura (1966) concluded that verbal form identification is a function of the left cerebral hemisphere, while the recognition of nonverbal stimuli is a function of the right cerebral hemisphere.

McGlone and Davidson (1973) investigated laterality in a two-part study. The first study measured performance on two visuospatial tasks and a dichotic listening task. Of the 99 subjects who had participated in the first study, 79 (38 females and 41 males) participated in the second study, with 35 subjects being right-handed and 44 subjects being left-handed. The subjects were high school students (mean age 16.8 years) and college students (mean age 20.2 years). In the second study all subjects were administered a dot enumeration test. Cards containing 3 to 10 dots were tachistoscopically presented for a duration of 70-80 msec. The distance from the presentation and the extent of the visual angle were not discussed. Based upon performance on the dot enumeration test, the subjects were classified as right or left field superior. The maximum score per field was 10 and the modal difference between the two fields was 1, indicating a very small difference between fields (McGlone & Davidson, 1973). Left-handed and right-handed subjects did not differ significantly on visual field superiority, but left-handed subjects did exhibit higher right field scores than did right-handed subjects. Gender differences were analyzed by a Chi-Square test and a significant ($p < .03$) result was reported. The authors indicated that the left field scores were proportionally higher for males, and right field scores were higher for females (McGlone & Davidson, 1973). This result conflicted with the nonsignificant gender effect reported by Kimura (1966).

McGlone and Davidson (1973) compared performance on Thurstone's Primary Mental Abilities Spatial Relations Test, one of the visuospatial measures evaluated in the first study, with the left-right visual field superiority determined by the dot enumeration test. Although a nonsignificant Chi-Square was reported for this comparison based on median scores for the Spatial Relations Test, results indicated that left visual field superiority was associated with better performance on the Spatial Relations Test. These findings were in agreement with the findings of Kimura (1966) and suggested that left hemispheric processing of visuospatial stimuli is not advantageous (McGlone & Davidson, 1973).

Socialization

Socialization theory (Sherman, 1967) suggests that differential childhood experiences influence an individual's spatial ability. According to this theoretical explanation, differential childhood experiences appear to be related to the gender identity of the individual (Green et al., 1982; Harris, 1974). Rubin et al. (1976) hypothesized that the fundamental beginning of one's future gender identity occurs at the time of birth. Maccoby & Jacklin (1974) suggested that by the age of six individuals are able to identify themselves according to the appropriate gender role. American society has typically held that the appropriate gender role for males is masculine and for females, feminine (Bem, 1975). The process by which individuals develop their gender identity is known as gender role socialization, and parents have been identified as major agents of socialization (Lewko & Greendorfer, 1978). Parents shape the child's gender identity by their interactions with the child and their reinforcement of the behaviors of the child that they deem appropriate according to the standards set by society (Block, 1973, 1979; Kelly & Worell, 1976; Orlofsky, 1979). According to Oglesby (1984), the masculine gender role stereotype implies that a person is active, aggressive, rule-governed, competitive, goal-oriented, organized, and instrumental; while the feminine gender role stereotype is that of a person who is passive, submissive, idiosyncratic, cooperative, chaotic, disorganized, and expressive. More behavioral limits are imposed by the feminine gender role stereotype than by the masculine stereotype (Lever, 1976), especially in the area of sport participation (Berlin, 1974; Birrell, 1983).

The majority of athletic activities, especially competitive athletics, have been classified as masculine and participation in these activities has often been considered by society as inappropriate for females (Colley et al., 1985; Duquin, 1978; Snyder & Spreitzer, 1978; Sutton-Smith et al., 1963). Zoble (1976) stated that the expressive orientation of the feminine gender role stereotype conflicts with the instrumentation orientation of competitive athletics. Based upon this premise, Duquin (1978) predicted that the majority of females with feminine gender identity will refrain from participating in such activities. Bem (1975) suggested that lack of participation in such activities, because of the stigma of gender inappropriateness, may result in the failure to learn behaviors associated with those activities. According to Sherman (1967), cultural gender role stereotyping may provide males and individuals with masculine gender identity more opportunities to practice temporal/spatial tasks.

The androgynous gender identity classification was described by Bem (1974) as the incorporation of aspects of both male and female characteristics. Spence, Helmreich, and Stapp (1975) further delineated the classification with the restriction that both the masculine and feminine scores must be above their respective medians. Bem (1975) reported that androgynous individuals were more behaviorally flexible than gender-typed individuals. Myers and Lips (1985) hypothesized that participation in athletics, which were deemed inappropriate for females, requires females to exhibit more behavioral flexibility than males. Friedman et al. (1985) related gender identity to performance of a motor task and concluded that gender identity, specifically androgyny, was related to superior performance of a motor task for females but not for males.

Socialization theory has been supported by the following findings: (a) females' spatial ability scores have been found to improve following training in spatial tasks (Liben, 1978; Stericker & LeVesconte, 1982); (b) significant correlations have been found between participation in activities with spatial demands and performance on spatial ability tests (Hansen et al., 1982; Lunneborg & Lunneborg, 1984; Newcombe et al., 1983); and (c) higher performance on spatial ability tests has been observed for individuals with masculine gender identity as compared to feminine, androgynous, and undifferentiated gender identity (Hansen et al., 1982; Jamison & Signorella, 1980; Popiel & DeLisi, 1984; Signorella & Jamison, 1986).

The underlying principle of the socialization theory is experience. Based on the focus of this study, experience is defined as competitive sport experience or participation. The studies reviewed dealt with gender identity and sports participation. Since the development of gender identity occurs during an individual's childhood, studies involving children as well as adults were reviewed.

Sutton-Smith et al., 1963) administered a 180-item play scale to 973 females and 928 males in grades three through six. Subjects indicated if they participated in each specific activity, and, if they did participate, they were to indicate if they liked the activity or not. Results indicated that at the third-fourth grade level, females became more interested in all types of activities (mature male: basketball, soccer; immature male: bandits, cops and robbers; mature female: crochet, skating; immature female: I spy, statues), while males became more interested in mature male activities. Even for the older age group, females were still interested in all types of activities not just the mature activities related to their gender as were the older males. These results may reflect a developmental time of gender role confusion for females or may be an effect of the nature of the items included in the play scale (Sutton-Smith et al., 1963).

Myers and Lips (1978) administered the Bem Sex Role Inventory to 23 female and 25 male racquetball players ranging in age from 17 to 48 years. Gender-role orientation was determined by the T-score method for the Bem Sex Role Inventory. These classifications were then compared to the normative sample that had been reported by Bem (1974). A Chi-Square analysis indicated that a significant difference existed between the normative data and the racquetball players. The distribution of the subjects within the Bem categories revealed 40% of the males were classified as masculine and 44% of the females were classified as androgynous.

In a second study, Myers and Lips (1978) assigned badminton, squash, and handball players to competitive and noncompetitive categories based upon the reason they gave for entering the tournament. There were 15 competitive females and 12 noncompetitive females. The subjects were then classified upon their performance on the Bem Sex Role Inventory. The highest proportion (40%) of competitive females were androgynous while the higher proportion (58%) of noncompetitive females were feminine. Males were not analyzed because all of the males were classified as competitive. It was suggested that the proportion of females classified as masculine or androgynous would increase as the competitiveness of the sport increases (Myers & Lips, 1978).

Salisbury and Passer (1982) employed the Attitudes Toward Women Scale in the assessment of gender-role attitudes for 189 adult female athletes. The adult sample ranged in age from 19-65 years. Athletes were categorized into two groups: (a) those participating in less feminine activities and (b) those participating in more feminine activities. The activities considered less feminine were soccer, basketball, and track/long distance running. The more feminine activities were volleyball, tennis, and softball. A significant correlation (r = .39, p < .001) between sport femininity and gender-role attitude was reported. Participants in less feminine activities exhibited more liberal gender-role attitudes than the participants in the more feminine activities (Salisbury & Passer, 1982). This finding strengthens the suggestion (Myers & Lips, 1978) of the possible increased androgynous or masculine classification of highly competitive females.

Green et al. (1982) conducted a longitudinal study to investigate the gender-typed differences of various behaviors among girls aged 4-12 years who were traditionally gender-typed or nontraditionally gender-typed. The subjects were divided into two groups based on their gender identity development. One group consisted of 50 traditionally gender-typed girls, while the other contained 49 nontraditionally gender-typed girls (tomboys). There were no significant differences between family and parental variables. A Chi-Square analysis was performed on the behavioral variable "plays sports with boys (but not with girls)" (Green et al., 1982, p. 256). A significant difference (p < .000) was reported with 32% of the nontraditional subjects describing it as a favorite activity as compared to 0% for the traditional subjects. Only 6% of the nontraditional subjects reported that they very rarely or never played sports with boys, as compared to 64% of the traditional subjects. A Chi-Square for participation in sports produced significant results for both the mothers' ($p < .000$) and fathers' ($p < .000$) views. Mothers reported that 68% of the nontraditional subjects and 6% of the traditional subjects participated in sports more than the average. Fathers held a similar view and reported that 67% of the nontraditional and 10% of the traditional subjects participated in sports more than the average. The statement "I want to be a boy" was stated significantly ($p < .000$) more frequently by the nontraditional subjects than the traditional subjects. Mothers reported 95% of the traditional subjects and 12% of the nontraditional subjects never made the statement. The fathers' percentage for the traditional subjects was identical to the mothers' (95%), but the percentage was higher (22%) for the nontraditional subjects. These results indicate a possible relationship between gender identity and sports participation (Green et al., 1982).

Colley et al. (1985) administered four tests to 156 undergraduate students between the ages of 18-29 years. There were three groups of 48 (24 female, 24 male) subjects who: (a) did not participate in sports on a regular basis, (b) participated in competitive individual sports, and (c) participated in competitive team sports. There was a group of 12 noncompetitive females who did participate in some type of regular individual sports. The four tests were: (a) Bem Sex Role Inventory, (b) Eysenck Personality Inventory, (c) Rotter Locus of Control, and (d) Sport Competition Anxiety Test. As expected, sex main effects were significant with masculinity scores higher for the males than the females ($p < .001$) and femininity scores higher for the females than the males ($p < .01$). Analysis with regard to sports participation produced a significant result for masculinity scores ($p < .01$). Tukey analyses indicated that participants in team sports and individual sports were similar in masculinity but had significantly higher masculine scores than nonparticipants ($p < .01$). A Chi-Square analysis was performed to investigate within gender differences. The following results (Colley et al., 1985) were reported for females, with a significant difference ($p < .02$) among sport participants in the gender categories of feminine, androgynous, and undifferentiated; that is, (a) the largest percentages of team participants were classified androgynous (41.7%) and feminine (33.3%); (b) the highest percentages of individual participants were in the classifications of feminine (33.3%) and undifferentiated (33.3%); and (c) the largest percentage of nonparticipants was classified as feminine (70.8%). For males, the results of the Chi-Square analysis indicated: (a) the majority of team and individual participants were classified as either masculine (45.8% and 58.3%, respectively) or androgynous (33.0% and 25.0%, respectively); and (b) the largest percentage of nonparticipants were masculine (41.7%) or undifferentiated (29.1%). The results of higher femininity classification for female nonparticipants is similar to the findings reported by Myers and Lips (1978).

Burke (1986) administered the Bem Sex Role Inventory to 49 female collegiate athletes (11 basketball, 12 softball, 17 swimming, 9 tennis). The athletes were grouped into gender appropriate sport (i.e., tennis and swimming) and gender inappropriate sport (i.e., basketball and softball). A significant difference (p < .05) was reported between the groups for the masculinity score, with athletes in inappropriate sports scoring higher. A comparison of the percentage of basketball and tennis players classified into each of the four gender role categories revealed the following: (a) identical percentages for both sport groups for the androgynous (45%) and undifferentiated (0%) categories; (b) basketball (36%) and tennis (33%) in the masculine classification; and (c) basketball (18%) and tennis (22%) in the feminine classification. These results tend to support the findings of Colley et al. (1985) and Myers and Lips (1978).

Spatial Ability--Spatial Visualization

The concept of spatial ability is extremely broad and difficult to define (Halper, 1986). Caplan, MacPherson, and Tobin (1985) criticized the opinion expressed by numerous researchers (Harris, 1978; Maccoby & Jacklin, 1974) that males' performance on spatial tasks is superior to that of females. The diversity of the types of tasks employed to measure spatial ability was noted as a major problem. McGee (1979) identified two factors that comprise spatial ability: (a) spatial visualization and (b) spatial orientation. Spatial visualization had been defined (French, Ekstron, & Price, 1963) as the mental manipulation of an object in three dimensional space. McGee (1979) included the mental folding of a two dimensional object and the unfolding of a solid object in the description of the spatial visualization factor.

Spatial visualization is concerned with manipulating and transforming objects in space (McGee, 1979). This process has an integral part in the performance of temporal/spatial tasks. Individuals must make judgments about a moving object and, based upon the judgment, formulate the appropriate movement pattern and the timing of that pattern (Higgins, 1977). Therefore, since the nature of this study was to investigate temporal/spatial task performance and spatial ability, the review was limited to studies that investigated the factor of spatial visualization as measured by the Differential Aptitude Space Relations Subtest (Bennett et al., 1973) for adult subjects.

The Space Relations Subtest of the Differential Aptitude Test (Bennett et al., 1973) involves mentally folding a two dimensional drawing into a three dimensional geometric figure and possibly rotating the object. The means and standard deviations for the Differential Aptitude Space Relations Subtest were reported by Bennett et al. (1973). The average number correct for 12th grade females was 30.8 with a standard deviation of 12.4, based upon a sample size of 244 subjects. For a sample of 240 12th grade males, the mean was 34.6 and the standard deviation was 12.9.

Sherman (1974) employed the DAT Space Relations Subtest as the measure of spatial visualization for 25 female and 25 male undergraduates. In addition to the DAT, the Group Embedded Figures Test, the Draw-A-Person Test, and the Rod-and-Frame Test were given. Each test result was analyzed by a t-test, and the DAT produced the only significant gender effect ($p < .05$). Males had better performance scores on the DAT than the females, although the range for the raw scores was very similar (23-88 for females, 28-90 for males). These results were consistent with the opinion (Maccoby & Jacklin, 1974) that males are superior to females in visual-spatial perception (Sherman, 1974).

The DAT Space Relations Subtest was utilized as a preliminary test in the investigation of spatial ability as represented by mental rotation (Tapley & Bryden, 1977). The subjects 20 female and 20 male undergraduates, completed a Paivio imagery questionnaire, the Standardized Road Map Test of Direction, and the Mental Rotation Test in addition to the DAT Space Relations Subtest. A nonsignificant gender effect was reported for the DAT performance, with the mean for females being 39.65 and for males 42.65. All measures were correlated and DAT was determined to be the best single predictor of mental rotation performance. DAT performance scores were correlated with the Paivio questionnaire and indicated that visual imagery ability appeared to be correlated with males who demonstrated high spatial visualization ability (r = .20). In contrast, verbal imagery ability was correlated with females who demonstrated high spatial visualization ability (r = .23). According to Tapley and Bryden (1977), these findings possibly suggested that: (a) females use a more verbal process in performance of the DAT Space Relations Subtest and (b) for males and not females, speed of performing a mental rotation task was increased by frequent use of visual imagery.

Streicker and LeVesconte (1982) investigated the effect of training upon performance of spatial tasks. Undergraduate students (45 female and 38 male) were administered the following four standard visual-spatial tasks: (a) Space Relations Subtest of the Differential Aptitude Test (DAT), (b) Group Embedded Figures Test (EMFT), (c) Vandenberg-Shepard Mental Rotations Test (VAN), and (d) Space Relations Test of the Primary Mental Abilities Test (PMA). All four tests were initially administered to all subjects. The test scores were averaged and, in combination with gender, were used to match the subjects. After being matched, the subjects were randomly assigned to either the control group or the experimental group. The experimental group received three 1-hour training sessions. Each session was divided into three 20-minute intervals and, during each interval, practice was provided for one of the following tests: (a) DAT, (b) EMFT, or (c) VAN. Subjects did not receive practice on the PMA. All four tests were taken again for the posttest. Analysis of the pretest scores showed a significant gender effect for all four tests. In particular, the mean for the DAT standard scores for females was 16.4 with a standard deviation of 5.6, and for the males the mean was 21.3 with a standard deviation of 4.03. A multivariate analysis was computed to determine the effects of sex and training on spatial task performance. A significant multivariate group effect ($p < .001$) was reported, indicating that training improved performance (Streicker & LeVesconte, 1982). Univariate analyses revealed that this significant improvement was evident for all four of the tests. To determine if training reduced the spatial-experience gap between the genders, an analysis between the male control subjects and the female experimental subjects was conducted. A significant difference between the two groups was computed for the pretest scores (DAT, $p < .01$), with male control subjects performing better. The analysis for the posttest scores revealed no significant differences. Training was determined to have a positive effect upon reducing the spatial-experience gap between the genders (Streicker & LeVesconte, 1982).

Meta-analysis has been applied to some of the research published concerning spatial ability and gender differences. Hyde (1981) conducted a meta-analysis on the studies reported by Maccoby and Jacklin (1974). Two measures were used to determine effect size. The first was $\underline{w}^2$, that is, "the proportion of the total variance in the population accounted for by gender differences" (Hyde, 1981, p. 893); the second being $\underline{d}$, or the ratio between the means of males and females to the standard deviation of the total group. There were 10 studies that were categorized under the heading visual-spatial. The mean value of $\underline{w}^2$ was .043 and the mean value of $\underline{d}$ was .043. These statistics indicated that gender differences accounted for 4% of the variance in visual-spatial ability, and the means for males and females were approximately one-half a standard deviation apart. Hyde (1981) concluded that the well-established differences to which Maccoby and Jacklin (1974) made reference were actually very small.

Rosenthal and Rubin (1982) expanded on Hyde's (1981) meta-analysis results to determine if the effect size had changed over the years. The results of the analysis indicated that a linear trend for female gains in cognitive skill relative to males was evident for the preceding 20-year period.

Linn and Petersen (1985) performed a meta-analysis on results of spatial ability studies that had been conducted after 1974. They divided their categories into spatial perception, mental rotation, and spatial visualization. For spatial visualization, effect sizes were found to be very small, with the average being .13 of a standard deviation unit. Most studies reported no gender differences, and this finding appeared constant across the life span (Linn & Petersen, 1985).

Temporal/Spatial Task Performance

A temporal/spatial task has been defined (Gentile et al., 1975) as one in which there is movement in and/or of the environment. The performance of a temporal/spatial task is dependent on the individual's ability to detect the movement and/or to interact at the appropriate time with the moving stimulus. This ability to interact with a moving stimulus has been defined as coincidence anticipation (Schmidt, 1968).

The reviewed studies evaluated performance of a temporal/spatial task with regard to coincidence anticipation. The specific procedures differed to some degree from study to study but the measurement of timing error (AE, CE, VE) was common to all studies. In addition, all studies utilized adults as subjects, either exclusively or as a particular age group in a broader study.

Dorfman (1977) employed a task that required the subject to manually manipulate a slide so that the dot controlled by the slide would intercept a target dot traveling diagonally across an oscilloscope screen. The subjects used their preferred hand to operate the slide. Twenty males and 20 females were included in each of five age groups: 6-7, 8-9, 10-11, 14-15, and 18-19. The results indicated a significant gender main effect ($p < .01$) for a multivariate analysis for the measures of absolute error (AE), constant error (CE), and variable error (VE). Performance differences between gender existed in all the age groups, with males consistently more accurate (lower AE and CE) and less variable (lower VE) than females, although the amount of difference decreased as a function of age. The task employed was highly complex and approached similarity to ball game situations. The possible explanation for the larger performance differences among the younger males and females provided by Dorfman (1977) was that males have earlier opportunity and consequently more exposure to activities that were similar to the task than did females. Dorfman (1977) concluded that although the performance differences decreased over age, males remained significantly more consistent and accurate than females.

Similar results to those of Dorfman (1977), with regard to the older age (18-19) group, were reported by Wrisberg et al. (1979). The subjects were 40 males and 40 females aged 18-40 years who were university students and faculty members. The subjects were seated perpendicularly to the end of a 9.5 ft runway of a Bassin Anticipation Timer. They were to depress, with their preferred thumb, a button to match the lighting of the last light on the runway. The speed of the stimulus was 9 mph. A significant gender main effect was reported for both absolute error ($p < .001$) and variable error ($p < .001$) but not for algebraic (constant) error. Wrisberg et al. (1979) suggested that the importance of background experiences (Schmidt, 1968) was a possible explanation for the results.

In an effort to investigate this explanation with the existing data, Wrisberg et al. (1979) did post hoc analyses between subjects with competitive athletic experience and those not having a great deal of competitive athletic experience. Nine females and eight males from the subject pool were identified as having competitive athletic experience. An equal number of subjects were randomly selected from the remaining subjects, those with little competitive athletic experience. Results indicated no differences among the females for all three measures, but noncompetitive males had both significant ($p < .05$) negative constant error and a higher variable error than competitive athletic males. There was no significant difference between males for absolute error. Although these results indicated partial support for Schmidt's (1968) experience concept, caution must be taken due to the nature of the analyses (post hoc) and the sample size (nine females and eight males in the experienced group).

Haywood (1980) employed an apparent motion task using a Bassin Anticipation Timer apparatus with a runway length of 5 ft and a stimulus speed that varied from 2-5 mph. Contrary to the findings of Wrisberg et al. (1979), no significant gender effect for coincidence anticipation accuracy was reported for the 18-32 age group. Haywood (1980) classified subjects into four age groups: 7-9, 11-13, 18-32, and 60-75 years, with 15 females and 15 males in each group. Measures of response time were also calculated, and the results indicated that males had faster mean response time than females. Because of the faster response time males had more viewing time, but they did not have more accurate or consistent coincidence anticipation performance than did females (Haywood, 1980).

Thomas, Gallagher, and Purvis (1981) correlated reaction time and coincidence anticipation time for five age levels: 7, 9, 11, 13, and 20 years. Fifteen females and 15 males comprised each age level. A visual reaction timer and a Bassin Anticipation Timer were used to obtain the measurements. The runway speed was 447 cm/sec, but the runway length was not reported. A significant gender main effect ($p < .05$) was reported, but a two-way age by gender ANOVA did not produce a significant gender main effect for coincidence anticipation time measured by constant error. A significant ($p < .05$) gender effect was reported for reaction time, but the gender by age interaction was not significant. Anticipation time and reaction time were significantly correlated ($p < .05$) for younger (7, 9, 11 years) males but not for females at any of the age levels. According to Thomas et al. (1981), performance on coincidence anticipation tasks by males at the younger ages may be influenced by reaction time, but, as the motor programs are developed, reaction time plays a less important role. The authors proposed that since younger females generally have less spatial experience than males, this more than slower reaction time was a possible reason for the poorer coincidence anticipation performance by the younger females. Thomas et al. (1981) concluded that as females develop more efficient motor programs their performance of coincidence anticipation tasks becomes equivalent to males, even though the females' reaction time is slower than the males. Therefore, as was reported by Haywood (1980), males had a longer viewing time, as was reflected by faster reaction time, but did not have improved accuracy or consistency in coincidence anticipation performance.

The previously mentioned studies have dealt with fine motor movements (i.e., finger press, foot press, and moving a lever for 114 cm). Jensen, Picado, and Morenz (1981) developed a task that necessitated the subject making a gross motor movement in order to interact with a moving stimulus. In the first of two experiments, 45 female and 45 male undergraduate physical education majors ran 10 and 15 ft patterns before arriving at an intercept point simultaneously with the arrival of a ball which had been traveling down a 20 ft chute. Males performed more accurately (lower absolute and constant error scores) than did females for the longer pattern but not for the shorter pattern, as indicated by a significant ($p > .05$) sex by distance interaction. The gender difference on the longer pattern was attributed to the greater explosive power of the males (Jensen et al., 1981).

In the second experiment (Jensen et al., 1981), the chute length was reduced (6.25 ft) and the movement patterns were also shortened (7.4, 10.75 ft) from the distances used in the first experiment. The only measure that revealed a significant gender main effect ($p < .05$) was constant error, in which males were more accurate than females. These results partially support the findings of Dorfman (1977) and Wrisberg et al., 1979) with regard to males performing with greater accuracy than females, but not with greater consistency.

Wrisberg et al. (1982) had 15 female and 15 male college age subjects finish a ballistic arm movement to coincide with the completion of a moving light pattern. A Bassin Anticipation Timer with a 295 cm runway provided the apparent motion light pattern. Stimulus speed varied (134.1, 233.2, 312.9 cm/sec) and ballistic movement distance varied (43, 73, 103 cm). Significant gender main effects ($p < .05$) were found for constant error and variable error. These findings support the results of Wrisberg et al. (1979) that males are more consistent than females in coincidence anticipation tasks.

Contrary to all previous studies, and in fact the only coincidence anticipation study to ever report a finding in which females were more accurate and less variable than males, was a study conducted by Dunham and Glad (1985). The subjects were 60 undergraduate students (30 females, 30 male) from required physical education classes. The subjects were required to release a switch to coincide with the arrival of a ball at a target flag. The ball rolled down a 12 ft runway on a rollerskate wheel car. The stimulus was presented in both frontal and sagittal planes and at the speed of either 4.5 mph or 3.6 mph. For constant error, a significant ($p < .05$) gender by speed interaction was reported. At the slower speed (3.6 mph) the performance of the male subjects was less accurate than the females. Analyses indicated a significant ($p < .05$) gender by plane interaction for variable error. The males' performance for frontal plane stimulus presentation was less consistent than the females. These findings are inconsistent with all previous coincidence anticipation literature, and the researchers attributed the difference to a psychological variable. Inattentiveness or an underestimation of the difficulty of the task were suggested as possible psychological variables (Dunham & Glad, 1985).

Petrakis (1985) investigated coincidence anticipation ability among adults with similar background experiences. This study was the first to compare coincidence anticipation ability among female and male athletes. Previously, Wrisberg et al. (1979) did a post hoc analysis in regard to competitive athletic experience as compared to limited competitive athletic experience, but investigated the variable within and not between genders. Petrakis (1985) compared coincidence anticipation ability between 15 male collegiate varsity baseball players and 9 female collegiate varsity softball players. A Bassin Anticipation Timer with a three section runway was used. The stimulus speed was 9 mph. No significant gender main effects were reported for the measures of constant, absolute, or variable error. These results are contrary to Dorfman (1977), Wrisberg et al. (1979), and Wrisberg et al. (1982) but are in agreement with Haywood (1980) and Thomas et al. (1981). Support for the importance of background experience as suggested by Schmidt (1968) is provided by these results.

Interaction of Variables

The nature/nurture dichotomy that has been the basis for gender difference research necessitates answers which previous researchers have been unable to provide consistently (Halpern, 1986). In an effort to provide such gender difference answers, investigators have begun to take integrated approaches which combine both environmental and biological variables (Halpern, 1986). The following studies have integrated various combinations of the following variables: (a) spatial visualization, (b) temporal/spatial task performance, and (c) background experiences. Only studies evaluating adult subjects are reviewed.

Beitel (1980) investigated the relationships among visual-perceptual attributes and performance of gross motor tasks for 80 undergraduate females enrolled in general physical education classes. Performance was measured on (a) a spatial gross motor task, (b) a temporal/spatial gross motor task, and (c) five visual perceptual tasks, two of which were the DAT Space Relations Subtest and the Bassin Anticipation Timer task. A positive but low correlation (r = .14) was reported for the two measures. A factor analysis was performed and the measures of the DAT Space Relations Subtest and the Bassin Timer task each loaded on separate factors, Factors II (degree of quick selection of pertinent environmental information) and IV (coincidence anticipation ability), respectively. The correlation between the two factors was low (r = .10) and not significant (critical value .22), indicating independence between the two variables. Temporal/spatial performance loaded onto Factor I and was inversely related to Factor II (r = .225) and Factor IV (r = .248). These results indicated that a relationship exists between fast performance early in the learning stage of a temporal/spatial task, coincidence anticipation ability, and the ability to determine pertinent environmental information quickly (Beitel, 1980).

According to Newcombe (1982), little research has investigated the relationship of environment and experiences to gender differences in spatial abilities. Newcombe et al. (1983) conducted two experiments which assessed the spatial nature of tasks and correlated spatial activity participation with performance on the DAT Space Relations Subtest. In the first experiment, 106 undergraduate students (61 females, 45 males) classified 231 activities based upon the degree of spatial ability required to perform the activity (required or not required). The subjects were also requested to classify the activities as either feminine or masculine sex-typed and to indicate if they participated in the activity. Correlations were computed among the various variables. Activities rated as requiring spatial ability had low but significant correlations with: (a) masculine sex-typed activities (r = .24, p < .001) and (b) greater male participation (r = .15, p < .05). These findings indicated that (a) more males participate in masculine typed activities and (b) these activities are considered to require spatial ability (Newcombe et al., 1983).

The second experiment (Newcombe et al., 1983) employed 45 undergraduate students (23 females and 22 males). The subjects completed the DAT Space Relations Subtest and a questionnaire of 81 activities based upon the results from the first experiment. For females, performance on the DAT was significantly correlated (r = .40, p < .05) with participation in spatial activities. Males' DAT performance and spatial activity performance was correlated (r = .18) but not significantly. Males attained higher scores on the DAT than the females (p < .05) as determined by a one-tail test. Although a significant correlation was reported for female participation and DAT performance, the researchers (Newcombe et al., 1982) advised caution in interpreting the results and suggested the spatial activities questionnaire may contain some activities which are not spatial.

In a similar study, Lunneborg and Lunneborg (1984) investigated the frequency of participation in spatial activities and the correlation of this participation with performance on two paper pencil measures of spatial ability. College freshmen (137 female, 115 male) were requested to complete a survey which had been developed during a previous study (Lunneborg, 1984) of spatial activity participation. In addition, each subject took the Spatial Ability and Mechanical Reasoning subtests of the Washington Pre-College Test Program. The Spatial Ability Subtest is similar to the DAT Space Relations Subtest. Based upon the survey of perceived abilities, the males perceived themselves to possess better spatial ability than did the females. Correlations were computed between spatial ability performance, self-assessment of spatial ability, and time spent in spatial activities. For females, the highest correlation between the variables and spatial ability was understanding math and science (r = .26). For the males, drafting and drawing provided the highest correlation (r = .44) with spatial ability. Although playing visual games correlated highly for the men (r = .26) in regard to time spent in the activity and spatial activity, the same was not true for the females (r = .18). Playing sports, time spent, or self-assessed spatial ability correlated low for both males (r = .18) and females (r = .02).

Spatial visualization and athletic performance have received little attention from the researchers. Hult and Brous (1986) analyzed the relationship of athletic performance, gender, spatial visualization, and various academic measures (i.e., SAT scores and coursework backgrounds). Spatial visualization was measured by the DAT Space Relations Subtest. Athletic performance was determined in a two-step process. Initially, deans from colleges of physical education ranked sports as either having a high or low demand for spatial visualization. Sports such as basketball, tennis, volleyball, racquetball, softball, and baseball were ranked as high demand, while jogging, track and field, swimming, and weight training were ranked as low demand sports. Subjects were then determined to be either highly skilled, in respect to these sports, or low skilled. Highly skilled subjects (24 females, 71 males) were either (a) current members of collegiate varsity teams or (b) students enrolled in introductory physical education classes who had been rated by coaches and physical education faculty members as being varsity-level performers. The low skilled subjects (34 females, 50 males) were enrolled in advanced English classes or in the introductory physical education classes and did not receive an advanced skill rating. A significant main effect for gender ($p < .05$) was reported for the DAT scores, with males scoring higher than females. A significant sex by skill interaction ($p < .01$) existed, with the high-skilled females outperforming the low-skilled females. Low-skilled males performed slightly but not significantly higher on the DAT than the varsity males. A Pearson correlation was performed between DAT scores, SAT scores, various types of course background, and sport experience. Significant correlations were reported between the DAT scores and the following: (a) sports demanding high visualization ($r = .138$, $p < .05$); (b) sports demanding low spatial ability ($r = .139$, $p < .05$); (c) total course background ($r = .282$, $p < .01$); and (d) SAT composite scores ($r = .446$, $p < .01$). An analysis of covariance with the total course background and SAT composite scores as covariates produced no significant gender effect as found with the initial analysis. However, a significant skill by gender interaction ($p < .05$) was still evident. These results indicated that numerous factors have influence upon spatial visualization ability (Hult & Brous, 1986).

Summary

The research concerning gender difference has produced conflicting and inconsistent results. The theories of lateralization and socialization have been unable to answer all the questions individually (Halpern, 1986).

The theory of lateralization has received conflicting support, but both of the studies that employed the dot enumeration task reported a left field superiority (Kimura, 1966; McGlone & Davidson, 1973). Kimura (1966) found a nonsignificant gender effect while McGlone and Davidson (1973) reported a significant gender difference for the dot enumeration task with males exhibiting superior performance. Replication of the results might produce stronger and more convincing evidence of a gender difference.

Socialization theory, as proposed by Sherman (1967), suggests that children's differential experiences may affect their performance of various tasks. In addition, the differential experiences are created by society's determination of gender appropriate and inappropriate activities and behaviors. Green et al. (1982) demonstrated through a longitudinal study that young females who were nontraditionally gender-typed were more active in sports and had a stronger desire to be a male than young females who were traditionally gender-typed. In relation to athletics for adults, female athletes have been reported to be less feminine gender-typed than female nonathletes (Colley et al., 1985; Myers& Lips, 1978). These results suggested that individuals gender-typed as masculine or androgynous, that is, higher than the average in masculine characteristics, may tend to have more childhood athletic experiences and be more involved in athletics as an adult.

Spatial visualization, the factor of spatial ability that requires manipulation of an object in space (McGee, 1979), has also produced conflicting experimental results. Sherman (1974) and Newcombe et al. (1983) reported males had higher scores for the DAT Space Relations Subtest than females. In contrast, Bryden and Tapley (1977) reported no gender difference. Meta-analyses by Hyde (1981) and Linn and Petersen (1985) contended that reported gender differences were, in actuality, very small. Rosenthal and Rubin (1982) reported a trend representing a narrowing of the gap between male and female scores for spatial tests over the years 1954 to 1974.

Studies investigating the performance of temporal/spatial tasks of coincidence anticipation have produced similar results to those reported for spatial visualization. Males have been reported as being both more consistent and less variable than females (Dorfman, 1977; Wrisberg et al., 1979; Wrisberg et al., 1981); and only less consistent than females (Jensen et al., 1981). In contrast, no gender difference was indicated by several researchers (Haywood, 1980; Petrakis, 1985; Thomas et al., 1981). In addition, one study reported females exhibited superior performance for frontal plane stimulus presentation

(Dunham & Glad, 1985). Explanations for the differences were based largely on the concept of socialization.

The research of gender differences which employed an integrated approach produced results which support the socialization theory. Males have been found to participate in more masculine activities which are considered to require more spatial ability (Newcombe et al., 1983). Along the same line, females' performance on the DAT Space Relations Subtest was correlated to sport participation (Newcombe et al., 1983). Hult and Brous (1986) reported a correlation between female sports participation and performance on the DAT, with female athletes scoring higher than nonparticipants.

Based upon the research reviewed, the following points are raised: (a) males have higher left visual field superiority than females (McGlone & Davidson, 1973); (b) spatial visualization performance and left visual field superiority are correlated (McGlone & Davidson, 1973); (c) no investigations of the relationship of laterality and sports performance have been conducted; (d) gender identity influences the amount and type of childhood experiences (Colley et al., 1985; Myers & Lips, 1978); (e) sports participation may influence performance on the DAT Space Relations Subtest, especially for females (Newcombe et al., 1983); (f) sport participation may influence coincidence anticipation performance for females (Petrakis, 1985); and (g) the relationship of gender identity and performance on the DAT Space Relations Subtest and coincidence anticipation performance has not been investigated. A study that integrates the theories of socialization and lateralization should provide more accurate answers in regard to the interrelationships of the numerous variables involved within the two theories.

CHAPTER III

PROCEDURES

The methodological procedures utilized while conducting this study included: (a) selection of subjects; (b) selection of assessment instruments; (c) procedures, schedule, and protocol; and (d) data analysis.

Selection of Subjects

Subjects were 119 right-handed students enrolled at The University of Tennessee, Knoxville, who composed two skill level groups: (a) skilled and (b) unskilled. For the skilled group, 29 males and 30 females were selected from students who were current members of either the organized collegiate basketball, tennis, or volleyball teams. These particular teams were chosen because the environmental demands of these sports are temporal/spatial, for the most part, as compared to the spatial environmental demands of the sports of golf, swimming, and track (Hult & Brous, 1986). Permission to test these subjects was obtained from their respective coaches through personal communication. For the unskilled group, 30 females and 30 males were selected in a two-step process from students enrolled in health classes and physical education classes. These students were evaluated on depth and breadth of competitive experience with tasks having temporal/spatial environmental demands through the administration of a questionnaire to assess their competitive athletic experience and their visual health (Appendix A).

Subjects were selected from the pool of students who: (a) were either members of the organized collegiate basketball, tennis, or volleyball teams or who had never had any competitive athletic experience; (b) were right-handed; (c) had no known uncorrected visual problems; and (d) were between 17 and 25 years of age. No subject was paid for their participation in the study. All potential subjects were given a letter of explanation (Appendix B) and were requested to sign a consent form (Appendix C) prior to participation in the study. The subject kept a copy of the letter and a copy of the consent form; the experimenter kept the signed consent form. Each participant was assigned a subject number for the purpose of integrating all data sets.

Selection of the Assessment Instruments

Selection of the assessment instruments was based upon the constructs of spatial visualization, gender identity, temporal/spatial task performance, lateralization, and their relationship to gender. Spatial visualization has been defined by French, Ekstron, & Price (1963) as the mental rotation and manipulation of objects in three dimensional space. Socialization studies have shown that gender identity has an effect upon the degree of participation in sport activities (Green et al., 1982; Myers & Lips, 1978). A relationship between the preference of space-related activities and spatial performance has been demonstrated (Newcombe et al., 1983). A relationship has also been established between coincidence anticipation and the performance of a temporal/spatial task (Beitel, 1980) and between spatial ability and performance of a temporal/spatial task (Beitel, 1980). Finally, research has revealed differences between males and females in lateralization (McGlone & Davidson, 1973), but the relationship of lateralization has not been evaluated with performance of a temporal/spatial task.

Coincidence Anticipation Performance

Coincidence anticipation performance was measured by the Coincidence-Anticipation Accuracy Microcomputer Diskette (Kluka & Zimmerman, 1985). The test controls for a variation in the stimulus speed, the lack of control of which has been a major criticism of the Bassin Timer apparatus (Haywood, 1986). The stimulus speed was 2 mph (3.218 kmph). The test consisted of three practice trials with knowledge of results, followed by 20 trials with no knowledge of results. A randomized foreperiod of 1, 2, and 3 seconds was employed and the inter-trial interval was 4 seconds. This test has been shown to have a reliability of .97 for males and females aged 6 to 78 years (Kluka & Zimmerman, 1985).

Lateralization

The degree of lateralization was measured by the dot enumeration test. This test utilized tachistoscopic presentation of nonverbal stimuli. According to Sergent (1983, p. 483), "the appropriateness of using tachistoscopic presentations to study hemispheric asymmetries is based on the anatomical property of the visual system whereby temporal hemiretinae project to the visual cortex ipsilaterally, whereas, nasal hemiretinae project contralaterally." Therefore, stimuli presented to the left of a fixation point (left visual field) are processed initially in the right cerebral hemisphere, while stimuli presented to the right of a fixation point (right visual field) are processed initially by the left hemisphere. To ensure that cerebral processing is initiated in the hemisphere contralateral to the visual field of presentation, two conditions must be met in tachistoscopic presentation (Sergent, 1983). First, the stimulus must be presented to the left or right of fixation. Second, the exposure duration of the stimuli should be 150 msec or less to prevent eye movements and the presentation of stimuli to both hemispheres.

The dot enumeration test (Kimura, 1966; McGlone & Davidson, 1973) was a tachistoscopic presentation of stimulus slides that each contained 3 to 10 dots located in one visual field. The subject, after a brief stimulus exposure, verbally estimated the number of dots in the presentation. The test consisted of 96 trials with 48 trials for each half field. An equal number of slides were presented for each number of dots. The visual field and the number of dots were randomly presented.

The stimuli were presented using a rear screen for a duration of 100 msec. The exposure time was determined by questioning the initial three subjects in the pilot study as to their ability to detect the dots at an exposure time of 50 msec. The subjects' negative responses and the limitations of the equipment necessitated an increase in exposure time to 100 msec. Thirteen subjects were then tested and, when questioned about their ability to detect the dots, all replied positively.

Slides of 4 x 6 inch (10.16 x 15.24 cm) black cards with 3 to 10 randomly arranged white dots were produced utilizing high intensity 35 mm film. The fixation point was a yellow dot located in the center of the screen, and the presented stimuli were 3° to 5.5° to the left or right of the fixation points. The array of dots was 2° to 6° in height and 2° to 3° in width.

Since no reliability coefficients had been reported in the literature, the data from the 13 subjects in the pilot study were analyzed using the odd-even method. Utilizing Pearson product-moment correlation and the Spearman-Brown prophecy formula on the pilot data, a significant ($p < .01$) internal consistency coefficient of $r = .93$ was produced.

The degree of lateralization was mathematically computed by a log-odds ratio method (Bryden & Sprott, 1981). Bryden and Sprott (1981) suggested that this method allows for more precision and better assessment of individual differences and laterality effects in individual subjects than previously used methods.

Spatial Visualization Ability

The variable of spatial visualization ability was measured by the Space Relations Subtest, Form V, of the Differential Aptitude Test (DAT) (Bennett et al., 1982). This is a test of mental manipulation; each of the 60 items required the subject to mentally fold a two-dimensional pattern into a geometric figure, rotate the figure, and identify the figure from a choice of four figures. This paper and pencil test required approximately 25 minutes to complete. The maximum correct score for the DAT Space Relations Subtest is 60. The means, standard deviations, and reliability for the DAT Space Relations Subtest, Form V, was reported by Bennett et al. (1982). Reliability of the test, determined by an odd-even method, for 12th grade girls is .94, and for 12th grade boys is .96. The mean for 12th grade girls was 30.2 with a standard deviation of 12.6. For 12th grade boys, the mean was 34.0 with a standard deviation of 13.8. These statistics were calculated on a sample size of 462 12th grade girls and 439 12th grade boys (Bennett et al., 1982).

Gender Identity

Gender identity originally was conceptualized as bipolar with masculinity and femininity at the opposite ends of the continuum (Bem, 1974). The Bem Sex Role Inventory (Bem, 1974) was developed in the assumption that masculinity and femininity are two independent dimensions. An individual is then classified as masculine, feminine, androgynous, or undifferentiated based upon the person's evaluation of masculine and feminine personality characteristics.

The Bem Sex Role Inventory is comprised of a single list of 60 personality characteristics which are an intermixing of 20 masculine, 20 feminine, and 20 neutral personality characteristics. The individual is requested to respond to a scale of 1 (never to almost never) to 7 (always or almost always) for each characteristic according to how strongly he/she feels the characteristic is reflected in their personality.

The normative data for the Bem Sex Role Inventory were collected from a population of 444 males and 279 females enrolled in an introductory psychology course at Stanford University in 1973. In addition, the Inventory was administered to 117 male and 77 female paid volunteers at Foothills Junior College (Bem, 1974).

The construct validity of the Bem Sex Role Inventory was determined by the evaluation of 400 personality characteristics which were compiled by Bem and several students; 200 items were positive in tone and either masculine or feminine and 200 items were neither masculine nor feminine in tone. One hundred (50 male, 50 female) Stanford students rated the desirability of these 400 personality characteristics and, based upon their ratings, 20 characteristics each that were masculine, feminine, and neutral were determined and incorporated to form the Bem Sex Role Inventory.

Reliability of the Bem Sex Role Inventory was determined by a test-retest method using 28 males and 28 females from the Stanford normative sample. The time interval between the first and second administration of the test was four weeks. Analysis of the data from both tests produced the following Pearson product-moment correlations: (a) masculinity $\underline{r} = .90$; (b) femininity $\underline{r} = .90$; and (c) androgynous $\underline{r} = .93$. These product-moment correlations indicate high reliability for a time interval of four weeks for the Bem Sex Role Inventory.

Procedures, Schedule, and Protocol

Data collection was conducted in both individual sessions and group sessions with the researcher. The assessment of coincidence anticipation performance and lateralization was conducted in a single individual session with each subject. The Space Relations Subtest of the DAT and the Bem Sex Role Inventory were administered in group sessions consisting of either team members for the skilled group or a group of not more than 10 same-sex individuals for the unskilled group. The subjects participated in the individual session prior to their participation in the group session. All answer sheets were prenumbered with tear-off name slips attached so that names were removed as the subject completed each phase. This allowed for accuracy in the integrating of the data from both phases of the process while maintaining confidentiality.

Coincidence Anticipation Performance

The Coincidence-Anticipation Accuracy Microcomputer Diskette (Kluka & Zimmerman, 1985) was employed to measure the level of coincidence anticipation performance (Appendix D). An Apple IIe computer with a monochrome monitor and a single disk drive was used for the test. The program was contained on a 5 1/4 inch (13.34 cm) floppy disk. The test administrator typed the appropriate data on the biographical sketch (Appendix E). The subject was then seated in front of the computer and informed of the procedure (Appendix D). The computer program was then engaged, and the subject received three practice trials with knowledge of results. Upon completion of the practice trials, the subject received 20 trials with no knowledge of results.

The task required the subject to strike the "open apple" key when a star that had moved across the screen was between the point marked by two lines. The subject used the index finger of the right hand to strike at the "open apple" key.

The star moved at a constant velocity of 2 mph (3.218 kmph), and there was a randomized foreperiod of 1, 2, and 3 seconds with an inter-response interval of 4 seconds. The response was recorded as an error score by the computer and converted into absolute error, constant error, and variable error measures by the test administrator.

Lateralization

The dot enumeration test was utilized to measure the degree of lateralization of the subject. The stimuli were slides of 48 different patterns of 3 to 10 dots, with each number of dots being equally represented in the total number of slides. The slides contained same-sized white dots on a black background.

Each slide was projected on a white reverse projection screen by a Kodak autofocus slide projector (Model 850H) with a Lafayette lens (Model No. 6350) which functioned as a tachistoscope. There was a 5-second inter-trial interval, and each slide was presented for 100 msec. The researcher initiated the first trial only. All subsequent trials ran automatically.

The subject was seated 24 inches (60.96 cm) from the screen with their head resting against a head rest and their chin on a chin rest to prevent movement. The subjects were prompted to fixate on a yellow dot that was located at the center point of the screen. The slide was back projected onto the screen for 100 msec. The projected image was 4 x 6 inches (10.16 x 15.24 cm), and the stimulus was 3° to 5.5° in height and 2° to 3° in width. Immediately following the presentation, the subject verbally estimated the number of dots that were present. The researcher recorded the response (Appendix G). Four practice trials were given, and each slide was shown again after the subject was informed of the exact number of dots that were present in the slide. The test consisted of 96 trials with 48 trials for each visual field; 6 trials for each possible number of dots were presented. The slides were presented in random order.

The number of correct responses for each visual field was determined and a log-odds ratio was computed according to the procedures outlined by Bryden & Sprott (1981). The log-odds ratio represents the degree of laterality.

Spatial Visualization Ability

The ability of spatial visualization was measured by the Space Relations Subtest, Form V, of the Differential Aptitude Test (Bennett et al., 1982). The subject was seated at a desk and provided with a test packet, which included the Space Relations Subtest booklet, answer sheet, Bem Sex Role Inventory, and a pencil (Appendix H). The subject was instructed to remove the Space Relations booklet and answer sheet (Appendix I) from the packet. The subject read all directions, performed the two sample problems, and was allowed to ask any questions related to the performance of the test. The 25-minute time limit was monitored by the test administrator and 5-minute intervals were posted.

The tests were scored by the test administrator. The measure of spatial visualization was the number of correct responses on the Space Relations Subject, Form V, of the Differential Aptitude Test (Bennett et al., 1982).

Gender Identity

The Bem Sex Role Inventory (Bem, 1974) was administered to measure gender identity. The test was administered at the same session as the Space Relations Subtest. After the 25-minute time limit for the Space Relations Subtest of the DAT had elapsed, the subjects were requested to place the Space Relations Subtest booklet and answer sheet back in the test packet and remove the Bem Sex Role Inventory from the test packet they received at the beginning of the testing session (Appendix J). The subjects were instructed to read the directions for the inventory (Appendix K) and were allowed to ask any questions. There was no time frame for the completion of the Inventory, and the subjects were informed that upon completion they were to place the Inventory back into the test packet with the Space Relations Subtest and answer sheet, secure the fastener on the envelope, and hand the envelope to the test administrator.

The inventory was scored by the test administrator. A masculinity and femininity score was determined for each subject by calculating the means of each subject's ratings of the masculine and feminine adjectives on the Bem Sex Role Inventory. Based on the total sample individual mean scores (males and females combined), the median score for both femininity and masculinity were determined. The subjects were then classified as either masculine, feminine, androgynous, or undifferentiated based upon the relationship of their masculine and feminine scores to the masculine and feminine median scores for the entire sample (Bem, 1974).

Data Analysis

The analysis of the data was accomplished using both parametric and nonparametric procedures. One parametric analysis was a 2 x 2 MANOVA with gender and skill level as the independent variables; degree of lateralization, spatial visualization ability, and coincidence anticipation performance (AE, CE, VE) were the independent variables. A 2 x 2 MANOVA, PROC GLM (Joyner, 1985) was utilized to answer the subproblems 1, 2, 3, and 4. This provided the multivariate F statistic utilizing Wilks' Lambda and the resultant univariate *F* statistics to answer Subproblem 1 (Joyner, 1985). The Bonferroni multiple comparison technique (Neter, Wasserman, & Kuter, 1985) was used to evaluate all possible pairwise comparisons. Contrasts that were determined significant in the multivariate model were investigated even if there was no significant interaction found in a specific univariate model. This procedure was performed to enable the researcher to determine the variables that contributed to the significant multivariate difference for each contrast.

The parametric correlational matrix generated by PROC CORR (Joyner, 1985) provided the answers to subproblems 2, 3, and 4. Subproblem 5 was evaluated utilizing the nonparametric test, Chi-Square for k independent samples, applied to the crosstabulation of gender by gender identity by skill level (Ferguson, 1981; Joyner, 1985).

CHAPTER IV

ANALYSIS OF DATA

This study was designed to investigate the relationships among gender, gender identity, depth of skill level, spatial visualization ability, the degree of lateralization, and coincidence anticipation performance. Spatial visualization ability was represented by the score on the DAT Space Relations Subtest. Coincidence anticipation performance was represented by the measures of absolute error, constant error, and variable error. The degree of lateralization was represented by the log-odds ratio (Bryden & Sprott, 1981) of the scores on the dot enumeration task.

Data for 119 subjects were collected during the spring of 1987. The subjects ranged in age from 17 to 25 years. To address the specific subproblems of this study, the findings were organized into five categories: (a) the differences of gender and/or skill level for spatial visualization ability, degree of lateralization, and coincidence anticipation performance (Subproblem 1); (b) the relationships between spatial visualization ability and the measures of coincidence anticipation performance (Subproblem 2); (c) the relationship between spatial visualization ability and the degree of lateralization (Subproblem 3); (d) the relationships between the degree of lateralization and the measures of coincidence anticipation performance (Subproblem 4); and (e) the interrelationships of gender, gender identity, and depth of skill level (Subproblem 5).

Subproblem 1

To investigate the effects of gender, skill level, and the interaction of gender and skill level upon spatial visualization ability, coincidence anticipation performance, and the degree of lateralization, a 2 x 2 (gender x skill level) MANOVA was utilized (Joyner, 1985). Wilks' Lambda ($p < .05$) was used to evaluate the multivariate F (Joyner, 1985); all possible pairwise comparisons were evaluated using the Bonferroni Multiple Comparison Technique ($p < .008$) (Neter et al., 1985). Utility indices (Dodd & Schultz, 1973; Gaebelein & Soderquist, 1974) were computed for significant effects within each univariate ANOVA. Contrasts that were determined significant in the multivariate model were investigated even if there was no significant interaction found in a specific univariate model. This procedure was performed to enable the researcher to determine the variables that contributed to the significant multivariate difference for each contrast. For each univariate analysis only significant contrasts were reported.

The model for the multivariate analysis contained the following dependent measures: (a) absolute error, (b) constant error, (c) variable error, (d) DAT Space Relations Subtest score, and (e) log-odds ratio for the scores on the dot enumeration task. The multivariate analysis, as evaluated by Wilks' Lambda, revealed the following significant results: (a) a gender main effect (Lambda = .7747, $F_{5,111} = 6.45$, $p = .0001$); (b) a skill level main effect (Lambda = .8402, $F_{5,111} = 4.22$, $p = .0015$); and (c) a gender by skill level interaction (Lambda = .9011, $F_{5,111} = 2.437$, $p = .0389$). The

Bonferroni technique was conducted to further investigate the interaction effect. The Bonferroni analyses revealed significant multivariate differences among the following: (a) skilled males and unskilled males (Lambda = .8321, $F_{5,111}$ = 4.480, p = .0009); (b) skilled males and unskilled females (Lambda = .7812, $F_{5,111}$ = 6.219, p = .0001); (c) unskilled males and unskilled females (Lambda = .7478, $F_{5,111}$ = 7.487, p = .0001); and (d) unskilled males and skilled females (Lambda = .8330, $F_{5,111}$ = 4.448, p = .001). No significant multivariate differences were found for the following comparisons: (a) skilled males and skilled females and (b) skilled females and unskilled females.

Absolute Error

The univariate analysis for the absolute error (AE) measure of coincidence anticipation performance (Table 1) produced a significant gender main effect ($F_{1,115}$ = 26.22, p = .0001) and a gender by skill level interaction ($F_{1,115}$ = 8.52, p = .0042). The gender effect accounted for 16.60% of the variability in the AE model while the gender by skill level interaction accounted for 4.94% of the variability in the model. Further investigation revealed the following significant Bonferroni controlled comparisons: (a) unskilled males (M = .026) were more accurate than skilled females (M = .036) ($F_{1,115}$ = 8.54, p = .0042); (b) unskilled males (M = .026) were more accurate than unskilled females (M = .047) ($F_{1,115}$ = 32.59, p = .0001; (c) skilled males (M = .031) were more accurate than unskilled females (M = .047) ($F_{1,115}$ = 18.60, p = .0001); and (d) skilled females

Table 1. Univariate ANOVA Table and Descriptive Statistics for Absolute Error.

Source	df	N	Sum of Squares	Mean	F	SD	PR>F
Gender	1		.005		26.22		.0001*
Male		59		.028		.013	
Female		60		.042		.016	
Skill Level	1		.000		1.01		.3170
Skilled		59		.034		.014	
Unskilled		60		.036		.018	
Gender*Skill Level	1		.002		8.52		.0042*
Male Skilled		29		.031		.014	
Male Unskilled		30		.026		.012	
Female Skilled		30		.036		.014	
Female Unskilled		30		.047		.016	
Error	115		.023				

*$p < .05$

($\underline{M}$ = .036) were more accurate than unskilled females ($\underline{M}$ = .047) ($\underline{F}_{1,115}$ = 7.76, $\underline{p}$ = .0062).

Constant Error

The univariate analysis for constant error (CE) of coincidence anticipation performance (Table 2) revealed two significant main effects: (a) a gender effect ($\underline{F}_{1,115}$ = 11.19, $\underline{p}$ = .0011) and (b) a skill level effect ($\underline{F}_{1,115}$ = 4.68, $\underline{p}$ = .0326). Gender accounted for 7.59% of the variability in the CE model, and skill level accounted for 2.74% of the variability in the model. Investigation of the significant multivariate contrasts revealed the following two significant contrasts: (a) unskilled males and unskilled females ($\underline{F}_{1,115}$ = 12.10, $\underline{p}$ .0007; and (b) skilled males and unskilled females ($\underline{F}_{1,115}$ = 15.04, $\underline{p}$ = .0002). Both skilled ($\underline{M}$ = .016) and unskilled (M = .016) males performed with less response bias (CE) on the coincidence anticipation task than did unskilled females ($\underline{M}$ = .039).

Variable Error

For variable error (VE), only a significant gender main effect was found ($\underline{F}_{1,115}$ = 14.21, $\underline{p}$ = .0003) (Table 3). Males performed with more consistency than females. Gender accounted for 9.32% of the variability in the model. Significant differences were found for unskilled males and both unskilled females ($\underline{F}_{1,115}$ = 13.47, $\underline{p}$ = .0004) and skilled females ($\underline{F}_{1,115}$ = 10.06, $\underline{p}$ = .0019). Unskilled males ($\underline{M}$ = .021) performed with more consistency than both unskilled females ($\underline{M}$ = .029) and skilled females ($\underline{M}$ = .028).

Table 2. Univariate ANOVA Table and Descriptive Statistics for Constant Error.

Source	df	N	Sum of Squares	Mean	F	SD	PR>F
Gender	1		.006		11.19		.0011*
Male		59		.017		.021	
Female		60		.031		.026	
Skill Level	1		.002		4.68		.0326*
Skilled		59		.019		.025	
Unskilled		60		.029		.024	
Gender*Skill Level	1		.001		2.52		.1229
Male Skilled		29		.016		.024	
Male Unskilled		30		.018		.018	
Female Skilled		30		.023		.025	
Female Unskilled		30		.039		.024	
Error	115		.071				

*$p < .05$

Table 3. Univariate ANOVA Table and Descriptive Statistics for Variable Error.

Source	df	N	Sum of Squares	Mean	F	SD	PR>F
Gender	1		.001		14.35		.0003*
Male		59		.023		.007	
Female		60		.029		.010	
Skill Level	1		.000		.47		.4880
Skilled		59		.026		.008	
Unskilled		60		.025		.010	
Gender*Skill Level	1		.000		.196		.1646
Male Skilled		29		.024		.006	
Male Unskilled		30		.021		.008	
Female Skilled		30		.028		.009	
Female Unskilled		30		.029		.011	
Error	115		.010				

*$p < .05$

Spatial Visualization Ability

The univariate analysis for spatial visualization ability revealed two significant effects (Table 4). The skill level main effect ($F_{1,115}$ = 10.33, p = .0017) and gender by skill level interaction ($F_{1,115}$ = 4.60, p = .034) were found to be significant. The variability in the model accounted for by skill level and gender by skill level were 7.10% and 2.74%, respectively. Significant comparisons were reported for unskilled males and: (a) skilled males ($F_{1,115}$ = 14.24, p = .0003) and (b) skilled females ($F_{1,115}$ = 11.50, p = .0010). Unskilled males (M = 45.867) had superior performance on the DAT Space Relations Subtest with respect to: (a) skilled males (M = 34.828) and (b) skilled females (M = 36.03).

Degree of Lateralization

The univariate analysis for the dependent measure of degree of lateralization produced no significant effects (Table 5). Descriptive statistics were calculated for degree of lateralization (Table 5).

Subproblems 2, 3 and 4

To determine the specific relationships addressed in subproblems 2, 3, and 4, Pearson product-moment correlation analysis was utilized. The degree of common variability was determined for the significant relationships.

Table 4. Univariate ANOVA Table and Descriptive Statistics for DAT Scores.

Source	df	N	Sum of Squares	Mean	F	SD	PR>F
Gender	1		307.206		2.43		.1214
Male		59		40.411		11.533	
Female		60		37.133		12.119	
Skill Level	1		1303.314		10.33		.0017*
Skilled		59		35.441		12.609	
Unskilled		60		42.050		10.239	
Gender*Skill Level	1		580.962		4.60		.0340*
Male Skilled		29		34.823		11.973	
Male Unskilled		30		45.867		8.102	
Female Skilled		30		36.033		13.371	
Female Unskilled		30		38.233		10.840	
Error	115		16704.874				

*$p < .05$

Table 5. Univariate ANOVA Table and Descriptive Statistics for Degree of Lateralization.

Source	df	N	Sum of Squares	Mean	F	SD	PR>F
Gender	1		.307		2.25		.1366
Male		59		-.118		.341	
Female		60		-.017		.400	
Skill Level	1		.323		2.36		.1270
Skilled		59		-.119		.387	
Unskilled		60		-.016		.354	
Gender*Skill Level	1		.034		.25		.6170
Male Skilled		29		-.188		.331	
Male Unskilled		30		-.050		.343	
Female Skilled		30		-.053		.429	
Female Unskilled		30		.018		.367	
Error	115		15.712				

Subproblem 2

To determine the relationship between coincidence anticipation performance and spatial visualization ability, the measures of absolute error, constant error, and variable error were correlated with the score for the DAT Space Relations Subtest. Two significant correlations at the $p < .05$ level were determined.

The measure of absolute error (AE) and the score on the DAT Space Relations Subtest were negatively correlated with $p = .0026$ and $r = -.274$. Thus, there was 7.508% common variability between spatial visualization and absolute error. Subjects having better spatial visualization (higher scores) performed with more accuracy (lower scores) on the coincidence anticipation task. This result supports the hypothesis of a significant negative relationship among the variables of spatial visualization ability and coincidence anticipation performance.

The measure of variable error and the score on the DAT Space Relations Subtest were negatively correlated with $p = .0066$ and $r = -.248$. The percent of common variability was 6.14. Subjects who had better spatial visualization ability (higher scores) had more consistent (lower scores) performance on the coincidence anticipation task. This result supported the hypothesis of this subproblem.

The measure of constant error and the score on the DAT Space Relations Subtest were negatively correlated, $r = -.167$, but this correlation was not significant ($p = .0692$). The hypothesis of a significant negative relationship was therefore not supported.

In summary, the correlations of all three measures of coincidence anticipation performance with the spatial visualization measure were in the predicted negative direction, with two being significant (absolute and variable error) and one just failing to achieve significance (constant error).

Subproblem 3

When the measure of spatial visualization ability (score on the DAT Space Relations Subtest) and the degree of lateralization (log-odds ratio of the scores on the dot enumeration task) were correlated, a negative relationship (r = -.108) was obtained, but it was not significant (p = .2437). Thus, the hypothesis of a significant negative relationship between spatial visualization ability and the degree of lateralization was not supported.

Subproblem 4

To determine the relationship between coincidence anticipation performance and the degree of lateralization, the measures of absolute error, constant error, and variable error were correlated with the log-odds ratio for the scores on the dot enumeration task. Low positive correlations were obtained in each case (AE, r = .057; CE, r = .124; VE, r = .022), but none achieved statistical significance ($p > .05$). Therefore, the hypothesis of a significant positive relationship between coincidence anticipation performance and degree of lateralization was not supported.

Subproblem 5

To evaluate the pattern among gender and gender identity within skill level (temporal/spatial task experience), a three-way Chi-Square analysis was computed. The contingency table with percentages for the Bem Sex Role classifications and the four subject groups is presented in Table 6.

The Chi-Square for the four group table with gender and skill level considered together produced a significant Chi-Square statistic (Chi-Square = 40.608, df = 9, $p < .001$). When the genders were separated by skill level a significant Chi-Square statistic was found for the females (Chi-Square = 10.454, $p = .015$). The largest percentage of unskilled females was classified as feminine (53.33%), while the largest percentage of skilled females was classified as androgynous (40.00%). The Chi-Square analysis for the males (Chi-Square = 6.224, $p = .101$) revealed a nonsignificant pattern.

A Chi-Square analysis by skill level indicated significant patterns between unskilled males and females (Chi-Square = 13.348, $p = .004$) and skilled males and females (Chi-Square = 12.803, $p = .005$). The largest percentages of unskilled males were identical for the classifications of undifferentiated (33.33%) and masculine (33.33%), while the largest percentage of unskilled females was classified as feminine (53.33%). The largest percentage of skilled males was classified as masculine (58.62%), while the largest percentage of skilled females was classified as androgynous (40.00%). These results supported the hypothesis that there is a significant

Table 6. Bem Classifications as a Function of Gender and Depth of Skill.

			Gender Identity							
			Masculine		Feminine		Androgynous		Undifferentiated	
Variable	Skill Level	N	N	Row %	N	Row %	N	Row %	N	Row %
Male	Unskilled	30	10	33.33	5	16.67	5	16.67	10	33.3
	Skilled	29	17	58.62	1	3.45	6	20.69	5	17.24
Female	Unskilled	30	1	3.33	16	53.33	5	16.67	8	26.67
	Skilled	30	6	20.00	8	26.67	12	40.00	4	13.33

interaction between gender, gender identity, and the depth of skill level.

CHAPTER V

DISCUSSION

The nature-nurture dichotomy has provided the framework upon which the majority of gender difference research has been developed (Halpern, 1986). Neither the nature nor nurture approach has been able to answer all the gender difference questions, and researchers have concluded that an integrated approach should be applied to address the question of gender difference (Halpern, 1986; Harris, 1981; Newcombe, 1982; Sherman, 1978).

This study integrated the biologically based explanation of lateralization with the nurture based explanation of socialization. This chapter is organized to relate to the subproblems:
(a) multivariate differences between gender, skill level, and gender by skill level for the degree of lateralization, spatial visualization ability, and coincidence anticipation performance (Subproblem 1);
(b) the relationship between spatial visualization ability and coincidence anticipation performance (Subproblem 2); (c) the relationship between spatial visualization ability and the degree of lateralization (Subproblem 3); (d) the relationship between coincidence anticipation performance and the degree of lateralization (Subproblem 4); and (e) the interaction between gender, gender identity, and skill level (Subproblem 5).

Subproblem 1

In order to determine the interrelationships among gender and/or skill level with the degree of lateralization, spatial visualization ability, and coincident anticipation performance, a 2 x 2 multivariate analysis was calculated. The multivariate analysis indicated significant gender, skill level, and gender by skill level interaction effects. Specific comparisons revealed significant multivariate differences among the following: (a) skilled males and unskilled females, (b) unskilled males and skilled males, and (c) unskilled males and unskilled females, and (d) unskilled males and skilled females. The multivariate differences were not significant among: (a) skilled males and skilled females, (b) skilled females and unskilled females.

The literature review failed to locate a study that integrated the above variables simultaneously, thus making it impossible to compare the multivariate results of this study to any other studies with all of these combined variables. Therefore, the individual univariate analyses were discussed in relation to the relevant literature with a subsequent multivariate summary.

Degree of Lateralization

In the organizational structure of the brain the right cerebral hemisphere is specialized for the synthesizing, analyzing, and simultaneous processing of parallel sources of visual, spatial, tactile, and nonlinguistic stimuli (Gazzangia, 1978; Ornstein, 1972). According to lateralization theory (Levy, 1972, 1974), males are more lateralized than females, which accounts for males having more hemispheric specialization for the processing of spatial tasks than females (Davidoff, 1977; Kimura, 1973; McGlone & Davison, 1973).

Lateralization has been evaluated by measuring the accuracy of enumeration of visual stimuli tachistoscopically presented to the left and right visual fields (Kimura, 1966; McGlone & Davidson, 1973). The anatomical structure of the visual system has been the theoretical basis for the development of tachistoscopic procedures (Sergent, 1983). Based on the concept of contralateral projection of visual stimuli to the cerebral hemispheres, the left visual field has been associated with more accurate spatial processing (Kimura, 1966; McGlone & Davison, 1973).

The univariate analysis of the degree of lateralization revealed no significant main effects. This result was in agreement with the findings of Kimura (1966) but conflicted with the significant gender difference reported by McGlone and Davidson (1973). These results reflected the contradictory nature of gender difference studies.

One possible explanation for the conflicting results of research studies using the dot enumeration task may be the difficulty in controlling the restriction of the subject's focal point so that each presentation is actually occurring in the proper visual field. In addition, the present study determined the degree of lateralization by computing a log-odds ratio which differed from previous studies.

Since there were no significant effects for lateralization, support was not determined for either a nature (gender) or nurture (skill level) explanation. These results possibly indicate that: (a) nature and nurture were contributing equally, (b) neither nature or nurture were contributing, and/or (c) the dot enumeration test may not have been a valid measure of lateralization.

Spatial Visualization Ability

Maccoby and Jacklin (1974) have reported that males' performance on spatial tasks is superior to that of females. Sherman (1974) compared college students on the DAT Differential Space Relations Subtest. The results supported Maccoby's and Jacklin's claim that males are superior to females with regard to spatial visualization ability.

The univariate analysis of this study reported both a significant ($p < .0017$) skill level effect and gender by skill level interaction ($p < .0340$) (Figure 1). Skill level accounted for 7.10% of the variance. The result of this study was affected by an extremely low score for the competitive males on the DAT Space Relations Subtest. The mean for the skilled males was 11.044 points lower than for the unskilled males.

This result substantiated the findings of Tapley and Bryden (1977) but conflicted with the results of several other studies (Hult & Brous, 1985; Newcombe et al., 1983; Sherman, 1974). As previously noted, the extremely low score for the skilled males may have influenced the results of the present study.

Newcombe et al. (1983) found males had better spatial visualization ability, as measured by the DAT Space Relations Subtest,

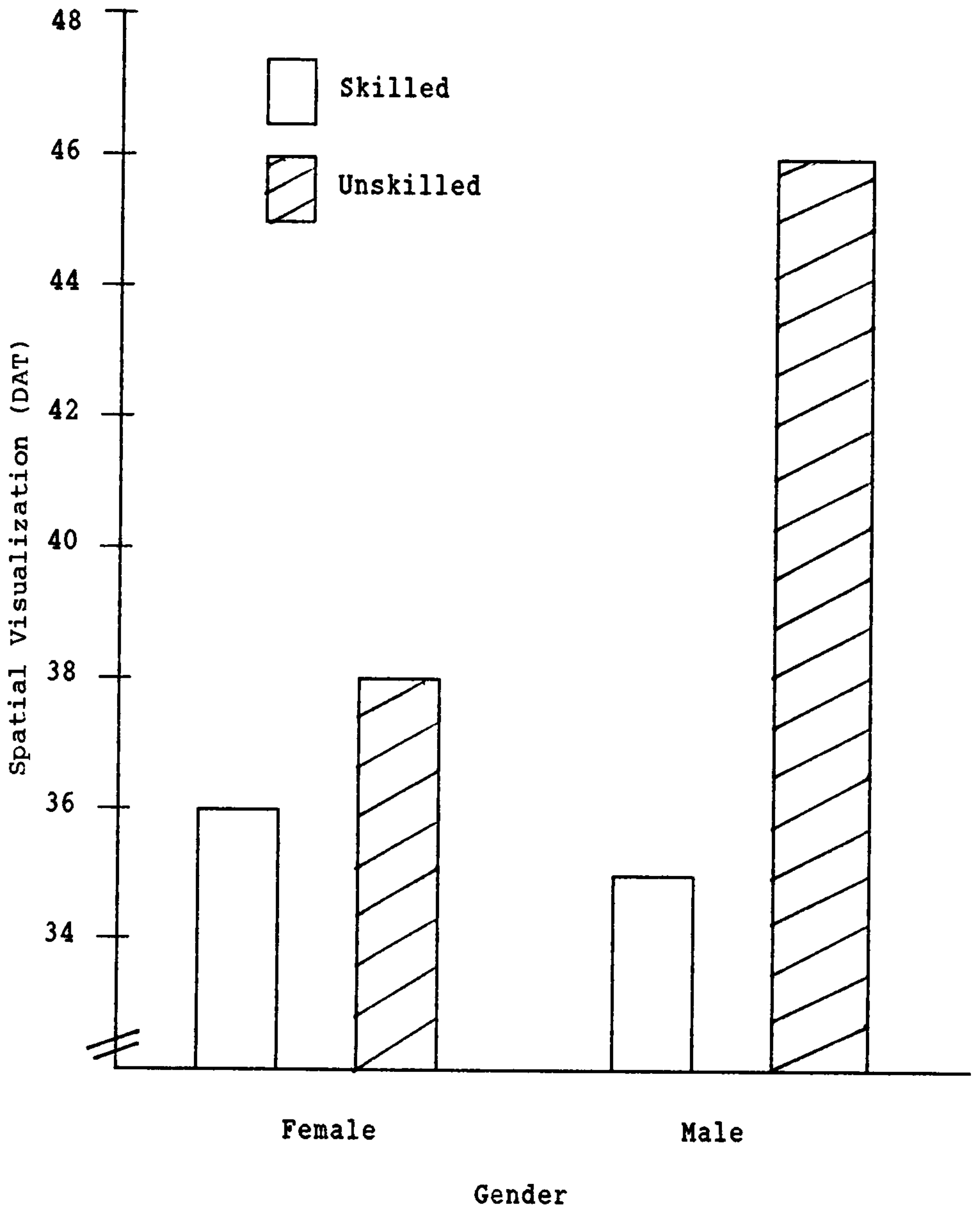

Figure 1. Gender x skill level interaction for spatial visualization

(Means and standard deviations are presented in Table 4, page 67.)

than did females. In addition, they correlated spatial task performance with the DAT scores and reported that the DAT scores correlated with the spatial performance variables for females but not for males. These researchers (Newcombe et al., 1983) cautioned about interpretation of the results because of the nature of the activities on the questionnaire used to determine spatial performance. None of the results of the present study revealed any differences that supported the findings of Newcombe et al. (1983).

Lunneborg and Lunneborg (1983) correlated sport participation with spatial visualization performance, as measured by a spatial test similar to the DAT. Their results indicated that, for females, spatial ability was highly correlated with the concepts of understanding math and science. For males, high correlations were achieved for a spatial test similar to the DAT with drafting and drawing, while low correlations were achieved for a spatial test similar to the DAT with sport participation. The significant skill level effect and interaction effect of the present study tend to support the findings of Lunneborg and Lunneborg (1983). Specifically, the fact that the unskilled males performed significantly ($p < .0003$) better than skilled males (Figure 1) substantiated the previous results (Lunneborg & Lunneborg, 1983). The high correlation between spatial activities, such as drafting and drawing, for males (Lunneborg & Lunneborg, 1983) may have indicated that the processing necessary to perform well on the task, as measured by the DAT Space Relations Subtest, was similar to the processing necessary for drafting and drawing.

Streicker and LeVesconte (1982) tested the effects of training on visual spatial ability tasks. They found significant differences between males and females for the DAT Space Relations Subtest and three other spatial tests. After the subjects were trained and received practice on the tasks, they were given the test again. For the second test no significant gender difference was reported for the DAT. The importance of spatial visualization experiences was reflected by this finding, especially in tasks that specifically demand the same visual processes and strategies.

Therefore, as was indicated by the findings of Streicker and LeVesconte (1982), Lunneborg and Lunneborg (1983), and the present study, individuals who engaged in activities which have similar processing demands and strategies to those of the DAT would perform better than individuals who did not participate in such activities. In addition, although sports participation demands an individual to use spatial abilities, the spatial abilities used are involved with movement and are designed to formulate movement patterns in extremely short periods of time. The DAT involves a flat two dimensional figure that never moves except in the individual's mind. The application of the concepts of similarity and specificity to the performance on the DAT may indicate that the more similar and specific the experiences are to the task involved in the DAT, the stronger the relationship to DAT performance. The concepts of task similarity/specificity may provide an explanation for the significant superior performance by the unskilled males in comparison to: (a) skilled males and (b) skilled females. The largest difference of the means was reported for skilled males, followed by skilled females. These results may indicate that individuals who were involved in collegiate athletics were involved in activities that had visual spatial demands that were not the same as the demands of the DAT, while unskilled males were involved in activities that have similar spatial visualization demands to that of the DAT. Similarly, it is possible that unskilled males were more challenged by the DAT task and had more desire to perform well, while skilled males were not interested in or challenged by this task. Thus, unskilled males might have been more motivated to perform well.

Hult and Brous (1985), the only study that compared athletes and nonathletes, reported males scored significantly higher than females in spatial visualization. In addition, highly skilled females outperformed the low skilled females; low skilled males scored slightly but not significantly better than highly skilled males. The results of the present study (Figure 1) did not support the findings of Hult and Brous (1985). Previous research (Lunneborg & Lunneborg, 1983; Newcombe et al., 1983) suggested possible relationships between spatial visualization ability and participation in spatial activities. The study of Hult and Brous (1985) reflected similar results to Newcombe et al. (1983). To develop a more encompassing understanding of gender differences, Hult and Brous (1985) used the factors of SAT scores and high school math courses as covariates for a second analysis which produced no gender effect. The researchers (Hult & Brous, 1985) concluded that the measurement of spatial ability is a complex process which requires evaluating numerous factors. The present study integrated several variables related to spatial ability in an attempt to explain further the nature of the gender difference question. Even though this study evaluated several variables, no concrete answers were obtained, and the conclusion of Hult and Brous (1985) that spatial ability is a complex process was supported by the results.

Coincidence Anticipation Performance

The temporal/spatial task of coincidence anticipation was investigated with regard to the following three measures: (a) absolute error, (b) constant error, and (c) variable error. The univariate analysis for each measure is discussed individually and subsequently summarized.

Absolute error. The univariate analysis for absolute error revealed a significant ($p < .0001$) gender main effect with males more accurate than females. Gender accounted for 16.60% of the variance in the AE model. Similar gender results, males more accurate than females, were reported by Dorfman (1977) and Wrisberg et al. (1979). In contrast, numerous studies (Dunham & Glad, 1985; Haywood, 1980; Thomas et al., 1981; Wrisberg et al., 1982) found no significant gender differences.

A significant ($p < .0042$) gender by skill level interaction was reported and accounted for 4.94% of the variance in the model. Further investigation of the gender by skill level interaction effect in the present study revealed: (a) no difference existed in accuracy between skilled and unskilled males, (b) unskilled males were more accurate

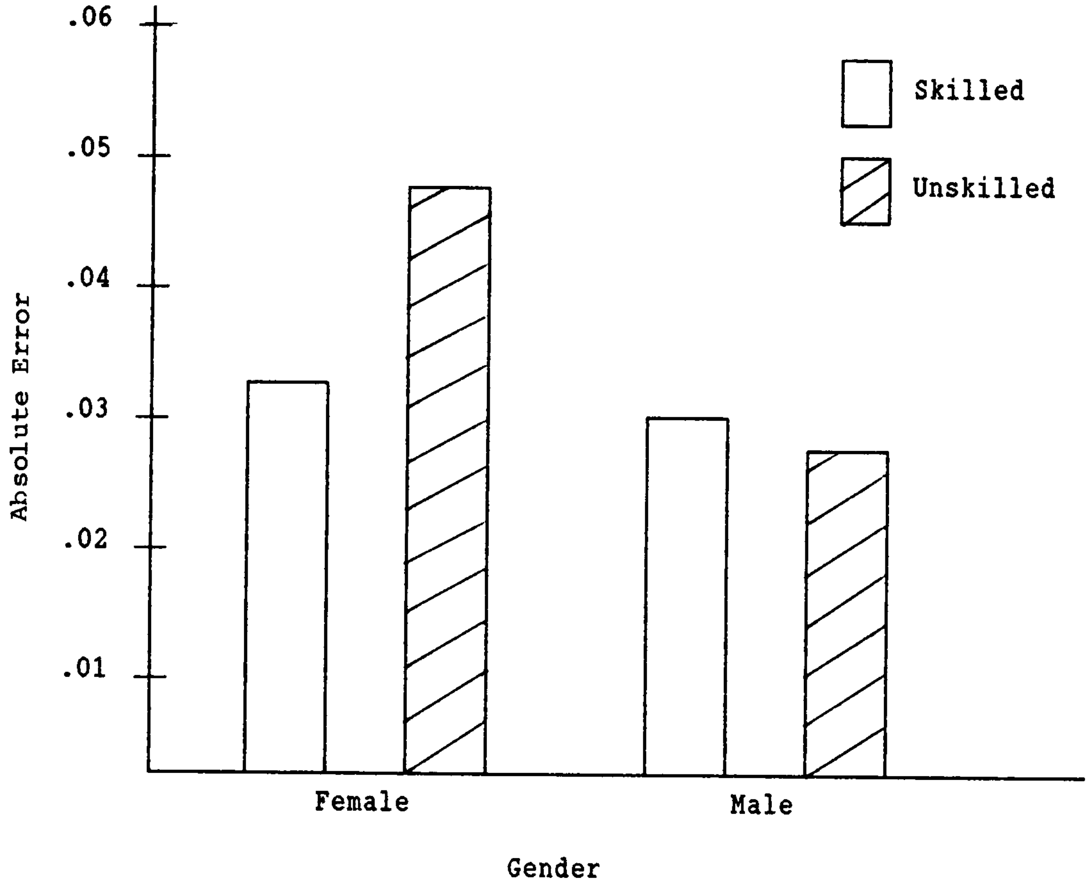

Figure 2. Gender x skill level interaction for absolute error.

(Means and standard deviations are presented in Table 1, page 62.)

than both unskilled and skilled females, (c) skilled males were more accurate than unskilled females, (d) skilled females were more accurate than unskilled females, and (e) no difference was found between skilled males and skilled females (Figure 2).

The nonsignificant results of this study supported the literature in two categories: (a) no differences between competitive and noncompetitive males as determined by the post hoc analysis computed by Wrisberg et al. (1979) and (b) the nonsignificant difference between skilled males and skilled females established by Petrakis (1985). The difference between unskilled males and both skilled and unskilled females may indicate: (a) that males as a group may biologically possess more coincidence anticipation ability and experience by females as a group will not eliminate the mean difference; (b) that even unskilled males have more opportunities than do skilled females to develop their coincidence anticipation ability; and/or (c) that unskilled males are more familiar with a computer and/or computer game type tasks, either through educational or recreational situations, than are females.

The results of the present study indicated that the unskilled females performed with less accuracy than skilled females and both skilled and unskilled males. Lack of experience in coincidence anticipation tasks may be related to less accurate performance by the unskilled females. If the latter case is true, the results of this study would support socialization theory in regard to the measure of absolute error for the performance of a coincidence anticipation task.

Constant error. The univariate analysis for constant error of coincidence anticipation performance revealed two significant main effects: (a) a gender effect ($p < .0011$) and (b) a skilled level effect ($p < .0326$). Gender accounted for 7.59% of the variability in the model, and skill level accounted for 2.74% of the variability.

The gender main effect for this study indicated that males had less response bias than females. This significant gender effect substantiated the findings of Dorfman (1977) and Wrisberg et al. (1979, 1981). The findings of this study conflicted with the nonsignificant gender results reported by several studies (Haywood, 1980; Thomas et al., 1981). This result was the reversal of the significant gender result reported by Dunham and Glad (1985). They found that at a low speed (3.6 mph) females had less response bias than males. Dunham and Glad (1985) suggested that the difference was due to a psychological variable (i.e., males were less attentive or underestimated the task difficulty). Based on their suggestion, the differences between the present study and the reverse results of Dunham and Glad (1985) may be explained.

The specific gender by skill level contrasts revealed significant differences between unskilled females and both skilled and unskilled males. Skilled and unskilled males performed with less response bias than the unskilled females. The skilled males did not significantly differ from unskilled males (Figure 3).

Wrisberg et al. (1979) found that noncompetitive males performed with more response bias than competitive males. The results of the

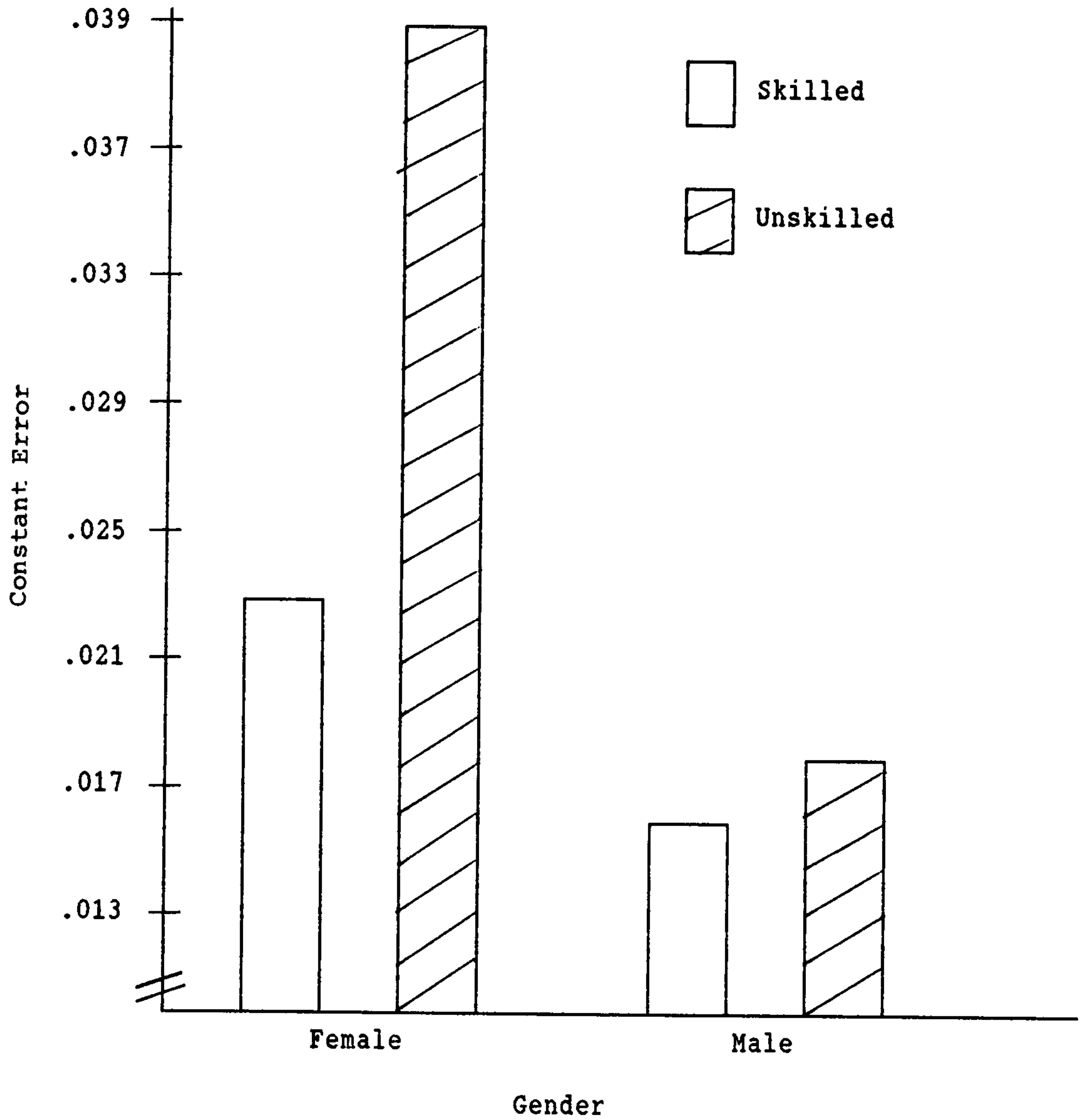

Figure 3. Gender x skill level interaction for constant error.

(Means and standard deviations are presented in Table 2, page 64.)

present study (Figure 3) that skilled males did not differ from unskilled males were contradictory to the findings of Wrisberg et al. (1979). Wrisberg et al. (1979) suggested caution in the interpretation of their results due to the nature of the competitive experience investigation (post hoc) and the small sample size (9 females, 8 males). This caution may provide the explanation for the discrepancy of the findings of Wrisberg et al. (1979) and the present study.

The results of the present study indicated that unskilled females responded in a positive direction ($\underline{M}$ = .039); that is, they had a stronger tendency to respond later than both skilled and unskilled males. This late response may possibly be attributed to the lack of experience of unskilled females in coincidence anticipation tasks. If the latter is true, the results of this study would support socialization theory (nurture) in regard to the measure of constant error for the performance of a coincidence anticipation task.

Variable error. For variable error, a significant ($\underline{p}$ < .0003) gender main effect was found, which accounted for 9.32% of the variance of the model. This significant gender result (Figure 4) supported the findings of numerous studies (Dorfman, 1977; Wrisberg et al., 1979, 1980). In contrast, Haywood (1980) and Thomas et al. (1981) reported no gender differences for the measure of variable error.

The specific gender by skill contrasts revealed a significant difference between unskilled males and both skilled and unskilled females, but no difference between skilled males and both unskilled and skilled females (Figure 4). In contrast, Wrisberg et al. (1979)

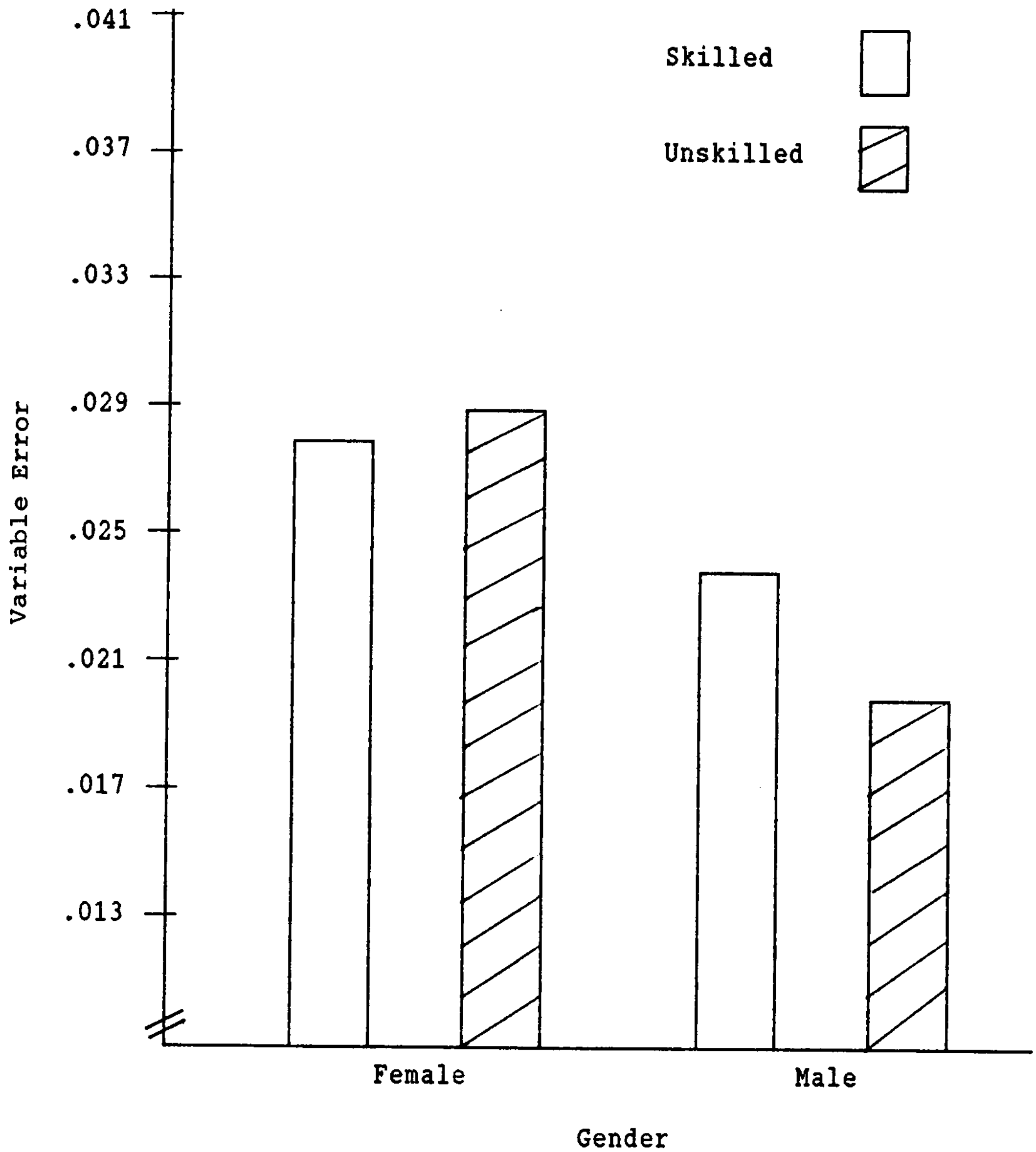

Figure 4. Gender x skill level interaction for variable error.

(Means and standard deviatiations are presented in Table 3, page 65.)

reported noncompetitive males had higher variable error than competitive males. Once again the caution of interpretation (i.e., the small sample size for their post hoc analysis) offered by Wrisberg et al. (1979) may account for the differences in the results of the two studies.

Dunham and Glad (1985) presented the moving stimuli at different speeds and in different planes. Females were found to be more consistent than males when the moving stimulus was presented in the frontal plane. Psychological variables were given as the explanation for the difference, implying that the males were bored and therefore inattentive. Dunham and Glad (1985) suggested that this inattentiveness reduced the consistency of the performance and produced inaccurate gender difference results. The explanation offered by Dunham and Glad (1985) may be applicable to the present study. In this study stimulus speed was 2 mph (3.218 kmph) for a fixed pattern, and the only body movement was to push a computer key. These factors may have influenced a highly skilled male to consider the task simple and not challenging; thus they may have been bored and performed at a lower level than that of which they were capable. This may account for the lack of difference finding between skilled males and unskilled females. This explanation is viable when considering the fact that the results indicated significant differences between the unskilled males and both unskilled and skilled females, with males being more consistent than females. If the latter explanation were true, a nature explanation may have been weakly supported.

A second possible explanation, supportive of the nurture portion of the nature-nurture dichotomy for the significant differences between unskilled males and both skill and unskilled females, is related to the concept of task specificity. Unskilled males may have more educational and/or recreational experience with computers than both unskilled and skilled females. If the latter is true, socialization theory is strongly supported by the results of the present study.

These two previous explanations, a weakly supported nature and a strongly supported nurture, represent both portions of the nature-nurture dichotomy, and only through the investigation and inclusion of other variables such as (a) background experience in computers, (b) video game experience, and (c) motivational questionnaire relevant to the task may gender differences be more precisely evaluated. As Hult and Brous (1985) concluded, the study of gender difference for spatial ability is complex and involves numerous variables.

Summary of Coincidence Anticipation Performance Measures

In summary, all three measures (AE, CE, VE) produced significant gender effects. In addition, on all three measures the main effect of gender accounted for the largest portions of the variance within each specific model. As has been the nature of research concerning coincidence anticipation, the results of the present study provided support for some of the studies reviewed and failed to support others. This may be because: (a) the task used for the present study was a computer task and none of the other studies employed an identical task; and (b) the nature of experience specificity of the subjects was different (i.e., all college students collectively versus college students categorized as competitive and noncompetitive). The results of the present study revealed that unskilled males were more consistent and accurate and had less response bias than unskilled females. Skilled males were more accurate and had less response bias than unskilled females, but did not differ from them on the measure of variable error. Unskilled males were more accurate and consistent than skilled females, while skilled males and skilled females did not differ with regard to accuracy.

Socialization may suggest stronger encouragement of males for sport and computer tasks for this age group; thus, given task specificity, both skilled and unskilled males might tend to do better than unskilled females. In addition, the lack of difference between skilled participants would also appear to support a socialization hypothesis. A biological explanation may be offered for the strong gender difference between the unskilled males and both unskilled and skilled females, but a socialization explanation may also be offered.

<u>Summary of Subproblem 1</u>

In explanation of the significant multivariate main effect for gender, there was a pattern of similar results grouped among the measures of coincidence anticipation (AE, CE, VE) in contrast to the pattern of similar results for the measures of spatial visualization ability and lateralization. This multivariate result indicated gender differences were concentrated in the temporal/spatial performance area but were not evident for the degree of lateralization nor the performance of a spatial visualization task. The finding suggested strong gender difference favoring males for the performance of a coincidence anticipation task.

The significant multivariate main effect for skill level revealed a pattern of similar results grouped among the coincidence anticipation measure of constant error and the spatial visualization ability in contrast to the pattern of similar results for the variables of absolute error, variable error, and degree of lateralization. The result indicated that skilled individuals performed significantly better than unskilled individuals with respect to less response bias on a coincidence anticipation task, but unskilled individuals performed better (higher scores) for the spatial visualization task. Experience and task specificity may be possible explanations for the result. Skilled individuals had a depth of experience with moving objects, whereas unskilled subjects may have had more experience with tasks which required only mental manipulation and no body involvement. These two experiences may have different task demands in regard to mental processing. Thus, based upon the concept of specificity, performance on the specific measures of the present study may be related to specific past experiences.

For the significant multivariate interaction effect of gender by skill level, there was a similar pattern of results for the variables of absolute error and spatial visualization ability in contrast to the pattern of results for constant error, variable error, and degree of lateralization. Further investigation of the gender by skill level interaction was conducted through the investigation of all possible pairwise comparisons. Significant multivariate differences were found between (a) unskilled males with skilled males, unskilled females, and skilled females; and (b) skilled males and unskilled females. For the multivariate performance, unskilled males performed better than skilled males and both unskilled and skilled females, while skilled males performed better than unskilled females.

Based upon these results, a single nature (gender) or nurture (skill level) answer is not completely supported. Findings of significant gender effects with no interactions and no skill level effects for the dependent measure of degree of lateralization would have provided strong support for a biological explanation (i.e., nature). These specific findings were not obtained in the present study. Findings of significant interactions and skill level effects would have provided strong support for the socialization explanation (i.e., nurture). Although no significant differences between skilled males and skilled females were found, which tends to support a socialization explanation, the lack of difference reported between skilled and unskilled females inhibits complete acceptance of a socialization explanation for the results. The findings of the present study supported the conclusion of Halpern (1986) that both nature and nurture explanations of gender differences have weaknesses and are unable to answer all the questions.

Subproblem 2

Whiting (1969) included spatial ability as one of the components in the learning and performance of motor tasks. According to information processing theories (Bernstein, 1967; Welford, 1972; Whiting, 1969), human motor performance incorporates the integration of environmental input through the processes of perception, translation, and effection. The process of perception (the organization and attaching of meaning to the stimuli received through the sensory system) is directly related to spatial visualization ability. The development of motor responses and the ensuing motor performance is mainly dependent upon the sensory modality of vision (Gentile, 1972; Schmidt, 1982). Based upon this theoretical rationale, it was hypothesized that spatial visualization ability would be negatively correlated with the performance of a motor task.

Spatial visualization ability was correlated with the three measures (absolute, constant, and variable error) of coincidence anticipation performance. All three of the correlations were negative, but only two (absolute and variable error) were significant. The measure of absolute error was significantly ($p < .0026$) correlated with the score on the DAT Space Relations Subtest. This result supported the hypothesis of Subproblem 2, indicating that individuals who score better on a spatial visualization task (higher scores) performed with more accuracy (lower scores) on a coincidence anticipation task.

The measure of variable error was significantly negatively correlated ($p < .0066$) with spatial visualization ability. Subjects who had better spatial visualization ability (higher scores) had more consistent performance (lower scores) on the coincidence anticipation task. This finding supported the hypothesis of this subproblem.

The literature review revealed that only the measure of constant error for coincidence anticipation performance had been correlated with performance on the DAT Space Relations Subtest. Beitel (1981), for female subjects only, reported a low, positive nonsignificant correlation ($\underline{r}$ = .10), while a low, negative nonsignificant correlation ($\underline{r}$ = .167) was obtained in the present study. This positive correlation direction in the former study may be reflective of the nature of the sample. According to Tapley and Bryden (1977), females approach spatial manipulation utilizing a verbal process, whereas males approach the task utilizing a visual process. Coincidence anticipation is a spatial/temporal task, and a verbal approach may produce scores with a high response bias. Therefore, based on this rationale, the correlation between DAT performance and the measure of coincidence anticipation for females may tend to fall in a positive direction.

In summary, the correlations of all three measures of coincidence anticipation performance with the spatial visualization ability measure (Subproblem 2) were in the predicted negative direction, with two being significant (absolute and variable error) and one just failing to achieve statistical significance (constant error). Therefore, the hypothesis of the present study was supported for the measures of absolute and variable error but was not supported for the measure of constant error. The results indicated that a relationship exists between better spatial visualization ability and more accurate and consistent coincidence anticipation performance.

In temporal/spatial tasks, the object and/or the individual may be moving at various velocities and changing flight patterns. For the temporal/spatial task of coincidence anticipation employed in this study, the moving object maintained a constant velocity and a fixed flight pattern. Thus, these results may be limited to temporal/spatial tasks that have constant velocities and fixed flight patterns.

Subproblem 3

According to the literature reviewed, the right cerebral hemisphere has been determined as the cerebral hemisphere specialized for the processing of spatial information (Gazzangia, 1978; Ornstein, 1972). Lateralization theory (Levy, 1972, 1974) states that males are more lateralized with verbal functioning in the left cerebral hemisphere and spatial functioning in the right. Females supposedly are bilateralized with the verbal functions overlapping into the right cerebral hemisphere and thus interfering with spatial processing (Levy, 1972, 1974). A strong negative correlation would indicate that more lateralized individuals are better at spatial processing and vice versa.

For this study a negative correlation was obtained for the measure of spatial visualization ability and the degree of lateralization but it was not significant; therefore, the hypothesis of the present study was not supported.

Only one other study compared spatial visualization ability with performance on a dot enumeration task (McGlone & Davidson, 1973). They compared performance on Thurstone's Primary Mental Abilities Spatial Relations Subtest with left-right visual field superiority and reported a nonsignificant result. Both this study and McGlone and Davidson (1973) produced similar results.

Tapley and Bryden (1977) found that for males the DAT had a high positive correlation with visual imagery, but that for females the DAT had a high positive correlation with verbal imagery. Their interpretation of this finding was that females employed a much more verbal processing strategy in the performance of a spatial manipulation task such as measured by the DAT. Possibly, in the present study, females who scored high on the DAT used a verbal approach, for which the left cerebral hemisphere is associated. This opposite hemispheric processing may have effected the correlation of this study.

Subproblem 4

Theoretically, the more lateralized an individual is, the more specialized the right cerebral hemisphere is for processing spatial tasks (Levy, 1972, 1974). Therefore, it might be hypothesized that individuals with a high degree of lateralization (lower scores) would tend to be very good (lower scores) on temporal/spatial tasks and vice versa.

Low positive correlations were obtained for the measures of coincidence anticipation performance (AE, r = .057; CE, r = .124; VE,

$r = .022$) but none achieved statistical significance. Thus, the hypothesis of the present study was not supported. Within the literature reviewed no study was identified that investigated the relationship between coincidence anticipation performance and the degree of lateralization.

Subproblem 5

The literature reviewed (Colley et al., 1985; Duquin, 1978; Snyder & Spreitzer, 1978) suggested (a) that the majority of athletic events, especially competitive athletics, have been classified as masculine and (b) that participation in these activities has often been considered by society as inappropriate for females. Duquin (1978) predicted that the majority of females with a feminine gender identity would refrain from participating in such activities. Support for the prediction by Duquin was provided by this study. A Chi-Square analysis indicated a significant cross tabulation ($p < .001$) for gender identity when gender and skill level were addressed collectively. When skill level was analyzed, a significant difference ($p < .005$) difference was revealed for the genders (Table 5, page 68). Skilled males had a larger percentage of masculine individuals (58.62%), while the largest percentage of skilled females were androgynous (40.00%).

Myers and Lips (1978) had reported a similar result for male and female racquetball players (i.e., males 40% masculine and females 44% androgynous). Further, in the present study, the largest percentages of unskilled males were classified as undifferentiated (33.33%) or masculine (33.33%), while the largest percentage of unskilled females were classified as feminine (58.33%). In the present study, the percentage reported for the unskilled females was identical to the result reported by Myers and Lips (1978). Myers and Lips (1978) did not conduct an analysis for gender identity of males because their sample consisted of only skilled males.

The Chi-Square analysis within gender revealed a significant ($p < .015$) difference for females but not for males ($p < .101$). The largest percentage of unskilled females were classified as feminine (58.33%), while the largest percentage of skilled females were classified as androgynous (40.00%).

The results of the present study replicate the findings of Colley et al. (1985) in regard to within gender differences with one exception. Colley et al. (1985) analyzed gender identity with sport participation but separated the sports into team and indívidual. To compare the results of Colley et al. (1985) with the present study, the individual and team sport percentages were combined to represent competitive skill level. Colley et al. (1985) found that the largest percentage (36%) of skilled females were classified as feminine, whereas in the present study the most dominant gender identity of skilled females was androgynous (40%).

Burke (1986) found that the largest percentage (45%) of collegiate female athletes were classified as androgynous, which was replicated in the present study (40%). In contrast, Burke (1986) reported that 0% of the females in his study were classified as undifferentiated, while in the present study 13% of the females were so classified.

An androgynous individual has been characterized by Bem (1975) as an individual who is more flexible; that is, they participate more freely in both masculine and feminine behaviors, as dictated by the situation, than individuals who are classified as masculine or feminine. Androgynous individuals will choose either a masculine or feminine behavior dependent upon the situational demands, whereas masculine and feminine individuals limit their behaviors to the behaviors specifically associated with their gender identity. Based on Bem's (1975) definition, Myers and Lips (1985) hypothesized, and subsequently supported their hypothesis, that female competitive sports participants were more androgynous because of the necessity for women to be flexible in sport.

The present study found the largest percentage of skilled females were classified as androgynous; this result supported the findings of Myers and Lips (1985). In the present study, the largest percentage of skilled males were classified as masculine, while the largest percentage of unskilled females were classified as feminine. This result was similar to the finding reported by Colley et al. (1985). According to society, males are to be masculine, implying the characteristics of aggression, competitiveness, activeness, and instrumentalism, and females are to be feminine, which implies the characteristics of being passive, submissive, cooperative, and expressive (Oglesby, 1984). Therefore, for Myers and Lips (1985) and the present study, the largest percentage of skilled females, those involved in situations that demand masculine characteristics, were classified as androgynous. For Colley et al. (1985) and the present study, the largest percentage of skilled males and unskilled females were classified in the category that was deemed appropriate for their gender, therefore restricting them to either masculine or feminine behaviors, respectively. If the behavior of feminine females is restricted, then their participation in temporal/spatial tasks would be limited and, according to Bem (1975), may result in their failure to learn behaviors associated with the activity. This concept may be an explanation for the poorer performance by unskilled females in the present study on the coincidence anticipation task.

Summary

In an effort to explore gender difference in temporal/spatial task performance an integrated model was developed. According to several researchers (Halpern, 1986; Harris, 1981; Sherman, 1978), the nature-nurture dichotomy has been unable to provide all the answers to the gender difference question in regard to spatial ability. The theories of lateralization and socialization were investigated simultaneously with regard to both gender related variables and performance/experience of a temporal/spatial task.

Support for lateralization theory (Levy, 1972, 1974) was centered in the measurement and analysis of the degree of lateralization, but the lack of a gender main effect reduced the viability of a nature answer. In addition, the degree of lateralization was not correlated with performance of a coincidence anticipation task or a spatial visualization task (DAT). One possible explanation for these findings is that the dot enumeration task may not be a valid instrument.

Socialization theory (Sherman, 1967) considers differential childhood experiences to be critical to the development of certain abilities. The multivariate model used in the present study revealed a significant skill level main effect as well as a significant skill level x gender interaction. Further investigation of the interaction revealed that unskilled males were significantly different from skilled males, unskilled females, and skilled females. Skilled males were also significantly different from unskilled females. These differences were evaluated for each univariate model. Skilled females did not differ from skilled males for the multivariate model. These interactions revealed that the experiences for the unskilled males, although not the same as they were for the skilled males, may be more similar to the tasks and strategies of the test used within the present study. This explanation was based upon the concept of similarity/specificity.

For the analyses of variance conducted on the three dependent measures of coincidence anticipation, unskilled males were significantly better than unskilled females on all three measures (absolute, constant, and variable error), while skilled males were better than unskilled females for absolute and constant error. In general, males were more accurate and had less response bias than unskilled females. Skilled females were more accurate than unskilled females but did not differ on any other measures. For the difference between the unskilled females and both skilled and unskilled males a possible nature explanation might be offered, but so may a stronger nurture explanation be offered also.

The analysis of spatial visualization ability produced results that tend to support the nurture concept of socialization. Unskilled males differed from skilled males and skilled females. A possible explanation for these differences was offered by Tapley and Bryden (1977); skilled males, because of boredom or an underestimation of task difficulty, failed to perform to their true ability level.

Finally, the investigation as to the gender identity of the various genders and skill levels revealed that skilled and unskilled males did not have different patterns, but skilled and unskilled females were significantly different. In addition, for within skill level, males and females differed. The largest percentage of skilled females were androgynous, while the largest percentages for skilled males and unskilled females were masculine and feminine, respectively. These results demonstrated that a larger percentage of masculine and feminine individuals were aligned with the skill level that is best representative of the types of behaviors characterized by their gender identity. Androgynous individuals, according to Bem (1975) are more flexible than masculine or feminine individuals. Researchers (Myers & Lips, 1978; Burke, 1986) reported that the largest percentage of female athletes are classified as androgynous. Similar results were reported for the present study.

According to Bem (1975), lack of participation in activities may result in an individual's failure to learn the behaviors associated with that activity. Since feminine females were the largest percentage representative of the unskilled female group, a possible explanation for their poorer performance on the coincidence anticipation task may be due to their lack of previous experiences.

When all the results were combined, unskilled males had the best performance and unskilled females had the poorest performance. The combination of the spatial task performances and the results of the gender identity analyses strongly supported a socialization explanation. However, not all the questions were answered. Based upon the results, it may be concluded that spatial ability is a complex concept and needs to be investigated further through an integrated approach.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

Summary

The purpose of this study was to explore an integrated approach to the investigation of gender related individual difference variables and the performance/experience of temporal/spatial tasks. The following variables were considered with regard to gender: (a) degree of lateralization, (b) spatial visualization, and (c) gender identity. The following variables were considered with regard to temporal/spatial performance/experience: (a) coincidence anticipation measures and (b) skill level. One hundred and nineteen college students aged 17 to 25 years served as subjects. Participants, consisting of 59 males and 60 females, were categorized as skilled or unskilled based upon their current and previous competitive athletic experience. Skilled subjects were current members of intercollegiate athletic (temporal/spatial task only) teams. Unskilled subjects were college students who had never participated in any type of organized competitive athletics (temporal/spatial or spatial only).

The dependent measures of spatial visualization ability, coincidence anticipation performance, and the degree of lateralization were selected based upon their relationship to spatial ability as documented by previously reported research. The Space Relations Subtest of the Differential Aptitude Test was used as the measure of spatial visualization ability. The dot enumeration test, as described by Kimura (1966) and McGlone and Davidson (1973) was used to determine the degree of lateralization. The Coincidence-Anticipation Accuracy Microcomputer Diskette (Kluka & Zimmerman, 1985) was utilized to measure coincidence anticipation performance. The Bem Sex Role Inventory (Bem, 1974) was used to determine the gender identity classification.

A 2 x 2 (gender by skill level) MANOVA was used to analyze the data for the measures of spatial visualization ability, degree of lateralization, and coincidence anticipation performance. Wilks' Lambda Criterion $p < .05$ was used to evaluate the multivariate F. Bonferroni multiple comparison method ($p < .008$) was applied for post hoc tests. Utility indices were calculated for significant effects within the univariate ANOVAs. The Pearson product-moment correlation technique was utilized to determine the relationship between the dependent measures. Chi-Square analysis was used to analyze the relationship of gender and skill level with gender identity.

The nature-nurture dichotomy has been the framework upon which most gender difference research studies have been conducted. Several researchers (Halpern, 1986; Harris, 1981; Sherman, 1978) have concluded that all the answers cannot be derived from this either-or concept. The results of this study would tend to support that conclusion. The nurture concept was supported strongly by the finding of no multivariate difference between skilled females and skilled males but was weakened by the lack of difference between skilled and unskilled females in many variables. The nature concept was not supported by the lack of difference between males and females in regard to the gender related variable degree of lateralization. However, for a significant gender main effect, the nature concept was a possible but weak explanation. Therefore, neither concept provided all the answers.

The theory of lateralization (Levy, 1971, 1974) states that males are more specialized in the right hemisphere for the processing of spatial information and that they have superior spatial ability as a result of this specialization. The findings of the present study do not support this theory. No difference was found between males and females across skill levels for the dot enumeration task, a measure of lateralization. The correlation of the dot enumeration task was nonsignificant for both spatial visualization ability and the measures of coincidence anticipation. A possible explanation for these results was based upon the research by Tapley and Bryden (1977). They found that for females <u>verbal</u> imagery was highly correlated with spatial visualization ability, while for males the high correlation was with <u>visual</u> imagery. Possibly the females employed a verbal strategy for the performance of the spatial tasks which, because of the left hemispheric processing of verbal information, may have influenced the correlation. Another possible explanation for the lack of difference result may be that the dot enumeration task may not have measured lateralization.

Socialization theory (Sherman, 1967) states that differential childhood experiences influence a person's spatial ability. For the present study, the strongest support was developed for the concept of socialization. The multivariate interactions revealed that skilled and unskilled males performed better than unskilled females, while skilled females did not differ from skilled males. These results provided strong support for the socialization concept.

The analyses of the univariate results were conducted to provide a better understanding of where the differences occurred. For the coincidence anticipation tasks collectively, the main effect of gender accounted for the largest portions of the variance for each model. Both skilled and unskilled males were significantly better than unskilled females for the measures of absolute and constant error, and skilled males were better than unskilled females. In addition, unskilled males were more accurate and consistent than skilled females. These results may be indicative of a viable nature answer (i.e., that males are biologically better) or indicative of a nurture explanation (i.e., that males have more experience than females).

The type of experience may also be related to the performance differences. Task specificity may explain the superior performance of the unskilled males. That is, the everyday experiences of unskilled males may be more highly correlated to the performance of the specific spatial tasks used within this study than are the sport experiences of the skilled males.

Maccoby and Jacklin (1974) reported that males' performances on spatial tasks are superior to those of females. The results of this study failed to substantiate the viewpoint of Maccoby and Jacklin (1974). The interaction revealed that unskilled males and both unskilled and skilled females differed, and unskilled males had the better performance. As before, the explanation for the result is presented with regard to a nature-nurture dichotomy.

Socialization theory (Sherman, 1967) is based upon differential childhood experiences, of which competitive athletics is one. These childhood experiences, according to Green et al. (1982) are related to gender identity. Since the majority of sports, especially competitive sports, have been classified as masculine by society, participation by females is deemed inappropriate. The present study investigated the interaction of gender and skill level with regard to gender identity. The results indicated that the gender identity patterns for the skilled and unskilled females were significantly difference, but that was not the case for the males. The results indicated that the largest percentage of skilled females were androgynous, while the largest percentage of unskilled females were feminine. The skilled males and the unskilled females followed society's expectations as represented by the largest percentages being masculine and feminine, respectively.

When all the results are considered together, it appears that unskilled males exhibited the best spatial performance in respect to the different measures evaluated and unskilled females had the poorest performance. Combining that result with the finding that unskilled females were mostly feminine provided the theory of socialization with the strongest support. But even with these combined efforts, the specific contribution of the concepts of nature and nurture are indefinite. Therefore, it may be concluded that temporal/spatial task performance is a complex concept that should be investigated further through an integrated approach.

Conclusions

The purpose of the present study was to explore an integrated approach to the investigation of gender related individual difference variables and the performance/experience of temporal/spatial tasks. Although both nature and nurture may be contributing, overall there was greater support for the nurture-based theory of socialization than for the nature based theory of lateralization. The results of the data suggested:

1. (a) Unskilled males were superior to unskilled females, skilled females, and skilled males in the performance of spatial tasks.

(b) Skilled males were superior to unskilled females in the performance of spatial tasks.

(c) Unskilled males were more accurate, consistent, and had less response bias than unskilled females in the performance of spatial tasks.

(d) Skilled females were more accurate than unskilled females in the performance of a coincidence anticipation task.

(e) Unskilled males were more accurate and consistent than skilled females in the performance of a coincidence anticipation task.

(f) Skilled males were more accurate and performed with less response bias than unskilled females in the performance of a coincidence anticipation task.

(g) Unskilled males were superior to skilled females and skilled males in spatial visualization ability.

(h) No significant difference existed between males and females, skilled and unskilled, in the degree of lateralization.

2. Significant negative relationships existed between spatial visualization ability and accurate and consistent performance on the coincidence anticipation task.

3. No significant relationship existed between the degree of lateralization and spatial visualization ability.

4. No significant relationship existed between the degree of lateralization and the performance of a coincidence anticipation task.

5. (a) Significant pattern differences in gender identity existed among males and females as a function of skill level.

(b) Significant pattern differences in gender identity existed among females (i.e., the largest percentage of unskilled females were feminine, 53.33%; skilled females were androgynous, 40%).

(c) No significant pattern differences in gender identity existed among males representing the two skill levels.

(d) Significant pattern differences in gender identity existed among unskilled individuals (i.e., largest percentage of unskilled females were feminine, 53.33%; unskilled males were masculine and undifferentiated, 33.33%).

(e) Significant pattern differences in gender identity existed among skilled individuals (i.e., largest percentage of skilled females were androgynous, 40%; skilled males were masculine, 58.62%).

Implications for Future Research

This study has demonstrated that the investigation of gender difference in spatial ability is complex and that numerous variables need to be incorporated to provide an accurate evaluation of the construct. The following recommendations for future research are related to the evaluation of the nature-nurture issue for gender related individual difference variables and motor performance.

1. Reexamine the dot enumeration test with simultaneous EEG measurement.

2. Evaluate numerous paper and pencil spatial visualization tests and correlate with performance on a coincidence anticipation task.

3. Investigate numerous methods to assess coincidence anticipation performance in a wide variety of types of tasks.

4. Conduct a longitudinal study to evaluate the development of spatial visualization ability.

5. Conduct a similar study with a new sample of skilled males.

6. Evaluate gender identity in relation to the dependent variables of the present study.

7. Include the variables of intelligence, cognitive style, and analytical ability in the evaluation of spatial visualization ability.

REFERENCES

REFERENCES

Bakan, P., & Putman, W. (1974). Right-left discrimination and brain lateralization. Archives of Neurology, 30, 334-335.

Beitel, P. A. (1980). Multivariate relationships among visual-perceptual attributes and gross-motor tasks with different environmental demands. Journal of Motor Behavior, 12, 29-40.

Belisle, J. J. (1963). Accuracy, reliability and refractoriness in a coincidence-anticipation task. Research Quarterly, 34, 271-281.

Bem, S. L. (1974). The measurement of psychological androgyny. Journal of Consulting and Clinical Psychology, 42, 155-162.

Bem, S. L. (1975). Sex role adaptability: One consequence of psychological androgyny. Journal of Personality and Social Psychology, 31, 634-643.

Bennett, G. K., Seashore, A. G., & Wesman, A. G. (1973). Differential aptitude tests: Directions for administration and norms. New York: The Psychological Corporation.

Bennett, G. K., Seashore, A. G., & Wesman, A. G. (1982). Differential aptitude tests: Administrator's book. New York: The Psychological Corporation.

Berlin, P. (1974). The woman athlete. In E. Gerber, J. Felshin, P. Berlin, & W. Wyrich (Eds.), The American woman in sport (pp. 283-384). Reading, ME: Addison Wesley.

Bernstein, N. (1967). The coordination and regulation of movements. New York: Pergamon Press.

Birrell, S. (1983). The psychological dimensions of female athletic participation. In M. Boutilier & L. San Govani (Eds.), The sporting woman (pp. 49-93). Champaign, IL: Human Kinetics.

Block, J. H. (1973). Conceptions of sex role: Some cross-cultural and longitudinal perspectives. American Psychologist, 28, 512-526.

Block, J. H. (1979). Another look at sex differentiation in the socialization behaviors of mothers and fathers. In J. Sherman & F. L. Denmark (Eds.), Psychology of women: Future of research (pp. 31-87). New York: Psychological Dimensions.

Bryden, M. P. (1965). Tachistoscopic recognition, handedness, and cerebral dominance. Neuropsychologia, 3, 1-8.

Bryden, M. P. (1966). Left-right differences in tachistoscopic recognition: Directional scanning on cerebral dominance. Perceptual and Motor Skills, 23, 1127-1134.

Bryden, M. P. (1976). Response bias and hemispheric differences in dot localization. Perceptual and Psychophysics, 11, 23-28.

Bryden, M. P., & Sprott, D. A. (1981). Statistical determination of degree of lateralization. Neuropsychologia, 19, 571-581.

Burke, K. (1986). Comparison of psychological androgyny within a sample of female college athletes who participate in sports traditionally appropriate and traditionally inappropriate for competition by females. Perceptual and Motor Skills, 63, 779-782.

Caplan, P. J., MacPherson, G. M., & Tobin, P. (1985). Do sex-related differences in spatial abilities exist? American Psychologist, 40, 786-799.

Cohen, G. (1973). Hemispheric differences in serial versus parallel processing. Journal of Experimental Psychology, 97, 349-356.

Colley, A., Roberts, N., & Chipps, A. (1985). Sex role identity, personality and participation in team and individual sports by males and females. International Journal of Sport Psychology, 16, 103-112.

Davidoff, J. (1977). Hemispheric differences in dot detection. Cortex, 13, 334-344.

Dodd, D. H., & Schultz, R. F. (1973). Computational procedures for estimating magnitude of effect for some analysis of variance designs. Psychological Bulletin, 79, 391-395.

Dorfman, P. W. (1977). Timing and anticipation: A developmental perspective. Journal of Motor Behavior, 9, 67-79.

Doyle, J. C., Ornstein, R., & Galin, D. (1974). Lateral specialization of cognitive mode: II EEG frequency analysis. Psychophysiology, 11, 567-578.

Dunham, P., & Glad, H. (1985). Effect of plane of movement and speed of stimulus on anticipatory coincidence. Perceptual and Motor Skills, 61, 1191-1194.

Duquin, M. E. (1978). The androgynous advantage. In C. A. Oglesby (Ed.), Women in sport: From myth to reality (pp. 89-106). Philadelphia: Lea and Febiger.

Ferguson, G. A. (1981). Statistical analysis in psychology and education. New York: McGraw-Hill.

French, J., Ekstrom, R., & Price, L. (1963). Manual for kit of reference tests for cognitive factors. Princeton, NJ: Educational Testing Services.

Friedman, M. P., Catalano, J. F., & Lombardo, J. P. (1985). Relationship between sex-role and acquisition of motor skill. Perceptual and Motor Skills, 61, 659-668.

Gaebelein, J. W., & Soderquist, D. R. (1974). Computational formulae for utility indices. Unpublished manuscript, University of North Carolina at Greensboro.

Galin, D., & Ornstein, R. (1972). Lateral specialization of cognitive mode: An EEG study. Psychophysiology, 9, 412-418.

Gazzangia, M. S. (1978). The bisected brain. New York: Appleton-Century-Crofts.

Gentile, A. M. (1972). A working model of skill acquisition and application to teaching. Quest, 3-23.

Gentile, A. M., Higgins, J. R., Miller, E. A., & Rosen, B. M. (1975). The structure of motor tasks. In C. Bard, M. Fleury, & J. Salmela (Eds.), Movement 7: Proceedings of Canadian psychomotor symposium. Quebec: Association of Professionals in Physical Education of Quebec.

Green, R., Williams, K., & Goodman, M. (1982). Ninety-nine "tomboys" and "non-tomboys": Behavioral contrasts and demographic similarities. Archives of Sexual Behavior, 11, 247-266.

Halpern, D. F. (1986). Sex differences in cognitive abilities. Hillsdale, NJ: Lawrence Erlbaum Associates.

Hansen, M., Jamison, W., & Signorella, M. (1982). Spatial performance, activity preferences, and masculinity-femininity. Washington, DC: American Psychological Association.

Harris, D. V. (1974). The sportswomen in our society. In G. Sage (Ed.), Sport and American society (p. 310). London: Addison-Wesley.

Harris, L. J. (1981). Sex-related variations in spatial skill. In L. Liben, A. Petersen, & N. Newcombe (Eds.), Spatial representation and behavior across the life span (pp. 83-125). New York: Academic Press.

Haywood, K. M. (1980). Coincidence-anticipation across the life span. Experimental Aging Research, 6, 451-562.

Haywood, K. M. (1986). Future directions in coincidence-anticipation research. Paper presented at the annual conference of the American Alliance for Health, Physical Education, Recreation, and Dance. Cincinnati, OH.

Higgins, J. R. (1977). Human movement: An integrated approach. St. Louis: C. V. Mosby.

Hughes, M., Wilson-Derose, M., & Kiely, B. (1980). Can alphabet recall be a part of a visuo-spatial task? British Journal of Psychology, 71, 557-560.

Hult, R. E., & Brous, C. W. (1986). Spatial visualization: Athletic skills and sex differences. Perceptual and Motor Skills, 63, 163-168.

Hyde, J. (1981). How large are cognitive gender differences? American Psychologist, 36, 892-901.

Jamison, W., & Signorella, M. L. (1980). Sex-typing and spatial ability: The association between masculinity and success of Piaget's water-level task. Sex Roles, 6, 345-353.

Jensen, B. E., Ficado, M. E., & Morenz, C. (1981). Effects of precision of knowledge of results on performance of a gross motor coincidence-anticipation task. Journal of Motor Behavior, 13, 9-17.

Joyner, S. P. (Ed.). (1985). SAS users guide: Statistics (Version 5 Edition). Cary, NC: SAS Institute.

Kelly, J., & Worell, L. (1976). Parent behaviors related to masculine, feminine, and androgynous sex role orientations. Journal of Consulting and Clinical Psychology, 44, 843-851.

Kimura, D. (1961). Cerebral dominance and the perception of verbal stimuli. Canadian Journal of Psychology, 15, 166-171.

Kimura, D. (1964). Left-right differences in the perception of melodies. Quarterly Journal of Experimental Psychology, 15, 166-171.

Kimura, D. (1966). Dual functional asymmetry of the brain in visual perception. Neuropsychologia, 4, 275-185.

Kimura, D. (1973). The asymmetry of the human brain. Scientific American, 228, 70-78.

Kimura, D., & Durnford, M. (1974). Normal studies on the function of the right hemisphere in vision. In S. Dimond & J. Beaumont (Eds.), Hemispheric function in the human brain (pp. 25-47). London: Elek.

Kluka, D. A., & Zimmerman, W. J. (1985). Microcomputer program to assess coincidence-anticipation accuracy. Denton, TX.

Lake, D., & Bryden, M. (1976). Handedness and sex differences in hemispheric asymmetry. Brain and Language, 3, 266-282.

Lever, J. (1976). Sex differences in games children play. Social Problems, 23, 478-487.

Levy, J. (1972). Lateral specialization of the human brain: Behavioral manifestation and possible evolutionary basis. In J. A. Kiger (Ed.), The biology of behavior. Corvalis, OR: Oregon University Press.

Levy, J. (1974). Psychobiological implications of bilateral asymmetry. In S. Dimond & J. Beaumont (Eds.), Hemispheric function in the human brain (pp. 121-183). London: Elek.

Levy, J., & Reid, M. (1976). Variations in writing posture and cerebral organization. Science, 194, 337-339.

Lewko, J., & Greendorfer, S. (1978). Family influence and sex differences in children's socialization into sport: A review. In D. Landers & R. Christina (Eds.), Psychology of motor behavior and sport (pp. 434-447). Champaign, IL: Human Kinetics.

Liben, L. S. (1978). Performance on Piagetian spatial tasks as a function of sex, field dependence, and training. Merrill-Palmer Quarterly, 24, 97-110.

Linn, M. C., & Petersen, A. C. (1985). Emergence and characterization of sex differences in spatial ability: A meta-analysis. Child Development, 56, 1479-1498.

Lunneborg, P. W. (1984). Sex differences in self-assessed, everyday spatial abilities. Perceptual and Motor Skills, 55, 200-202.

Lunneborg, C., & Lunneborg, p. W. (1984). Contribution of sex-differentiated experiences to spatial and mechanical reasoning ability. Perceptual and Motor Skills, 59, 107-113.

Maccoby, E. E., & Jacklin, C. (1974). The psychology of sex differences. Stanford, CA: Stanford University Press.

McGee, M. (1979). Human spatial abilities: Psychometric studies and environmental, genetic, hormonal, and neurological influences. Psychological Bulletin, 86, 889-918.

McGlone, J. (1977). Sex differences in the cerebral organization of verbal functions in patients with unilateral brain lesions. Brain, 100, 775-793.

McGlone, J. (1978). Sex differences in functional brain asymmetry. Cortex, 14, 122-128.

McGlone, J. (1980). Sex differences in human brain asymmetry: A critical survey. The Behavioral and Brain Sciences, 3, 215-263.

McGlone, J., & Kertesz, A. (1973). Sex differences in cerebral processing of visuospatial tasks. Cortex, 9, 313-320.

Milner, B. (1962). Laterality effects in audition. In V. B. Mountcastle (Ed.), Interhemispheric relations and cerebral dominance (pp. 177-195). Baltimore, OH: Johns Hopkins Press.

Myers, A. M., & Lips, H. M. (1978). Participation in competitive amateur sports as a function of psychological androgyny. Sex Roles, 4, 571-578.

Nash, S. C. (1979). Sex roles as a mediator of intellectual functioning. In M. A. Wittig & A. C. Petersen (Eds.), Sex related differences in cognitive functioning (pp. 263-302). New York: Academic Press.

Nebes, R. D. (1973). Perception of spatial relationships by the right and left hemisphere in commisirotomized man. Neurophychologia, 11, 285-289.

Neter, J., Wasserman, W., & Kutner, M. (1985). Applied linear statistical models (2nd ed.). Homewood, IL: Richard D. Irwin.

Newcombe, N. (1982). Sex related differences in spatial ability: Problems and gaps in current approaches. In M. Potegal (Ed.), Spatial abilities (pp. 223-252). New York: Academic Press.

Newcombe, N., Bandura, M., & Taylor, D. (1983). Sex differences in spatial ability and spatial activities. Sex Roles, 9, 177-385.

Oglesby, C. (1984). Interactions between gender identity and sport. In J. Silva & R. Weinberg (Eds.), Psychological foundations of sport (pp. 387-399). Champaign, IL: Human Kinetics.

Olson, D., & Eliot, J. (1986). Relationships between experiences, processing style, and sex related differences in performance of spatial tasks. Perceptual and Motor Skills, 62, 447-460.

Orlofsky, J. L. (1979). Parental antecedents of sex-role orientation in college men and women. Sex Roles, 5, 495-512.

Ornstein, R. (1972). The psychology of consciousness. San Francisco: W. H. Freeman.

Petrakis, E. (1985). Sex differences and specificity of anticipation of coincidence. Perceptual and Motor Skills, 61, 1135-1138.

Popiel, E. M., & DeLisi, R. (1984). An examination of spatial ability in relation to factors from the Bem Sex-Role Inventory. Perceptual and Motor Skills, 59, 131-136.

Poulton, E. C. (1957). On prediction in skilled movements. Psychological Bulletin, 54, 467-478.

Ray, W., Morell, M., Frediana, A., & Tucker, D. (1976). Sex differences and lateralization of hemispheric functioning. Neuropsychologia, 14, 391-394.

Ray, W., Newcombe, N., Semon, J., & Cole, P. (1981). Spatial abilities, sex differences and EEG functioning. Neurophyschologia, 19, 719-722.

Rosenthal, R., & Rubin, D. (1982). Further meta-analytic procedures for assessing cognitive gender differences. Journal of Educational Psychology, 74, 708-712.

Rubin, J. Z., Provenzeno, F. T., & Luria, Z. (1976). The eye of the beholder: Parents' views on sex of newborns. In A. Kaplan and J. Bean (Eds.), Beyond sex role stereotypes: Readings toward a psychology of androgyny (pp. 178-186). Boston: Little, Brown.

Salisbury, J., & Passer, M. W. (1982). Gender-role attitudes and participation in competitive athletics of varying stereotypic femininity. Personality and Social Psychology Bulletin, 8, 486-493.

Schmidt, R. A. (1968). Anticipation and timing in human motor performance. Psychological Bulletin, 70, 631-646.

Schmidt, R. A. (1982). Motor control and learning. Champaign, IL: Human Kinetics.

Sergent, J. (1983). Role of the input in visual hemispheric asymmetries. Psychological Bulletin, 93, 481-512.

Sherman, J. A. (1967). Problem of sex differences in space perception and aspects of intellectual functioning. Psychological Review, 74, 290-299.

Sherman, J. A. (1974). Field articulation, sex, spatial visualization, dependency, practice, laterality of the brian and birth order. Perceptual and Motor Skills, 38, 1223-1235.

Sherman, J. A. (1978). Sex related cognitive differences: An essay on theory and evidence. Springfield, IL: Charles C. Thomas.

Signorella, M. L., & Jamison, W. (1986). Masculinity, androgyny and cognitive performance: A meta-analysis. Psychological Bulletin, 100, 207-228.

Snyder, E. E., & Spreitzer, E. (1978). Social aspects of sport. Englewood Cliffs, NJ: Prentice Hall.

Spence, J. T., Helmreich, R., & Stapp, J. (1975). Ratings of self and peers on sex role attributes and their relation to self-esteem and conceptions of masculinity and femininity. Journal of Personality and Social Psychology, 32, 29-39.

Springer, S., & Deutsch, G. (1981). Left brain, right brain. San Francisco: W. H. Freeman.

Stadulis, R. E. (1971). Coincidence-anticipation behavior in children. Unpublished doctoral dissertation, Teachers College, Columbia University.

Stericker, A., & LeVesconte, S. (1982). Effect of brief training on sex-related differences in visual-spatial skill. Journal of Personality and Social Psychology, 43, 1018-1029.

Sutton-Smith, B., Rosenberg, B., & Morgan, E. (1963). Development of sex differences in play choices during preadolescence. Child Development, 34, 119-126.

Tapley, S. M., & Bryden, M. P. (1977). An investigation of sex differences in spatial ability: Mental rotation of three-dimensional objects. Canadian Journal of Psychology, 31, 122-130.

Thomas, J. R., Gallagher, J. D., & Purvis, G. J. (1982). Reaction time and anticipation time: Effects of development. Research Quarterly for Exercise and Sport, 52, 359-367.

Tucker, D. (1976). Sex differences in hemispheric specialization for synthetic visuospatial functions. Neuropsychologia, 14, 447-454.

Welford, A. T. (1972). The obtaining and processing of information: Some basic issues relating to analyzing input and making decisions. Research Quarterly, 43, 295-311.

Whiting, H.T.A. (1969). Acquiring ball skill. Philadelphia: Lea and Febiger.

Wrisberg, C. A., Hardy, C. J., & Beitel, P. A. (1982). Stimulus velocity and movement distance as determiners of movement velocity and coincident timing accuracy. Human Factors, 24, 599-608.

Wrisberg, C. A., Paul, J. H., & Ragsdale, M. R. (1979). Subject gender, knowledge of results, and receptor anticipation. Research Quarterly, 50, 699-708.

Zoble, J. (1976). Femininity and achievement in sports. In A. Yiannakis, T. McIntyre, M. Melnick, & D. Hart (Eds.), Sport sociology: Contemporary themes (pp. 185-193). Dubuque, IA: Kendall Hunt.

APPENDICES

APPENDIX A

INITIAL SURVEY FOR PROSPECTIVE SUBJECTS

INITIAL SURVEY FOR PROSPECTIVE SUBJECTS

NAME ______________________________

ADDRESS (LOCAL) ______________________________

____

TELEPHONE NUMBER ______________________________

DOMINANT HAND RIGHT ________ LEFT ________

1. HAVE YOU EVER PARTICIPATED ON ANY ORGANIZED COMPETITIVE ATHLETIC TEAMS OR CLUBS? (I.E. COACHED WITH REGULARLY SCHEDULED GAMES)

   YES ________ NO ______

2. DO YOU ENGAGE IN ANY REGULAR ATHLETIC ACTIVITIES?

   YES ________ NO ________

   IF YES, SPECIFY THE ACTIVITIES AND THE NUMBER OF HOURS PER WEEK YOU PARTICIPATE IN SUCH AN ACTIVITY.

ACTIVITIES	HRS/WEEK

3. DID YOU HAVE AN ORGANIZED AND STRUCTURED PHYSICAL EDUCATION PROGRAM DURING YOUR ELEMENTARY SCHOOL EDUCATION? YES _____ NO _____

4. DID YOU HAVE AN ORGANIZED AND STRUCTURED PHYSICAL EDUCATION PROGRAM DURING YOUR HIGH SCHOOL EDUCATION? YES _____ NO _____

5. HOW MANY PHYSICAL EDUCATION CLASSES HAVE YOU TAKEN DURING YOUR COLLEGE EDUCATION? __________

   PLEASE SPECIFY THE ACTIVITIES ______________________________

   ____

   ____

6. DO YOU HAVE ANY PARTICULAR VISION PROBLEMS? YES _______ NO _______

7. DO YOU WEAR CORRECTIVE LENSES? ____ ____ CONTACT LENSES? ____ ____
   Y N Y N

APPENDIX B

LETTER OF EXPLANATION

LETTER OF EXPLANATION

March, 1987

Dear

You have been specially selected to participate in a study concerned with factors which explain differences in the performance of spatial and temporal/spatial tasks (similar to a computer game). This study is directed by Jolynn Kuhlman and is part of her doctoral dissertation.

The study will consist of two testing sessions. The first part is a forty minute individual testing session during which you will complete both a computerized temporal/spatial task and a visual lateralization task. The second part of the study consists of a 50 minute group testing session during which you will complete two paper and pencil tasks.

Your scores are considered confidential information and no names will be recorded on the score sheets. Only group data will be used in reporting the results and conclusions.

This study can only be accomplished with your help. Your contribution is very important and you are doing a real favor if you agree to participate. However, if you so choose, you may withdraw from the study at any time without penalty.

Thank you very much for your assistance.

Sincerely,

Jolynn Kuhlman

693-9002 Home Phone
Office 368 HPER Building
974-5111 Office Phone

APPENDIX C

INFORMED CONSENT FORM

INFORMED CONSENT FORM

I have read the letter explaining the expectations and I understand that the purpose of this study is to learn more about factors which explain differences in the performance of spatial and temporal/spatial tasks.

I confirm that my participation as a subject is entirely voluntary. No coercion of any kind has been used to obtain my cooperation.
I understand that I may withdraw my consent and terminate my participation at any time during the investigation without penalty.

I have read the procedures that will be used in the study and understand what will be required of me as a subject. I understand that I may ask any questions for clarification at any time.

I understand that all of my responses and scores will remain completely confidential.

I wish to give my cooperation as a subject.

Signed --

Witness --

Date --------------------------

Campus Address ---

Local Phone ---------------------------

Testing session times ----------------- -------------
Date Date

Room ---------------- Room -------------

Jolynn Kuhlman
Phone 974-5111 (Office)
693-9002 (Home)
Office 368 HPER Building

APPENDIX D

PROTOCOL FOR COINCIDENCE ANTICIPATION TASK

PROTOCOL FOR COINCIDENCE ANTICIPATION PERFORMANCE TASK

The subject entered the room and was seated alongside the researcher in front of the computer. The researcher asked the subject the biographical questions (Appendix E) and typed the subject's answers into the computer. At the conclusion of the questions the researcher said:

The task you are going to perform is a timing task (Kluka & Zimmerman, 1985). The object of the task is for you to strike the open apple key (indicating where the key is located on the keyboard) with the index finger of your right hand. Strike the key when you believe the "star" that is moving across the screen from left to right will arrive at the point marked by the lines on the screen. Please strike the key; don't just press the key and hold it down. You may rest your finger on the key, but remember to use a striking motion to depress the open apple key.

You will have three practice trials and for each one you will be informed of the accuracy of your response. A negative response indicates that you strike the key before the "star" arrived at the point. A response of zero indicates you struck the key at the exact moment the star arrived at the point, and a positive response indicates that you struck the key after the star arrived at the point. After you have performed the three practice trials, you will perform 20 more trials for which you will not be provided information concerning the accüracy of the response. Prior to every trial the computer will warn you to be ready. The time between the warning and the initiation of the movement of the "star" will vary. I will watch the practice trials and answer any questions but will not watch while you perform the 20 trials. The computer will inform you when the final trial is completed. At that time, do not touch any keys on the computer and inform me that you are finished.

Do you have any questions? (Questions were answered.) You may press the return key to begin the practice trials.

Following completion the researcher typed in the subject number to store the data in the computer.

APPENDIX E

BIOGRAPHIC INFORMATION/DATA COMPUTER PRINT OUT

BIOGRAPHIC INFORMATION/DATA COMPUTER PRINT OUT

DATE YEAR/MONTH/DAY

SUBJECT # _____________

BIRTHDATE YEAR/MONTH/DAY

HAND PREFERENCE _________________

CORRECTIVE LENS _________________

CONTACT LENS _________________

CURRENT SPORTS __________________________________

DATA-------

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

APPENDIX F

PROTOCOL FOR DOT ENUMERATION TASK

PROTOCOL FOR DOT ENUMERATION TEST

After completing the coincidence anticipation performance task, the subject moved and was seated in a chair located directly in front of a rear projection screen. The researcher then explained the procedure for the dot enumeration task.

The subject was told:

You are now going to perform a dot enumeration task. The object of the task is for you to focus on the yellow dot on the screen at all times and, when the slide flashes on the screen, determine how many white dots appeared on the screen. There will be between 3 and 10 white dots in every slide.

You will place your chin on the chin rest and your head against the head rest. At no time do you want to move your head. The yellow dot on the screen is where you want to be focusing your attention all the time. Once we begin, a projection, with anywhere from 3 to 10 white dots, will appear on the screen for a very brief time--much less than a second. Immediately after the projection is over, you should verbally tell me how many dots you saw in the projection. Please remember not to move your head when you give me your answer. The time between each trial is 5 seconds and there will be 96 trials. After 48 trials there will be a 1-minute break while I change the slide tray. It is of the utmost importance that you focus at all times on the yellow dot and remember that each slide contains between 3 and 10 white dots.

You will be given four practice trials. The slide will be shown and you should verbally tell me how many dots you saw. Then a black slide will be shown while I inform you how many dots were in the previous slide. You will then be shown the original slide again. This pattern will be the same for all four of the practice trials. I will inform you of the completion of the practice trials and when the task will begin. You will not receive information concerning the number of dots during the rest of the trials.

Do you have any questions?

Any questions were answered and then the researcher said:

Please position you head on the chin rest and against the head rest and get comfortable. Remember to focus on the yellow dot at all times. Are you ready?

The practice trials commenced when the subject replied yes.

After the first practice slide the researcher said:

There were 4 dots in that slide, now you'll see that slide again.

After the fourth practice slide, the researcher said:

There were 9 dots in that slide, now you'll see that slide again.

After the seventh practice, the researcher said:

There were 7 dots in that slide, now you'll see that slide again.

After the tenth practice slide, the researcher said:

There were 6 dots in that slide, now you'll see that slide again.

After the twelfth slide, the researcher said:

That concludes the practice trials. You will see two blank slides and then the task will begin. There are no more blank slides once the task begins.

APPENDIX G

DOT ENUMERATION SCORE SHEET

DOT ENUMERATION SCORE SHEET

SUBJECT # ____________ SEX ________ DATE ________________________

TR#	SIDE	DOTS	RESP.	O.C.	E.C.	TR#	SIDE	DOTS	RESP.	O.C.	E.C.
1	L	7				49	R	10			
2	L	5				50	R	4			
3	L	6				51	L	4			
4	R	7				52	R	5			
5	R	9				53	L	5			
6	R	4				54	R	9			
7	R	4				55	R	6			
8	L	7				56	R	10			
9	R	5				57	R	5			
10	R	3				58	L	7			
11	L	9				59	R	10			
12	R	9				60	R	9			
13	L	10				61	L	8			
14	R	8				62	R	7			
15	R	5				63	R	9			
16	L	3				64	R	10			
17	R	3				65	L	10			
18	L	9				66	L	6			
19	R	4				67	R	8			
20	L	5				68	R	3			
21	L	7				69	R	7			
22	L	4				70	L	8			
23	L	8				71	L	4			
24	R	6				72	L	9			
25	L	4				73	R	10			
26	R	3				74	L	10			
27	R	8				75	R	4			
28	L	3				76	L	8			
29	R	6				77	L	3			
30	L	5				78	R	6			
31	R	3				79	L	8			
32	R	7				80	L	7			
33	L	6				81	L	6			
34	L	9				82	R	5			
35	R	3				83	R	6			
36	R	6				84	L	10			
37	R	7				85	L	7			
38	R	4				86	L	6			
39	L	10				87	L	3			
40	L	8				88	R	8			
41	L	3				89	L	5			
42	L	4				90	L	6			
43	L	5				91	R	8			
44	R	10				92	R	5			
45	R	9				93	R	7			
46	L	3				94	L	4			
47	L	9				95	L	9			
48	L	10				96	R	8			

3 dot total ____________________
4 dot total ____________________
5 dot total ____________________
6 dot total ____________________
7 dot total ____________________
8 dot total ____________________
9 dot total ____________________
10 dot total ____________________

Even total _____ Right _____ Left _____
Odd total _____ Right _____ Left _____

APPENDIX H

PROTOCOL FOR SPACE RELATIONS SUBTEST OF DIFFERENTIAL APTITUDE TEST

PROTOCOL FOR SPACE RELATIONS SUBTEST

OF DIFFERENTIAL APTITUDE TEST

The subjects entered the testing room and received a test packet identified by their subject number on the outside of the envelope and a tear label with their name on it. After receiving their test packet they were seated. The test packet contained two envelopes, one labeled Packet #1 and the other labeled Packet #2. The test packet also contained a pencil.

The subjects were informed not to open the packet until the test administrator so informed them. After all subjects assigned to the specific testing session had received their test packet and were seated the test administrator said:

Please remove the Packet #1 from your test envelope and the pencil. Please do not open the test booklet until you are so directed. Please check the number on your answer sheet to verify that it matches the number on the outside of your test packet and remove your name label from the answer sheet. If the number matches, place both envelopes under your chair. If the number does not match, please inform me.

If there was a mismatch in numbers the test administrator checked the problem and provided a new answer sheet with the appropriate subject number. If there were no mismatches, the administrator said:

Please turn to page 42 of the test booklet (Bennett, Seashore, & Wesman, 1982). You are to read the instructions and examples on these two pages. When you have completed reading, <u>do not turn</u> the page, but wait for further instructions.

Time was allowed for students to read the instructions. When the test administrator observed that all subjects had completed reading the instructions and attempting the examples, the administrator said:

Please do not write in the test booklet. Mark your answer by writing the letter (a, b, c, or d) of the figure you have determined to be correct in the appropriate space on your answer sheet. Remember to give only one answer per item. You will have 25 minutes to complete the test and you want to answer as many questions as possible within the time frame. If you are having difficulty with a question, skip that question and go on to the next. If you have time left you can go back to that question. The time remaining will be posted on the blackboard in 5-minute intervals for the first 20 minutes and in 1-minute intervals for the last 5 minutes. When there is 1 minute remaining, a verbal signal is given. When you finish the test, place your answer sheet inside your booklet and close the booklet. Please leave the booklet on your desk and sit quietly until the entire allotted time has elapsed. Are there any questions?

The administrator answered any questions at that time. After the questions had been answered or if there were no questions the administrator said:

You may turn the page and begin.

After 24 minutes the administrator said:

There is 1 minute remaining.

After the 25 minutes had elapsed the test administrator said:

Please put down your pencil. Place your answer sheet inside your test booklet and close the booklet. Take the envelopes from under the chair, place the test booklet back into the envelope labeled Packet #1, and place that envelope back in the test packet.

APPENDIX I

SCORE SHEET FOR THE SPACE RELATIONS SUBTEST

OF THE DIFFERENTIAL APTITUDE TEST

SCORE SHEET FOR THE SPACE RELATIONS SUBTEST

OF THE DIFFERENTIAL APTITUDE TEST

1. _____	16. _____	31. _____	46. _____
2. _____	17. _____	32. _____	47. _____
3. _____	18. _____	33. _____	48. _____
4. _____	19. _____	34. _____	49. _____
5. _____	20. _____	35. _____	50. _____
6. _____	21. _____	36. _____	51. _____
7. _____	22. _____	37. _____	52. _____
8. _____	23. _____	38. _____	53. _____
9. _____	24. _____	39. _____	54. _____
10. _____	25. _____	40. _____	55. _____
11. _____	26. _____	41. _____	56. _____
12. _____	27. _____	42. _____	57. _____
13. _____	28. _____	43. _____	58. _____
14. _____	29. _____	44. _____	59. _____
15. _____	30. _____	45. _____	60. _____

Total Number Correct: ________________

Subject Number: ______________

Have you ever taken this test before?   Yes   No

APPENDIX J

PROTOCOL FOR THE BEM SEX ROLE INVENTORY

PROTOCOL FOR THE BEM SEX ROLE INVENTORY

After subjects completed the Space Relations Subtest of the DAT and had placed the Space Relations envelope back into the test packet. The test administrator said:

Please remove the envelope labeled Packet #2 from the test packet and remove the Inventory (Bem, 1974) from the envelope. Do not read any part of the Inventory until directed to do so by the test administrator. Please make sure the subject number on the Inventory matches the number on the outside of the tesk packet. If the numbers do not match, please inform me immediately.

If there were any mismatches, the administrator provided an Inventory with the appropriate subject number. If there were no mismatches, the test administrator said:

Please place the envelopes under your chair. You are not under a time limitation for the completion of this Inventory. When you have finished, place the Inventory back into the envelope labeled Packet #2 and then into the test packet envelope. Please remove your name label from the outside of the test packet. You may then hand in your test packet to the test administrator and leave. Read the instructions and examples on the first page carefully so you understand the proper way to answer the Inventory. Please answer all items honestly and sincerely. You may begin.

APPENDIX K

BEM SEX ROLE INVENTORY

BEM SEX ROLE INVENTORY

In this inventory you will be presented with sixty personality characteristics. You are to use those characteristics in order to describe yourself. That is, you are to indicate, on a scale from 1 to 7, how true of you these various characteristics are. Please do not leave any characteristic unmarked.

Example: _____ Sly

Mark a 1 if it is never or almost never true that you are sly.

Mark a 2 if it is usually not true that you are sly.

Mark a 3 if it is sometimes but infrequently true that you are sly.

Mark a 4 if it is occasionally true that you are sly.

Mark a 5 if it is often true that you are sly.

Mark a 6 if it is usually true that you are sly.

Mark a 7 if it is always or almost always true that you are sly.

Thus, if you feel it is sometimes but infrequently true that you are "sly," never or almost never true that you are "malicious," always or almost always true that you are "irresponsible," and often true that you are "carefree," you would rate these characteristics as follows:

3 Sly	7 Irresponsible
1 Malicious	5 Carefree

Subject Number _____________

Have you ever taken this inventory before? ______________

1	2	3	4	5	6	7
Never or Almost Never True	Usually Not True	Sometimes But Infrequently True	Occasionally True	Often True	Usually True	Always or Almost Always True

___ 1. Self-reliant
___ 2. Yielding
___ 3. Helpful
___ 4. Defends own beliefs
___ 5. Cheerful
___ 6. Moody
___ 7. Independent
___ 8. Shy
___ 9. Conscientious
___10. Athletic
___11. Affectionate
___12. Theatrical
___13. Assertive
___14. Flatterable
___15. Happy
___16. Has strong personality
___17. Loyal
___18. Unpredictable
___19. Forceful
___20. Feminine
___21. Reliable
___22. Analytical
___23. Sympathetic
___24. Jealous
___25. Has leadership abilities
___26. Sensitive to the needs of others
___27. Truthful
___28. Willing to take risks
___29. Understanding
___30. Secretive
___31. Makes decisions easily
___32. Compassionate
___33. Sincere
___34. Self-sufficient
___35. Eager to soothe hurt feelings
___36. Conceited
___37. Dominant
___38. Soft-spoken
___39. Likable
___40. Masculine
___41. Warm
___42. Solemn
___43. Willing to take a stand
___44. Tender
___45. Friendly
___46. Aggressive
___47. Gullible
___48. Inefficient
___49. Acts as a leader
___50. Childlike
___51. Adaptable
___52. Individualistic
___53. Does not use harsh language
___54. Unsystematic
___55. Competitive
___56. Loves children
___57. Tactful
___58. Ambitious
___59. Gentle
___60. Conventional

VITA

Jolynn Sue Kuhlman was born in Columbia, Pennsylvania, on March 22, 1950. At the age of three she moved to Lebanon, Pennsylvania, where she attended elementary and junior high schools and was graduated from Cedar Crest High School in June 1968. She attended The Pennsylvania State University where she was a member of the varsity riflery and softball teams, was elected to Lakonides honorary society, and graduated in 1972. In the fall of 1972, she accepted in teaching position with the Blue Mountain School District, Orwigsburg, Pennsylvania. From 1972 to 1984 she taught Health and Physical Education and coached swimming. In 1982 she took a sabbatical leave, accepted a graduate teaching assistantship at The University of Tennessee, Knoxville, and graduated with a Master of Science degree in Physical Education in August 1983. After teaching another year in the Blue Mountain School District, she returned to The University of Tennessee, Knoxville, as a graduate teaching assistant. During this period she was awarded the Chancellor's citation for "Extraordinary Professional Promise" (1987) and was named "Doctoral Student of the Year" in the Department of Physical Education and Dance, 1986/1987. She was co-recipient of the Edward A. Capen Award for excellence in graduate study through research presentations and publications, 1987.

She was initiated into the Phi Kappa Phi and Phi Lambda Theta honorary associations during 1984. She received the Doctor of Philosophy degree with a major emphasis in Motor Behavior/Sport

Psychology in August 1987. She will be employed by the Department of Physical Education, Indiana State University, after graduation.