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Individual Differences in Verbal and Spatial Memory: The Contribution of Gender, Verbal Ability, Spatial Ability, and Sex-Role Orientation

Mary H. Sarafolean

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INDIVIDUAL DIFFERENCES IN VERBAL AND SPATIAL MEMORY: THE CONTRIBUTION OF GENDER, VERBAL ABILITY, SPATIAL ABILITY, AND SEX-ROLE ORIENTATION

by
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Master of Arts, Mankato State University, 1982

A Dissertation
Submitted to the Graduate Faculty of the University of North Dakota in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Grand Forks, North Dakota

May 1990
This dissertation submitted by Mary H. Sarafolean in partial fulfillment of the requirements for the Degree of Doctor of Philosophy from the University of North Dakota has been read by the Faculty Advisory Committee under whom the work has been done, and is hereby approved.

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This dissertation meets the standards for appearance and conforms to the style and format requirements of the Graduate School of the University of North Dakota, and is hereby approved.

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They said it couldn't be done and they were almost right.

Many times I doubted whether this project would ever be completed. Thanks to all of you who continued to believe that it would someday be finished.

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ABSTRACT

The present study examined the degree to which reported sex differences in verbal and spatial memory performance are due to confounds between the sexes on the individual difference factors of verbal ability, spatial ability, and sex-role orientation. Specifically, college age males and females were administered psychometric tests of verbal ability, spatial ability, and sex-role orientation. The contribution of each of these factors to predicting subjects' scores on verbal and spatial memory tasks was analyzed using regression analysis procedures.

Results indicated a male advantage on spatial ability tasks, however, no sex differences in verbal ability were found. Gender of subject was not found to be a significant predictor of either verbal or spatial memory performance. Males were found to identify themselves as more traditionally masculine than did females. However, both males and females were found to aspire to traditionally masculine intellectual traits. Factors which emerged as predictive of memory performance included spatial ability and a more masculine view of one's intellectual attributes. A masculine sex-role
orientation and high spatial ability were found to predict spatial memory performance on one task, however, on a second spatial memory task a more feminine sex-role orientation was predictive of better performance.

The results of the present study suggest that differences in memory performance are in part explained by individual differences in cognitive abilities and sex-role orientation and cannot be adequately explained by looking only at sex of subjects.
Chapter 1
INTRODUCTION AND REVIEW OF LITERATURE

The Question of Sex Differences

The past two decades have seen dramatic growth in the amount of research examining sex differences in behavior. Traditionally, sex differences research has taken a sex as subject variable approach, attempting to determine how males and females are different in any of a number of behaviors, traits, and capabilities. This approach is best exemplified by Maccoby and Jacklin's (1974) review of more than 1400 published studies of sex differences. Based on their review the authors concluded that existing evidence supported only four clear differences between males and females. Three of these differences are found in the area of cognitive abilities: (a) male superiority on visual-spatial and mathematical tasks and (b) female superiority on verbal tasks. In the area of social behavior only one difference, greater male than female aggressiveness was consistently supported by research data. Maccoby and Jacklin agreed that while their review of existing research supported only these four
differences between the sexes future research could conceivably reveal additional areas of consistent sex differences. Thus Maccoby and Jacklin's review served as a catalyst for researchers to investigate possible differences between the sexes in a wide variety of areas including prosocial behavior, conformity, nonverbal behavior patterns, and reward allocation.

The conclusions reached by Maccoby and Jacklin have not gone unchallenged (Block, 1976). Subsequent analyses of sex-of-subject research have revealed important qualifications to many findings. Situational interactions and the selection of tasks often play a critical role in eliciting or suppressing sex differences. For example, in a study of aggressive behavior Frodi, Macaulay, and Thome (1977) found that situational factors such as sex of the instigator or victim, arousal of anxiety or guilt, and certain types of external aggressive cues are related to observed sex differences in aggressive behavior between men and women. Deaux and Farris (1977) reported that differences in causal attribution (that is, how one accounts for success or failure on a task) between men and women occurred primarily when the task was labeled masculine and did not occur when the task was labeled feminine. Further, when considering any specific behavior the amount of variance accounted for by sex of subject is
typically quite small, generally accounting for less than 5% of the variance (Deaux, 1985).

A recent alternative to the sex-as-subject variable approach takes into account the fact that sex-as-a-psychological variable often serves as only a gross marker in predicting individual differences in behavior (Deaux, 1977). The emphasis in this approach remains on individual subject differences, but differences of a psychological rather than demographic nature. Exemplifying this approach is the plethora of studies examining masculinity, femininity, and the concept of androgony as they relate to specific behaviors or abilities. Much of the research activity as well as controversy in this area has been generated by the theoretical framework first proposed by Bem (1974). She proposed in her initial formulation that a particular personality type (androgyny) could be reliably measured and used to predict specific behaviors. Biological sex itself was considered irrelevant to these predictions. Bem's operational definition of androgyny has undergone considerable revision since its inception (Bem, 1977) and other researchers have since attempted to define and interpret the concept more narrowly (Spence & Helmreich, 1978).
The following review of literature will explore in greater detail research generated by these two approaches: (a) studies focusing on gender or sex of subject as an independent variable and (b) studies specifically concerned with the personality variables of masculinity and femininity. Evidence for sex-related differences in cognitive abilities including memory processes will be presented. Second, an overview of current theories explaining observed sex-related differences in cognitive abilities will be reviewed.

**Sex-Related Differences in Cognitive Abilities**

A number of researchers have addressed the issue of sex-related differences in cognitive functioning (Harris, 1978; Hoyenga & Hoyenga, 1979; Maccoby & Jacklin, 1974; Sherman, 1978; Witting & Petersen, 1979). Recent comparisons of the sexes have focused on specific aspects of cognitive ability rather than the concept of general intelligence. The overall consensus is that clear evidence exists for sex differences in a limited number of cognitive domains. The following provides a brief overview of the findings related to sex differences in cognitive ability.
Verbal Ability

In the summary of research on sex differences reported by Oetzel (1966), females performed with consistent superiority over males in most tests of verbal abilities. The studies summarized used subjects ranging in age from one month to adulthood and covered such areas as reading comprehension, articulation, fluency, spelling grammar, and age of first speech. The literature since 1966 supports the general finding of sex differences in favor of females on measures of verbal ability, however, the differences are often small and at times not statistically significant.

Sex differences in performance on tests of receptive or productive language and psychometric measures of verbal skill such as Wechsler Vocabulary subtests are seldom found between the ages of 3 to 11 years (Wittig & Petersen, 1979). Female superiority at verbal tasks, especially measures of verbal fluency, begins to appear reliably around the age of 10 or 11 (Maccoby & Jacklin, 1974) and may persist well into old age (Cohen, 1977). This female verbal superiority includes vocabulary, receptive and expressive language, performance on verbal analogies, comprehension of difficult prose material, creative writing, verbal fluency, and spelling (Hoyenga & Hoyenga, 1979). Among adults between the ages of 16 and
64 years women are known to obtain higher mean scores than men on the verbal ability subtests of the Wechsler Adult Intelligence Scale (Similarities and Vocabulary; Wechsler, 1955). A longitudinal study of elderly adult twins ages 60 to over 90 years (Blum, Fosshage, & Jarvik, 1972) found the mean scores of women exceeded those of men on nearly all verbal subtests administered initially as well as 20 years later. Women outperformed men on both the Vocabulary (Stanford Binet) and Similarities (Wechsler) subtests, the differences reaching statistical significance initially and at the 20-year retesting. In a sample of college graduates over the age of 70 Schaie and Strother (1968) found women achieved significantly higher scores than men on all verbal ability subtests of Thurstone's Primary Mental Ability battery.

It might also be noted that males suffer significantly more speech and reading problems than do females (Thompson, 1975) and attain lower mean verbal subtest scores than females on standardized tests such as the American College Test (ACT) and Scholastic Aptitude Test (SAT) (Cross, 1971). Thus a slight but consistent sex difference in verbal skills favoring females has been documented across the lifespan.
Mathematical Ability (Quantitative Ability)

Maccoby and Jacklin (1974) concluded that no consistent sex-related differences occur in quantitative ability prior to adolescence. However, when differences are found at ages 9-12 they tend to favor males. After age 12-13 the quantitative skills of males improve at a faster rate than females, and adolescent males outperformed adolescent females in the majority of studies reviewed by Hoyenga and Hoyenga (1979) and Maccoby and Jacklin (1974). This same pattern of equivalent mathematics achievement between the sexes before approximately the ninth grade, with the emergence of male superiority in performance thereafter, has been reported by other researchers as well (Mullis, 1975; Wilson, 1974; Wood, 1976).

More recently the work of Benbow and Stanley (1980, 1983) has provided new data documenting sex differences in mathematical aptitude, differences they suggest are evident even prior to adolescence. Using the SAT as a criterion with a large sample of seventh-grade students, these authors found a mean difference of approximately 30 points between males and females. Subsequent analyses of these data suggest the male-female difference occurred primarily on algebraic items and was not evident on arithmetical or geometric problems (Deaux, 1985).
Fennema and Sherman (1977) have suggested that perhaps the relatively fewer number of higher level math courses taken by females as compared to males is a major factor in explaining the sex differences in mathematics achievement that reliably occurs by the twelfth grade. Weitzman (1979) reported that in the entering class of the University of Maryland only 15% of white women and 10% of black women had the math prerequisites for a college major in science, engineering, or any other math-based subject. Richardson (1981) proposed that, rather than reflecting an inherent difference in mathematical ability, this discrepancy between males and females in higher level math preparation may reflect the fact that math is labeled as a male activity. As such, adolescent girls may avoid math as a way of avoiding the negative labels that accompany divergence from traditional feminine pursuits.

Thus as early as junior high school significant sex differences in mathematical ability emerge and continue on into adult life. Whether this disparity reflects innate differences in ability, differential socialization, or a combination of these factors remains unclear.

Spatial Ability

McGee (1979), in his review of human spatial abilities, provides factor analytic evidence to support
the existence of two dimensions of spatial ability, visualization and orientation. Spatial visualization is said to involve the ability to rotate and manipulate two- or three-dimensional objects mentally. For example, the Spatial Visualization Test of the French et al. (1963) Kit of Reference Tests of Cognitive Factors, requires the examinee mentally to fold and unfold a piece of paper and choose the correct alternative after it has been unfolded. Spatial orientation involves the comprehension of the arrangement of elements within a stimulus pattern as well as an ability to determine spatial orientation with respect to one's own body. For example, the Guilford Zimmerman Spatial Orientation Test requires the examinee to imagine riding in a boat whose prow (forward part) is always visible in the foreground of the pictures that comprise each item and to choose among the alternative new directions of the boat. McGee points out that both spatial orientation and visualization require short-term visual memory.

Other tasks often used to measure spatial abilities include: mazes (subjects must find and trace the correct route from one end of the maze to the other); formboards (fragmented pieces of familiar geometric shapes are presented and subjects are asked to choose the correct formed design from a set of several choices); and block
counting (subjects are presented with two-dimensional drawings of three-dimensional block piles and must arrive at the total number of blocks) from the Differential Aptitudes Test (DAT) and from the Primary Mental Abilities (PMA). The Embedded Figure Test (subjects must identify a hidden figure embedded in a more complex one) and Rod and Frame Test (subjects are asked to adjust a rod within a luminescent square frame when either the frame or the subject is tilted at an angle) have also been used as measures of spatial ability.

Regardless of how it is defined or measured, males in general perform better than females on tests of spatial ability, beginning around the time of puberty. With subjects 13 years and older, 8 of 10 studies of spatial visualization without verbal mediation (nonanalytic spatial ability) and 22 of 43 studies of spatial visualization combined with verbal mediation (analytic spatial ability) found a significant sex difference, with males outperforming females (Maccoby & Jacklin, 1974). In the Comprehension, Picture Completion, and Block Design subtests of the WAIS, adult males achieved higher mean scores in six of the seven age groups studied by Wechsler (1955). On a perceptual maze test, Davies (1965) found men's performance consistently higher than women's before the age of 60 years. Also, with cubes, cards, spatial
orientation and spatial relationship tasks, Very (1967) found that men scored higher than women. Blum et al. (1972) tested a sample of 20 males and 34 females at ages 64 and 84 years using the Block Design subtest of the WAIS. At both testings the women outscored the men though the differences were not statistically significant. Cohen (1977) administered a test battery (including six measures of spatial ability) to 96 men, mean age 69 years, and 100 women, mean age 70 years. Mean score differences favored men on five of these six measures. McGee (1979) concluded from his review that the male superiority found at puberty on tasks requiring spatial visualization and orientation is one of the most consistent findings in the individual differences literature.

McGee proposes that sex differences in other areas of cognitive functioning (for example, mathematics) may result as a secondary consequence of sex differences in spatial ability. There is evidence that cognitive tasks with a spatial component do tend to show a male advantage. For example, among 10-year-olds, boys were found to be better than girls at discriminating between various two-dimensional shapes (Etaugh & Turton, 1977). Coltheart, Hull, and Slater (1975) reported that when college-age males and females were asked to search the alphabet mentally either for a given shape or for a given
sound, males were faster and made fewer errors than females on the shape task. While females were faster and made fewer errors than males on the sound task.

**Memory Processes**

While not traditionally a focus of sex differences research, the study of individual differences in human memory represents an area of increasing research interest. Previous work has infrequently observed sex differences in memory performance (Maccoby & Jacklin, 1974). According to Maccoby and Jacklin, boys and girls are equally likely to use strategies such as rehearsal to aid recall. Furthermore, paired associate learning scores are not significantly different for males and females, nor are there differences between males and females on incidental learning or learning through imitation tasks. However, their review did cite evidence of a female advantage on recall scores for verbal material, especially after the age of seven. Sex differences in memory performance were seldom found for objects or digits.

Given the consistent sex differences reported in the areas of verbal and spatial ability, sex differences might be expected for some aspects of memory performance. A direct comparison of male and female memory performance revealed that females tend to show better retention of
verbal material than do males, while males are more likely to excel when memory tasks require the use of spatial skills (Arlin & Brody, 1976). Longstreth and Madigan (1982) examined sex differences in a variety of memory processing components. Using a digit span task they measured memory span by presenting subjects with a string of digits (ranging from four to five digits) at a rate of one per second. They then asked subjects to recall immediately the string of digits in order by writing them down after the last digit in the series appeared. No sex differences in overall memory performance were found. However, they did find that speed of short-term memory (STM) scanning, that is, the time it takes to scan the list of digits in memory and decide if a new stimulus is part of that set, is positively correlated with memory span in females but not in males. Memory span is also positively correlated with immediate free recall of word lists in females but not in males. Finally, memory span is positively correlated with recognition memory of word lists in males but not in females. However, the correlation is reduced when letters rather than digits are used for memory span measurement.

Several studies have examined the relationship between psychometric measures of verbal ability, spatial ability and memory performance. For example, Hunt,
Frost, and Lunneborg (1973) and Hunt, Lunneborg, and Lewis (1975) found positive correlations between spatial ability and performance on tasks requiring imaginal processing and positive correlations between verbal ability and performance on memory tasks involving verbal material. Hunt et al. (1975) reported that letter-pair matches were found to take longer when letter names versus letter shapes were being compared. For example, when subjects were presented with the letters (AA) or the letters (Aa) and asked to decide if the two letters were the same, (Aa) decisions took longer than (AA) decisions. Hunt et al. hypothesized that this difference reflected the added time required to retrieve letter names from long-term memory (LTM) store. Further, Hunt et al. found that subjects characterized by high verbal ability scores were significantly faster at making name matches than were subjects with low verbal ability scores; presumably reflecting faster access to LTM among high verbal subjects. Goldberg et al. (1977) examined the effects of verbal ability and sex of subject on performance in a simultaneous matching task. Subjects were required to decide if word-pairs were the same or different based on physical features or semantic attributes (for example, homophones, taxonomic category). Similar to Hunt et al. (1975), Goldberg et al. found that high verbal subjects
were faster than low verbal subjects in making semantic as well as physical shape matches. No sex differences were reported in terms of speed of accessing LTM. However, males and females were matched for verbal ability; potentially reducing sex differences in the speed of LTM access between males and females.

In a correlational study Ernest (1983) examined objective and subjective indices of imagery, spatial ability and verbal ability, and their relationship to recognition memory in males and females. Specifically, subjects were administered three objective measures of spatial ability, Flags, Space Relations, and the Minnesota Paper Formboard test. The Flags test consisted of 21 items. For each item a flag is presented with six other flags in different positions to its right. Subjects must decide if each flag is the "same" or "opposite" compared to the stimulus flag. For the Space Relations test subjects decided for each of 40 items which one of four three-dimensional objects could be formed from a two-dimensional drawing. The Minnesota Paper Formboard test required subjects to decide for each of 64 items which one of five figures depicted how geometrically shaped segments would look if all segments were fitted together. Subjects were also administered two objective measures of verbal ability (Vocabulary and Verbal
Fluency). The Vocabulary test consisted of 36 items. Subjects were asked to choose the correct meaning of each word from five alternatives. The Verbal Fluency test required subjects to generate associations to four concrete and four abstract words. One minute was allowed for each of the eight words. The total number of words generated across the eight words constituted the score. Subjects also completed three self-ratings of imagery and verbal ability (subjects rated the vividness of their images across senses, the ease with which they can control or manipulate their images, and the extent to which they rely on verbal or imagery methods of thinking in various situations). These measures were then correlated with subjects' recognition scores on word or picture lists. Both learning and test lists for the picture and word recognition tasks contained 80 items (words or pictures) presented at a rate of one every five seconds. Each test list included 40 items previously seen in the learning list and 40 new (distractor) items. Subjects responded "yes" if they recognized a word or picture from the learning list and "no" if they did not recognize the word or picture. Approximately three and one-half minutes separated learning and test lists. Results revealed a female advantage on both picture and word recognition tasks. For all subjects recognition memory
for pictures was positively correlated with two objective measures of spatial ability (Space Relations and Minnesota Paper Formboard). No correlations were found between verbal tests and word recognition. All spatial measures correlated positively and significantly with verbal ability as measured by the Vocabulary test for females but not for males. No verbal test was found to predict word list memory for any subjects. Ernest (1983) concluded that objective spatial ability is a significant predictor of picture recognition memory in both males and females. Further, regardless of the nature of the memory task, females performed better than males despite the fact that they did not excel on the ability tests correlated with memory performance.

Some memory studies which report using sex of the subject as an independent variable have found superior performance by males on spatial memory tasks but no difference between males and females on verbal memory tasks (Grossi, Orsini, Monetti, & DeMichele, 1979; Hall, 1978; Orsini, Schiappa, & Grossi, 1981; Townes, Martin, Trupin, & Goldstein, 1980), while others not only report male superiority in spatial memory but have also found that females surpass males in verbal memory (Andersen, 1976; Majeres, 1983). A study by Kail and Siegel (1977) revealed a male advantage on spatial memory tasks as well
as a female advantage on verbal memory tasks. The procedure utilized by Kail and Siegel allowed the comparison of verbal and spatial memory under conditions in which the structure and demands of the task were the same for recall of both types of information. Specifically, nine 4x4 matrices displaying either three, five, or seven letters were used. Third-grade, sixth-grade, and college-age subjects viewed each slide for seven seconds. Before viewing each slide they were instructed to remember either the names of the letters (verbal memory), the positions of the letters within the matrix (spatial memory), or both the names of the letters and positions of the letters. All main effects except Sex of Subject were significant. Recall increased with age; recall was greater for seven-item than for five-item sets; recall was lower when both letters and positions were recalled more accurately than positions. A significant Sex by Stimulus Type interaction revealed that males remembered letters more accurately than positions. Neuman-Keuls analyses revealed that females' recall of positions was less than their recall of letters and less than males' recall of letters or positions (ps < .05). This pattern of results was consistent across grade level with the exceptions that third-grade boys and girls
remembered letters equally well and college women recalled positions more accurately than did college males.

In an effort to extend the findings of Kail and Siegel (1977), Tabor, Sarafolean, and Petros (1984) tested only college-age subjects with the same procedures as did Kail and Siegel, but in addition, matched males and females on their verbal ability as measured by the WAIS Vocabulary subtest. Duration of slide exposure was also varied in this study, such that each slide was exposed for either three, five, or seven seconds. Subjects were 28 male and 28 female college students. The results indicated that college-age females consistently recalled fewer positions than did college males regardless of the duration of slide exposure or the size of the stimulus set to be recalled. While there were no sex differences in the number of letters recalled, subjects of both sexes classified as High Verbal recalled more letters than did Low Verbal subjects. Verbal ability had no effect on the recall of positions.

The research to date examining sex differences and memory suggests the need to consider factors other than gender of subjects to understand better the differences in memory performance between males and females. Verbal ability and spatial ability represent two of these factors.
The theoretical explanations of sex differences in cognitive functioning fall under the headings of: (a) genetic influences, (b) hormonal influences, (c) neurological influences, and (d) socialization. A brief overview of each of these perspectives, along with representative research, will be presented next.

Genetic Influences

Sex-Linked Major Gene Hypothesis

Initial research on the question of inheritance of specific cognitive abilities suggests that while both verbal and spatial abilities seem to have high levels of heritability, verbal ability seems to be more influenced by cultural and educational variables while spatial abilities appear less affected by such factors (Vandenberg, 1968). A genetic theory of spatial ability was originally proposed by O'Connor in 1943 to account for the often observed male advantage on spatial tests. The basic hypothesis suggests that a recessive gene on the X chromosome enhances performance on tasks requiring spatial visualization (Vandenberg & Kuse, 1979). In his original
study O'Connor (1943) observed that only 25% of the females in his sample scored above the male median on a test of spatial ability. He suggested that the data were consistent with recessive sex-linked determination of a trait.

As McGee (1979) explains, in a population at equilibrium, one-third of the X-linked genes are carried by males and two-thirds are carried by females since females inherit two X chromosomes (one from each parent) compared to the male's one X chromosome. Thus males will exhibit the recessive trait (for example, enhanced spatial ability) whenever the gene is transmitted to them. Females, however, would exhibit the trait only upon receiving the gene from both parents.

Females with a double recessive genotype would be expected to occur in the population with a frequency of \( q^2 \)--the square of the frequency of males carrying the single recessive gene (McGee, 1979). Where the frequency of the recessive spatial enhancing gene \( q \) equals 0 or 1.0 the absolute sex difference \( (q - q^2) \) will be 0 (Jensen, 1975). As the value of \( q \) departs from 0 or 1.0, the absolute sex difference will increase. With a gene frequency of 0.5 the sex difference in spatial ability is maximized with a 1:2 ratio of enhanced females to males.
Supporting evidence for the sex-linked major gene hypothesis comes primarily from studies which have focused on the correlation between the spatial performance of children and their same-sex and opposite-sex parents (for a comprehensive review see: Harris, 1978; Vandenberg & Kuse, 1979). The pattern of these correlations for an X-linked trait is distinguishable from the pattern for autosomal inheritance. Harris (1978) explains that a sex-linked recessive trait can be expressed in females only if it is present on both chromosomes. But, if present, it can be expressed in any male since there is no dominant counterpart in the absence of another X chromosome. Thus, if the mother carries the recessive gene for enhanced spatial ability on both her chromosomes then all her sons will express the spatial ability trait. The mother's daughter may, or may not, express the spatial ability trait depending on whether or not the X chromosome contributed by her father also carries the spatial ability gene. The sex-linked recessive gene model thus predicts a higher mother-son than mother-daughter correlation on spatial ability scores. Because the father does not transmit an X chromosome to his son the correlation between their spatial abilities should be very low if not zero. In contrast to the pattern of correlations predicted by the sex-linked recessive model,
no difference in the parent-child correlations would be expected for autosomal inheritance.

A number of family correlation studies reviewed by Harris (1978) provide evidence to support a recessive sex-linked model for the inheritance of spatial ability. For example, Stafford (1961) gave the Identical Blocks Test (a measure of spatial visualization) to 104 fathers and mothers and to their 58 teenage sons and 70 teenage daughters. Correlations were fairly high for both mothers and their sons (r=0.39) and for fathers and their daughters (r=0.36). The mother-daughter correlation was lower (r=0.18) and the father-son correlation was zero. A similar pattern of correlations was reported by Hartlage (1970) who tested 25 families with the spatial subtests or the Differential Aptitude Test.

One of the largest family correlation studies (DeFries, Wandenberg, & McClearn, 1976) tested 400 families using three different tests of spatial ability (Mental Rotation, Paper Form Board, and Card Rotations). This study failed to demonstrate evidence for the sex-linked pattern of familial correlations. However, two other large family studies (Bock & Kolakowski, 1973; Yen, 1975) did obtain results largely consistent with the sex-linked recessive gene hypothesis.
The most convincing challenge to the recessive gene model has come from findings of spatial performance in individuals who suffer a chromosomal anomaly known as Turner's syndrome (Turner, 1938). Garron (1970) has pointed out an inconsistency between the implications of the model and these findings. Unlike normal females the two X chromosomes (XX), and normal males with one X and one Y (XY), Turner's syndrome cases typically have only one sex chromosome (XO). Although these females perform as well as normal females on verbal tests, they appear to suffer a deficit on performance tests which require spatial skills (Vandenberg & Kuse, 1979). If spatial ability is X-linked Turner's syndrome females should display the same level of spatial skills as normal males since the X chromosome complement is similar in both groups (Garron, 1970). However, the evidence is just the opposite: females with Turner's syndrome have less rather than more spatial ability than normal females.

Garron's criticism of the recessive gene model seems well founded. However, others have suggested that perhaps the lack of male-like spatial abilities in Turner's victims is related to a hormonal imbalance (Bock, 1970; Bock & Kolakowski, 1973). Since gonadal agenesis is a common occurrence in Turner's females, a lower than average amount of ovarian testosterone is produced. There
is some evidence that a threshold level of testosterone must be reached before the recessive trait of spatial ability can be expressed (Harris, 1978). Several researchers have speculated on how genetic sex differences in cognitive abilities might be translated into phenotypic differences. The most popular hypotheses have invoked the effects of pre- and post-natal sex hormones (testosterone and estrogen).

**Hormones and Cognitive Functioning**

Several authors have suggested the sex hormones as a possible biological mechanism influencing the report sex-related differences in cognitive functioning (Broverman, Klaiber, Kobayashi, & Vogel, 1968; Englander-Golden, Willis, & Dienstbier, 1976; Petersen, 1976). The search for linkages between the sex hormones and the sex-related differences in cognitive functioning was initiated by a belief that behaviors showing differences between the sexes could be related to the more obvious biological differences between males and females (Petersen, 1979). Broverman and his colleagues (Broverman, Broverman, Vogel, & Palmer, 1964) have focused on the relationship of the sex hormones to various types of behavior for over two decades. These investigators described two contrasting cognitive styles which they
propose are correlated with an individual's hormonal levels.

The automitization style is characterized by the ability to perform well on tasks requiring "rapid, skillful, repetitive, articulation or coordination of 'lightweight' overlearned responses" (Broverman et al., 1968, p. 25). The authors cite speed of color naming and the Digit Symbol subtest of the WAIS as examples of tasks with a significant automitization factor.

A second style, which involves what Broverman and Klaiber (1969) have labeled perceptual restructuring, involves the cognitive ability to inhibit responses to obvious stimulus characteristics in favor of responses to less obvious stimulus relationships. Broverman and Klaiber argue that this style is advantageous to skillful performance on spatial tasks such as the Embedded Figures Test (Witkin, 1950) and two Wechsler subtests, Block Design and Object Assembly (Wechsler, 1955). Factor analyses of performance scores on these types of cognitive tasks have consistently revealed a single bipolar factor with the simple repetitive automitization tasks defining one pole and perceptual-restructuring tasks defining the other pole (Broverman, 1964; Broverman & Klaiber, 1969; Klaiber, Broverman, & Kobayashi, 1967).
The effect of sex hormones on cognitive style is proposed to occur as a result of the influence of the sex hormones on nervous system activity (Broverman et al., 1968). Cognitive functioning is conceptualized by Broverman, Broverman, Broverman, and Klaiber (1966) as the result of two competing systems: (a) the Adrenergic nervous system and (b) the Cholinergic system. The Adrenergic system has a mobilizing function that prepares it for activation and thus facilitates the performance of simple repetitive tasks. The Cholinergic system functions to promote relaxation or inhibition of activity and thus contributes to the cognitive ability to delay and inhibit initial responses to obvious stimulus attributes in favor of responses to less obvious stimulus relationships (Harris, 1978). Males' androgen steroids are presumed to produce a hormonal balance favoring cholinergic activity, thus facilitating performance on perceptual restructuring tasks. Females, on the other hand, tend to be more adrenergic than cholinergic and therefore perform better on tasks requiring automimization relative to tasks requiring perceptual-restructuring ability.

Most of the direct supporting evidence for the Broverman model comes from animal studies (Harris, 1978). The model has been criticized on physiological (Parlee, 1972) and methodological (Singer & Montgomery, 1968)
grounds and has never been fully borne out by experimental means (including attempts to do so in their own laboratory; cf. Klaiber, Broverman, Vogel, Abraham, & Cone, 1971).

The most consistent evidence in support of a hypothesized relationship between sex hormones and cognitive function in humans has come from studies inferring endocrine status from somatic characteristics (for example, muscle versus fat distribution, overall body shape, pubic hair distribution). For example, Broverman et al. (1964) and Broverman and Klaiber (1969) examined the relationship between androgenicity (level of androgens), as indexed by greater amounts of body and pubic hair and performance on spatial tasks in adolescent boys and young men. They observed an inverse relationship such that the more androgenized males performed relatively worse on spatial tests as compared to the less androgenized males. A more recent study by Petersen (1976) used similar but not identical cognitive measures to those used by Broverman. In addition to spatial ability measured with the Wechsler Block Design subtest and the Space subtest of the Primary Mental Abilities Test (PMA), Petersen obtained a measure of fluent production, defined as the rapid and accurate production of symbolic codes or names as measured by the Digit
Symbol subtest of the WAIS and the Word Fluency subtest from the PMA. Both tests contain a component of verbal ability as well as automatization style. The results of Petersen's study replicated Broverman's findings for males but not for females. The results revealed that for males at ages 16 and 18, greater biological androgyny (that is, less sex stereotypic in physical appearance) was related to better spatial ability scores relative to fluent production scores. In contrast, males with more extremely masculine physical characteristics were better at fluent production relative to spatial ability. With females the results varied from expectations based on past research with males. Androgyny in terms of somatic indices of endocrine influence was only related to spatial ability. Females who were good spatial visualizers tended to be androgynous in physical appearance (that is, less sex stereotypic). For females, fluent production was not related to physical androgyny in any consistent fashion.

The pattern of results obtained by Petersen was inconsistent with previously outlined sex differences in cognition. If we accept the conclusion that males tend to perform better than females on spatial tasks and females tend to perform better than males on verbal ones, a reasonable hormonal hypothesis might be that more "male" hormones should result in a proficiency at "masculine"
cognitive asks (spatial ability; while more "female" hormones should produce the "feminine" cognitive abilities (verbal fluency). The first part of this proposal does hold true for females; that is, females scoring higher at spatial tests do appear to be more masculinized (biologically androgynous). However, males who are more masculinized do less well on spatial tasks and perform better on those tasks at which females excel. To account for this seeming discrepancy, Petersen has proposed a curvilinear relationship between hormone influences and spatial ability such that at intermediate levels the androgen/estrogen ratio is most favorable to high spatial ability. The good spatial visualizer of either sex, therefore, is less sexually differentiated in terms of sex hormone levels (Harris, 1978; Petersen, 1979).

The effect of androgens on intellectual functioning has been examined in a number of clinical populations. One such group is comprised of genetic males whose physical appearance resembles phenotypic females. In this syndrome, known as androgen insensitivity syndrome, genetically male "girls" produce normal amounts of both estrogen and androgen but are unable to make use of the androgen. The result is phenotypic females who are unable to bear children but exhibit female secondary sexual characteristics. These individuals are typically
raised as females. In a study of 15 of these patients (ages 5 to 27 years), Masica et al. (1969) found that their poorest scores were on spatial subtests of the WAIS and their best scores were on the verbal subtests. These findings are surprising insofar as the subjects are chromosomal and gonadal males, but not surprising when one considers that they are phenotypic and hormonal females. Burstein et al. (1980) observed at the date of testing these individuals had been raised as females presumably with the concomitant socialization practices, so that environmental and hormonal influences operated in the same direction.

A second clinical group which has been studied consists of individuals with adrenogenital syndrome (AGS), an autosomal-recessive disorder with excessive production of androgens in the fetus, and the resultant virilization of female fetuses (Money & Lewis, 1966). These individuals assume the normal appearance of their genetic sex, but have had increased androgenic stimulation during fetal life. Baker and Ehrhardt (1974) hypothesize that if fetal hormones are involved in the development of normal sex differences in cognitive abilities in humans, then females exposed to high levels of androgens would show a pattern of strengths and weaknesses in cognitive abilities more similar to normal males than to normal females. These investigators compared AGS individuals'
performance on the Block Design and Object Assembly subtests of the WAIS and Thurstone's PMA tests with their parents' and siblings' performances. No significant differences were found between verbal and performance IQ for the AGS sample. The subjects did not perform significantly different from their parents or siblings on the subtests. Performance on the spatial subtests was not significantly better for the AGS sample than for the controls. Similarly, McGuire et al. (1972) found no difference between AGS patients and matched family controls on sex-typed tasks of cognitive abilities, though they did find that both groups scored significantly higher than normals.

Another line of hormonal research has investigated the relationship between naturally occurring cyclic variations in hormone levels of the female menstrual cycle and cognitive abilities. A wide range of functions from simple perceptual judgments to critical thinking have been studied in relation to the menstrual cycle.

In her review of this literature, Asso (1983) concluded that "objectively measured performance on perceptual motor, and on more complex cognitive functions, does not change in any well-defined way with the cycle, in women in general" (p. 73). Somer (1973) and Graham (1980) reached similar conclusions in their earlier reviews.
In a further examination of cognitive changes across the menstrual cycle, Broverman et al. (1981) carried out a study based on the model of automitization and perceptual restructuring styles outlined earlier. Specifically, they predicted that the performance of automitization tasks should be better just prior to ovulation (when estrogen levels peak) than in the post-ovulatory phase (when estrogen declines and progesterone peaks). The reverse pattern was predicted for perceptual-restructuring tasks. For women with anovulatory cycles no variability in task performance was predicted. Subjects were 87 women, 21 (24%) of whom were found to be anovulatory during the menstrual cycle under study. Ovulation was determined by the rise and fall of basal body temperatures. Each subject was administered two automitization tasks: (a) speed of reading repeated color names and (b) speed of naming repeated colors, and two perceptual-restructuring tasks: (a) the Embedded Figures Test and (b) the WAIS Block Design subtest. Subjects were administered this battery of four tasks on two occasions: (a) at Day 10 (pre-ovulation) and (b) at Day 20 (post-ovulation). Results indicated that, as predicted, the anovulatory group did not show significant differences in task performance between Day 10 and Day 20. Among the group of women who ovulated the predicted
changes in performance of automitization and perceptual-restructuring tasks were found but only when testing occurred in close temporal relation to the actual pre-ovulatory estrogen peak and the post-ovulatory progesterone peak. In this study only 19 (22%) subjects were tested at the appropriate times with respect to the inferred hormonal peaks. Broverman et al. commented that this small percentage of "hits" may explain why many studies fail to find menstrual cycle changes in cognitive performance.

Sommer (1973) found that when self-report studies of cognitive performance are considered that 8% to 16% of women report their faculties are reduced, particularly in the premenstrual phase, despite the lack of objective evidence of impaired performance. Self-reported difficulties in concentration tend to be highest during the premenstrual or menstrual phase (Garling & Roberts, 1980; Golub, 1976; Moos et al., 1969).

The effects of oral contraceptives on cognitive performance have just begun to be explored. One report (Wuttke et al., 1975) found that combination pill-users (equal amounts of estrogen and progesterone in one tablet) compared with non-users, had slower reaction times and took longer to do simple arithmetic problems. Another study, using an abstract reasoning task, found that women
taking a combination pill had higher scores than those not taking oral contraceptives (Sommer, 1972). Sommer suggested that future research might explore whether the higher scores obtained by pill-users might be accounted for by factors other than the pill. She hypothesized that the pill-users as a group may have slightly higher motivation and/or intelligence and may also be rather more stable and less anxious as a group.

A clear understanding of the role of pre- and post-natal hormones in the developmental of differential cognitive abilities is yet to be achieved. However, it is likely that these factors exert their influence by directly or indirectly influencing the organization or functioning of the brain.

Neurological Influences

Neurological studies showing variations in the lateral organization of the human brain suggest a structural source of the variation in human cognitive abilities. Further, evidence of differences in localization of cognitive functions (lateralization) and perhaps in brain anatomy between males and females has been offered as an explanation for sex differences in verbal and spatial abilities.
Hemispheric specialization. Language function was the first higher mental process found to be asymmetrically represented in the human brain (Nebes, 1974). Kimura (1961) was among the first investigators who employed Broadbent's (1936) technique of dichotic listening for the examination of hemispheric specialization. She demonstrated that when pairs of contrasting digits were presented simultaneously to the right and left ears, those presented to the right ear were more accurately reported. Right ear (left hemisphere) advantage for processing verbal stimuli (for example, numbers, words, and letters) has since been confirmed by other investigators (Milner, Taylor, & Sperry, 1968; Sparks & Geschwind, 1968; Sparks & Geschwind, 1968; Studdert-Kennedy & Shankweiler, 1970).

Conversely, a left ear (right hemisphere) advantage for the processing of difficult-to-verbalize stimuli (for example, melodies, sonar signals, and abstract patterns of sound) has also been demonstrated using tachistoscopic procedures (Curry, 1967; Kimura, 1964, 1966; Vignolo, 1969).

Buffery and Gray (1972) found convincing evidence that each hemisphere primarily subserves its contralateral limbs and visual hemifield and that in about 96% of the normal adult population, cerebral dominance for verbal
functions is subserved by the left hemisphere, whereas the right hemisphere predominates in subserving nonverbal functions. Several investigations of patients with unilateral brain lesions have demonstrated that spatial abilities are more adversely affected by right than by left cerebral injury (Kimura, 1967; McFie, Piercy, & Zangwill, 1950; Milner, 1962). Similarly, it has been demonstrated that patients who have suffered lesions of the left temporal lobe show impaired memory for verbal materials but nonsignificant performance decrements on tasks such as memory for faces (Milner et al., 1968) and maze learning (Corkin, 1965; Milner, 1965).

**Lateralization and sex differences in cognitive abilities.** McGee (1979) proposed that sex differences in hemispheric specialization, or lateralization, underlie sex differences on tasks requiring verbal versus spatial ability. Specifically, he reviewed clinical and experimental data which supports the conclusion that males have greater right hemispheric specialization than females, and thus have superior spatial skills. Knox and Kimura (1970), for example, studied dichotic listening to nonverbal stimuli (environmental and animal noises such as a phone ringing, a dog barking) among 80 right-handed male and female children between the ages of five and
eight years. Males showed a greater left ear (right hemisphere) superiority than females across all ages.

Witelson (1976) presented children ages 3 to 13 years with a tactual version of the dichotic recognition technique. The children (all right-handed) were instructed to touch unfamiliar shapes and then to identify the forms by pointing to a visual display of a group of shapes. Males at age five and beyond showed a significant left-hand (right hemisphere) advantage. Girls showed significant left-hand superiority but not until after age 13. Witelson concluded that the right hemisphere may be specialized for spatial processing earlier in boys than in girls.

Opposition to the conclusion that males have greater right hemisphere specialization and thus greater spatial ability than females has been proposed by Buffery and Gray (1972). Based on developmental studies they proposed that females are in fact more lateralized than males for both language and spatial skills. Further, they argued that while unilateral control of speech embraces verbal ability, spatial ability is enhanced by bilateral (both hemispheres) representation.

Another opposing hypothesis has been offered by Harris (1978). According to Harris, "the male eventually equals and then surpasses the female in degree of left
hemisphere lateralization, so that in adulthood, language in females is bilaterally represented, thus impeding her spatial ability" (p. 460). In other words, lateralization for speech perception is stronger in males than females. Levy (1969) proposed that unilateral dominance for speech is associated with better spatial ability since linguistic processing is likely to interfere with spatial processing when the two are mediated by the same hemisphere. Harris provided support for the postulate that bilateral cerebral representation impedes spatial skills mainly on the basis of studies of left-handers. The assumption is that left-handers tend to be less well lateralized (more bilateral) than right-handers in terms of cerebral representation of verbal and spatial functions (Bryden, 1965). The implication is that left-handers, like females, should score lower on tests of spatial ability than right-handers, since they are less well lateralized. Evidence exists to support the relationship between left-handedness and spatial deficits (Levy, 1969; McGlone & Davidson, 1973; Nebes & Briggs, 1974). However, McGee (1979) points out that these studies are typically based on small samples and differences associated with sex are not always examined. In addition, numerous other studies (Fagan-Dubin, 1974; McGee, 1976, 1978; Newcombe & Ratcliff, 1973) fail to support the prediction of poorer
overall performance on spati - tasks by left- than right-handers.

Some evidence of anatomical asymmetry of the brain has been found to correspond to the sex differences in functional asymmetry observed in various studies of performance. In postmortem measurements of the planum temporale (an area of the superior surface of the temporal lobe, important for language functions), Wada (1974) found the left temporal lobe to be larger than the right in males, while female brains appeared more symmetrical. Similar differences in fetal brains have been reported by Wada as well as McGuinness and Pribram (1979). More recently, Goleman (1989) summarized a study by Witelson which found that part of the corpus callosum, the fibers that connect the right and left hemispheres of the brain, is larger in women than in men. In a second study reported by Goleman, magnetic resonance imaging techniques found a positive correlation between the size of the splenium (a part of the corpus callosum) and performance on a verbal fluency test in a study of 29 women. These researchers hypothesize that the larger the corpus callosum the greater the communication between hemispheres and thus the better one's language skills.

In summary, the clinical and experimental literature clearly supports right hemisphere dominance for nonverbal
(including spatial) skills and left hemisphere dominance for verbal skills. The causal relationship, if any, between sex differences in hemispheric specialization and sex differences in cognitive performance remains to be determined.

Socialization: Sex-Role Orientation as a Mediator in Cognitive Functioning

Beginning in the 1970s the concept of psychological androgyny has been a focus of social psychology research. Much of this literature is based on the assumption that:
(a) masculinity and femininity are not mutually exclusive and (b) for individuals of both sexes it is a disadvantage to be strongly sex-typed, that is, strongly committed to a traditional masculine or feminine set of values, traits, and behaviors (Taylor & Hall, 1982).

Bem (1974) used standardized differences between femininity and masculinity scores on the Bem Sex Role Inventory (BSRI) to identify three types of people: (a) those reporting predominantly feminine characteristics, (b) those reporting predominately masculine characteristics, and (c) the "androgynous" individual, who reported a balance of masculine and feminine traits. In her initial proposal, Bem defined adrogy as a minimal difference between masculinity and
femininity scales of the BSRI. As such, Bem's initial formulation resulted in a unidimensional scale, ranging from high masculinity at one end to high femininity at the other, with androgyny falling at mid-range.

Bem's operational definition of androgyny was challenged by Spence, Helmreich, and Stapp (1975), who advocated that the androgynous label be reserved for individuals who score high on both the masculinity and femininity scales. Using this model a four-group typology results which classifies individuals as: (a) male-typed (high masculine and low feminine), (b) female-typed (high feminine and low masculine), (c) androgynous (high masculine and high feminine), and (d) undifferentiated (low masculine and low feminine). Originally implemented with the masculinity and femininity scores of the Personal Attributes Questionnaire (PAQ; Spence, Helmreich, & Stapp, 1974) this four-category model has been adopted by most sex-role investigators, including Bem (1977).

The advantages attributed to androgynous individuals include such qualities as adaptability and flexibility (Bem, 1975). Bem explained that the highly sex-typed individual (either masculine or feminine) is motivated to keep his behavior consistent with an internalized sex-role standard, suppressing any behavior that may be at odds with this masculine or feminine self-concept.
However, "a mixed, or androgynous, self-concept might allow an individual to fully engage in both 'masculine' or 'feminine' behaviors" (p. 155).

Other researchers have focused attention on the association between androgyny and measures of psychological health and adjustment. Spence et al. (1975) examined the correlations between sex-role orientation and self-esteem. They found that in both sexes androgynous and second, masculine, individuals scored higher on measures of self-esteem and lower on measures of anxiety and depression than did feminine or undifferentiated individuals.

Since the initial research on androgyny first appeared a number of investigators have engaged in more careful analyses of the construct. A central issue in this regard concerns the meaning of the scale itself and what it measures. Many investigators, led by Spence and Helmreich (1978), have argued for a narrower interpretation of masculinity and femininity than originally proposed by Bem. From this viewpoint the so-called "masculinity" scale is primarily a measure of self-assertive, instrumental attributes (for example, independent, active, self-confident) and the "femininity" scale is primarily a measure of interpersonally-oriented expressive qualities (for example, kind, tactful, aware.
of others' feelings). As such, these measures should allow good prediction of behaviors that are highly weighted in favor of instrumental and expressive traits (for example, career choice), but should not necessarily predict other domains of gender-related behaviors (Deaux, 1984).

A second and related issue concerns the unique predictability of androgyny (the interaction of masculinity and femininity) versus the main effect contributions of the masculine and feminine scales alone. A review by Taylor and Hall (1982) offers evidence to support the conclusion that the contributions of masculinity and femininity are additive and that the interaction of the two factors does not offer any greater predictability.

Several studies have examined the relationship between sex-role orientation and cognitive performance. Researchers have hypothesized that an individual's degree of masculinity or femininity may be correlated with cognitive abilities, especially those found to correlate with gender (for example, spatial and verbal skills).

Nash (1975) investigated the relationship between spatial ability, sex-role concept, and sex-role preference among groups of sixth-grade (N=105) and ninth-grade (N=102) students. Subjects' visual-spatial
aptitudes were assessed on the Differential Aptitude Space Relations Test, Form A (Bennett, Seashore, & Wesman, 1947). Subjects' sex-role conceptions were assessed on two instruments: (a) an open-format questionnaire and (b) a closed-format bipolar semantic differential task. The open-format questionnaire was used to assess sex-role preference and the subject's view of our culture's preferred sex-role. Subjects were asked to respond to the questions: Is it better to be male or female? Explain and Would you rather be male or female? Explain.

The closed-format questionnaire consisted of 98 items chosen from among (a) the sex-role stereotypes spontaneously offered by 360 pilot study subjects and (b) the sex-typed attributes and activities rated stereotypic by college and adult subjects in the Broverman, Broverman, Clarkson, Rosenkrantz, and Vo~1 (1970) study. The method involved bipolar representation of sex-typed traits and activities (for example, active-passive) on seven-point semantic differential scales. For each of the paired attributes subjects were asked to indicate where on the continuum he or she would rank the "average man", "average woman", "self", and "ideal self". Ten items were identified by Nash as being intellectually relevant, that is, having implications for intellectual ability. For
example, "likes math and science", "does not give up easily".

Results indicated that among sixth-grade subjects there were no sex differences on the DAT Space Relation Test. Among ninth-grade subjects boys scored significantly higher than girls on this measure. Nash (1975) also found that, for all subjects, scores on the 10 intellectually relevant items of the closed-format questionnaire were significantly correlated with spatial ability as measured by the DAT. Specifically, the more masculine a boy rated his actual self on these items the better his spatial performance; the more masculine he rated others relative to himself, the worse his performance. For females, the more masculine a girl rated her ideal-self, the better her spatial performance; the more masculine she rated other females relative to herself, the worse her performance. In addition, subjects who stated a preference to be boys scored significantly higher on the DAT than subjects who preferred to be girls. Nash concludes that masculine males perform better than feminine males, and masculine females perform better than feminine females on spatial visualization tests.

Newcombe and Bandura (1983) examined the contributions of rate of maturation (timing of puberty), brain hemisphere specialization (as measured by a
recognition test of haptically explored nonsense forms), sex-role orientation, and participation in spatial activities (for example, building model planes, doing carpentry) to spatial ability scores in a group of 85 sixth-grade girls. Spatial ability was measured by the Spatial Relations subtest of the Primary Mental Abilities Test (PMA; Thurstone, 1962) and the Block Design subtest of the Wechsler Intelligence Scale for Children. Measures of sex-role orientation included: (a) the Femininity Scale of the California Personality Inventory (CPI), (b) the Personal Attributes Questionnaire (PAQ), (c) Actual Self and Ideal Self ratings on the 10-item scale of intellectually relevant sex-typed items used by Nash (1975), and (d) a questionnaire asking subjects the extent to which they would prefer to be a person of the opposite sex.

Regression analysis revealed that later maturers had higher spatial scores than earlier maturers. No significant relationship between laterality (right versus left hemisphere dominance) and spatial ability was found. A significant overall relationship between a set of eight psychosocial variables (CPI Femininity Scale, PAQ Masculinity Scale, PAQ Femininity Scale, PAQ M-F Scale, Nash's Actual and Ideal Self Scales, wanting to be a boy, and spatial activities participation) and spatial ability
was found, accounting for 37% of the variance in spatial ability. Five predictors were individually significant: (a) PAQ Masculinity Scale (positively correlated), (b) Nash's Ideal Self Scale (positively correlated), (c) wanting to be a boy (positively correlated), (d) PAQ Femininity Scale (negatively correlated), and (e) the CPI Femininity Scale (positively correlated). However, only the first three predictors were found to have significant simple correlations with spatial ability. The spatial activity score was not related either to maturation rate or to spatial ability.

Thus, this study supported the hypothesized relationship between masculine personality traits and spatial ability in girls. Newcombe and Bandura concluded that an instrumental (masculine) personality, aspiring to masculine intellectual interests, and a desire to be a boy seemed to foster spatial ability in this sample. Possessing feminine traits may or may not be relevant to spatial ability.

A study by Popiel and DeLisi (1984) looked at specific factors of the Bem Sex-Role Inventory as they relate to spatial ability. Subjects were 39 male and 86 female students drawn from senior high school and college freshman courses. Spatial ability was measured by two tasks: (a) a paper-and-pencil version of the Piagetan
water-level task (Liben, 1978) which requires subjects to imagine and depict the spatial orientation of liquid inside a sealed container rotated to various angles and (b) the VZ-2 paper-folding test developed by Educational Testing Service. This task requires subjects to fold and unfold a piece of paper mentally and then choose the alternative that represents the paper after it has been unfolded. Significant sex differences on both tests were found with males outperforming females. No significant effects for sex-role classification were found for performance on either spatial ability measure.

Kaplan and Plake (1981) examined factors related to sex differences in mathematics achievement. Specifically, these authors looked at level of cognitive development (concrete versus formal) and sex-role orientation as they relate to mathematics achievement in a group of 29 male and 57 female undergraduates. Level of cognitive development was evaluated by the Test of Formal Operations (TOFO; Tomlinson-Keasey & Campbell, 1977). High (formal) and low (concrete) levels of cognitive development were determined by a median split on the total score. Sex-role orientation was measured by the Bem Sex-Role Inventory which yielded a Masculinity subscale and a Femininity subscale. Mathematics performance was measured by a
32-item multiple choice mathematics test derived from the American College Testing Program.

Analysis of variance results showed significant main effects for biological sex and cognitive level. Significant interactions of biological sex with masculinity scores and cognitive level with masculinity scores were also found. Further analysis of these interactions revealed that male subjects with strong masculine identification scored lower on the math test than males with low masculine identification. Females with high and low masculinity scores performed below both of these male groups on the math test. As regards cognitive level, for students at the concrete level, math performance was better for subjects with low BSRI masculinity scores. For students at the formal level, math performance was better for subjects with high BSRI masculinity scores. Knowledge of a subject's femininity scale score did not contribute significantly to predicting math performance.

The relationship between masculinity and femininity and the cognitive variables of math and verbal ability was examined in three groups of adolescents by Mills (1981). Masculinity and femininity were assessed using the Bem Sex-Role Inventory, the Femininity Scale from the California Personality Inventory (CPI; Gough, 1952), and
the Study of Values (Allport, Vernon, & Lindzey, 1970). The study utilized three groups of seventh and eighth grade males and females: (a) a "gifted" or intellectually talented group, (b) a private school sample, and (c) a public school sample. Cognitive scores were obtained from the Scholastic Aptitude Test, Verbal and Mathematics Sections (SAT-V & SAT-M) for the gifted sample, the General School Abilities Test (GSAT) for the private school students, and the Iowa Test of Basic Skills (ITBS) for the public school sample.

Results revealed significantly higher math scores for males than for females in all three groups. Verbal scores did not differ significantly between males and females in any of the groups.

Analysis of the relationship between the BSRI and math and verbal scores revealed a significant positive correlation between femininity scores and verbal ability scores for public school males but not for the other two groups of boys. A significant positive correlation between math scores and masculinity scores was found for public school girls but not for boys. In the gifted group, a significant negative correlation between masculinity and math scores was found. The same relationship, though not significant, was found for private school boys. For private school girls there was a
positive relationship between femininity scores and math scores.

Multiple regression analysis revealed that gifted boys with high verbal ability had feminine interests, a "moral introversion" personality style, and a preference for feminine values, particularly aesthetic values. Males with high math ability also had feminine interests, but with a masculine value orientation. Thus gifted boys of high ability (either math or verbal) were characterized by feminine interests and personality style.

The gifted girls' verbal scores were positively related to high femininity values. Mathematics scores were negatively related to stereotypic masculine interests and expressive (feminine) characteristics.

For the private school group math scores for the boys were positively related to masculine values and negatively related to masculine traits. There was a negative relationship between verbal scores and stereotypic masculine interests for private school boys. Private school girls showed a positive relationship between feminine values and verbal scores, and a positive relationship between math scores and feminine behavior traits.

Mills concluded that some support for her hypothesized relationship between math and masculine
variables for girls and verbal and feminine variables for boys was found but mainly in the public school sample. For the private school and gifted groups the relationship between math ability and masculine variables and between verbal ability and feminine variables was often found for both sexes.

Thus it appears from the studies just reviewed that sex-role orientation is one factor which accounts for a portion of the variance between males and females in spatial and verbal ability scores. This relationship between sex-role orientation and cognitive performance is complex but initial findings suggest that a masculine orientation is often conducive to better performance, especially on spatial tasks, for both sexes. The effect of feminine sex-role orientation on cognitive performance is less clearly understood.

Present Study

As the foregoing review illustrates, sex differences in a number of cognitive domains have been documented. A number of explanations for these sex differences have been proposed and investigated though no definitive conclusions have been reached regarding the exact mechanism(s) underlying sex differences in cognitive
performance. Certainly both biological and psychosocial factors have been shown to be relevant to understanding these differences.

The present study focused on one aspect of cognitive performance, human memory, and attempted to replicate and expand on previous sex difference research in this area (Andersen, 1976; Arlin & Brody, 1976; Grossi et al., 1979; Kail & Siegel, 1977; Majeres, 1983; Orsini et al., 1981; Tabor et al., 1984; Townes et al., 1980).

Specifically, male and female subjects were administered tests of verbal and spatial memory. Evidence exists to support a positive relationship between both verbal and spatial abilities (as measured by psychometric tests) and memory tasks with a corresponding verbal or spatial component (Hunt et al., 1973; Tabor et al., 1934). Furthermore, sex differences exist in the population on psychometric tests of verbal and spatial ability. Therefore, reported sex differences in verbal and spatial memory performance might be explained in part by these individual differences in psychometric measures of verbal and spatial ability. Thus, the contribution of psychometric differences in spatial and verbal ability to sex differences in memory performance was examined. With regard to sex-role orientation, a number of studies suggest that a relationship exists between sex-role
orientation and sex differences in various cognitive tasks including verbal and spatial performance. Both general measures of sex-role orientation such as the Personal Attributes Questionnaire and the Bem Sex-Role Inventory as well as more specific measures of sex-role attitudes such as Nash's (1975) intellectually relevant 10-item scale have been reported to be predictive of individual differences in patterns of cognitive performance. Therefore, reported sex differences in memory performance might be explained in part by individual differences in sex-role orientation.

The subjects in this study were college-age males and females. Each subject was administered psychometric measures of verbal and spatial ability as well as a general measure of sex-role orientation (Personal Attributes Questionnaire) and a more specific measure of stereotypic sex-role attitudes toward intellectual abilities (Nash, 1975, 10-item scale). The contribution of each of these factors to subjects' memory performance on both verbal and spatial memory tasks was analyzed using multiple regression procedures.

The primary purpose of this study was to replicate and extend previous research on sex differences in verbal and spatial memory by measuring spatial ability, verbal ability, and sex-role orientation and statistically
determining their contribution to the variance observed in memory scores.
Chapter 2

METHOD

Subjects

Thirty-seven males (mean age = 24.5 years) and 36 females (mean age = 25.9 years) served as subjects. All were undergraduate students at the University of North Dakota who volunteered to participate in this study in exchange for course credit. All participants were native English speakers and all reported 20/20 vision (natural or corrected).

Measures

Tests of Individual Differences in Cognitive Abilities

The following tests of verbal and spatial ability were utilized. All have been reported to yield consistent sex differences in performance scores.

**Verbal ability.** Subjects were administered a printed version of the Vocabulary subtest of the Wechsler Adult
The Intelligence Scale-Revised (WAIS-R) (Wechsler, 1981). This test consists of 35 words of increasing difficulty (based on frequency in the English language) which subjects are asked to define. Responses are scored as either 0, 1, or 2 points depending on the accuracy and completeness of their responses. Scores can range from 0-70.

Spatial ability. Visual-spatial aptitude was assessed using two separate measures of spatial ability. The Space Relations subtest of the Differential Aptitude Test, Form T (DAT) (Bennett et al., 1947) and the Block Design subtest of the WAIS-R (Wechsler, 1981). The Space Relations test requires subjects to decide for each of 80 items which of four three-dimensional objects could be formed from a two-dimensional drawing. Correct solutions require: (a) an ability to visualize a constructed three-dimensional object from a two-dimensional picture of a pattern (structural visualization) and (b) an ability to visualize the position of an object if rotated in various directions (space perception). The test is timed (35 minutes) and items become progressively more difficult. Scores can range from 0-60.

A second measure of visual-spatial aptitude, the Block Design subtest of the WAIS-R was also administered.
The Block Design test requires subjects to reproduce a three-dimensional block design from a two-dimensional picture using either four or nine red and white blocks. Responses are scored for accuracy as well as time taken to reach a correct solution. The test consists of nine designs and scores can range from 0-48.

**Sex-Role Orientation.**

Measures of masculine and feminine personality traits were obtained using the Personal Attributes Questionnaire (PAQ) (Spence & Helmreich, 1978) and Nash's (1975) 10-item scale of "intellectually relevant" sex-typed traits (see Appendix A). The PAQ consists of 24 items which make up three eight-item scales. For each item subjects are asked to rate themselves on a 0-4 point scale. The Masculinity (M) Scale of the PAQ consists of items that specify personality traits judged to be (a) more characteristic of males than females and (b) socially desirable to some degree in both sexes. The Femininity (F) Scale of the PAQ consists of items judged to be (a) more characteristic of females than males and (b) socially desirable to some degree in both sexes. In content, the M-scale items primarily describe self-assertive, instrumental characteristics, for example, "can make decisions easily", while the F-scale items
primarily describe interpersonally-oriented expressive characteristics, for example, "very understanding of others". The third scale, M-F, contains items that (a) stereotypically differentiate the sexes and (b) have different social desirability ratings for males versus females. Items in this scale reflect both instrumental and expressive characteristics, for example, "very dominant", "very home oriented".

Responses to the M and M-F scale items are keyed in a "masculine" direction and the responses to the F-scale items in a "feminine" direction. Total scores on each scale are obtained by summing the eight-item rating scores. Scores range from 0-32. The M and F scales have been found to be essentially orthogonal in both sexes. The M-F scale has more bipolar properties, showing a moderate positive correlation with the M-scale and a smaller but significant negative correlation with the F-scale. Sex differences have been consistently reported on all three scales in groups of widely varying ages and socioeconomic origin. Males score significantly higher than females on the M and M-F scales, and score significantly lower than females on the F-scale (Spence & Helmreich, 1978).

The Nash 10-item intellectual interest scale was included immediately following the 24 PAQ items. This
scale consists of 10 items judged by subjects in Nash's original (1975) study to represent stereotypic male or female traits with possible implications for intellectual ability. For each item subjects are asked to make two ratings: (a) the degree to which each trait describes their "actual self" and (b) the degree to which each trait describes their "ideal self". Ratings are made using the same 0-4 point scale and summed over the 10 items to yield an "actual self score" and an "ideal self score".

Memory Tests

The memory task developed by Kail and Siegel (1977) was employed to assess verbal and spatial memory simultaneously. In addition, a separate measure of spatial memory, the Visual Retention Test (Warrington & James, 1967) and a separate measure of verbal memory, free recall of three 12-word lists were utilized.

The Kail and Siegel task consists of 27 slides each containing a 4x4 matrix. Sixteen consonants, randomly selected, were used to construct nine sets of three, five, and seven letters. These letters were then randomly placed in one of the 16 cells of the matrix with the constraints that the letters not form a recognizable pattern and that no letter is used twice in any given
slide. Subjects were given instructions to recall the letters on the slide, the positions on the slide where the letters had appeared, or the letters in the specific positions they were presented. Answer booklets were constructed to reflect the recall instructions given for each slide. The retention test followed immediately after each slide was presented. Subjects were given unlimited time to respond.

The Visual Retention Test consists of 20 slides. Each slide displayed a 4x4 white square (16 total squares) with five smaller blackened squares appearing in various positions. Each slide was exposed for two seconds after which time subjects were asked to choose the correct stimulus figure from a set of four figures. The choices for recognition were graded in difficulty by varying in a constant manner the number of black squares each alternative had in common with the target stimulus. Thus the 20 choice situations reflect four degrees of difficulty; one, two, three, and four common squares in the choice situation. This test was originally developed as a measure of visual-spatial retention with brain-damaged patients. It was designed with the intent of minimizing the influence of verbal mediation.

Four 12-word lists were constructed as a measure of verbal memory. The words were recorded on audiotape at a
rate of one word per second. One of the lists was used as a practice trial while three of the lists served as experimental lists.

Procedure

The experiment took place in two separate testing sessions. In the first session subjects as a group were administered the Space Relations subtest of the Differential Aptitudes Test (DAT), the WAIS-R Vocabulary subtest, the Personality Attributes Questionnaire, and the Nash 10-item scale. Experimenters in both testing sessions were female.

The Space Related test is designed for a group testing format. Subjects were given the Space Relations test booklets and separate answer sheets, read the instructions by the examiner, and allowed a maximum of 35 minutes to complete the 60 items. After completing the Space Relations test subjects were asked to write out the meanings of the 35 words from the WAIS-R Vocabulary subtest (in standardized intellectual assessment words are presented orally). One example of a correct response was provided to give subjects an understanding of how best to respond and to minimize ambiguity about the specificity of definitions required. Unlimited time was
allowed for subjects to complete the Vocabulary test. Subjects were next given a booklet containing the PAQ as well as Nash's 10-item scale. Instructions to subjects were read aloud by the examiner as well as printed on the test booklets. At the conclusion of the first session subjects arranged a time with the experimenter to complete their participation in the study.

In the second experimental session, subjects completed the Block Design test, the Visual Retention Test, and verbal memory test (word list recall), and the Kail and Siegel (1977) task. The order of these four measures was counterbalanced across subjects. During this session subjects also completed a brief questionnaire to assess their typical level of caffeine consumption. Female subjects were asked to provide information concerning their use of oral contraceptives and to estimate the number of days since their last menstrual period ended.

The Block Design subtest of the WAIS-R requires subjects to reproduce nine geometric designs presented on cards using red and white colored blocks. Designs 1-5 require four blocks to complete the design while designs 6-9 require nine blocks. A time limit of 60 seconds is imposed for designs 1-5 while 120 seconds is allowed for designs 6-9. Four points are scored for each
design successfully completed within the time limit, plus a maximum of three bonus points per design is awarded for quick, perfect performance. No credit is given for partially correct or incomplete performance.

The Visual Retention Test was administered using 20 slides of 4x4 white squares. Each slide contained five blackened squares in various positions within the larger white square. Each slide was projected one meter from the subject for two seconds. Subjects were instructed to view each slide for the entire time it was exposed. Immediately after each slide was exposed subjects were asked to choose the stimulus figure just viewed from a set of four figures (three distractors plus the correct figure). After marking their choice in the answer booklet the next slide was presented and so on throughout the remaining 19 slides.

The verbal memory test consisted of four 12-word lists (one practice plus three test lists) presented to each subject via audiotape at the rate of one word per second. Following each list subjects were asked to report orally as many of the words as they could recall in any order.

The Kail and Siegel (1977) task consisted of 27 slides each of which was projected on a white wall one meter from the subject. Slides were exposed for either
three, five, or seven seconds. Immediately before each slide was projected subjects were instructed to remember "letters only" (a block of nine slides), "positions only" (a block of nine slides), or "both letters and positions" (a block of nine slides). The appropriate retention test immediately followed each slide exposure. Subjects were given unlimited time to respond. Within each type of memory task and exposure duration subjects were given a practice trial of three letters followed by test trials of five and seven letters. The order of presentation for the memory task type (letters, positions, both), time exposure duration (three seconds, five seconds, seven seconds) was counterbalanced across subjects. Further, specific slides appeared in each of these conditions equally often across subjects.

Following completion of this second session subjects were debriefed and given proof of participation to exchange for class credit.
Chapter 3

RESULTS

Table 1 provides means and standard deviations for males and females on tests of verbal ability, spatial ability, and sex-role orientation. A one-way analysis of variance revealed significant sex differences on spatial ability measures (Block Design and DAT) with males scoring higher than females. No sex differences in verbal ability as measured by the WAIS Vocabulary test were found. Males scored significantly higher on the PAQ Masculinity scale while females scored significantly higher on the Femininity scale. Males rated their "actual self" as more traditionally masculine than did females. No differences were found on ratings of "ideal self", both males and females scored in a traditionally masculine direction.

Verbal and Spatial Memory: Analysis of Data from Kail and Siegel Memory Task

The analysis of these data included one between subjects factor of gender and four within subjects
Table 1
Means and Standard Deviations

<table>
<thead>
<tr>
<th>Measure</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>WAIS Vocabulary</td>
<td>50.33</td>
<td>7.53</td>
</tr>
<tr>
<td>DAT Spatial Relations</td>
<td>41.66</td>
<td>11.57</td>
</tr>
<tr>
<td>Block Design</td>
<td>41.76</td>
<td>6.38</td>
</tr>
<tr>
<td>PAQ Masculinity</td>
<td>22.76</td>
<td>3.40</td>
</tr>
<tr>
<td>PAQ Femininity</td>
<td>21.96</td>
<td>3.62</td>
</tr>
<tr>
<td>Nash Actual Self</td>
<td>24.30</td>
<td>3.79</td>
</tr>
<tr>
<td>Nash Ideal Self</td>
<td>27.90</td>
<td>3.47</td>
</tr>
</tbody>
</table>
factors. The within subjects factors were: (a) Memory Load (one stimulus—letters or positions, two stimuli—letters and positions); (b) Stimulus Type (letters, positions), (c) Stimulus Size (five items, seven items); and (d) Exposure Duration (three seconds, five seconds, seven seconds).

A 2 (Sex) x 2 (Memory Load) x 2 (Stimulus Type) x 2 (Stimulus Size) x 3 (Exposure Duration) mixed analysis of variance was computed on the number of letters and positions correctly recalled. All significant effects were observed with a \( p < .05 \). All subsequent analyses utilized Newman-Keuls procedures with alpha set to .05.

The were significant main effects of Memory Load, \( F (1,64) = 40.60, p < .001 \); Stimulus Type, \( F (1,64) = 12.69, p = .001 \); Stimulus Size, \( F (1,64) = 207.71, p < .001 \); and Exposure Duration \( F (2,128) = 32.57, p < .001 \). Further analyses of these effects revealed that subjects recalled fewer items when asked to recall both letters and positions simultaneously (\( M = 4.90 \)) than when instructed to recall letters or positions independently (\( M = 5.22 \)). In addition, subjects recalled more letters (\( M = 5.13 \)) than positions (\( M = 4.94 \)) and recalled more items when presented with seven items (\( M = 5.5 \)) than when presented with five items (\( M = 4.6 \)). Finally, a post-hoc analysis of the exposure duration effect revealed that
fewer items were recalled at the three-second exposure duration (M = 4.79) than at either the five-second (M = 5.19) or seven-second (M = 5.20) exposure duration. Recall scores at the five- and seven-second exposure durations were not found to be significantly different.

A significant Stimulus Type x Stimulus Size interaction, $F(1,64) = 15.12$, $p = .001$, indicated that more letters than positions were recalled when five items were presented. However, when seven items were presented letter and position scores were not significantly different (see Table 2).

A significant Memory Load x Stimulus Type interaction, $F(1,64) = 9.34$, $p = .004$, indicated that fewer total items were recalled when both letters and positions were to be recalled simultaneously than when either was to be recalled independently. However, the decline in performance as a function of memory load was greater for position scores than for letter scores (see Table 3). Further analysis revealed that the recall of letters was significantly greater than the recall of positions but only under the simultaneous (letters and positions) memory load condition.

A significant Stimulus Type x Exposure Duration interaction was also observed, $F(2,128) = 8.01$ (see Table 4).
Table 2

Stimulus Type x Stimulus Size Two-Way Interaction Means

<table>
<thead>
<tr>
<th></th>
<th>Five items</th>
<th>Seven items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Letters</td>
<td>4.802</td>
<td>5.556</td>
</tr>
<tr>
<td>Positions</td>
<td>4.404</td>
<td>5.486</td>
</tr>
</tbody>
</table>

Table 3

Memory Load x Stimulus Type Two-Way Interaction Means

<table>
<thead>
<tr>
<th></th>
<th>Load 1</th>
<th>Load 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Letters</td>
<td>5.267</td>
<td>5.092</td>
</tr>
<tr>
<td>Positions</td>
<td>5.178</td>
<td>4.712</td>
</tr>
</tbody>
</table>

Table 4

Stimulus Type x Exposure Duration Two-Way Interaction Means

<table>
<thead>
<tr>
<th></th>
<th>Three seconds</th>
<th>Five seconds</th>
<th>Seven seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Letters</td>
<td>4.943</td>
<td>5.200</td>
<td>5.34</td>
</tr>
<tr>
<td>Positions</td>
<td>4.656</td>
<td>5.169</td>
<td>5.010</td>
</tr>
</tbody>
</table>
Subsequent analysis revealed that subjects recalled more letters at seven seconds exposure duration than at five seconds exposure duration and recalled more letters at both five and seven seconds exposed duration than at three seconds exposure duration. Position scores were greater at seven and five seconds than at three seconds exposure duration. However, subjects recalled significantly more positions at the five-second than at the seven-second exposure duration.

A significant Exposure Duration x Stimulus interaction, $F(2,128) = 12.872, p = .001$, was observed and is displayed in Table 5.

Subsequent analysis revealed that when five items were presented subjects recalled fewer total items at the three-second exposure duration than at the five-second exposure duration. Recall at the seven-second duration was not significantly different from either the five-second or three-second duration. When seven items were presented both the seven-second exposure and the five-second exposure produced significantly higher recall scores than the three-second exposure duration. There was no significant difference between the five- and seven-second exposure durations when seven items were presented.
Table 5

Exposure Duration x Stimulus Size Two-Way Interaction Means

<table>
<thead>
<tr>
<th>Duration</th>
<th>Three seconds</th>
<th>Five seconds</th>
<th>Seven seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Five items</td>
<td>4.490</td>
<td>4.682</td>
<td>4.637</td>
</tr>
<tr>
<td>Seven items</td>
<td>5.108</td>
<td>5.687</td>
<td>5.768</td>
</tr>
</tbody>
</table>
A significant Memory Load x Stimulus Size interaction, $F(1,64) = 11.55$, $p < .002$, is presented in Table 6.

Further analysis revealed that fewer items were recalled when both letters and positions were to be recalled simultaneously rather than independently. However, the decline was greater when seven items were presented for recall than when five items were presented.

A marginal Sex x Stimulus Load x Stimulus Type interaction, $F(1,64) = 3.796$, $p = .056$ was also observed and is presented in Table 7.

Analysis of this three-way interaction revealed that males remembered significantly more letters than did females but only when letters and positions were recalled independent of each other. Further, males remembered significantly more positions than females but in this case only when letters and positions were to be recalled simultaneously.

A significant Sex x Exposure Duration x Stimulus Size interaction, $F(2,128) = 3.250$, $p = .042$ is presented in Table 8.

Subsequent analysis of this three-way interaction revealed that when five items were presented males and females performed equally well regardless of the length of
Table 6

**Memory Load x Stimulus Size Two-Way Interaction Means**

<table>
<thead>
<tr>
<th>Load 1</th>
<th>Load 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Five items</td>
<td>4.684</td>
</tr>
<tr>
<td>Seven items</td>
<td>5.761</td>
</tr>
</tbody>
</table>

Table 7

**Sex x Stimulus Load x Stimulus Type Three-Way Interaction Means**

<table>
<thead>
<tr>
<th>Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
</tr>
<tr>
<td>Letters</td>
</tr>
<tr>
<td>Sex: Males</td>
</tr>
<tr>
<td>Sex: Females</td>
</tr>
<tr>
<td>Positions</td>
</tr>
<tr>
<td>Sex: Males</td>
</tr>
<tr>
<td>Sex: Females</td>
</tr>
</tbody>
</table>
Table 8

Sex x Exposure Duration x Stimulus Size Three-Way Interaction Means

<table>
<thead>
<tr>
<th>Duration</th>
<th>Three seconds</th>
<th>Five seconds</th>
<th>Seven seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Five items</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>4.558</td>
<td>4.683</td>
<td>4.725</td>
</tr>
<tr>
<td>Females</td>
<td>4.424</td>
<td>4.681</td>
<td>4.549</td>
</tr>
<tr>
<td><strong>Seven items</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>5.375</td>
<td>5.833</td>
<td>5.800</td>
</tr>
<tr>
<td>Females</td>
<td>4.840</td>
<td>5.542</td>
<td>5.736</td>
</tr>
</tbody>
</table>
exposure duration (that is, three versus five versus seven seconds). However, under the seven-item condition, males recalled more items than females at both the three-second and five-second exposure rates. No significant differences between males and females were observed at seven seconds.

Analysis of Covariance: Verbal and Spatial Memory (Kail and Siegel)

A 2 (Sex) x 2 (Memory Load) x 2 (Stimulus Type) x 2 (Stimulus Size) x 3 (Exposure Duration) analysis of covariance was next computed on the number of letters and positions correctly recalled. Subjects' scores on the Differential Aptitude Test (DAT), Block Design (BD), and Vocabulary (VOC) tests were used as covariates in this model to determine whether or not individual differences in the population on these measures of spatial and verbal ability would significantly influence the pattern of results previously reported.

No significant changes in the pattern of main effects or interaction effects was observed when the DAT, Block Design scores, or WAIS Vocabulary scores were employed as a covariate (see Appendix B.)
Stepwise multiple regression analyses were performed for overall memory scores on the Kail and Siegel task as well as separately for verbal memory (letters) and spatial memory (positions). In this particular regression model variables were entered sequentially into the equation if they reach statistical significance. The variable that explains the greatest amount of variance in the dependent variable will enter first, the variable that explains the greatest amount of variance in conjunction with the first will enter second, and so on.

The predictor variables used in the model for predicting overall memory performance were: (a) verbal ability (WAIS Vocabulary), (b) spatial ability (Block Design), (c) sex of subject, (d) caffeine consumption, (e) number of days since last menstrual period, (f) use of birth control pills, (g) Nash's Actual Self score, and (h) Nash's Ideal Self score. The results of the regression analysis revealed that WAIS Vocabulary scores, Block Design, caffeine consumption scores, along with Nash's Actual and Ideal Self scores predicted a significant amount of the variance in overall memory scores (see Table 9).
Table 9

Regression Analysis: Kail and Siegel Verbal and Spatial Overall Memory Scores

<table>
<thead>
<tr>
<th>Factor</th>
<th>Coefficient</th>
<th>Beta</th>
<th>F</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary</td>
<td>.0065</td>
<td>.0562</td>
<td>4.07*</td>
<td>.0026</td>
</tr>
<tr>
<td>Block Design</td>
<td>.0272</td>
<td>.1787</td>
<td>40.33**</td>
<td>.0524</td>
</tr>
<tr>
<td>Sex of Subject</td>
<td>.0159</td>
<td>.0069</td>
<td>.02</td>
<td>.0000</td>
</tr>
<tr>
<td>Caffeine Consumption</td>
<td>-.0003</td>
<td>-.0821</td>
<td>10.77**</td>
<td>.0052</td>
</tr>
<tr>
<td>Days Since Last Menstrual Period</td>
<td>-.0131</td>
<td>-.0189</td>
<td>.13</td>
<td>.0701</td>
</tr>
<tr>
<td>Birth Control</td>
<td>-.0532</td>
<td>-.0199</td>
<td>.46</td>
<td>.0003</td>
</tr>
<tr>
<td>Nash Actual Self</td>
<td>.0239</td>
<td>.0983</td>
<td>10.00**</td>
<td>.0025</td>
</tr>
<tr>
<td>Nash Ideal Self</td>
<td>-.0291</td>
<td>-.0792</td>
<td>8.06*</td>
<td>.0058</td>
</tr>
</tbody>
</table>

*(p < .05)

**(p < .01)
The regression coefficients presented reveal the change in the dependent variable observed for each unit change in the independent variable. The beta weights represent the standardized regression coefficients that can be compared to one another for their relative magnitude. In this case, an examination of the beta weights indicated that increases in Vocabulary scores and Block Design scores were related to increases in memory scores, while increases in caffeine consumption scores were related to decreases in memory performance. Also increases in scores on the Nash Actual Self scale were associated with increased memory performance while increases in scores on the Nash Ideal Self scale were associated with decreased memory scores. Taken together these variables account for approximately 8.79% of the variance in Kail and Siegel memory performance. Tests of interaction between gender and spatial ability and gender and verbal ability were not significant.

Separate regression analyses were computed for verbal and spatial memory scores (letters and positions). In the analysis of verbal memory the predictor variables were: (a) WAIS Vocabulary scores, (b) Block Design scores, (c) sex of subject, (d) caffeine consumption, (e) days since last menstrual period, (f) use of birth control pills, (g) PAQ-Masculinity score,
(h) PAQ-Femininity score, (i) Nash Actual Self score, and (j) Nash Ideal Self score. Significant predictor variables which emerged included Block Design, caffeine consumption, Nash Actual Self, and Nash Ideal Self (see Table 10).

An examination of the beta weights revealed that increases in Block Design scores were associated with increases in verbal memory performance while increases in caffeine consumption were associated with decreases in verbal memory performance. In addition, higher scores on the Nash Actual Self scale were associated with higher verbal memory scores while increases in the Nash Ideal Self scale were associated with decreased verbal memory performance. These predictors account for approximately 7.4% of the variance in verbal memory scores. No interactions were significant.

A stepwise multiple regression analysis was conducted on the spatial memory scores with the same predictors outlined above. In this model Block Design and PAQ-Masculinity are the two predictors to reach statistical significance (see Table 11).

Both are positively correlated with spatial memory. That is, increases in Block Design and PAQ-Masculinity scores were associated with increased spatial memory performance. Sex of subject, verbal ability (VOC), and
Table 10

Regression Analysis: Kail and Siegel Verbal Memory Scores (Letters)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Coefficient</th>
<th>Beta</th>
<th>F</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary</td>
<td>0.0063</td>
<td>0.0647</td>
<td>2.72</td>
<td>0.0030</td>
</tr>
<tr>
<td>Block Design</td>
<td>0.0129</td>
<td>0.0945</td>
<td>5.66**</td>
<td>0.0213</td>
</tr>
<tr>
<td>Sex of Subject</td>
<td>0.0081</td>
<td>0.0042</td>
<td>0.00</td>
<td>0.0000</td>
</tr>
<tr>
<td>Caffeine Consumption</td>
<td>-0.0006</td>
<td>-0.1976</td>
<td>31.28**</td>
<td>0.0391</td>
</tr>
<tr>
<td>Days Since Last Menstrual Period</td>
<td>0.0098</td>
<td>0.0165</td>
<td>0.05</td>
<td>0.0002</td>
</tr>
<tr>
<td>Birth Control</td>
<td>0.0107</td>
<td>0.0047</td>
<td>0.01</td>
<td>0.0000</td>
</tr>
<tr>
<td>Nash Actual Self</td>
<td>0.0304</td>
<td>0.1490</td>
<td>11.94**</td>
<td>0.0070</td>
</tr>
<tr>
<td>Nash Ideal Self</td>
<td>-0.0271</td>
<td>-0.0878</td>
<td>4.97*</td>
<td>0.0071</td>
</tr>
</tbody>
</table>

*(p < .05)

**(p < .01)
<table>
<thead>
<tr>
<th>Factor</th>
<th>Coefficient</th>
<th>Beta</th>
<th>F</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary</td>
<td>0.080</td>
<td>0.0827</td>
<td>2.63</td>
<td>0.0027</td>
</tr>
<tr>
<td>Block Design</td>
<td>0.0047</td>
<td>0.3506</td>
<td>47.97**</td>
<td>0.0821</td>
</tr>
<tr>
<td>Sex of Subject</td>
<td>-0.0066</td>
<td>-0.0034</td>
<td>.00</td>
<td>0.0000</td>
</tr>
<tr>
<td>PAQ-Masculinity</td>
<td>0.0205</td>
<td>0.0941</td>
<td>3.72*</td>
<td>0.0043</td>
</tr>
<tr>
<td>PAQ-Femininity</td>
<td>0.0069</td>
<td>0.0288</td>
<td>.34</td>
<td>0.0004</td>
</tr>
</tbody>
</table>

*(p < .05)

***(p < .01)**
femininity did not contribute significantly to variability in spatial memory scores. The overall model accounts for approximately 8.62% of the variance.

**Free Recall of Word Lists**

A 2 (Sex) x 3 (Serial Position) analysis of variance was computed for subjects' free recall scores on the three 12-word lists. The proportion of words recalled from the primary position (words 1-4), middle position (words 5-8), and the recency position (words 9-12) was computed for each word list.

A significant main effect of serial position was found, \( F(2,128) = 24,197, p < .001 \). Subsequent analysis revealed that subjects recalled a greater proportion of the words which appeared either at the end of the word list (M = .623) or at the beginning of the word list (M = .625) as compared to the words in the middle of the list (M = .434). No sex differences in free recall of words were found.

A 2 (Sex) x 3 (Serial Position) analysis of covariance was computed to ascertain whether individual differences in verbal and spatial abilities as measured by VOC, BD, and DAT were influencing the observed effect of serial position on free recall. The factors DAT, BD, and VOC were employed as covariates. Neither DAT nor BD
scores influenced the pattern of findings. Similarly, VOC scores when used as a covariate did not alter the results, that is, a significant main effect of serial position.

Stepwise multiple regression analyses were computed to determine the best predictors of verbal memory as measured by free recall of word lists. In the first regression model free recall scores were regressed on the independent variables of sex of subject, verbal ability (WAIS Vocabulary), spatial ability (Block Design or DAT Spatial Relations), serial position, PAQ-Masculinity Scale, PAQ-Femininity Scale, Nash's Actual Self and Ideal Self scores. In the second model the variables caffeine consumption, days since last menstrual period, and use of oral contraceptives were also included in the model. The results of these analyses are shown in Tables 12 and 13. None of the variables reached significant significance.

**Visual Retention Test**

A one-way analysis of variance failed to reveal significant sex differences in VRT scores (Males mean = 19.23; Females mean = 19.36).

Stepwise regression analyses were performed using the same models as outlined for free recall scores with the exception that serial position was not a relevant variable in these analyses. Specifically, VRT scores were first
### Table 12

**Regression Model 1: Free Recall Scores**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Coefficient</th>
<th>Beta</th>
<th>F</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary</td>
<td>0.0031</td>
<td>0.1482</td>
<td>3.48</td>
<td>0.0243</td>
</tr>
<tr>
<td>DAT</td>
<td>0.0007</td>
<td>0.0391</td>
<td>0.23</td>
<td>0.0020</td>
</tr>
<tr>
<td>Sex of Subject</td>
<td>-0.0172</td>
<td>-0.0415</td>
<td>0.25</td>
<td>0.0007</td>
</tr>
<tr>
<td>PAQ-Masculinity</td>
<td>-0.0015</td>
<td>-0.0318</td>
<td>0.18</td>
<td>0.0009</td>
</tr>
<tr>
<td>PAQ-Femininity</td>
<td>0.0026</td>
<td>0.0496</td>
<td>0.42</td>
<td>0.0015</td>
</tr>
</tbody>
</table>
Table 13

Regresssion Model 2: Free Recall Scores

<table>
<thead>
<tr>
<th>Factor</th>
<th>Coefficient</th>
<th>Beta</th>
<th>F</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary</td>
<td>.0018</td>
<td>.0852</td>
<td>1.10</td>
<td>.0113</td>
</tr>
<tr>
<td>Block Design</td>
<td>.0028</td>
<td>.1024</td>
<td>1.56</td>
<td>.0253</td>
</tr>
<tr>
<td>Sex of Subject</td>
<td>.0442</td>
<td>.1064</td>
<td>.51</td>
<td>.0025</td>
</tr>
<tr>
<td>Caffeine Consumption</td>
<td>-.0001</td>
<td>.0986</td>
<td>1.83</td>
<td>.0072</td>
</tr>
<tr>
<td>Days Since Last Menstrual Period</td>
<td>-.0201</td>
<td>-.1571</td>
<td>1.13</td>
<td>.0015</td>
</tr>
<tr>
<td>Birth Control</td>
<td>-.0012</td>
<td>-.0025</td>
<td>.00</td>
<td>.0000</td>
</tr>
<tr>
<td>Nash Actual Self</td>
<td>-.0017</td>
<td>-.0390</td>
<td>.19</td>
<td>.0019</td>
</tr>
<tr>
<td>Nash Ideal Self</td>
<td>-.0022</td>
<td>-.0374</td>
<td>.16</td>
<td>.0000</td>
</tr>
</tbody>
</table>
regressed on the independent variables of sex of subject, verbal ability (WAIS Vocabulary), spatial ability (Block Design or DAT), PAQ-Masculinity, PAQ-Femininity, and Nash's Actual and Ideal Self scores. In the second regression model the variables caffeine consumption, days since last menstrual period, and use of oral contraceptives were included in the model. Results are summarized in Tables 14 and 15. PAQ-Femininity scores emerged as the only significant predictor of VRT scores. This variable is positively correlated with spatial memory as measured by the VRT and accounts for approximately 4.5% of the variance.
Table 14

Regression Model 1: Visual Retention Test

<table>
<thead>
<tr>
<th>Factor</th>
<th>Coefficient</th>
<th>Beta</th>
<th>F</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary</td>
<td>0.0242</td>
<td>0.1979</td>
<td>2.16</td>
<td>0.0479</td>
</tr>
<tr>
<td>DAT</td>
<td>0.0082</td>
<td>0.2297</td>
<td>0.32</td>
<td>0.0046</td>
</tr>
<tr>
<td>Sex of Subject</td>
<td>-0.2439</td>
<td>-0.1008</td>
<td>0.51</td>
<td>0.0236</td>
</tr>
<tr>
<td>PAQ-Masculinity</td>
<td>0.0254</td>
<td>0.0935</td>
<td>0.53</td>
<td>0.0077</td>
</tr>
<tr>
<td>PAQ-Femininity</td>
<td>0.0957</td>
<td>0.3132</td>
<td>5.80*</td>
<td>0.0453</td>
</tr>
</tbody>
</table>

*(p < .05)*
Table 15

Regression Model 2: Visual Retention Test

<table>
<thead>
<tr>
<th>Factor</th>
<th>Coefficient</th>
<th>Beta</th>
<th>F</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary</td>
<td>.0218</td>
<td>.1786</td>
<td>1.72</td>
<td>.0373</td>
</tr>
<tr>
<td>DAT</td>
<td>.0049</td>
<td>.0474</td>
<td>.11</td>
<td>.0016</td>
</tr>
<tr>
<td>Sex of Subject</td>
<td>.2274</td>
<td>.0941</td>
<td>.14</td>
<td>.0018</td>
</tr>
<tr>
<td>Caffeine Consumption</td>
<td>-.0004</td>
<td>-.1068</td>
<td>.68</td>
<td>.0088</td>
</tr>
<tr>
<td>Days Since Last Menstrual Period</td>
<td>-.2189</td>
<td>-.2941</td>
<td>1.45</td>
<td>.0597</td>
</tr>
<tr>
<td>Birth Control</td>
<td>-.2035</td>
<td>-.0725</td>
<td>.25</td>
<td>.0063</td>
</tr>
<tr>
<td>PAQ-Masculinity</td>
<td>.0149</td>
<td>.0549</td>
<td>.16</td>
<td>.0026</td>
</tr>
<tr>
<td>PAQ-Femininity</td>
<td>.0851</td>
<td>.2789</td>
<td>4.36*</td>
<td>.0454</td>
</tr>
</tbody>
</table>

*(p < .05)*
The present study examined verbal and spatial memory performance in a sample of 66 college-age males and females. Subjects' scores on psychometric measures of verbal and spatial ability as well as their self-reported sex-role orientation were analyzed to determine the contribution of each to predicting memory performance.

Significant sex differences were found on measures of spatial ability with males scoring significantly higher than females. However, no sex differences emerged on a measure of verbal ability. These findings are consistent with previous studies which show a consistent male advantage on spatial tasks. The lack of a sex difference in verbal ability may be due to the finding that in general a female advantage on verbal tasks, while reported, is considered a less robust finding than the reputed male advantage on spatial tasks (Deaux, 1984). A meta analysis of 165 studies comparing male and female verbal ability scores (Hyde & Linn, 1988) found that the gender difference in verbal ability was so small.
(one-tenth of a standard deviation) as to be considered insignificant.

In terms of sex-role orientation males were found to identify themselves as more traditionally masculine than did females. Not surprisingly, females described themselves as significantly more feminine than did males. When asked specifically about sex-typed attributes relevant to intellectual abilities males attributed a greater number of masculine traits to themselves than did females. However, both males and females were found to aspire to (Ideal Self ratings) traditionally masculine intellectual traits.

The present study did not find evidence of a difference between males and females in verbal and spatial memory for designs. Further inspection of the spatial memory data (Visual Retention Test) suggests that the absence of any significant difference on this measure may have been due to the simplicity of this task. All subjects obtained near perfect scores on this task suggesting that it is not a very sensitive measure of spatial memory. The absence of gender differences on the word recall task may reflect the similar verbal abilities of males and females in this sample and may not generalize beyond this study. However, verbal ability did not predict word
recall scores nor did the interaction of verbal ability and gender.

The performance of males surpassed that of females on the Kail and Siegel (1977) memory task under the specific condition of less time given to view items and more items to recall. Thus, males may be able to process and retain more information (regardless of type) than females in situations of limited time. A trend toward more accurate recall of letters by males than by females was found in the case where letters were remembered independently of positions. Males also remembered more positions than females but only when positions were to be recalled simultaneously with letters. Thus, the male advantage in recalling spatial information reported by Kail and Siegel and by Tabor et al. (1984) was in part supported by the present study. However, when the data were analyzed using multiple regression procedures a rather different conclusion emerges. That is, gender does not account for a significant amount of variance in memory performance after the predictor of spatial ability was entered in the equation. Furthermore, any tests of the interactions of gender and verbal ability or gender and spatial ability were nonsignificant. Therefore, the present data suggest that gender differences in memory performance can be
accounted for by individual differences in spatial ability.

Factors which emerged as predictive of memory performance included spatial ability, identification with masculine intellectual traits, aspiring to masculine intellectual traits, and caffeine consumption. Specifically, increases in spatial ability scores and a more masculine view of one's actual self were predictive of better performance on both verbal and spatial memory tasks. In addition, the more masculine one's ideal self, and the more caffeine one consumed, the less well one would be predicted to do on measures of verbal and spatial memory in this study. Proficiency at verbal memory tasks was best predicted by high spatial ability and a more masculine view of one's intellectual attributes. Subjects who aspired to a more masculine ideal self and who consumed greater amounts of caffeine did less well on verbal memory tasks. A masculine sex-role orientation and high spatial ability were found to predict higher scores on the spatial memory component of the Kail and Siegel (1977) task. However, performance on the Visual Retention Test was best predicted by feminine sex-role orientation, the more feminine the better one's performance. For none of the memory tasks was the gender of the subject a significant predictor of performance. This supports the
argument made in this study as well as in previous studies that it is necessary to look beyond main effects of gender to explain individual differences in cognitive performance.

The present study provides some support for the notion that individual differences in verbal and spatial ability are important factors to consider when attempting to predict or explain differences in memory performance. Similar to previous investigations this study found evidence that subjects who performed well on spatial memory tasks were those who possessed higher levels of spatial ability. However, in contrast to results reported by Tabor et al. (1984), verbal memory performance in this study was not predicted by verbal ability but rather by spatial ability. The differences in study design (for example, subjects matched for verbal ability in Tabor et al.) as well as the inclusion of a spatial ability measure in this study may account in part for this discrepancy. Further, both of the spatial ability measures employed in this study correlate significantly with verbal ability (Vocabulary scores). Thus, the fact that one of these spatial ability measures (Block Design) is a significant predictor of verbal memory performance may say more about the overlap between measures than about
the relationship between spatial ability and verbal memory performance.

This study also shed some light on the relationship between personality factors, specifically sex-role orientation and memory performance. A less than consistent pattern of results emerged. However, as suggested in earlier research, a masculine sex-role orientation was found to be positively correlated with performance on spatial memory tasks. The role of feminine sex-role orientation is less clear. In this study it did not predict verbal memory performance as might have been expected, yet was positively correlated with at least one measure of spatial memory.

The fact that sex-role orientation in general was not an especially powerful predictor of memory performance should perhaps not be surprising. Deaux (1985) has argued that masculinity and femininity are very complex, multidimensional concepts and are not readily captured by two-dimensional questionnaires. The scales on measures such as the Bem Sex-Role Inventory and the Personal Attributes Questionnaire can be viewed as measures of dominance and self-assertiveness (masculinity) on the one hand, and nurturance and interpersonal warmth (femininity) on the other. Thus, the predictive power of such measures would likely be more impressive for behaviors requiring
assertiveness or nurturance and less so for behaviors such as memory performance which are less clearly associated with these attributes. The present study attempted to address this argument by including Nash's (1975) Actual and Ideal Self ratings of intellectually relevant sex-typed items as predictors of verbal and spatial memory performance. Nash reported that a more masculine perception of one's actual and ideal self was positively correlated with spatial ability. In the present study a masculine (versus feminine) rating of one's actual self on these attributes was found to be predictive of overall memory scores but was not predictive of spatial memory performance. However, it was found in this study that a masculine rating of ideal self was negatively correlated with verbal memory performance. This suggests that subjects who aspire to a very stereotyped masculine image do less well on verbal memory tasks, perhaps because doing well in this area is inconsistent with their idealized image of themselves as highly masculine.

The present study raises some interesting questions about individual differences in memory performance and factors other than gender which might account for these differences. One limitation of the present study may have been the measures chosen as predictor variables. An attempt was made to choose well-established measures of
verbal and spatial ability which have demonstrated sex differences in previous research. However, other measures may have more accurately measured the constructs of verbal and spatial ability and/or may have accounted for more of the variance in memory scores. Alternatively, it could be argued that defining verbal and spatial memory as a subject's performance on the measures employed in this study is open to question. The possibility exists that these measures represent only very superficial estimates of verbal and spatial memory. In addition, sample size may be cited as a limitation of the present study in that a larger sample have increased the power of the statistical analyses to detect significant sources of variance.

Recommendations for future research include using more complex and ecologically valid measures of verbal and spatial memory. That is, measures which more accurately reflect the demands of verbal and spatial memory processes in everyday life. For example, with a college-age sample, measuring verbal memory with a simulated "essay exam" involving free recall of relevant prose material or perhaps testing subject's recall of locations on a city map as a measure of spatial memory. Likewise, measures of sex-role orientation may need to be further refined if they are to accurately measure beliefs
and behaviors relevant to predicting cognitive performance. Nash's (1975) scales represent a start in the direction of intellectually relevant sex-typed attributes. However, given the complexity of this aspect of personality it is likely that a more comprehensive measure or perhaps a combination of measures will be needed to clarify what relationship, if any, exists between sex-typed beliefs and verbal and spatial memory.
APPENDICES
Appendix A

PERSONAL ATTRIBUTES QUESTIONNAIRE

The items below inquire about what kind of a person you think you are. Each item consists of a pair of characteristics, with the letters A-E in between. For example:

Not at all artistic A...B...C...D...E Very artistic

Each pair describes contradictory characteristics, that is, you cannot be both at the same time, such as very artistic and not at all artistic.

The letters form a scale between the two extremes. You are to choose a letter which describes where you fall on the scale. For example, if you think you have no artistic ability, you would choose A. If you think you are pretty good, you might choose D. If you are only medium, you might choose C, and so forth.

Now, go ahead and answer the questions on the answer sheet. Be sure to answer every question, even if you are not sure.

REMEMBER TO ANSWER QUICKLY:

YOUR FIRST IMPRESSION IS THE BEST
1. Not at all aggressive
2. Not at all independent
3. Not at all emotional
4. Very submissive
5. Not at all excitable in a major crisis
6. Very passive
7. Not at all able to devote self completely to others
8. Very rough
9. Not at all helpful to others
10. Not at all competitive
11. Very home oriented
12. Not at all kind
13. Indifferent to other's approval
14. Feelings not easily hurt
15. Not at all aware of feelings of others

A...B...C...D...E

A...B...C...D...E

A...B...C...D...E

A...B...C...D...E

A...B...C...D...E

A...B...C...D...E

A...B...C...D...E

A...B...C...D...E

A...B...C...D...E
16. Can make decisions easily
   A...B...C...D...E
   Has difficulty making decisions

17. Gives up very easily
   A...B...C...D...E
   Never gives up easily

18. Never cries
   A...B...C...D...E
   Cries very easily

19. Not at all self-confident
   A...B...C...D...E
   Very self-confident

20. Feels very inferior
    A...B...C...D...E
    Feels very superior

21. Not at all understanding of others
    A...B...C...D...E
    Very understanding of others

22. Very cold in relations with others
    A...B...C...D...E
    Very warm in relations with others

23. Very little need for security
    A...B...C...D...E
    Very strong need for security

24. Goes to pieces under pressure
    A...B...C...D...E
    Stands up well under pressure

25. Likes math and science very much
    A...B...C...D...E
    Dislikes math and science very much

26. Does not enjoy art and literature at all
    A...B...C...D...E
    Enjoys art and literature at all

27. Minds very much when things are not clear
    A...B...C...D...E
    Does not mind at all when things are not clear

28. Not at all easily influenced
    A...B...C...D...E
    Very easily influenced
29. Thinks men are superior to women  

A...B...C...D...E  

Does not think men are superior to women

For the next 10 items (30-39) rate the items using the same rating procedure you used on the previous items only this time rate the items in terms of how well they describe your "Ideal Self". In other words, the type of person you would ideally wish to be regardless of whether or not you believe you actually are this type of person.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Rating Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.</td>
<td>Likes math and science very much</td>
<td>A...B...C...D...E</td>
</tr>
<tr>
<td>31.</td>
<td>Never gives up easily</td>
<td>A...B...C...D...E</td>
</tr>
<tr>
<td>32.</td>
<td>Can make decisions easily</td>
<td>A...B...C...D...E</td>
</tr>
<tr>
<td>33.</td>
<td>Does not enjoy art and literature at all</td>
<td>A...B...C...D...E</td>
</tr>
<tr>
<td>34.</td>
<td>Very active</td>
<td>A...B...C...D...E</td>
</tr>
<tr>
<td>35.</td>
<td>Very independent</td>
<td>A...B...C...D...E</td>
</tr>
<tr>
<td>36.</td>
<td>Minds very much when things are not clear</td>
<td>A...B...C...D...E</td>
</tr>
<tr>
<td>37.</td>
<td>Not at all easily influenced</td>
<td>A...B...C...D...E</td>
</tr>
<tr>
<td>38.</td>
<td>Feels superior</td>
<td>A...B...C...D...E</td>
</tr>
<tr>
<td>39.</td>
<td>Thinks men are superior to women</td>
<td>A...B...C...D...E</td>
</tr>
</tbody>
</table>

Dislikes math and science very much  

Gives up very easily  

His difficulty making decisions  

Enjoys art and literature very much  

Very passive  

Not at all independent  

Does not mind when things are not clear  

Very easily influenced  

Feels inferior  

Does not think men are superior to women
### Appendix B

**KAIL AND SIEGEL: ANALYSIS OF VARIANCE ADJUSTED FOR COVARIATES BLOCK DESIGN, DAT, AND VOCABULARY**

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1.207</td>
<td>0.352</td>
</tr>
<tr>
<td>Memory Load (L)</td>
<td>40.366</td>
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<td>40.366</td>
<td>40.601*</td>
</tr>
<tr>
<td>Stimulus Type (TP)</td>
<td>21.509</td>
<td>1</td>
<td>21.509</td>
<td>12.699*</td>
</tr>
<tr>
<td>Stimulus Size (SZ)</td>
<td>330.832</td>
<td>1</td>
<td>330.832</td>
<td>207.710*</td>
</tr>
<tr>
<td>Exposure Duration (D)</td>
<td>54.348</td>
<td>2</td>
<td>27.174</td>
<td>32.569*</td>
</tr>
<tr>
<td>L x TP</td>
<td>8.326</td>
<td>1</td>
<td>8.326</td>
<td>9.340*</td>
</tr>
<tr>
<td>SX x L x TP</td>
<td>3.384</td>
<td>1</td>
<td>3.384</td>
<td>3.796</td>
</tr>
<tr>
<td>TP x D</td>
<td>8.739</td>
<td>2</td>
<td>4.370</td>
<td>8.011*</td>
</tr>
<tr>
<td>L x SZ</td>
<td>9.874</td>
<td>1</td>
<td>9.874</td>
<td>11.550*</td>
</tr>
<tr>
<td>TP x SZ</td>
<td>10.578</td>
<td>1</td>
<td>10.578</td>
<td>15.120*</td>
</tr>
<tr>
<td>D x SZ</td>
<td>18.844</td>
<td>2</td>
<td>9.422</td>
<td>12.872*</td>
</tr>
<tr>
<td>SX x D x SZ</td>
<td>4.758</td>
<td>2</td>
<td>2.379</td>
<td>3.250*</td>
</tr>
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</table>

*(p < .05)*

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REFERENCES
REFERENCES


Sparks, R., & Geschwind, N. (1968). Dichotic listening in man after section of neocortical commissures. *Cortex, 4,* 3-16.


