A STUDY OF THE ANALYTICAL SPATIAL PERCEPTION ABILITY OF SELECTED STUDENTS IN ART, ARCHITECTURE, LANDSCAPE ARCHITECTURE, AND INTERIOR DESIGN

By

LOUISE STEINBRINK HARRIS

Bachelor of Science
Sam Houston State University
Huntsville, Texas
1961

Bachelor of Arts
Mount Vernon College
Washington, District of Columbia
1978

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of the Oklahoma State University
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DESIGN

Thesis Approved:

Margaret Weber
Thesis Adviser

Carl Hall

David Fournier

Norman N Durham
Dean of the Graduate College

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CHAPTER I

THE RESEARCH PROBLEM

Introduction

Male-female differences have been shown in several aspects of intellectual performance. Females early establish a verbal superiority, and this has been assumed to be due to their spending more time with their mothers. Males acquire greater spatial and perceptual-analytic skill, and it has been suggested that this may be due to their greater opportunity to explore and manipulate objects in their environment (Maccoby, 1966).

Within the realm of differences in learning abilities and learning styles lies the possibility that there may be sex differences in the basic processes of learning as well. Hilgard (1956), in his discussion of the theories of learning, cites six aspects of learning: capacity (What is one's capacity to learn? Is the limit set at birth?); practice (Does repetition mean improved result? Can repetition be harmful as well as helpful?); motivation (What part is played by drive, incentive, reward and punishment?); understanding (How is learning different with regard to knowledge we appear to acquire blindly vs. that which we work hard to acquire?); transfer (How does learning in one situation help to facilitate learning in a new situation?); and forgetting (What mental processes are involved in remembering and forgetting? How much control does a person have over these processes?).

Learning theories are divided into stimulus-response and cognitive theories. The differences between the two are basically a matter of interpretation. The stimulus-response theory holds that what is learned are habits; while the cognitive theory holds that cognitive structures are the result of learning. A learner, according to the stimulus-response theory, assembles habits from past experiences and applies them to the new problem based on elements in the new problem that are common to past situations. The learner brings out responses from the behavior pool until an appropriate response is found. The cognitive theory, on the other hand, sees learning as perceptual structuring leading to insight or an understanding of relationships involved in the new situation (Hilgard, 1956). If the sexes do learn based on different perceptual biases, it may affect their individual development and help to explain differences that appear later in aptitude and interests (Stevenson, 1970).

In studying the intellectual development of males and females, there are questions that arise. If males and females differ in the rate of progress they make in various areas, do they finally achieve a similar level, or could they, given the necessary training and experience? People differ in their generalized capacity to learn. There are people who have the ability to learn more readily than others, regardless of the material or the incentive offered. People differ in prepardedness for certain specific learning and in preestablished biases they bring to a learning situation. Accepting this premise, it would follow that learning ability as such would not differ between the sexes but that the differences would be found in their readiness to learn associations that are especially relevant to their sex. Individual persons may progress more rapidly than others in the development of strategy acquisition and use. Differences may also be found in reliance on various strategies. Developmental differences might then be found between the sexes with regard to any of the processes that made up the storage and retrieval of learned material (Maccoby and Jacklin, 1974).

The type of information and the type of response required affect the speed of the response output. Males excel when information is in the form of visual display and the response requires large muscle units. Conversely, females perform better when the information is in the form of symbolic material and the response requires attention to detail (McGuinnes, 1976). McGuinnes maintains that distinction between visual input and symbolic input is relevant in explaining sex differences. The sexes utilize these types of information differently and show response differences as well. McGuinnes (1976) maintains that a female-typical response should be paired with a male-specific input (and vice-versa) in order to disentangle stimulus and response effects. According to Sherman (1967, p. 297), ". . . the question of the degree to which spatial skill can be learned has a potential significance beyond explaining results of studies in analytic cognitive approach." Insofar as spatial perception skill is a factor in more complex mental functions, the possibility exists that remedial education may be developed to improve the skill. In addition, Sherman feels that the link between sex, sex roles, and spatial skill could significantly affect the relationship between personality variables and performance on perceptual tasks. Witkin, Dyk, Faterson, Goodenough and and Karp (1962) have maintained that, generally speaking, if skill on spatial tasks is learned and if the opportunities to learn are sex-typed, then male sex-typing would promote field independence or the ability to experience objects as discrete from their backgrounds. Conversely, female sex-typing would promote field dependence or the inability to separate an object from its background. The authors maintain that individuals low in analytical field approach do tend to show more female than male characteristics.

Standardized intelligence tests are divided into tests of achievement and tests of ability. Achievement tests focus on subject matter on which the respondents have received some training. Ability tests are designed to predict a person's future success on particular kinds of tasks. Knowledge already gained is reflected on an achievement test, whereas testing the capacity to learn something new is the intention of the ability test.

One of the generalizations in the study of sex differences is that of female superiority on verbal tasks. When a sex difference is found in testing, it is usually in favor of females who score higher than males on a variety of verbal skills. On tests of quantitative ability and numerical operations and concepts, there appears to be no sex difference in the preschool and early school years. However, after age 9-13, males receive higher scores (Maccoby and Jacklin, 1974). Beginning at about age eight, males show higher scores on visual-spatial ability tests and maintain the lead into adulthood. Set-breaking, or restructuring, has been identified as an important dimension of problem-solving ability. Maccoby and Jacklin summarize a discussion of tests of male-female differences on the ability to restructure.

> It has been alleged that field independence forms part of a larger cluster of abilities, sometimes called analytic abilities. A field-independent individual is alleged to be skilled in a large range of tasks that require ignoring a task-irrelevant context or focusing upon only selected elements of a stimulus display. Field independence has also been thought to imply an ability to restructure a problem-solving situation--to inhibit a well-established response in the interests of breaking away from an unproductive set and taking a fresh approach to a problem. In our review we have found the following:
>
> 1. . . . The development of sex differences in field independence parallels that in non-analytic spatial abilities.
>
> 2. The sex difference in field independence is quite narrowly confined to visual-spatial tasks. . . .
>
> 3. There is no reliable tendency for either sex to be generally more able to inhibit a dominant response while exploring potentially more successful solutions. . . .
>
> 4. The use of an "analytic style" in grouping . . . is not more common in one sex than the other.
>
> 5. . . . There are enough instances . . . in which the sexes do not differ on tasks that seem to call for restructuring that we cannot feel confident that set-breaking per se is the factor distinguishing the performance of the sexes . . . (pp. 104-105).

The tendency is for females to score somewhat higher on general intelligence tests at the preschool level and for males to take the lead during the high school years and maintain it (Maccoby, 1966). In the preschool and early school years, females excel in most aspects of verbal performance and males at arithmetical reasoning and spatial tasks in high school and beyond. Broverman and his colleagues (1968) maintain that females excel in simple repetitive behavior and males in problem-solving complex behavior. Garai and Scheinfeld (1968) maintain that males perceive through looking and females through listening. They further suggest that:

> A difference in sense modality between the sexes . . . if corroborated . . . would provide an explanation for the apparent tendency of girls to develop superior verbal skills, as well as for that of boys to excel in spatial perception (p. 193).

The most common meaning of the word "creative" describes a person who produces something unique. Men are many more times recognized than women in the ranks of outstanding creative artists. The question is whether men have greater ability to think creatively. In general, tests of creativity reflect females' superior scores in verbal skills, while little evidence has been found to favor either sex on non-verbal measures of creativity (Maccoby and Jacklin, 1974). The tendency is for boys and men to excel on tests of creativity when the emphasis is on the ability to break-set or restructure a problem and when the problem involves a large perceptual component. Conversely, when the tests call for solutions to verbally presented problems, girls and women produce more of a variety of ideas (Klausmeier and Wiersma, 1964; Trembly, 1964; Maccoby, 1966). It has been reported by Barron (1957) and MacKinnon (1962) that creative men score toward the feminine end of a Male-Female (M-F) scale than do less creative men. They conclude that the difference is due to a wider variety of interests among creative men, such as aesthetic interests, which are included as feminine indicators on an M-F scale (Maccoby, 1966).

Cross-sex typing appears to influence creativity and originality in both sexes. MacKinnon (1962) maintains that presence or absence of repression has a generalized impact upon thought processes. Repression interferes with the accessibility of the person's previous experiences. The person using repression as a defense mechanism cannot be "fluent in scanning thoughts" (MacKinnon, 1962, p. 493). "MacKinnon has evidence that creativity is in fact associated with the absence of repression . . . and Barron reports that originality is associated with 'responsiveness to impulse and emotion'" (Maccoby, 1966, p. 44). Wallach and Kagan (1965), after asking creative people to describe the nature of the thought processes during artistic or scientific productivity, conclude that the creative process involves, "First, the production of associative content that is abundant and that is unique; second, the presence in the associator of a playful, permissive attitude" (p. 289).

Investigators have explored male-female differences in several areas of learning and intellectual development, among which is included sex-differences in analytic spatial perception ability (Maccoby, 1966; Sherman, 1967; Witkin et al., 1962; Fairweather and Hutt, 1972). Two paths of investigation have been followed: that biological differences affect analytic spatial perception ability and that the differences found between the sexes are affected by cultural practices, such as sex-typing. Much work already has been done (Allen, 1974; Buffery and Gray, 1972; Coates, 1974; Eliot and Salkind, 1975) with male-female differences in spatial perception with young children, but more studies remain to be done with the university-age population.

Among established sex differences are differences in the ways males and females perceive space and ways in which they mentally manipulate objects in space. Some studies suggest that males exhibit greater ability to visualize spatial relation and are better able to separate objects from the background of which they are a part. These abilities may play a part in creativity or in the production of something unique in character. Cross-sex-typing appears to enhance these abilities in females. The present study investigates analytic spatial perception ability in male and female college undergraduates in various design majors.

Statement of the Problem

Students in all areas of design need the ability to perceive space--the amount of space needed for human beings to function along with the equipment and materials encountered in everyday life. The question arises--Do the university students majoring in any of the design-related areas of Interior Design, Art, Architecture and Landscape Architecture differ from each other in space perception ability? Are there differences in space perception ability between males and females majoring in these design areas?

Investigation of the literature reveals a difference in male and female spatial perception ability and evidence exists that this difference becomes most profound and sustained after the onset of puberty. Even so, few studies of college age students have explored this phenomenon and this researcher has found no study addressed to differences between students in the design-related majors of Interior Design, Art, Architecture and Landscape Architecture. Consequently, there appears to be a need to assess the spatial perception ability of these groups of students and to determine what, if any, male-female differences appear and how these correlate with the various majors.

Purpose and Objectives

The purpose of this study was to test students for their analytic spatial perception ability. Students participating in the study were those enrolled in Housing, Design, and Consumer Resources (HDCR) 1123, Graphic Design for Interiors; and HDCR 2313, Housing for Contemporary Living, the beginning courses in Interior Design. In addition, those students enrolled in the beginning course for majors in Art (ART 1103), Basic Drawing; Architecture (ARCH 2013), Basic Design; and Landscape Architecture (HORT 2002), Landscape Delineation were included in the survey.

The specific objectives of the study were as follows:

1. To determine if there is a difference in the analytic spatial perception ability of the students in Interior Design, Art, Architecture and Landscape Architecture compared to students in a comparative group as evidenced by their scores on the Abstract Reasoning and Space Relations sections of the Differential Aptitude Tests.

2. To investigate differences between males' and females' analytic spatial perception and abstract reasoning ability.

3. To investigate the extent to which differences in educational background are associated with analytic spatial perception and abstract reasoning ability.

4. To investigate the extent to which differences in the selected socio-demographic variables of age, skill level on selected activities, travel and leisure activities, residence patterns, and parents' education and occupation are associated with students' analytic spatial perception and abstract reasoning ability.

5. To make recommendations for further research in the area of analytic spatial perception ability.

Hypotheses

The hypotheses for this study were as follows:

H_{01} - There will not be a significant difference between the various majors on their scores of abstract reasoning and spatial perception ability as measured by the Abstract Reasoning and Space Relations sections of the Differential Aptitude Tests (DAT).

H_2 - There will be a significant difference between males' and females' abstract reasoning and analytic spatial perception ability as measured by the Abstract Reasoning and Space Relations sections of the Differential Aptitude Tests.

H_3 - There will be significant differences between the extent to which educational background of students is associated with their abstract reasoning and analytic spatial perception ability as measured by the Abstract Reasoning and Space Relations sections of the Differential Aptitude Tests.

H_4 - There will be a signficiant difference between the extent to which selected socio-demographic variables of age, skill level on selected activities, travel and leisure activities, residence patterns, and parents' education and occupation are associated with students' abstract reasoning and analytic spatial perception ability as measured by the Abstract Reasoning and Space Relations sections of the Differential Aptitude Tests.

Assumptions

This study was subjected to assumptions that may tend to affect the scope of the research. These were:

1. That the students tested were able to understand the instructions and complete the spatial perception tasks and that they appreciated the worth of the study and performed the tasks accordingly.

2. That the researcher determined a pertinent scale by which to measure the responses on the spatial perception tasks and that sex-bias was eliminated from this scale.

3. That the population selected for this study provided a representative sample of the students majoring in each of the fields under consideration.

Limitations

The following limitations tended to affect the scope of the research:

1. The testing was done at one point in time--the Fall semester, 1980.

2. The influence an individual students' background may have had on the test results was not measured in this study.

Definition of Terms

The following terms are defined for use in this study:

> <u>Visual Cognition</u>: . . . deals with the process by which a perceived, remembered, and thought-about world is brought into being from as unpromising a beginning as the retinal pattern. . . . refers to all the processes by which the

sensory input is transformed, reduced, elaborated, stored, recovered and used. It is concerned with these processes even when they operate in the absence of relevant stimulation . . . (Neisser, 1967, p. 4).

Creativity/Creativeness: . . . true creativeness fulfills at least three conditions. It involves a response or an idea that is novel or at the very least statistically infrequent. . . . it must to some extent be adaptive to, or of, reality. It must serve to solve a problem, fit a situation, or accomplish some recognizable goal. And, thirdly, true creativeness involves a sustaining of the original insight, an evaluation and elaboration of it, a developing of it to the full (MacKinnon, 1962, p. 485).

Spatial Perception: . . . the capacity to rotate or isolate visual images into new planes or combinations (McGuinnes, 1976, p. 138).

Field-Dependent: The inability to separate an item from the field or background of which it is a part; experiences the environment in a global fashion; the background exerts a strong influence on the objects within it (Witkin et al., 1962, p. 35).

Field-Independent: The ability to separate an item from the field or background of which it is a part; experiences the environment in an analytical fashion; experiences objects as discrete from their backgrounds (Witkin, et al., 1962, p. 35).

CHAPTER II

REVIEW OF LITERATURE

Introduction

Analytical spatial perception ability has been one of the well accepted male-female differences. Some authors held that these differences were biologically based and that such factors as hormone levels contributed to these as well as other sex traits. An opposing view was that sex-stereotyping and cultural influences affected the experiential learning and development of attitudes and skills which impacted analytic spatial perception ability. Factors that contributed to sex differences, while operative at an early age, became more pronounced and sustained from the late teen years (Witkin, Lewis, Hertzman, Machaver, Neissner and Warner, 1954). Another approach considered that difference in perception may have had a counterpart in intellectual functioning in that problems calling for creativity also required that parts of the problem be separated from the context in which they were embedded and brought into new relationships (Witkin et al., 1962, p. 59).

Spatial Perception Ability

Hochberg (1968) talked about the act of perceiving as an analysis of the structure of visually perceived form and identification of the components of perceptual processing that had an effect on set. Perception, then as a construct, was based on subjects' responses and to the physical stimulus. The term form perception was used when considering subjects' responses to stimuli. Accordingly, a response, or set of responses, was considered by Hochberg to be perceptual in nature when the responses were completely independent of the stimuli and imagination and memory were factors.

Haber (1968) discussed two hypotheses that have been used to interpret the effects of set. The older one addressed perceptual enhancement or "tuning." That is, when the subject paid attention to a particular attribute of a stimulus it became more noticeable. Conversely, attributes of the stimulus that were not given more attention did not stand out. According to this hypothesis, then, the effect of set occurred while the stimulus was being viewed.

The alternate hypothesis was that set did not affect perception as such but some aspects of memory. Haber (1968) discussed three aspects of this response hypothesis. First, set facilitated relevant responses and by so doing, increased the probability that the subject could identify the stimulus. Second, set caused the emphasized attributes of the stimulus to be reported first, hence more accurately, before memory of the stimulus faded. And thirdly, set had a modifying effect on memory so that the more important attributes were retained more accurately. Haber maintained that there was an important difference between reporting experience and reporting remembered attributes of the stimuli.

Perception is a constructive process with input information playing a large role in the process (Neisser, 1967). Neisser likened it to the similar role played by the accumulation of information stored in long-term memory; i.e., the role that stored information had in recall was similar to the role that stimulus information had in perception. Accordingly, a subject "sees" an object after carrying out a process of construction, which used relevant stimulus information. Conversely, a subject recalls or "remembers" an object after carrying out a process of reconstruction, which used relevant stored information (Neisser, 1967).

Neisser (1967) maintained that this reconstruction was based on information left from previous processes of construction. So these traces of earlier cognitive acts were stored for later retrieval and these earlier fragments became information bits on which to build new constructions. Neisser defined a cognitive structure as

> . . . a non-specific but organized representation of prior experiences. . . . Because these residues (of experiences) are organized in the sense that their parts have regular and controlling interrelationships, the term 'cognitive structures' is appropriate . . . (p. 287).

He further included sensation, perception, imagery, retention, recall, and problem-solving as stages or aspects of cognition.

> The central assertion is that seeing, hearing and remembering are all acts of construction, which may make more or less use of stimulus information depending on the circumstances. . . . The constructive processes are assumed to have two stages, of which the first is fast, crude and wholistic and parallel while the second is deliberate, attentive, detailed and sequential (p. 287).

Witkin et al. (1954) discussed tests for perception in males and females, ages 8 to 17 years. Their results showed that differences in visual field dependence occurred from age 8 years to age 17 years.

However, it was not until the 17 year level that a statistically significant difference in scores appeared between the males and the females. This difference became significantly consistent only at the adult level. The authors therefore concluded that while factors contributing to sex differences in perception were operative at an early age, it was at the adult level that they produced marked sex differences.

> . . . the tendency of adult males to be more self-consistent in perception than females under various test conditions was also clearly demonstrated at the 15 and 17 year levels. . . . In general . . . from about 15 years on, males tend to be more consistent in perception than females, despite variations in the specific circumstances under which their perception is tested (p. 170).

Gibson (1969) spoke of locating objects in space as a product of sensory-motor learning. This followed the writings of Piaget and Inhelder (1956) when they spoke of the role of sensory-motor schemata in developing space perception. Gibson went on to write

> . . . that space becomes better differentiated with practice and with the extension of a child's sphere of activities. . . . But I do not believe that the perception of the continuity of the ground and the adjacency of other surfaces to the ground has to be gradually pieced together (p. 374).

Neisser (1967) saw space as an important cognitive dimension. In general, people relate to themselves and to the world around them in spatial terms and information about these spatial aspects of construction remains available in their minds for recall.

Anastasi (1965), in discussing sex differences in aptitudes, maintained that mean differences in spatial perception that had been established at a satisfactory level of statistical significance were large enough to be of practical significance. However, these sex differences were appearing under the existing cultural conditions. In addition, there was evidence of possible relation between personality characteristics and perception task performance.

Thurstone (1951) reported 10 factors of spatial perception. Smith (1964) discussed the three factors of spatial perception reported by French in 1951: space; spatial orientation; and spatial visualization. The space factor was the ability to accurately perceive and compare spatial patterns. This factor was identified as being integral to the perception of both two- and three-dimensional space. Spatial orientation was the ability of the perceiver to not become confused by spatial patterns presented in varying orientations. The perceivers' ability to mentally manipulate objects in space was the factor labeled spatial visualization.

Guilford (1967) identified two spatial factors, but defined them differently. The first factor was spatial orientation or the ability to perceive spatial relationships with reference to the body of the perceiver. The second was spatial visualization or the ability to imagine movement or other changes in visual objects.

In summary, imagination and memory factors played a role in a subject's perceptual responses to a physical stimulus. The study of spatial perception has been embarked upon from different approaches, i.e.

1. that the subjects could accurately perceive and compare spatial patterns; or

2. that the subjects could remain unconfused by spatial patterns or varying orientations; or

3. that the subjects could accurately perceive spatial relationships with reference to their own bodies; or

4. that the subjects could mentally manipulate objects in space; or

5. that the subjects could imagine movement or other changes in visual objects.

In the human subject, there is reason to believe that the male is superior to the female in performance of tasks requiring perception, judgment and manipulation of spatial relationships (Maccoby and Jacklin, 1974; Garai and Scheinfeld, 1968; Buffery and Gray, 1972). Buffery and Gray (1972) maintained that male superiority in spatial perception tasks was observed when manipulation of spatial relationships was involved. On the other hand, females exhibited superior performance when the task involved discrimination and/or comparison of fine visual details.

In their discussion of sex differences in spatial ability, Tapley and Bryden (1977) proposed that females exhibited difficulty in visualizing and mentally manipulating spatial relations rather than in perceiving spatial relations. They maintained that an insufficient number of studies addressed adult subjects and that there was not a clear differentiation as to whether females were generally less accurate or simply slower in processing the mental rotations.

They set out to test for a sex difference on a mental rotation task using real three-dimensional objects. Their findings showed females exhibiting a trend for slower response times and lessened accuracy for mental rotation tasks. In a second study, subjects were asked to describe their approach to the mental rotation tasks. The approaches were classified as "visual-holistic" and "verbal-analytic." The conclusion drawn was that male-female differences exist in mental rotation tasks performance. But the question raised was what effect did choice of strategy have on that ability? The authors concluded that how a subject performs a mental rotation task was not clear but that further research into the relationship of performance of mental rotation tasks with other factors identified with sex differences and spatial perception would be in order.

Findings cited by Maccoby (1966) indicated that cross-sex-typing was associated with optimal intellectual development in females. Differential learning because of sex-typed activities was consistent with evidence cited showing a correlation, but not necessarily a casual relationship, between lessened analytical skill and increased dependency and conformity in females. Accordingly, independent, nonconforming females would be more expected to engage in activities that are contrary to cultural sex-role expectations. Several factors tended to be closely tied together with conventional sex-typing: dependency; less exploration; increased verbal skill; and decreased spatial skill (Sherman, 1967).

In task performance, males have been consistently superior in manipulation of spatial relationships while females have been shown to be superior in the discrimination of fine visual detail. These differences were more pronounced after puberty. Some researchers, it has been noted, have questioned whether females' difficulty lies in visualizing and mentally manipulating spatial relationships rather than in the actual perception of spatial relations. Additionally, it has not been clearly established whether females were generally less accurate or merely slower in processing mental relations. In any case, past research has dealt primarily with elementary, middle and high school students. There has been a lack of data available on male-female differences in spatial perception ability with college students as subjects.

Background Influences

In the past few years, studies of analytical spatial ability have been focused on some of the correlates of the spatial analytic factor. Recent studies reflected the trend to determine the environmental and genetic factors that impacted the individual differences in spatial test scores. Those who felt that environmental factors accounted for the sex differences in spatial ability claimed that the tests measuring this ability were biased in favor of males.

Socialization and training may have also affected spatial task performance. If males were superior to females on the performance of spatial tasks, then significantly higher father-son than father-daughter correlations for scores on spatial ability tests would be expected. McGee (1976) did not find such correlations. Positive transfer of training on spatial tasks was demonstrated by Blade and Watson (1955). It could be expected that females would respond more favorably than males to training on spatial ability tasks if the females' deficit was due to differential learning experiences. Smith (1964) did not find this to be the case.

> While a cognitive-developmental theory of psyche-sexuality suggests that cognitive advance should have an important impact on sexual attitudes in the early school years, it also suggests that this impact should be greater for boys than for girls (Kohlberg and Zigler, 1976, p. 440).

The mother is the first and the most important adult model. The boy normally shifts to preferring the father as a model. This shift comes about as a result of cognitive mechanisms that consolidate the sex-role identity of the boy and give meaning and prestige to the father's work role. The girl's psychosexual development does not, however, require this shift in parental model (Kohlberg and Zigler, 1976).

> A cognitive-developmental interpretation of I.Q.-personality correlates, then, suggests that I.Q. should be more determining of the development of sex-role attitudes of boys than of girls because the girl's parental identification can be based on more concrete imitative learning processes under conditions of greater exposure to the model, and because such identification does not require a radical developmental shift in model (p. 441).

Sex-typed behavior may be interpreted, in the social-learning theory, as behavior that elicits different rewards for one sex than for the other. Sex-typed behaviors have different consequences depending on the sex of the performer.

According to social-learning theory, the acquisition and performance of sex-typed behaviors are influenced by reward, non-reward and punishment under specific circumstances as well as the influence of direct and non-direct conditioning. The so-called appropriate sex-typing involves the extent to which the person's behavior conforms to that which is considered to be typical of his or her own sex. The degree to which these behaviors have value to the individual affects the acquisition of sex-typing (Mischel, 1966).

Children make generalizations about sex differences in response to their own experiences and from observations of models as well as from the effects of direct reinforcement for specific behaviors. The consequences a child incurs from the performance of sex-typed behaviors are critical determinants of subsequent performance of these behaviors. The child learns to label behaviors as appropriate or inappropriate for each sex. Response acquisition is influenced by sensory and cognitive processes that may be enhanced by reinforcement, but not necessarily dependent on it.

Differences in conditioning of male and female children impacted differences in attitudes and responses. Through conditioning, words and other symbols can become powerful conditioning stimuli with the ability to bring about autonomic responses. These words or symbols take on a value and affect otherwise neutral stimuli when they are considered together.

> Extrapolating to sex-differences, it is apparent that numerous activities, goals, interests, and the like acquire differential value for the sexes by being differentially associated with positive or negative outcomes and labels (Mischel, 1966, p. 61).

Mischel (1966) put forth the idea that some of the behavior differences between the sexes may reflect differences in the kinds and levels of standards acceptable for certain types of performances. He suggested that acceptable performance levels in, for instance, arithmetic and child-care, were different for the sexes.

Anastasi (1958) commented that ". . . the fact that two children have been brought up in the same home is no indication that they have had identical psychological environments" (p. 63). The psychological environment consists of the sum total of the stimulation the individual received in a lifetime. This concept of the environment sees the physical presence of objects as important as they serve as stimuli for the individual.

According to the additive contribution theory, both heredity and environment contribute to behavior development. Hereditary and environmental factors influenced the effect of each other in the development of behavior patterns. That is, environmental factors exerted varying influences depending on the hereditary material on which it impacted. Likewise, hereditary factors affected environmental factors differently under different conditions (Anastasi, 1958).

A combination of heredity and environment impact social class and socio-economic class. Social class membership may have an effect on an individual's emotional and intellectual development. Social class differences are reflected in differences in home life, education, recreational outlets and community resources and activities.

In her study of reading readiness and parent-child interaction, Milner (1951) found that lower class children perceived adults to be hostile and that they had lessened opportunity for verbal exchange with adults. This is one of several studies linking a close relationship between language development and socio-economic level.

There was also reason to believe that class differences in attitude toward education were important factors.

> Studies of both the children themselves and their parents indicate that higher-status children are taught to respond favorably to the competitive situations represented by schoolwork and intelligence tests; and that they are more strongly motivated for personal achievement and academic advancement. The expectations and attitudes of teachers and school administrators may also contribute to the superior scholastic attainments of higher-status children (Anastasi, 1958, p. 511).

Likewise, Anastasi (1958, pp. 521-533) reported on a body of data indicating a positive relationship between I.Q. test scores and occupational level of father: "In general, there seems to be a difference of about 20 points between the mean I.Q.'s of the children of professional men and those of the children of unskilled laborers."

Another theory addressed the children's intellectual development in terms of the cultural level in which they were reared. It put forth the idea that the child who grew up in the home of an unskilled laborer did not have the same intellectual development opportunities as the child of a professional man. Still another theory put forth the possibility that both socio-economic and intellectual variables may have been related through other factors such as personality characteristics, national origin or family size.

There were studies done several years ago that would indicate that rural children as a group average significantly lower than urban children on I.Q. tests. Reasons suggested for this difference were elements of the physical and social environment. Differences in environmental opportunities were contributing factors to the child's intellectual development. More recently, however, there has been some indication that the urban-rural gap in I.Q. test performance is rapidly shrinking.

Anastasi pointed out that I.Q. tests have been standardized predominately on urban populations and urban subjects have greatly outnumbered the rural subjects in the standardization sample. Likewise, I.Q. tests have been validated against such criteria as school achievement, which tends to favor middle-class subjects.

The social-learning theory holds that behavior becomes sex-typed as it elicits reward, non-reward or punishment. The extent to which a person's behavior conforms to that which is considered typical for that sex indicates the extent of sex-typing that has occurred. Heredity, environment, social class and socio-economic status influence the development of behavior and personality characteristics.

Social class differences are reflected in differences in home environment, educational opportunities, attitude toward education, recreation and leisure time activities. There has been shown to be a correlation between the intellectual development in children and the cultural/intellectual level of the environment in which they were reared.

Male-Female Differences

Sherman (1967) hypothesized that cultural sex-role patterns may result in sexually different childhood experiences which may tend to affect the development of visual-spatial abilities. Fennema and Sherman (1977), in a study of sex-related differences in mathematics achievement, found that socio-cultural factors greatly impact the sex-related differences in mathematics achievement and spatial visualization. Additionally, males' confidence scores in mathematics achievement were significantly higher than females'.

Other studies (Blade and Watson, 1955) indicated that spatial ability was trainable to some extent. In a test of embedded figures performance, Conner, Schackman and Servin (1978) found that both males and females benefitted from practice which was further enhanced by a training procedure. Females' poorer performance was remedied by practice when a pre-test was used or by prior training when no pre-test was used. The conclusion was that sex differences in visual-spatial ability, as well as ability ranking within each sex, appeared to be modified by training and/or practice.

That there are major sex differences in aptitude and personality traits was accepted by researchers in the field. One question that arises concerning these differences was whether they were the result of heredity, biological differences, social stereotypes, sex roles, or other cultural pressures. The sexes differ biologically in many ways and some of these physical differences were reflected in psychological differences, either directly or indirectly. In addition, most cultures promoted differences in psychological climate for the two sexes and these may have impacted with biological differences (Anastasi, 1965).

Terman and Tyler (1954) discussed sex differences having been reported for almost every physical variable including body build, anatomical characteristics, physiological functioning and biochemical composition. In commenting on these differences, Anastasi (1965) maintained that these physical differences may impact sex differences in play activities, interests and various kinds of mental and physical achievement.

> It is reasonable to expect, for example, that the greater strength and mobility of boys increase the likelihood of their manipulating mechanical objects, and thus indirectly facilitate the development of clearer mechanical concepts (p. 463).

Even before the onset of puberty and the development of adolescent sex roles, there were relevant differences. Males generally spent more play time in aiming at targets and in games, in model construction and building with blocks and other materials. It would seem logical that these activities would affect the development of spatial skills in children. It would be unwise to assume, taking into consideration such studies as Blade and Watson (1955), that all children normally experience a mix of cultural and learned factors to develop fully their spatial skills (Sherman, 1967).

The roles of males and females in reproduction may lead to other sex differences in emotional development, intellectual functioning and achievement. Anastasi (1965) maintained that the functions of child-bearing and rearing have important implications for differences in interests, emotional traits, vocational goals and in various areas of achievement. Sex hormones influenced differences in psychological traits. The presence of male or female sex hormones influences certain aspects of behavior, and it was the proportion of these hormones in the individual that determined the degree of development of masculine or feminine characteristics.

A possibility reported earlier by Witkin et al. (1954) suggested that differences between males and females in biological role and anatomic make-up may contribute to differences in the development of articulation of experience.

> The fact that the sex organs of women are 'hidden' may make it more difficult for them to develop a clear conception of the body. This, in turn, may affect the further development of articulation of experience (p. 220).

Bruner (1966) pointed out three central themes that recur in discussions of growth and the conditions that shape it. The first pertained to the means by which growing human beings represent their experience of the world and how they organize their experiences for future use. The second theme addressed the influence of culture in the nurturing and shaping of growth. He took the position that all the manifestations of cognitive growth occur as much from the outside as from the inside. And thirdly, mankind's evolutionary history indicated a capacity for helplessness that was alleviated by external shaping and devices.

There was evidence as well of sex differences in mode of field approach. Males tended to be more analytical than females in both perceptual and intellectual functions. "Significant relations between mode of field approach and measures of masculinity-femininity have also been found within each sex" (Witkin et al., 1962, p. 221). Differences in favor of males had been reported repeatedly in spatial and mechanical aptitude tests. Anastasi (1965) suggested that several facts indicated that this difference was primarily culturally based. Male superiority was more pronounced and consistent in tests using mechanical information rather than on more abstract tests of spatial relations and male superiority in this function was not manifested as early as was verbal superiority in females.

Another important sex difference was found in the developmental acceleration of females. It has been suggested (Anastasi, 1965) that females may be accelerated in intellectual as well as in physical development, but this was inferred by analogy with physical development. Developmental rate may have had widely varying degrees of effect, but acceleration of females in infancy may have had an important effect on their more rapid progress in the acquisition of language and verbal development taken as a whole. With regard to emotional and personality characteristics, the earlier onset of puberty in females introduced an uncontrolled factor in sex comparisons at certain ages. The female has been traditionally younger than the males with whom she associates, younger than the man she marries, and generally has been surpassed by most of her male associates in education, intellectual development and general experience. Such social situations as these may have affected social attitudes toward the two sexes and age differences may have been interpreted as sex differences.

Fairweather and Hutt (1972), in a discussion of their studies, pointed out a highly significant difference between males and females in the slope of the curve measuring channel capacity--or the speed of response, or reaction time, to information signals. Their results indicated that ". . . it demonstrates a developmental increase in channel capacity, and second, that this itself reveals a marked sex difference" (p. 170). They concluded that "The further possibility which must be considered is that there is a neuro-endocrinological basis for both the overall sex difference and the age changes" (p. 171).

Witkin et al. (1962), in their discussion of surveys on sex differences, reported that many studies had found sex differences ". . . in some behavior manifestations of a developed sense of separate identity" (p. 218). Females, taken as a group, had been repeatedly described as more dependent on others, more apt to be more concerned with people and with the impressions they make than were males. Females generally excelled in memory for names and faces and the authors suggested that concern for the facial expression of others was characteristic of people with a relatively undeveloped sense of separate identity and was common in persons with a global field approach. Another study related to achievement showed that threatened withdrawal of social approval increased achievement for females but not for males. Conversely, stress of intellectual failure increased achievement for males but not for females. It was suggested that this difference may be based on the greater dependence of females on others.

Females early establish their verbal superiority and this skill develops as a means of satisfying their needs. Males, on the other hand, lacking these social communication skills, may have a tendency to use their superior musculature to satisfy their needs. Thus, having already established the pattern of not being able to control or be controlled by words, the stage could be set for sex differences in active exploration and active rather than verbal means to problem solution in males. Conversely, dependency on others could grow out of this verbal approach in females and thus inhibit the exercise and development of spatial skills. This trend for both males and females would be fostered by the cultural sex-typing of activities. The corollary for males is that action and non-verbal approaches would become fixed patterns of behavior with the result that verbal, socially mediated behavior would not develop adequately (Sherman, 1967).

According to Witkin et al. (1962), another possible basis for sex differences came from the encouragement of a more dependent role for women in our culture.

> . . . men more often engage in activities, as work and warfare, that place emphasis on self-reliance and achievement. Women, in contrast, more often have the nurturant role of homemaker and child-rearer. These differences are consistent with differences in training goals for the two sexes, with training for boys more often focused on independence (p. 220).

Another consideration was the positive value society apparently attaches to developed differentiation for males and limited differentiation for females. Society tends to favor characteristics indicative of independence in males. As a result, Witkin et al. (1962) maintained that social pressures in society contribute to sex differences in differentiation.

In considering the differences in male-female spatial perception ability, the influence of socio-cultural patterns may be very influential. Sex-role patterns established in childhood may affect the development of visual-spatial abilities. Females, who early show verbal skills, may continue to use verbal means to satisfy their needs partially because socio-cultural patterns promote this behavior. Males, on the other hand, are allowed and encouraged to engage in more active behavior and are able to do so because of their greater musculature. In addition, functions of child-bearing and rearing may influence differences in emotional traits, vocational goals and levels of achievement, again promoted by socio-cultural patterns. It has been demonstrated, to some extent, that visual-spatial ability is somewhat enhanced by training. While several authorities in the field have been referenced regarding this aspect of spatial perception ability, little work has been done with college students.

One approach to the study of sex differences was the comparison of responses to test items which were indicators of male-female characteristics in our contemporary culture. Test items were designed to discriminate between the responses of the sexes. And so, the test score provided an index of masculinity-femininity in the sense that it reflected the characteristic male-typical and female-typical responses in our culture. The masculinity-femininity tests were designed to indicate an exaggeration of sex differences. The purpose of the test was to measure the differences between males and females as much as possible. Therefore, the masculinity-femininity score indicated how closely a subject's responses agreed with those most characteristic of males and females in our contemporary culture (Anastasi, 1965).

A very extensive investigation of characteristic sex differences in personality was conducted by Terman and Miles (1936). They concluded that there was evidence to suggest that cultural influences were stronger than biological influences in contributing to sex differences in personality. They found correlations between the masculinity-femininity scores and physical characteristics to be nonsignificant and concluded that the correlates that were found were probably the result of social effects of physical characteristics rather than the result of underlying biological factors.

Their studies also indicated that highly intelligent and well-educated women scored toward the masculine end of the scale and that men who have artistic or cultural interests scored toward the feminine end of the scale. Thus they concluded that the equalizing influence of training and experience tended to bring about a convergence of the personality characteristics of the sexes. A part of this training and experience was the environment in which the child grew and developed and these factors appeared to be more closely related to masculininity-femininity scores than were physical traits.

Tests to indicate the degree of masculinity or femininity in a subjects' responses were designed to reflect male-typical and female-typical characteristics in our contemporary culture. Well-educated women were found to score toward the masculine end of the scale while artistic men tended to score toward the feminine end of the scale. Training and experience have tended to bring masculine and feminine personality characteristics closer together. The environment in which the child develops is an integral part of training and experience in a variety of abilities. The cultural environment exerts a stronger influence than the biological in contributing to sex differences in personality.

Break-Set or Restructuring in Problem Solving

According to Witkin et al. (1962, p. 113), "The evidence suggests that children who tend to experience analytically are also better able to structure their experiences." The authors reported on their study of the relationship between ability to analyze and ability to structure experience in children. Structuring ability was evaluated through an analysis of the subjects' perception of the Rorschach figures. The children with a relatively analytical field approach imposed more organization on the Rorschach figures than did the children with a more global approach. Another study investigated memory and structuring of experiences. The hypothesis was that experiences which have been structured on initial registration were more likely to survive in memory than would vague experiences. Therefore, children with a more analytical field approach should be expected to structure their experiences and should demonstrate better memory for earlier events. This expectation was confirmed for boys for not for girls. Boys with a relatively analytical field approach scored above boys with a relatively global approach.

A study to explore differences among children in quality of experience was undertaken. The children were interviewed to obtain accounts of their everyday life. Emphasis in the interview was placed on information which would be useful in evaluating articulateness of experience in both its analytical and structuring aspects--the dimension labeled "cognitive clarity" (p. 114). The children who demonstrated a relative analytical field approach showed greater cognitive clarity.

Witkin et al. (1962) maintained that articulation implies that experience is both analyzed and structured. Field-dependence/independence tests required the respondent to separate an item from the field or background of which it was a part and which exerted a strong influence upon it. The respondent was expected to break-up the field. The field-independent perceiver tended to be more analytical in response to environment and experienced objects as discrete from their backgrounds. Conversely, the field-dependent person experienced the environment in a more global fashion and the field, or background, exerted a strong influence on the objects within it.

Some people's perception seemed to be stimulus-directed. Such perception conformed closely to the characteristics of the stimulus as it was represented at the sensory surface. Constancy was minimal. People at the other extreme, perceived the stable characteristics of the objects viewed. Constancy was maximal. Such perceptual differences related to the ability to overcome an embedding context or break-up a percpetual field. People with the stimulus-directed approach perceived an object independently from the context in which it occurred. Such people were described as having an analytical attitude. Conversely, people who were strongly influenced by the context--or field--an item was in were said to have a global approach. The degree of analytical attitude in people differed. This dimension was referred to as field-dependence or independence and appeared to be distinct from the ability to overcome the effects of distracting fields or backgrounds (Witkin et al., 1962).

Witkin et al. (1962) reported on studies with Einstellung problems which provided evidence that the ability to overcome the field was expressed in both the perceptual and intellectual functioning of an individual. "Set-breaking may be conceptualized in terms of ability to overcome embeddedness" (p. 77). In order to break the set, the elements must be considered as separate entities in the initial organization and rearranged into a new organization.

> If we consider that set-breaking in the Einstellung involves the ability to overcome an established mode of organizing elements, as a condition for combining them into a new pattern, we have further evidence in those results that the capacity to overcome an embedding context extends through an individual's perceptual and intellectual functioning (p. 78).

Many studies have been done with children and their ability to distinguish items as distinct from their backgrounds--the characteristic referred to as field independence. Those who perceived an object independently from the context in which it occurred were said to have a stimulus directed approach. Conversely, those said to have a global approach were strongly influenced by the field the item was in. Children with a relatively analytical field approach demonstrated both analytical and structuring aspects in articulating their experiences.

Creativity, Personality Characteristics and Intellectual Functioning

Reese and Goldman (1961) reported their comparison of results on projective tests and self-report personality inventories. Their attempt was to identify some personality characteristics common to creative persons and to ascertain the role of emotional adjustment in the creative process. Their conclusions were that ". . . creativity is associated with lack of negativism and a positive enthusiasm. . . .

Creative people may be less outgoing and social than the average person" (p. 146).

Witkin et al. (1954, 1962) considered the possibility that differences in perception might have a counterpart in intellectual functioning. Intellectual problems calling for creativity also required that parts of the problem be separated from the context in which they were embedded and brought into new relationships. They felt that

> It is likely--and this is of course subject to experimental test--that if a person has this basic ability to 'break-up' a configuration it will be manifested not only in straight forward perceptual situations, but in problem-solving situations as well (Witkin et al., 1954, p. 477).

Durie (1976) maintained that the individual's ability to image must play a valuable role in creative functioning.

> . . . one of the most important processes in cognition is memory, or the coding of information for storage and retrieval in the memory system. 'Imagery' refers to internal figural representations or codings which are related to sensory experiences . . . (and) refers to both product and process. . . . imagery as product refers to cognitive figural or spatial constructions; and as process, it can either be evoked as response to external stimulus, or invoke congnitive responses itself by serving as stimulus. Thus, imagery can be involved in decoding, encoding, and cognitive construction processes of figural or spatial content (p. 234).

It would appear, from reviewing the literature, that imagery was involved to some degree in the creative process (Bruner et al., 1966; MacKinnon, 1962). In creative endeavor the artists manipulated their past experiences. This was not enough, however, to explain the use of imagery in creative endeavor. It would have seemed logical to conclude that adults who could recapture vivid perception in the form of visual, auditory and kinesthetic imagery were capable of more novel responses.

The creative adult, however, must also be able to transmit these responses to others and so could not be considered as child-like in being tied solely to iconic representation (Durie, 1976).

Durie (1976) took the position that imagery was a language system separate from symbolic coding and that this approach was the best way to study creative functioning. Hence, in order to achieve the highest level of creative functioning, both iconic and symbolic systems had to be employed. She cited several investigators who agreed that imagery processing was dependent on the physical similarity of stimuli and spatial context.

She concluded that flexibility, the ability to look at a problem from many angles, was important to creativity. This position raised questions to investigators. Does the person who used predominately imagery code have more creative cognitive constructions than the person who used verbal coding? What part did imagery play in creative and flexible problem-solving? Imagery, she maintained, allowed more elaboratation of problem components than resulted when linguistic coding alone was employed. Also, visual representation may have allowed playful shifting of the elements in a problem.

MacKinnon (1962) discussed some of the personality characteristics that emerged from his studies of creative people. One finding was that they had a good opinion of themselves and this high level os self-acceptance allowed them to speak more openly and critically about themselves.

He found little relationship between creativity and intelligence in the subjects tested but admittedly, there was a narrow restriction in range of intelligence. On the whole, there was a positive relationship between creativity and intelligence; but above a certain required minimum level of intelligence, the more intelligent were not necessarily the more creative.

There was, however, evidence of psychopathology in the creative subjects but evidence also of adequate control mechanisms. Such control mechanisms were manifest in the success with which they handled their productive and creative lives.

The most striking characteristic was an extremely high peak on the masculininity-femininity scale scored by the male subjects. He concluded that the creative persons were more open about their feelings and emotions, possessed a sensitive intellect and a level of self-awareness, and exhibited a wide range of interests which, in the contemporary American culture, were classified as feminine.

He went on to describe the subjects in his study as having a preference for the perceptive attitude that allowed for flexibility and spontaneity. The subjects indicated that they were relative uninterested in small details or in facts for their own sake. They were intellectually curious and did not harness their impulses or images.

Studies of creative people have indicated personalities that show a high level of positive enthusiasm, flexibility, imagination and spontaneity. The ability to look at a problem from many angles involved being able to separate it from the context in which it was embedded. These abilities have been tied to intellectual functioning as well. Male subjects who demonstrated a high level of creativity also scored toward the feminine end of a masculinity-femininity scale.

CHAPTER III

RESEARCH PROCEDURES

Introduction

As evidenced by the literature review, interest in spatial perception ability goes back to the early part of the century. Several studies cited in the literature review have linked sex differences in spatial perception ability to physiological sex differences. Others have maintained that the cultural effects of sex-typing influence intellectual differences between the sexes.

The ability to go beyond a previous learning experience and to thereby come to new solutions to problems is a characteristic of the human species. The questions arise: How does such creative behavior begin in the human mind? Are these differences inherent between the sexes? Do those who exhibit creative behavior tend to go into career fields that require this ability? How is the development of creative behavior either encouraged or discouraged in the human mind? What background and experience factors have an influence? Explanations have been sought to interpret how one person can respond to a situation with uninspired reactions while another can combine the same elements into a novel response. The production of novel responses implies that the individual maintains a relationship with the external object world that allows selective responses and that an analytical approach is employed in problem-solving.

The perceptual process is an abstract phenomenon. It is a continuing process ongoing in time as opposed to a single, isolated element. As such the examination of the process requires a segmentation in order to bring it into a setting for investigation. In studying perception, the investigator cuts cross sections through the process at different points in its development and draws conclusions about what has happened in between. The present study addressed differences between males and females enrolled in selected design-oriented courses. It further investigated certain background influences and experiences as they might tend to influence responses as measured by two standardized tests.

This chapter discusses the design of the research. The population and sample are described, as well as the selection of the instrument and the development of the questionnaire. In addition, data collection and analysis are addressed.

Type of Research Design

A key element in many social scientific studies in the description of situations and events as they exist at a point in time. Best (1977) comments on the descriptive method of research:

> Selection of a particular design is based on the purpose of the experiment, the type of variables to be manipulated, and the conditions or limiting factors under which it may be conducted (p. 102).

He also states, "A descriptive study describes and interprets what is . . . concenred with conditions or relationships that exist . . . primarily concerned with the present" (p. 116). This study fits the descriptive method of research because it examines intact groups of people on a one-time basis for characteristics that they may share.

The present study was designed to assess the analytic spatial perception ability of students enrolled in Interior Design, Art, Architecture and Landscape Architecture at Oklahoma State University at Stillwater, Oklahoma. To accomplish this, the survey method of gathering data was employed. Kerlinger (1973) explains the survey as

> . . . studies large and small populations . . . by selecting and studying samples chosen from the population to discover the relative incidence, distribution, and interrelationships of sociological and psychological variables (p. 410).

Intact classes were surveyed for this study. The beginning studio classes for each of the design-oriented majors were selected as the intent was to survey the respondents as they began study in their major field. It was determined that analytical spatial perception ability would be manifested in these studio courses and thus amenable to testing. The courses selected from the Art and the Housing, Design and Consumer Resource Departments had a number of non-majors enrolled. These students comprised the comparative group for the study.

A one-time test procedure was adopted for this study as the objective was to consider college students as they selected a major and began career planning. Best (1977) comments on the one-time test procedure:

> . . . designed . . . to estimate the degree of achievement of a large number of individuals who have been exposed to a great variety of educational and environmental influences (p. 119).

The intent of the study was to ascertain the level of analytic spatial perception ability in the students tested and to identify any possible male-female differences. To assess this ability in the students, the Abstract Reasoning and the Space Relations sections, Form T, of the Differential Aptitude Tests (DAT) were chosen. These are standardized tests by Bennett, Seashore and Wesman which were developed in 1947 and revised in 1959. The tests were administered to the students in the Fall semester of 1980.

Population and Sample

The population available for the present study included all Art, Architecture, Landscape Architecture and Interior Design majors registered at Oklahoma State University in Stillwater, Oklahoma, for the Fall semester, 1980. Data obtained from each of the participating departments revealed that their student populations were as follows: 886 students enrolled in courses in the Art Department; 352 students enrolled in the School of Architecture; 125 students enrolled in courses in Landscape Architecture; and 165 students enrolled in courses in Housing, Design and Consumer Resources.

Table I illustrates the breakdown of the beginning courses for the majors surveyed. Students enrolled in these five courses made up the sample for this study. The courses listed in Table I are the beginning courses with a studio component for each of the major fields considered. Beginning courses were selected in order to tap students' spatial perception ability before the influence of course work was established. The classes surveyed yielded a sample size of 355 of which 177 were males and 178 were females. Students who were majoring in other fields but who were enrolled in either the art of one of the Interior Design courses comprised the comparative group. Table II illustrates the breakdown of the sample from each major as well as the male-female ratio in each major.

TABLE I

BREAKDOWN OF SAMPLE BY COURSES SURVEYED

Department	Course Number	Course Name
Art	1103	Basic Drawing
Architecture	2013	Basic Design
Landscape Architecture	2002	Landscape Delineation
Housing, Design and Consumer Resources	1123	Graphic Design for Interiors
Housing, Design and Consumer Resources	2313	Housing for Contemporary Living

The largest number of subjects in the subsample were the Architecture majors where the male-female ratio was almost four to one. Art majors and Landscape Architecture majors were the smallest subsamples with 24 and 28 subjects, respectively. The Landscape Architecture majors were the only group almost evenly split by males (15) and females (13). The greatest male-female ratio was in the 52 Interior Design majors where the males were outnumbered by almost eight to one (46 to 6). The Comparative Group of 104 subjects represented majors from the following departments: Biology; Business Administration; Clothing and Textiles Merchandising; Computer Science; Education; Engineering; Family Relations and Child Development; Food, Nutrition and Institutional Administration; Home Economics Education; Hotel and Restaurant Administration; Pre-Medicine; Pre-Veterinary Medicine; Psychology; Public Relations; Recreation, Leisure and Physical Education; Zoology and undeclared majors (see Table II).

TABLE II

CHARACTERISTICS OF SAMPLE BY SEX WITHIN MAJOR

Major	Sex	n	% of Major	% of Sample
Art	Males	9	37	2.5
	Females	15	63	4.5
Total		24	100	7
Architecture	Males	115	79	33
	Females	32	21	8
Total		147	100	41
Landscape Architecture	Males	15	54	4.3
	Females	13	46	3.7
Total		28	100	8
Interior Design	Males	6	11	2
	Females	46	89	13
Total		52	100	15
Comparative Group	Males	32	30	9
	Females	72	70	20
Total		104	100	29
Total Sample	Males	177		
	Females	178		
		355		

Instrumentation

The Abstract Reasoning and the Space Relations sections, Form T, of the Differential Aptitude Tests were chosen after reviewing a number of standardized spatial perception tests. These appeared to be the most representative to assess the ability to mentally perceive operating principles and three-dimensional objects. This battery of tests by Bennett, Seashore and Wesman (1959) was developed to provide a standardized procedure for measuring the abilities of young adults for the purposes of educational and vocational guidance.

The Abstract Reasoning section measures the student's ability to perceive an operating principle in the changing figures and to designate the diagram that would logically follow. The task required is thinking with abstract symbols. The Space Relations section assesses the student's ability to visualize solid, three-dimensional objects from a picture of a pattern and to manipulate these visualizations. The task required for the solution to the test items is a judgment of how the objects would look if constructed and rotated.

Reliability

Statistics to measure reliability have been designed to indicate whether or not a particular test or measurement, when repeatedly applied to the same subject, would yield the same or similar results each time. Reliability is concerned with consistency in measurement. The authors of the DAT were concerned about securing reliable scores within the practical time limits for testing. The authors computed reliability coefficients (for internal consistency) using the "split-half" method, corrected by the Spearman-Brown Prophecy formula, for students in grades 8 through 12 (Bennett, Seashore and Wesman, 1959).

According to Nunnally (1978), the most appropriate reliability measurement for a speed test is made by correlating forms:

> A time-saving approximation of the alternative form reliability can be obtained by correlating separately timed halves of one test. . . . The correlation between the separately timed halves would then be corrected to provide an estimate of the alternative-form reliability of the whole test (p. 304).

The "split-half" procedure provides a maximum likelihood estimate of the reliability coefficient. That is, the actual reliability score is somewhat less than the coefficient obtained by the "split-half" procedure. Nunnally (1978) comments on the "split-half" method of estimating reliability:

> . . . one may estimate reliability from various subdivisions of a test. The most popular is the 'split-half' approach, in which items within a test are divided in half and scores on the two half-tests are correlated.
>
> One appropriate use of the 'split-half' method is in measuring variability of traits over short periods of time when alternative forms are not available (pp. 232 (pp. 232-33).

Reliability estimates for males and females in grades 12 were obtained by the DAT authors. These results appear in Table III.

The authors of the DAT computed reliability coefficients for each test section of each form for both males and females at each grade level. Each of these subsamples were randomly selected from the standardization sample and included approximately 250 cases.

> The reliability coefficients were computed by correlating raw scores on even-numbered items and raw scores on odd-numbered items (r^{c}). These 'split-half' coefficients were corrected by the Spearman-Brown Prophecy formula to reflect the reliability of the total test (r_{1i}) (Bennett, Seashore and Wesman, 1959, p. 126).

In general, the reliability estimates of the DAT for males and females in grade 12 represent a fairly high degree of confidence for accurately estimating individual scores. Nunnally (1978) reports a reliability coefficient of .95 to be a desirable standard for applied measures when the results will be used to make decisions affecting one's life. Standards for basic research usually require a minimum level of .50. The reliability estimates for the DAT can generally be assumed to indicate a reasonable estimate of accuracy for males and females in high school and suitable for use with beginning college students as well. These reliability coefficients would appear to be appropriate for data gathering and basic group comparison research which is reported in this study. However, use of the DAT for making decisions about life circumstances must be made with caution.

TABLE III

RELIABILITY COEFFICIENTS[d]

Test	Sex	Grade	n of Cases	Reliability Estimate r^a	r_{1I}^b	r^c	Mean	SD
Abstract Reasoning	M	12	248	.94	.95	.90	35.2	11.0
Space Relations	M	12	248	.95	.96	.93	35.0	13.4
Abstract Reasoning	F	12	237	.93	.93	.87	34.8	9.9
Space Relations	F	12	237	.94	.93	.87	30.9	11.4

[a]Reliability estimates, corrected for variability of norms groups.

[b]Correlation of odd and even scores, corrected by Spearman-Brown Prophecy formula.

[c]Uncorrected "split-half" reliability estimates.

[d]Bennett, Seashore and Wesman, 1959, p. 128.

In addition, a standard error of measurement was computed to provide a statistical estimate of how close an obtained raw score was to the theoretical true score.

> In terms of probability theory, the standard error--indicated the extent to which the sample estimates will be distributed around the population parameter. . . . Probability theory indicates that certain proportions of the sample estimates will fall within specified increments of standard errors from the population parameter (Babbie, 1979, p. 172).

Table IV illustrates the standard errors of measurement for males and females in grade 12, using Form T of the DAT.

TABLE IV

STANDARD ERRORS OF MEASUREMENT[a]

Test	Sex	Grade	SE	Mean	SD
Abstract Reasoning	M	12	2.4	35.2	11.0
Space Relations	M	12	2.8	35.0	13.4
Abstract Reasoning	F	12	2.6	34.8	9.9
Space Relations	F	12	3.0	30.9	11.4

[a]Bennett, Seashore and Wesman, 1959, pp. 129-30.

The standard errors (SE) of measurement reported above were based on the test results from the same students who were used for computing the reliability coefficients. The SE may be interpreted as a two out of three chance that the subjects' obtained scores do not vary from their true scores by more than the number of points indicated by the SE.

It may be considered then, that the standard error of measurement would be similar to the reliability estimate for males and females in high school and beginning college. And as such, the test sections could be regarded as satisfactory for the research purposes of the study reported here.

Validity

In commenting on validity, Nunnally (1978) states

> In a very general sense, a measuring instrument is valid if it does what it is intended to do. . . . Validity usually is a matter of degree rather than an all-or-none property. . . . strictly speaking, one validates not a measuring instrument but rather some use to which the instrument is put (pp. 86-87).

The authors of the DAT, in commenting on the validity of their battery of tests, observe that

> The usefulness of any test depends ultimately on the extent to which it is able to predict the subjects' performance as measured by relevant criteria. Excellence in other technical characteristics is wasted unless the test results have a consistent, demonstrated relationship with important external criteria (Bennett, Seashore and Wesman, 1959, p. 80).

Studies aimed at establishing the validity of the DAT battery were conducted at both vocational and traditional high schools. The largest number of validity coefficients for the DAT involve the prediction of grades for students in specific courses and the prediction of scores on the Scholastic Aptitude Test (SAT). In commenting on validity, the DAT authors have observed that there has been a tendency for academic course grades for females to be more predictable than grades for males. The Abstract Reasoning subsection has been a fairly consistent predictor of course grades in Data Processing, while there is some indication that the Space Relations subsection may be a good predictor of course grades in Art and Drafting (Bennett, Seashore and Wesman, 1959).

A study by Armbrust (1969) has shown that in a sample of 118 first-year students of drafting, the Abstract Reasoning and Space Relations scores correlated well with course grades. Wood and Lobold (1968), in a study of 510 engineering students, found that graphics grades were associated with the highest validity coefficients in their study with a correlation of .49 for the Space Relations section.

Table V illustrates some selected validity coefficients between DAT scores and course grades in miscellaneous courses. The data were collected from various schools across the United States in the 1972-1973 academic year.

The validity coefficients reported suggest that the DAT is a fairly good predictor of educational performance for some students. The Abstract Reasoning section was a reasonably good predictor for geometry courses. For the vocational courses, grades for females in data processing were predicted consistently by Abstract Reasoning and Space Relations sections. For males, the Abstract Reasoning and Space Relations sections were consistent predictors for drafting courses.

The validity coefficients indicate the relationship which exists between scores on a given test and a criterion measure. They represent the best estimate that can be made on a student's probable performance based on what students with similar scores have done before. Generally, a coefficient of .30 is indicative of a minimally valid measurement (Nunnally, 1978). As such, the Abstract Reasoning and Space Relations sections may be considered as valid measures for the research purposes posed in this study.

TABLE V

VALIDITY COEFFICIENTS BETWEEN DAT SCORES AND COURSE GRADES IN MISCELLANEOUS COURSES[a]

Course	Grade[b]	Sex	n of Cases	Coefficients of Correlation: Abstract Reasoning	Coefficients of Correlation: Space Relations
Geometry	10	M	74	.53[c]	.37[c]
Art	10	M	30	.33	.31
Drafting	11	M	27	.43[d]	.54[c]
Geometry	10	F	66	.31[d]	.35[c]
Art	10	F	44	.31[d]	.53[c]
Data Processing	12	F	28	.57[c]	.53[c]

[a]Bennett, Seashore and Wesman, 1959, pp. 88-107.

[b]Few validity coefficients were available for 12th grade students in design-related areas.

[c]Significant at the .01 level (Bennett, Seashore and Wesman, 1959, pp. 88-107).

[d]Significant at the .05 level.

Background Questionnaire

A background questionnaire was developed to determine certain biographical and demographic characteristics of the students surveyed. Questions were designed to ascertain the variables of sex, major, academic classification, age, parental education and occupation, previous course work or experience in specified areas and achievement level on various skills. In addition, questions addressed residence patterns of parents and respondents as well as travel and leisure activities of respondents. A copy of the questionnaire appears in Appendix B, page 123.

Data Collection

The Abstract Reasoning and the Space Relations sections, Form T, of the Differential Aptitude Tests (DAT) were administered to the subjects in the selected courses by this researcher with assistance from Interior Design faculty and graduate teaching assistants. Each of these courses had two hour studio components which were selected as the test time. Tests were administered during the first three weeks of classes for the Fall semester, 1980.

The regularly scheduled studio classrooms were the locations chosen for test administration. Manila envelopes containing all the test materials were either already in place on each drawing board before the subjects entered the studio or were distributed after the instructor introduced the test administrator. Materials were arranged in the envelopes in the following order: Answer Sheet, Abstract Reasoning Test Booklet, Space Relations Test Booklet and Student

Biographical/Demographical Questionnaire. Two well-sharpened, soft-lead pencils were included. Instructions printed on the outside of the envelope advised subjects not to open them until directed to do so. Students were advised that their participation in the survey was voluntary and that their inclusion in the survey represented no risk to them individually.

When all the subjects were seated at the drawing boards, they were instructed to remove only the answer sheets and pencils from the envelopes and to fill in their names, course and number and student identification number by blackening-in the appropriate rectangles on the answer sheets. The subjects were then given an explanation of the envelope contents. They were informed that the Abstract Reasoning Test was designed to assess the ability to recognize an operating principle in each of the diagrams illustrated and that the Space Relations Test was designed to assess the ability to visualize and mentally rotate three-dimensional objects. The subjects were instructed in the proper procedure for answering the problems. Both test sections were timed, with 25 minutes assigned to each.

The subjects were then instructed to remove the Abstract Reasoning Test booklet from the envelope and to open it to the directions. The directions were read aloud by the examiner. The subjects were told that should they finish the test before time was called, they could go back over the problems but could not proceed to the next test. After asking for questions, the examiner set the stopwatch and instructed the subjects to begin. When the time had expired, the subjects were instructed to replace the Abstract Reasoning Test booklet inside the envelope and to remove the Space Relations Test booklet. The same procedure was followed with regard to reading the directions and beginning the test.

At the end of the alloted time for the Space Relations Test, the subjects were instructed to replace the booklet and the answer sheet in the manila envelope and to remove the questionnaire. Completion of the questionnaire was not timed, but took an average of 10 minutes. The subjects were requested to replace the questionnaire and the pencils in the manila envelope which was collected by the examiner. Time required for the complete administration was approximately one hour and fifteen minutes.

Names of students were used to match answer sheets from the Abstract Reasoning and Space Relations tests with the background questionnaire. Once the answer sheets were attached to the corresponding questionnaire, the students' names and identification numbers were deleted to protect individual anonymity. Each subject response--answer sheet and questionnaire--was assigned a numeric designation for purposes of analysis.

Data Analysis

The dependent variables for this study were the test scores achieved by the subjects on the two test sections administered--Abstract Reasoning and Space Relations. The independent variables considered in this study were college major, age and sex of respondents. In addition, other independent variables addressed educational and experience background in selected subjects, skill level on selected activities, parental education and occupation and residence patterns.

To investigate H_{01}, an analysis of variance was used to determine significant differences on mean test scores between students with different declared majors. The Least-Significant Difference (LSD) procedure was utilized to determine differences between the majors.

A t-test was employed for the analysis of H_2 to determine significant differences on mean test scores between the two sexes. A subsequent Multiple Range Test revealed test scores achieved for males and females within each major. For H_3, a t-test was used to determine significant differences on mean test scores between students grouped according to previous course work in any of several subjects listed.

H_4 addressed several variables. Analysis of variance was used to determine significant differences on mean test scores between groups categorized according to age of respondent, respondents' reported skill level on selected activities, frequency of visits to art museums and fathers' and mothers' educational levels and occupations. Subsequent LSD procedures were used to reveal differences between age groups, between classifications of frequency of visits to art museums and between levels of parents' education and occupation categories. A t-test was employed to indicate significant differences in mean test scores between respondents' grouped according to residence patterns. The Multiple Range Test revealed the mean scores achieved by those respondents who reported a competency level for the various skills addressed.

Summary

The present study was undertaken to investigate differences between males' and females' ability to solve problems requiring the determination of abstract principles and the ability to mentally construct and rotate three-dimensional objects. The objective was to determine whether beginning students who had selected a design-oriented major would achieve significantly higher test scores than those in a comparative group and what, if any, differences existed between the majors considered.

The research study examined intact groups of people on a one-time basis. Students enrolled in beginning courses in Interior Design, Art, Architecture and Landscape Architecture were surveyed as the intent was to investigate the spatial perception ability of students as they began study in their major field. The courses surveyed yielded a sample size of 355, of which 177 were males and 178 were females. A comparative group was composed of students enrolled in one of the surveyed courses who were majoring in other non-design oriented fields.

Two sections from a battery of standardized tests were employed to assess the analytical spatial perception ability. These were the Abstract Reasoning and the Space Relations sections of the Differential Aptitude Tests which were developed as tools for educational and vocational guidance. A one-time test procedure was employed. In addition, a questionnaire addressed selected socio-demographic and background characteristics of the respondents. Data collection was accomplished during the first three weeks of the Fall semester of 1980 at Oklahoma State University in Stillwater, Oklahoma. This researcher, with assistance from Interior Design faculty and graduate teaching assistants, was responsible for the test administration.

The Statistical Package for the Social Sciences (SPSS) was the computer program utilized to analyze the data. Statistics employed were the Analysis of Variance (ANOVA), t-test and Multiple Range Test, including the Least-Significant Difference (LSD) procedure.

CHAPTER IV

FINDINGS AND DISCUSSION

Introduction

This chapter examines the analysis of data as related to the hypotheses for the study. Beginning students in selected design-oriented courses were tested for their analytic spatial perception ability. Test results were analyzed for differences between majors and the sexes. In addition, selected educational characteristics, as well as age and academic classification, were considered. Other socio-demographic and background characteristics addressed in a questionnaire were parental education and occupation, travel and residence patterns and skill level on selected activities.

The data were collected during the Fall semester of 1980 at Oklahoma State University in Stillwater, Oklahoma. The survey yielded a sample composed of 177 males and 178 females. It consisted of the following majors: Art, Architecture, Landscape Architecture, Interior Design and a comparative group which was composed of students who had enrolled in one of the selected courses as a non-major. Seventy-one percent of the sample were freshmen or sophomores and 59 percent were less than 20 years of age.

The students included in the sample were tested for their analytic spatial perception ability using the Abstract Reasoning and Space Relations section, Form T, of the Differential Aptitude Tests. Almost

20 percent of the students had taken both of these test sections at some previous time. A questionnaire was developed to ascertain certain biographical and demographical characteristics. The Statistical Package for the Social Sciences was the computer program employed to generate the statistical analysis of the data which is herewith reported.

Comparison of Test Scores for Majors

> H_{01}: There will not be a significant difference between the various majors on their scores of abstract reasoning and spatial perception ability as measured by the Abstract Reasoning and Space Relations section of the Differential Aptitude Tests.

Abstract Reasoning Section

Table VI reports results of the analysis of variance test for majors on the Abstract Reasoning section of the DAT. The F-value obtained from the analysis was 1.86, and was not significant at the 0.05 level. This indicates that the mean scores on the Abstract Reasoning section for the various majors did not differ significantly. The null hypothesis was not rejected.

Space Relations Section

Table VII reports results of the analysis of variance for majors on the Space Relations section of the DAT. The F-value of 11.18 indicates that the range of mean scores for the various majors was wide enough to have differences significant beyond the 0.05 level. The null hypothesis was rejected.

TABLE VI

ANALYSIS OF VARIANCE FOR COMPARING MEAN SCORES ON THE ABSTRACT REASONING SECTION FOR THE VARIOUS MAJORS

	Sum of Squares	DF	Mean Square	F	Prob.
Between	316.20	4	79.05	1.86	N.S.
Within	14823.61	348	42.60		
Total	15139.80	352			

TABLE VII

ANALYSIS OF VARIANCE FOR COMPARING MEAN SCORES ON THE SPACE RELATIONS SECTION FOR THE VARIOUS MAJORS

	Sum of Squares	DF	Mean Square	F	Prob.
Between	3374.81	4	843.70	11.18	.001
Within	26422.88	350	75.49		
Total	29797.69	354			

The Multiple Range Test revealed the number of cases, mean scores and standard deviations for the various majors. The differences in the Space Relations mean scores are reported in Table VIII. The lowest mean score on the Space Relations section was attained by the Art majors at 39.04, and the highest was attained by the Architecture majors at 46.76. The LSD procedure was performed to compare the mean test scores for the majors and to determine which majors differed significantly from each other. For the Space Relations section, the difference in the mean score for the Architecture majors was found to be at the 0.05 significance level when compared with each of the other majors' mean scores.

TABLE VIII

COMPARISON OF MEAN SCORES ON THE SPACE RELATIONS SECTION ACHIEVED BY THE VARIOUS MAJORS

	Major				
Scores	Interior Design n=52	Art n=24	Architecture n=147	Landscape Architecture n=28	Comparative Group n=104
Space Relations					
mean score	39.42*	39.04*	46.76	42.68*	41.39*
std. dev.	7.95	9.03	9.14	8.08	4.86

*The LSD procedure revealed that the Architecture majors' mean scores differed significantly from all other majors' mean scores.

The hypothesis of no significant difference between the various majors on their mean test scores is not rejected for the Abstract Reasoning section. The mean scores for the various majors fell within a narrow range, and no significant differences between them were revealed. The hypothesis is rejected for the mean test scores on the Space Relations section, as differences in mean test scores significant at the 0.05 level or greater did appear between some of the majors.

Comparison of Test Scores for Males and Females

H_2: There will be a significant difference between males' and females' abstract reasoning and spatial perception ability as measured by the Abstract Reasoning and Space Relations sections of the Differential Aptitude Tests.

Abstract Reasoning Section

A t-test was used to determine differences in mean test scores achieved by males and females. Table IX presents results of the t-test for the Abstract Reasoning test section which reveals a t-value of .56. This value indicates no significant difference between mean test score achieved by the males and mean test score achieved by the females. The hypothesis of there being a significant difference between males' and females' abstract reasoning and analytic spatial perception ability as measured by the Abstract Reasoning section is not accepted as mean test scores for the males and females were close enough so that no significant differences were observed.

Space Relations Section

A t-test was also used to determine differences in mean test scores achieved by males and females on the Space Relations test section. The results appear in Table X. The t-value of 5.73 indicates that the difference between the mean score of 45.79 for males and 40.73 for females is significant at the 0.001 level for the Space Relations test section. The hypothesis is accepted for this test section.

TABLE IX

T-TEST FOR MEAN DIFFERENCES IN THE ABSTRACT REASONING SECTION SCORES BY SEX OF RESPONDENT

	n of Cases	Mean Scores	Std. Dev.	t-Value	Probability
Males	177	41.25	7.68	.56	N.S.
Females	178	40.87	5.23		

TABLE X

T-TEST FOR MEAN DIFFERENCES IN THE SPACE RELATIONS SECTION SCORES BY SEX OF RESPONDENT

	n of Cases	Mean Scores	Std. Dev.	T-Value	Probability
Males	177	45.79	9.41	5.73	.001
Females	178	40.73	8.23		

Mean Test Scores for Males and Females Within Each Major

Further t-tests were used to investigate the differences between the males' and females' mean test scores within each major. No significant differences appeared on the Abstract Reasoning section mean test scores. Significant differences did appear between the males' and females' mean test scores on the Space Relations section for two of the majors. The results of these t-tests are summarized in Table XI.

TABLE XI

T-TESTS COMPARING MEAN SCORES ON THE SPACE RELATIONS TEST SECTION FOR MALES AND FEMALES WITHIN THE MAJORS

			Space Relations			
Major	Sex	n	Mean Score	Std. Dev.	t-Value	Prob.
Interior Design	male	6	35.67	8.04	-1.22	N.S.
	female	46	39.91	7.79		
Art	male	9	45.00	5.20	3.24	0.001
	female	15	35.58	9.12		
Architecture	male	115	47.64	9.28	2.39	0.02
	female	36	43.66	8.02		
Landscape Architecture	male	15	44.80	9.40	1.58	N.S.
	female	13	40.23	5.63		
Comparative Group	male	32	41.88	8.92	0.37	N.S.
	female	72	41.18	8.30		

Male Art majors were outnumbered almost two to one (9-15) by the females. Still, a difference significant at the 0.001 level appeared between the scores in favor of the males. Within Architecture majors, the male-female ratio was almost four to one (115 to 36). The males' mean score was 47.64 versus 43.66 for the females. The greater proportion of males may have tended to skew the mean scores. The difference between mean scores for males and females in Architecture was found to be significant at the 0.02 level. The hypothesis of a difference between males' and females' spatial perception ability is accepted with regard to the Space Relations section, as significant differences did appear between the males and females in the total sample and between the males and females in Art and Architecture subsamples.

Comparison of Test Scores by Educational Background

> H_3: There will be significant differences between the extent to which educational background of students is associated with their abstract reasoning and spatial perception ability as measured by the Abstract Reasoning and Space Relations sections of the Differential Aptitude Tests.

The students were asked to indicate whether they had had a previous course in any of the following subjects: Art, Technical Drawng, Freehand Drawing, Painting, Sculpture, Woodworking, Mechanical Operations and Electrical Installations. A t-test was the statistical test used to determine differences in mean scores achieved.

Abstract Reasoning Section

Table XII illustrates the mean test scores, standard deviations, t-values and probabilities of the Abstract Reasoning section mean socres for the students who indicated whether or not they had had previous course work in the selected subjects listed above. For most of the course work considered, those students reporting having had a previous course achieved lower scores on the Abstract Reasoning section than those students who had not taken previous courses in the listed subjects. Only one significant difference was found with regard to

TABLE XII

T-TESTS FOR COMPARING MEAN DIFFERENCES IN ABSTRACT REASONING TEST SCORES WITH PREVIOUS COURSE WORK

Course	n of Cases		Mean Score		Std. Dev.		t-Value	Prob.
	Yes	No	Yes	No	Yes	No		
Art	225	116	40.91	41.72	5.79	7.13	-1.19	N.S.
Technical Drawing	114	178	41.60	40.74	7.37	5.96	1.09	N.S.
Freehand Drawing	140	189	40.01	42.12	7.22	5.40	-2.94	0.001
Painting	114	214	40.51	41.66	7.10	5.88	-1.54	N.S.
Sculpture	37	279	41.76	41.21	5.34	6.52	0.60	N.S.
Woodworking	74	246	41.03	41.35	6.46	6.31	-0.34	N.S.
Mechanical Operations	38	272	41.11	41.15	7.72	6.55	-0.25	N.S.
Electrical Installations	13	300	37.85	41.33	10.99	6.44	-1.27	N.S.

this list of previous courses and that was for those students who reported having had a course in Freehand Drawing. Those who had not had a previous course in Freehand Drawing achieved a significantly higher mean test score (42.12) than those students who reported having had a previous course (mean score of 40.01) in Freehand Drawing.

Space Relations Section

Table XIII, reporting the results of t-tests, addresses the same list of selected courses and the mean test scores on the Space Relations section. A negative relationship appeared with regard to a previous course in Freehand Drawing. Those students who had not taken a course in Freehand Drawing achieved a mean score of 44.22, compared to a mean score of 42.02 for those students who had taken a previous course. This difference in mean scores was found to be significant at the 0.02 level.

Three other courses were found to exert significant differences on mean scores achieved. Students who had taken a course in Technical Drawing achieved a higher mean score (46.03) than those students who had not (41.05). This difference in mean scores was significant at the 0.001 level.

In addition, students who had taken a course in Woodworking achieved a higher mean score (45.19) than those students who had not (42.78). This difference in mean scores was significant at the 0.01 level. Likewise, students who had taken a course in Mechanical Operations achieved a higher mean score (45.03) than those students who had not (43.01). This difference in mean scores was significant at the 0.05 level.

TABLE XIII

T-TESTS FOR COMPARING MEAN DIFFERENCES IN SPACE RELATIONS TEST SCORES WITH PREVIOUS COURSE WORK

Course	n of Cases		Mean Score		Std. Dev.		t-Value	Prob.
	Yes	No	Yes	No	Yes	No		
Art	225	116	42.70	44.32	8.96	9.48	-1.45	N.S.
Technical Drawing	114	178	46.03	41.05	8.68	9.11	5.16	0.001
Freehand Drawing	140	189	42.02	44.27	9.51	8.82	-2.32	0.02
Painting	114	214	42.29	43.89	9.59	8.97	-1.36	N.S.
Sculpture	37	279	44.71	43.08	5.34	6.52	0.60	N.S.
Woodworking	74	246	45.19	42.78	8.86	9.23	2.52	0.01
Mechanical Operations	38	272	45.03	43.01	9.48	9.19	1.99	0.05
Electrical Installations	13	300	43.28	43.00	10.30	9.22	0.14	N.S.

Comparison of Test Scores by Experiential Learning

In addition to previous course work, experiential learning was also addressed. Students were asked to indicate whether or not they had had previous experience in Technical Drawing, Woodworking, Mechanical Operations and Electrical Installations. A t-test was the statistical procedure to determine differences in mean scores achieved.

Abstract Reasoning Section

Table XIV illustrates the mean test scores, standard deviations, t-values and probabilities on the Abstract Reasoning section, when compared by selected experiential learning. The only experiential learning found to have a significant influence on the Abstract Reasoning mean scores was that in Woodworking. The mean score for those with that experience was 42.44, compared to 40.77 for a mean score for those students without that experience. The difference in mean scores was significant at the 0.03 level. As the mean test scores achieved were very close with regard to the other types of experience, no significant differences were observed.

Space Relations Section

A t-test was the statistical procedure used to determine differences in mean test scores achieved on the Space Relations section with regard to the same types of experiential learning listed in Table XIV. The results appear in Table XV. Experiential learning in all four of the experiences listed impacted the mean scores on the Space Relations

TABLE XIV

T-TESTS FOR COMPARING MEAN DIFFERENCES IN ABSTRACT REASONING TEST SCORES WITH PREVIOUS EXPERIENCE

Experience	n of Cases		Mean Score		Std. Dev.		t-Value	Prob.
	Yes	No	Yes	No	Yes	No		
Technical Drawing	58	271	41.33	41.07	7.03	5.16	0.25	N.S.
Woodworking	89	241	42.44	40.77	6.33	6.25	2.25	0.03
Mechanical Operations	61	266	41.70	40.85	6.36	6.14	0.89	N.S.
Electrical Installations	34	288	42.23	40.92	6.50	5.82	0.93	N.S.

TABLE XV

T-TESTS FOR COMPARING MEAN DIFFERENCES IN SPACE RELATIONS TEST SCORES WITH PREVIOUS EXPERIENCE

Experience	n of Cases		Mean Score		Std. Dev.		t-Value	Prob.
	Yes	No	Yes	No	Yes	No		
Technical Drawing	58	271	45.88	42.63	8.96	9.14	2.62	0.01
Woodworking	89	241	47.19	41.87	9.38	9.13	5.18	0.001
Mechanical Operations	61	266	46.89	42.41	8.98	9.11	3.50	0.001
Electrical Installations	34	288	42.85	40.63	8.69	9.82	2.31	0.03

section. In all cases, the higher score was achieved by those who had had experience in these areas. The differences in mean scores were found to be significant beyond the 0.05 level for those students who had had the previous experience.

The hypothesis of there being significant differences between the extent to which the educational background of students is associated with their abstract reasoning and analytic spatial perception as measured by the Abstract Reasoning and Space Relations section of the DAT is accepted. A difference significant at the 0.001 level appeared on the Abstract Reasoning mean scores with regard to previous course work in Freehand Drawing. Significant differences appeared in the Space Relations mean scores with regard to previous course work in Technical Drawing, Freehand Drawing, Woodworking and Mechanical Operations.

Comparison of Test Scores by Selected Variables

H_4: There will be a significant difference between the extent to which the selected sociodemographic variables of age, skill level on selected activities, travel and leisure activities, residence patterns and parents' education and occupation are associated with students' abstract reasoning and spatial perception ability as measured by the Abstract Reasoning and Space Relations sections of the Differential Aptitude Tests.

Age

Abstract Reasoning Section

An analysis of variance was used to determine significance of mean score differences between age groups on the two test sections. Table XVI presents results of the analysis of variance for the Abstract

Reasoning section. The F-value of 3.93 was significant at the 0.02 level, indicating that there was a significant difference on mean test scores on the Abstract Reasoning section when compared by age groups.

TABLE XVI

ANALYSIS OF VARIANCE FOR COMPARING MEAN SCORES ON THE ABSTRACT REASONING SECTION BY AGE OF RESPONDENT

	Sum of Squares	DF	Mean Square	F	Prob.
Between	337.37	2	168.68	3.93	.02
Within	14269.66	333	42.85		
Total	14607.03	335			

Space Relations Section

Table XVII presents results of the analysis of variance for the comparison of the mean scores on the Space Relations section. The F-value of 3.74 was significant at the 0.02 level, indicating that there was a significant difference in mean test scores on the Space Relations section achieved when compared by age groups.

The Multiple Range Test revealed the mean test scores for each age group (Table XVIII). The mean scores on both test sections declined with increase in age, though the differences between Group I

TABLE XVII

ANALYSIS OF VARIANCE FOR COMPARING MEAN SCORES ON THE SPACE RELATIONS SECTION BY AGE OF RESPONDENT

	Sum of Squares	DF	Mean Square	F	Prob.
Between	600.37	2	300.18	3.74	.02
Within	26752.75	333	80.34		
Total	27353.12	335			

TABLE XVIII

COMPARISON OF MEAN SCORES ON THE ABSTRACT REASONING AND SPACE RELATIONS SECTIONS ACHIEVED BY AGE GROUPS

	Abstract Reasoning		Space Relations	
Age Group	Mean Score	Std. Dev.	Mean Score	Std. Dev.
Group I (17-18 yrs.)	41.34	5.26	44.19	9.47
Group II (19-21 yrs.)	41.33	6.61	43.47	8.65
Group III (22 yrs. and older	38.45	8.50	39.98	9.06

Note: Mean score differences between Groups I and II with Group III were statistically significant at the .05 level on both test sedtions.

(17-18 years) and Group II (19-21 years) were slight. For both test sections, mean score differences between Group I and Group III and between Group II and Group III were significant at the 0.05 level. The mean scores for Groups I and II were significantly higher than the mean scores for Group III. The hypothesis of there being a significant difference between the extent to which age of respondent is associated with abstract reasoning and spatial perception ability is accepted, as differences significant at the 0.02 level did appear in the mean scores on both the Abstract Reasoning and the Space Relations sections.

Academic Classification

An analysis of variance was employed to investigate differences in mean test scores compared by academic classification. The F-value of 1.38 indicates that there was no significant difference found in the mean test scores on the Abstract Reasoning section between the academic classifications. Likewise, the F-value of 1.58 was not significant at the 0.05 level, indicating that there was little difference between the mean scores achieved by the various academic classifications on the Space Relations section.

Skill Assessment on Selected Activities

The Multiple Range Test revealed the number of cases, the mean scores and standard deviations for each of the skill level assessments in the areas of mathematics, art or drawing, English or writing, working with people, working with things, working with numbers, typing, playing a musical instrument, sports using a ball, working jigsaw puzzles and speaking a foreign language. The results of this analysis appear in Tables XXVII and XXIX in Appendix C. Table XXVII addresses the mean scores and standard deviations on the Abstract Reasoning section compared by respondents' reported skill level assessment on the various activities. The data presented in Table XXIX, also a product of the Multiple Range Test, summarized the mean scores and standard deviations on the Space Relations section when compared by respondents' reported skill level assessments on the same list of selected activities.

Abstract Reasoning Section

The analysis of variance test was employed to investigate differences in mean scores on the Abstract Reasoning section compared by respondents' reported confidency and competency assessments for mathematics, art or drawing, English or writing, working with people, working with things, working with numbers, typing, playing a musical instrument, sports using a ball, working jigsaw puzzles and speaking a foreign language. Table XIX reports the compilation of the analyses of variance statistical tests addressing the Abstract Reasoning section mean scores when compared by respondents' reported skill level assessments on the various activities selected for investigation.

Mathematics. The F-value of 4.07, significant at the 0.003 level, indicates that there were significant differences in the mean scores on the Abstract Reasoning section when compared by respondents' reported skill level for mathematics. The LSD procedure was used to ascertain where these significant differences occurred. Differences significant at the 0.05 level occurred in the mean test scores for the Interior Design majors who reported "somewhat confident" against

TABLE XIX

ANALYSES OF VARIANCE FOR COMPARING ABSTRACT REASONING SECTION MEAN SCORES BY RESPONDENTS' REPORTED SKILL LEVEL FOR SELECTED ACTIVITIES

	Sum of Squares	DF	Mean Square	F	Prob.
Mathematics					
Between	684.53	4	171.13	4.07	.003
Within	13820.23	330	41.88		
Art or Drawing					
Between	98.44	4	24.61	.56	N.S.
Within	15007.98	342	43.76		
English or Writing					
Between	508.40	4	127.10	3.00	.02
Within	14627.18	346	42.28		
Working with People					
Between	163.73	3	54.58	1.27	N.S.
Within	14971.84	347	43.15		
Working with Things					
Between	45.73	3	15.24	.35	N.S.
Within	15089.84	347	43.49		
Working with Numbers					
Between	1098.81	4	274.70	6.77	.001
Within	14036.77	346	40.57		

TABLE XIX (Continued)

	Sum of Squares	DF	Mean Square	F	Prob.
Typing					
Between	394.17	4	98.54	2.31	N.S.
Within	14692.35	345	42.59		
Playing a Musical Instrument					
Between	443.16	4	110.79	2.59	.04
Within	14657.36	343	42.73		
Drawing					
Between	45.41	4	11.35	.26	N.S.
Within	15090.16	346	43.61		
Sports Using a Ball					
Between	167.61	4	41.90	.97	N.S.
Within	14967.96	346	43.26		
Working Jigsaw Puzzles					
Between	939.61	4	234.90	5.73	.001
Within	14195.97	346	41.03		
Speaking a Foreign Language					
Between	634.54	4	158.63	3.79	.005
Within	14501.04	346	41.91		

those who reported "confident." Likewise, differences significant at the 0.05 level occurred in the mean test scores for the Landscape Architecture majors who reported "somewhat confident" against those who reported "not very confident." There were no other groups significant at the 0.05 level.

English or Writing. The analysis of variance test for investigating differences in mean scores on the Abstract Reasoning section and skill assessment level for English or writing reveals an F-value of 3.00, which was significant at the 0.02 level. The LSD procedure was performed to indicate where significant differences occurred in the mean scores on the Abstract Reasoning section when compared by respondents' confidence in their English or writing ability. The only significant differences occurred with the Architecture majors where those who reported "not at all confident" achieved significantly lower scores than those who reported all other categories of skill assessment.

Working with Numbers. The analysis of variance test for reporting the comparison of mean scores on the Abstract Reasoning section by respondents' reported skill level for working with numbers shows an F-value of 6.77. This indicates that the differences in mean scores on the Abstract Reasoning section, when compared by respondents' reported confidency in their ability to work with numbers, varied enough so as to indicate differences at a statistically significant level. The LSD procedure for indicating where these significant differences occurred in the mean scores was performed. Significant differences were found for all majors except Art majors. Generally, the higher mean scores were associated with greater skill assessment levels. For the majors (except Art majors) and the Comparative Group, those who selected "very confident" or "somewhat confident" achieved a higher mean score than those who selected "confident" as their skill level.

Playing a Musical Instrument. The analysis of variance test for comparing the mean scores on the Abstract Reasoning section with respondents' reported skill level for playing a musical instrument shows an F-value of 2.59, which indicates that significant differences did appear between the mean scores. The LSD procedure was performed to indicate where these significant differences occurred. The significant differences appeared in the mean scores for the Architecture majors and the Comparative Group. Generally, the greater degree of competence was reflected in higher mean scores achieved. Those Architecture majors who selected "very competent" as their skill level achieved a statistically higher mean score than those who selected "not at all competent." In the Comparative Group, those who selected "somewhat competent" achieved a statistically higher mean score than those who selected "not very competent" and "not at all competent."

Working Jigsaw Puzzles. The analysis of variance test reporting the comparison of mean scores on the Abstract reasoning section by respondents' reported competency level for working jigsaw puzzles shows an F-value of 5.73. This indicates that significant differences did appear between the mean scores. The LSD procedure was employed to indicate where these significant differences occurred in the mean scores on the Abstract Reasoning section. The only significant differences appeared in the Architecture majors' mean scores. Significant differences appeared in all competency levels. The greater competency levels were associated with the higher mean scores.

Speaking a Foreign Language. An analysis of variance was used for comparing the mean scores on the Abstract Reasoning section with respondents' reported skill level for speaking a foreign language. The F-value of 3.79 indicates that significant differences did appear in the mean scores. The LSD procedure was used to indicate where those significant differences appeared. The significant differences in the mean scores were found in the Architecture and Landscape Architecture majors where those who assessed their skill level at "not very competent" or "not at all competent" achieved higher mean scores than those who assessed their skill as "very competent."

Other Skills. Analyses of variance statistical tests were performed to investigate differences in mean test scores when compared by the other skills. The F-values obtained revealed no statistically significant difference in mean test scores and respondents' reported skill level assessments for art, drawing, working with people, working with things, typing or sports using a ball.

The hypothesis of there being a significant difference between the extent to which skill level on selected activities is associated with students' abstract reasoning and analytic spatial perception is accepted for some of the selected skills and not accepted for others. On the Abstract Reasoning section, significant differences in mean scores achieved were found when compared by respondents' reported skill level for mathematics, English or writing, working with numbers, playing a musical instrument, working jigsaw puzzles and speaking a foreign language. The hypothesis is accepted for these skills. The hypothesis is not accepted for art or drawing, working with people, working with things, typing, drawing or sports using a ball.

Space Relations Section

The analysis of variance test was employed to investigate differences in mean scores on the Space Relations section compared by respondents' reported confidency and competency assessments for mathematics, art or drawing, English or writing, working with people, working with things, working with numbers, typing, playing a musical instrument, sports using a ball, working jigsaw puzzles and speaking a foreign language. Table XX reports the compilation of the analysis of variance tests addressing the Space Relations section mean scores when compared by respondents' reported skill level assessments on the various activities selected for investigation.

Mathematics. The analysis of variance test for comparing the mean scores on the Space Relations section with respondents' reported skill level for mathematics reveals on F-value of 11.07. This indicates that differences significant beyond the 0.001 level did appear in the mean scores on the Space Relation section when compared by respondents' reported skill assessment for mathematics. The LSD procedure was performed to indicate where the significant differences occurred in these mean scores. Significant differences were found in the mean scores on the Space Relations section for the Interior Design and the Art majors and the Comparative Group. Differences in mean scores significant at the 0.05 level appeared for those Interior Design

TABLE XX

ANALYSES OF VARIANCE FOR COMPARING SPACE RELATIONS SECTION MEAN SCORES BY RESPONDENTS' REPORTED SKILL LEVEL FOR SELECTED ACTIVITIES

	Sum of Squares	DF	Mean Square	F	Prob.
Mathematics					
Between	3268.28	4	817.06	11.07	.001
Within	24350.79	330	73.79		
Art or Drawing					
Between	166.60	4	41.65	.51	N.S.
Within	28080.48	343	81.87		
English or Writing					
Between	399.96	4	99.99	1.24	N.S.
Within	27936.72	346	80.74		
Working with People					
Between	763.78	3	254.59	3.20	.04
Within	27572.91	347	79.46		
Working with Things					
Between	250.19	3	83.40	1.03	N.S.
Within	28086.50	347	80.94		
Working with Numbers					
Between	2754.82	4	688.71	9.32	.001
Within	25581.86	346	73.94		

TABLE XX (Continued)

	Sum of Squares	DF	Mean Square	F	Prob.
Typing					
Between	68.38	4	17.09	.21	N.S.
Within	28256.57	345	81.90		
Playing a Musical Instrument					
Between	430.23	4	107.56	1.33	N.S.
Within	27845.45	343	81.18		
Drawing					
Between	295.94	4	73.99	.91	N.S.
Within	28040.75	346	81.04		
Sports Using a Ball					
Between	306.71	4	76.68	.95	N.S.
Within	28029.98	346	81.01		
Working Jigsaw Puzzles					
Between	2128.27	4	532.07	7.02	.001
Within	26208.41	346	75.75		
Speaking a Foreign Language					
Between	921.72	4	230.43	2.91	.02
Within	27414.97	346	79.23		

majors who selected "somewhat confident" against those who selected "confident." For the Art majors, those who selected "somewhat confident" achieved a significantly higher mean score than those who selected "confident," "not very confident," and "not at all confident." Those students in the Comparative Group who selected "very confident" achieved a significantly higher mean score than those who selected all other levels of skill assessment.

Working with People. The analysis of variance test reporting the comparison of mean scores on the Space Relations section by respondents' reported skill assessment for working with people reveals an F-value of 3.20. This indicates that significant differences in mean scores on the Space Relations section did appear with regard to this skill. The LSD procedure was performed to indicate where those significant differences occurred in the mean scores. The Interior Design and the Architecture majors who selected "very confident" as their skill level achieved a significantly higher mean score than those who selected "not very confident."

Working with Numbers. The analysis of variance test reporting the comparison of mean scores on the Space Relations section by respondents' skill assessment for working with numbers reveals an F-value of 9.32. This indicates that differences significant beyond the 0.001 level did appear in the mean scores on the Space Relations section when compared by respondents' reported skill level for working with numbers. The LSD procedure was performed to indicate where these significant differences occurred in the mean scores. Significant differences were found for the Art majors and for the Comparative Group. The

Art majors who selected "somewhat confident" achieved a higher mean score than those who selected "not very confident" and "not at all confident" as their skill level. Those students in the Comparative Group who selected "very confident" achieved a significantly higher mean score than those who selected all other levels of skill assessment.

Working Jigsaw Puzzles. The analysis of variance test for comparing the mean scores on the Space Relations section with respondents' reported skill level for working jigsaw puzzles reveals an F-value of 7.02. This indicates that significant differences beyond the 0.05 level did appear between the mean scores on the Space Relations section when compared by respondents' reported skill level for working jigsaw puzzles. The LSD procedure was used to determine where these significant differences occurred in the mean scores. Art majors who selected "somewhat competent" achieved a significantly higher mean score than those who selected "not very confident." The other subgroup in which a significant difference appeared was the Architecture majors. Those who selected "very competent" and "somewhat competent" achieved significantly higher scores than those who selected "competent," "not very competent" and "not at all competent."

Speaking a Foreign Language. The analysis of variance test for comparing the mean scores on the Space Relations section with respondents' reported skill level for speaking a foreign language reveals an F-value of 2.91. This indicates that differences significant at the 0.02 level did appear in these mean scores. The LSD procedure revealed that the significant differences in mean scores occurred with the Architecture majors where those who selected "very competent" or "somewhat competent" achieved lower mean scores than those who selected "not very competent" or "not at all competent."

Other Skills. No significant differences were found in the Space Relations section mean scores when compared by the other skills. The analysis of variance statistical test for comparing mean test scores by respondents' reported skill level for art, drawing, English or writing, working with things, typing, playing a musical instrument or sports using a ball revealed no differences between scores that occurred at a statistically significant level.

The hypothesis of there being a significant difference between the extent to which skill level on selected activities is associated with students' abstract reasoning and analytic spatial perception is accepted for some of the selected skills and not accepted for others.

On the Space Relations section, significant differences in mean scores achieved were found when compared by respondents' reported skill level for mathematics, working with people, working with numbers, working jigsaw puzzles and speaking a foreign language. The hypothesis is accepted for these skills. The hypothesis is not accepted for art or drawing, English or writing, working with things, typing, playing a musical instrument, drawing and sports using a ball. The skills for which the hypothesis is accepted for both test sections are mathematics, working with numbers, working jigsaw puzzles and speaking a foreign language.

Residence Patterns

Respondents were asked whether or not they had lived all their lives in Oklahoma and, if not, to list the states and/or countries in which they had lived. In addition, respondents were asked to indicate the states and countries they had visited. Table XXI illustrates these residences and travel patterns reported by the respondents.

TABLE XXI

RESPONDENTS' REPORTED RESIDENCE AND TRAVEL PATTERNS

Have Not Lived All of Life in Oklahoma		No. of States and/or Countries Lived in				No. of States Traveled in				No. of Countries Traveled in			
		2 or Less		3-5 or Less		10 or Less		11-25 or Less		3 or Less		4-5 or Less	
n	%	n	%	n	%	n	%	n	%	n	%	n	%
193	55	124	63	182	93	172	53	286	87	327	93	290	79

Of the 355 subjects in the sample, 55 percent had, at some time, lived somewhere other than Oklahoma. Slightly more than half of the sample (53%) had traveled in from 1 to 10 states other than Oklahoma. Almost all of the subjects in the sample (93%) had traveled in one to three foreign countries. Seventeen subjects in the sample were students from foreign countries. Eleven of these students were enrolled in the School of Architecture.

Abstract Reasoning Section

The t-test for comparing differences in mean scores on the Abstract

Reasoning section by respondents' residence patterns in Oklahoma revealed a t-value of .80. This value was not significant at the 0.05 level, indicating that whether or not the respondents had lived their lives in Oklahoma had little difference on the mean score achieved. The t-test for comparing differences in mean scores on the Abstract Reasoning section by whether or not the respondents had lived in urban or rural communities revealed a t-value of 1.16. This value was found not to be significant at the 0.05 level. This residence pattern had negligible effect on the mean scores achieved on the Abstract Reasoning section.

Space Relations Section

The t-test for comparing differences in mean scores on the Space Relations section by respondents' residence patterns in Oklahoma revealed a t-value of .78. This was found to be not significant at the 0.05 level, indicating that whether or not the respondents had lived their lives in Oklahoma had little difference on the mean score achieved.

The t-test for comparing differences in mean scores on the Space Relations section by whether or not the respondents had lived in urban or rural communities revealed a t-value of .30. This was found not to be significant at the 0.05 level. This residence pattern had negligible effect on the mean scores achieved on the Space Relations section.

The hypothesis of there being a significant difference in the extent to which travel and residence patterns are associated with students' analytic spatial perception abilities is not accepted. No significant differences appeared in the mean scores on either the

Abstract Reasoning or the Space Relations sections when compared by residence patterns.

Visits to Art Museums and Other Leisure Activities

Respondents were asked to list their favorite leisure activities. The summation appears in Table XXII. Almost two-thirds of the subjects in the sample (64%) reported jogging or aerobic dancing as a favorite activity. Approximately another third (27%) engage in other active sports. Respondents were asked, in the questionnaire, to indicate their frequency of visits to art museums. As noted in Table XXII, 88 percent reported going to art museums at least once a year.

Abstract Reasoning Section

Table XXIII illustrates the analysis of variance test addressing the differences in mean scores on the Abstract Reasoning section when compared by frequency of visits to art museums. The F-value of 2.77 was significant at the 0.03 level, indicating that there were significant differences in the mean scores on the Abstract Reasoning section when compared by frequency of visits to art museums.

The LSD procedure was employed for indicating between which groups in the subsample the significant differences occurred. Significant differences were found between those groups who reported "often" as their frequency against those who reported "occasionally," "seldom" and "never" as their frequency. The highest mean score (42.10) on the Abstract Reasoning section, when compared by frequency of visits to art museums, was achieved by those who reported "never" as their

TABLE XXII

FREQUENCY DISTRIBUTION OF RESPONDENTS' REPORTED LEISURE ACTIVITIES

Activity	n	%
Visit art museums at least once a year	313	88
Engage in quiet activities such as: reading, music, board games, gardening, photography	200	36
Engage in sports such as: handball, tennis	84	27
Engage in sports such as: jogging, aerobic dancing	228	64
Pursue such activities as: sewing, needlework, ceramics	60	17
Pursue such activities as: travel, cars, charity work, church related work	107	30

TABLE XXIII

ANALYSIS OF VARIANCE FOR COMPARING ABSTRACT REASONING SECTION MEAN SCORES BY RESPONDENTS' REPORTED FREQUENCY OF VISITS TO ART MUSEUMS

	Sum of Squares	DF	Mean Square	F	Prob.
Between	460.55	4	117.14	2.77	.03
Within	14594.70	344	42.30		
Total	15018.25	348			

frequency. With the exception of the "very often" (39.33) and "often" (37.42), the less frequently the respondent visited art museums, the higher was the mean score achieved on the Abstract Reasoning section.

TABLE XXIV

COMPARISON OF MEAN SCORES ON THE ABSTRACT REASONING SECTION WITH RESPONDENTS' REPORTED FREQUENCY OF VISITS TO ART MUSEUMS

Group	n of Cases	Mean Score	Std. Dev.
Never	80	42.10	4.89
Seldom	125	41.49	5.57
Occasionally	108	40.81	7.66
Often	24	37.42	9.74
Very Often	12	39.33	5.76

Note: Never = less than once in two years; Seldom = once every one to two years; Occasionally = once every six months to one year; Often = every three to six months; Very Often = at least every three months.

Space Relations Section

The analysis of variance test for comparing mean scores on the Space Relations section with frequency of visits to art museums revealed an F-value of .66. This indicates that the mean scores on the Space Relations section, when compared by frequency of visits to art museums, were close enough so that no significant differences appeared between them.

The hypothesis of there being a significant difference in the extent to which leisure activities are associated with students' abstract reasoning and analytic spatial perception ability is accepted for frequency of visits to art museums on the Abstract Reasoning section, as significant differences did appear in these mean scores. No significant differences appeared in the mean scores on the Space Relations section when compared by respondents' reported frequency of visits to art museums, so the hypothesis is not accepted for this test section.

Parental Education

The analysis of variance test was used to determine differences in mean scores on the Abstract Reasoning and Space Relations sections when compared by fathers' and mothers' educational level. The statistical tests comparing mean test score differences and fathers' level of education are presented first.

Fathers' Level of Education

Abstract Reasoning Section. The analysis of variance test for comparing mean scores on the Abstract Reasoning section by fathers' educational level reveals an F-value of .88. This indicates that differences in mean scores on the Abstract Reasoning section were not found to be at a significant level

Space Relations Section. The analysis of variance for the comparison of mean test scores on the Space Relations section compared by fathers' education reveals an F-value of 1.11. This indicates that the fathers' level of education had relatively little impact on the mean scores achieved on the Space Relations section.

Mothers' Level of Education

Abstract Reasoning Section. The analysis of variance for investigating differences in mean test scores on the Abstract Reasoning section and mothers' level of education reveals an F-value of 1.58. This indicates a narrow range of mean scores on the Abstract Reasoning section when compared by mothers' educational level. No significant differences were found between these mean scores.

Space Relations Section. The analysis of variance test for comparing mean scores on the Space Relations section with mothers' level of education reveals an F-value of 1.32. This indicates that no significant differences were found between the mean scores on the Space Relations section when compared by mothers' educational level.

Table XXV summarizes the mean scores achieved on the Abstract Reasoning and Space Relations sections when compared by parents' level of education. These data were revealed by the Multiple Range Test.

Generally, the higher the educational level of the parent, the higher the mean test score achieved. Two exceptions were found with educational level of the mother where those whose mothers had a high school education achieved a higher mean score than those whose mothers had had some college or technical school training.

The hypothesis of there being significant differences in the extent to which parents' educational level is associated with students'

TABLE XXV

COMPARISON OF MEAN SCORES ON THE ABSTRACT REASONING AND SPACE RELATIONS SECTIONS ACHIEVED WITH PARENTS' EDUCATIONAL LEVEL

Parent	Educational Level	n of Cases	Abstract Reasoning		Space Relations	
			Mean Score	Std. Dev.	Mean Score	Std. Dev.
Father	5	69	41.36	6.07	44.13	9.21
	4	131	41.70	6.29	43.73	8.53
	3	79	40.44	7.69	43.58	9.41
	2	51	40.39	5.35	41.72	9.57
	1	17	39.82	8.25	39.41	11.87
Mother	5	30	41.73	10.68	44.07	9.38
	4	95	41.79	7.06	43.80	8.53
	3	108	40.69	6.64	42.90	9.42
	2	104	41.00	5.50	43.93	8.29
	1	14	37.00	5.35	35.57	14.62

Note: 5 = advanced degree; 4 = college graduate; 3 = high school plus some college or technical school; 2 = 9-12 grade; 1 = 1-8 grade.

abstract reasoning and analytic spatial perception ability is not accepted. No significant differences in the mean scores on either the Abstract Reasoning or the Space Relations sections appeared when compared by fathers' and mothers' educational level.

Parental Occupation

The analysis of variance was used to determine differences in mean scores on the Abstract Reasoning and Space Relations sections when compared by fathers' and mothers' occupation. The statistical tests comparing mean test score differences and fathers' occupation are presented first.

Fathers' Occupation

Abstract Reasoning Section. Table XXVI illustrates the analysis of variance test for comparing mean scores on the Abstract Reasoning section by fathers' occupation. The F-value of 2.84, found to be significant at the 0.02 level, indicates that significant differences did appear in the mean scores on the Abstract Reasoning section when compared by fathers' occupation. The LSD procedure was used to determine where these significant differences in mean scores occurred.

The significant differences in mean scores on the Abstract Reasoning section were found for those whose fathers were in the professional and managerial occupation category as compared to those whose fathers were in all the other occupation categories. Those whose fathers were in the professional/managerial occupation category achieved the significantly higher mean score.

TABLE XXVI

ANALYSIS OF VARIANCE FOR COMPARING ABSTRACT REASONING SECTION MEAN SCORES BY RESPONDENTS' FATHERS' OCCUPATION

	Sum of Squares	DF	Mean Square	F	Prob.
Between	475.31	4	118.83	2.84	.02
Within	13270.72	323	41.82		
Total	13746.03	327			

Space Relations Section. The analysis of variance test reporting the comparison of mean scores on the Space Relations section by fathers' occupation reveals an F-value of 1.02. This indicates that significant differences did not appear in the mean scores on the Space Relations section when compared by fathers' occupation.

Mothers' Occupation

Abstract Reasoning Section. The analysis of variance test for investigating differences in mean test scores on the Abstract Reasoning section with mothers' occupation reveals an F-value of 2.14. This indicates that the mean scores on the Abstract Reasoning section were close enough together, when compared by mothers' occupation, that no significant differences were found between them.

Space Relations Section. The analysis of variance test for comparing the mean scores on the Space Relations section with mothers' occupation reveals an F-value of 1.56. This indicates that no significant differences were found between the mean scores on the Space Relations section when compared by mothers' occupation.

Table XXVII summarizes the mean scores achieved on the Abstract Reasoning and Space Relations sections when compared by parents' occupation. These data were revealed by the Multiple Range Test.

The highest mean score on the Abstract Reasoning section was achieved by those subjects whose fathers were in occupational classification #1 (Professional/Managerial). The lowest mean scores were attained by the subjects whose fathers were in the Service (#3) occupation category. This is where the only significant difference in mean scores with respect to parents' occupation was found. The highest mean score on the Space Relations section was achieved by the subjects whose fathers were in the #1, Professional and Managerial category.

For both the Abstract Reasoning and the Space Relations sections, the highest mean scores were achieved by those subjects whose mothers were in the #2 or Clerical and Sales occupation category. The lowest mean scores on both sections were attained by those subjects whose mothers were in the occupation category #4 or Agriculture related. Housewife or homemaker is included in the #3 or Service occupation category.

The hypothesis of there being significant differences in the extent to which parents' occupation is associated with students' abstract reasoning and analytic spatial perception ability is accepted for fathers' occupation. Significant differences did appear in mean scores achieved on the Abstract Reasoning section when compared by fathers' occupation. The hypothesis is not accepted for the Space

TABLE XXVII

COMPARISON OF THE ABSTRACT REASONING AND THE SPACE RELATIONS SECTIONS' MEAN SCORES ACHIEVED WITH PARENTS' OCCUPATION

			Abstract Reasoning		Space Relations	
Parent	Occupation Category	n of Cases	Mean Score	Std. Dev.	Mean Score	Std. Dev.
Father	1	210	41.77	5.84	44.03	8.81
	2	35	41.14	5.17	42.31	9.15
	3	10	37.90	10.52	42.50	8.42
	4	29	41.31	4.33	42.41	7.38
	5	43	39.49	7.20	41.43	10.61
Mother	1	20	41.34	6.53	43.85	9.44
	2	79	41.40	5.60	44.14	8.93
	3	151	40.82	6.76	42.74	8.93
	4	6	40.67	5.61	37.14	11.67

Note: 1 = professional and managerial; 2 = clerical and sales; 3 = service; 4 = agriculture related; 5 = all others.

Relations section for fathers' occupation nor for either Abstract Reasoning or Space Relations sections and mothers' occupation, as no significant differences in mean scores achieved appeared in these comparisons.

Summary

The sample for this study was composed of students enrolled in selected beginning design-oriented courses at Oklahoma State University in the Fall semester of 1980. The students were tested for their analytic spatial perception ability. In addition, a questionnaire addressed socio-demographic background characteristics that were considered in the analysis of the data.

Significant differences were found on mean test scores attained for the various majors. Significant differences were also found when comparing male and female test scores achieved. Previous course work was investigated for several subject matter areas. Technical Drawing, Freehand Drawing, Woodworking and Mechanical Operations were found to have the greatest impact on mean test scores achieved on the Space Relations Section. Significant differences were found on the mean test scores when compared by age group of respondent but not by academic classification. Significant differences did appear on several of the skill level variables. The ones found to exert the greatest impact were mathematics, working with numbers, working jigsaw puzzles and speaking a foreign language. No significant differnece was found on mean test scores with regard to respondents' residence patterns. Increased frequency of visits to art museums did have a negative impact on mean test scores achieved. No significant differences in mean test scores were observed with regard to mothers' or fathers' educational level. A significant difference was found in the mean scores on the Abstract Reasoning section when compared by fathers' occupation. No significant differences appeared in the mean scores on Space Relations sections when compared by fathers' occupation. Mothers' occupation did not exert a significant influence on the mean scores achieved on either test section.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

The research reported here was a study conducted to assess the three-dimensional spatial perception ability of beginning university students who had selected either Art, Architecture, Landscape Architecture or Interior Design as their major. A review of the literature addressing male-female differences cites the ability to envision three-dimensional space as one of the characteristics on which there is a sex-related difference (Maccoby, 1966; Maccoby and Jacklin, 1974; Stevenson, 1970). The present study was undertaken to determine a mechanism by which to assess the level of these abilities in the students. A significant aspect of the study was to address male-female differences in spatial perception in the students who had selected these major courses of study.

The instrument selected was two sections from the battery of Differential Aptitude Tests developed by Bennett, Seashore and Wesman in 1947. The first section was the Abstract Reasoning test, which requires the subject to recognize the principle governing the sequential change of form and/or position in the abstract diagrams. The second section was the Space Relations test, which requires the subject to mentally visualize solid, three-dimensional objects from pictures of the pattern.

The data were collected during the Fall semester of 1980 at Oklahoma State University in Stillwater, Oklahoma. Classes were surveyed during the first three weeks of the semester in their regularly scheduled studio classrooms. This researcher, with assistance from Interior Design faculty and graduate teaching assistants, was responsible for test administration. After completing the tests, the subjects were given a biographical-demographical background questionnaire to answer. The Statistical Package for the Social Sciences was the computer program employed to generate the statistical analysis.

Summary of Findings

The hypotheses which guided the study included:

H_{01} - There will not be a significant difference between the various majors on their scores of abstract reasoning and spatial perception ability as measured by the Abstract Reasoning and Space Relations sections of the Differential Aptitude Tests.

H_2 - There will be a significant difference between males' and females' abstract reasoning and spatial perception ability as measured by the Abstract Reasoning and Space Relations sections of the Differential Aptitude Tests.

H_3 - There will be significant differences between the extent to which educational background of students is associated with their abstract reasoning and spatial perception ability as measured by the Abstract Reasoning and Space Relations sections of the Differential Aptitude Tests.

H_4 - There will be a significant difference between the extent to which selected socio-demographic variables of age, skill level on selected activities, travel and leisure activities, residence patterns and parents' education and occupation are associated with students' abstract reasoning and spatial perception ability as measured by the Abstract Reasoning and Space Relations sections of the Differential Aptitude Tests.

The analysis of variance test for investigating differences in mean test scores for the various majors on the Abstract Reasoning section revealed no significant differences. Conversely, a statistically significant difference did appear on the analysis of variance test comparing the mean test scores for the various majors on the Space Relations section. The Multiple Range test revealed that the mean score for the Architecture majors was higher than each of the other majors' mean scores. The LSD procedure indicated that this difference was statistically significant.

A t-test was used to determine differences in mean test scores achieved by the males and the females in the sample. The mean scores for each of the sexes on the Abstract Reasoning section indicated no significant differences in mean scores. A t-test was also used to investigate differences in mean test scores for the males and the females on the Space Relations section. Differences in mean scores did appear which were found to be statistically significant.

Additional t-tests investigated differences in mean test scores between males and females in each of the majors. No significant differences appeared in the mean scores on the Abstract Reasoning section. Significant differences did appear between the males' and females' mean scores on the Space Relations section in the Art and the Architecture majors. A statistically significant difference appeared in the mean scores for the Art majors in favor of the males who were outnumbered by the females by almost two to one. The mean score for the male Architecture majors was significantly higher than the mean score for the females. The male-female ratio for the Architecture majors was almost four to one.

A t-test was used to determine differences in mean test scores compared by whether or not students had taken previous course work in Art, Technical Drawing, Freehand Drawing, Painting, Sculpture, Woodworking, Mechanical Operations and Electrical Installations. Only one significant difference with regard to the previous course work was found on the Abstract Reasoning section mean test scores. Those respondents who reported having had previous course work in Freehand Drawing achieved the lower mean score.

The t-tests reporting differences in mean scores on the Space Relations section when compared by this same list of courses revealed statistically significant differences in mean test scores for four courses. These courses were Technical Drawing, Freehand Drawing, Woodworking and Mechanical Operations. Those students with previous course experience in Technical Drawing, Woodworking and Mechanical Operations achieved the significantly higher mean scores. Those students reporting previous course work in Freehand Drawing achieved a significantly lower mean score.

An analysis of variance test was used to determine differences in mean test scores on each of the test sections when compared by age groups. For both test sections, mean score differences between age groups were found to be statistically significant. The younger the age group, the higher the mean test score achieved.

Analysis of variance was the statistical test employed to investigate differences in mean scores on both test sections when compared by respondents' reported skill assessment level for selected activities. These activities were mathematics, art or drawing, English or writing, working with people, working with things, working with numbers, typing, playing a musical instrument, sports using a ball, working jigsaw puzzles and speaking a foreign language. Differences in mean test scores on the Abstract Reasoning section were found to be statistically significant for skill assessment in mathematics, English or writing, working with numbers, playing a musical instrument, working jigsaw puzzles and speaking a foreign language. Generally, the greater the skill assessment, the higher the mean score.

The differences in mean scores on the Space Relations section were found to be at a statistically significant level were with regard to skill assessment in mathematics, working with people, working with numbers, working jigsaw puzzles and speaking a foreign language. Higher mean scores were associated with increased skill assessment.

A t-test was used to determine differences in mean test scores when compared by respondents' residence patterns. Whether or not the students had lived all their lives in Oklahoma or had lived primarily in urban or rural communities had negligible effect on mean scores for both test sections.

The analysis of variance was used to reveal differences in mean test scores when compared by frequency of visits to art museums. Differences at a statistically significant level did appear in the mean scores on the Abstract Reasoning section. In general, the less frequent the visits to art museums, the higher was the mean test score.

The analysis of variance was employed to reveal differences in mean scores on the Abstract Reasoning and Space Relations sections when compared by fathers' and mothers' educational level. No significant differences appeared. Analysis of variance was also used to reveal differences in mean scores on the Abstract Reasoning and Space Relations sections when compared by fathers' and mothers' occupation. The only significant difference was in mean scores on the Abstract Reasoning section compared by fathers' occupation. Those respondents whose fathers were in the professional/managerial occupation category achieved a significantly higher mean score than those whose fathers were in all other occupation categories.

Conclusions

The following conclusions are made based on the findings for this study:

1. There were no differences in the mean scores between the majors on the Abstract Reasoning test. The Abstract Reasoning test section appeared to test manipulative and mathematical skills versus space perception ability.

Significant differences did appear between some of the majors mean scores on the Space Relations test section. Based on the findings for this study, the Architecture majors appeared to have greater space perception ability than students majoring in the other design fields.

2. No significant differences appeared between the males' and females' mean scores on the Abstract Reasoning test section. This indicates that the males and females in this sample did not differ significantly in the ability that was measured by that test section.

However, significant differences did appear in the Space Relations section mean scores. The males did appear to be better able to perceive three-dimensional space than did the females in this study.

3. Within the individual majors, the significant differences in mean test scores appeared in the Art and the Architecture majors subsamples. The male Art majors appeared to solve the space perception problems better than the females. The males' mean test score was significantly higher than the females', even though the females outnumbered the males by almost two to one.

Based on the mean scores on the Space Relations section, the male Architecture majors were better able to perceive the operating principles in the test problems. The male-female ratio in the Architecture majors was almost four to one, and this may have tended to skew the mean test score.

4. Students who reported having had previous course work in Freehand Drawing achieved significantly lower scores on both the Abstract Reasoning and Space Relations test sections. Course experience in this subject matter apparently tended to interfere with the preciseness required to solve the test problems.

Additionally, significant differences were found in the mean scores on the Space Relations section with regard to previous course work in Technical Drawing, Woodworking and Mechanical Operations. Experience in technical drawing was expected to enhance the three-dimensional space perception ability, as it is concerned with the two-dimensional drawing of three-dimensional objects. Physically manipulating the three-dimensional pieces of wood in woodworking courses apparently increased the ability to mentally manipulate the objects in the test problems. A parallel relationship can be drawn with regard to course work in Mechanical Operations.

5. Significant differences were found in the mean scores on both the Abstract Reasoning and the Space Relations test sections when compared by age groups. The youngest group achieved the highest mean scores. That they were the more recent high school graduates may have tended to impact the mean scores more than the greater degree of life experience for the older group, since the age differences were slight.

6. With a few exceptions, the greater the respondents' reported skill level assessment on a variety of activities, the greater the mean test score achieved. Significant differences in mean test scores were found for at least some of the majors on all the skills. The significant differences in mean scores on both test sections were found in skill assessments for mathematics, working with numbers, working jigsaw puzzles and speaking a foreign language. These activities employ the ability to restructure the problem to get at a new solution but may be more reflective of mathematical ability than spatial perception ability.

Architecture majors who reported a high level of skill for speaking a foreign language achieved the lowest mean test scores. The greatest number of international students were male Architecture majors. They may have lacked experience with these types of tests commonly used in the United States school systems. Also, they may have had some language difficulty with the test instructions and/or cultural bias may have impacted the test scores. Additionally, foreign language skills may be more closely related to language skills in general than to the ability to mentally restructure a problem.

7. No significant differences were observed in the mean scores on either test section when compared by respondents' residence patterns. These results indicate that having lived in different places does not necessarily increase one's ability at mental image-making. Likewise, the rural community is no longer as isolated from external influences as it once was or was thought to be.

8. Generally, the more often the frequency of visits to art museums, the lower was the mean score on the Abstract Reasoning test section. The exposure to works of art, therefore, either two- or three-dimensional, did not increase the mental image-making ability in the subjects for this study. The relative low age of the subjects and the lack of art-related opportunities may have influenced the results.

9. Parental educational level and occupation category had little effect on mean test scores achieved by the subjects in the study. The only significant difference was found with regard to fathers' occupation where those subjects whose fathers were in the professional/managerial occupation category achieved a significantly higher mean test score. This would uphold the theory that the children in higher socioeconomic levels have more opportunity in education, recreation and leisure activities and more positive reinforcement in skill acquisition from parents.

Recommendations

The following recommendations are made with regard to further research:

To administer the test to all the students during the first week of classes in a semester. Once classes have been in session for a couple of weeks, the students are involved in projects associated with course content.

To carefully select the days, time of day and location for test administration so as to create the most positive atmosphere possible.

To refine and elaborate the questions in the questionnaire pertaining to residence and travel patterns and to parental education and occupation.

To replace the Abstract Reasoning test section of the DAT with another test designed to measure three-dimensional space perception. The Abstract Reasoning test section appeared to be more indicative of mathematical related abilities.

To seek a Control Group composed of students from various non-design majors who were enrolled in courses other than those that were design- or art-oriented. To limit the size of the Control Group so that it is not one of the largest subsamples.

To retest the same classes at the end of the semester in order to compare the two scores. Also, to compare the test scores to students' grades in the surveyed courses.

To carefully consider the Interior Design curriculum and teaching methods in light of the results of this study. To carefully consider teaching methods adapted to males' and females' ability levels, as they would appear to perceive space differently. To consider the possibility of time differences required by males and females to perform the spatial perception tasks.

Concluding Statement

Male-female differences did appear in the test scores in general and between the males and females within the majors. Not all of these were at a significant level. However, the only major that had an almost equal number of male and female students was Landscape Architecture. All the other subgroups were heavily weighted to either males or females even though the sample as a whole was almost evenly split by males and females.

Other differences appeared in course work and respondents' reported skill levels on selected activities. Certain background courses tended to increase the test scores on the Space Relations section at a statistically significant level. These were Technical Drawing, Woodworking and Mechanical Operations. This indicates that the abilities required for the solution to the test problems can be learned. A similar relationship would appear to be the case with regard to respondents' reported skill levels. The greater the amount of knowledge or practice with regard to a particular task, the greater is the ability and the greater is the competency level for that task. Considering this, then, the implication could be made that three-dimensional spatial perception ability can be taught. And, once taught, the student has an increase in ability. With an increase in ability comes an increase in competency assessment.

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APPENDIXES

APPENDIX A

SCRIPT FOR EXAMINER AT TEST ADMINISTRATION

There is a study being conducted across campus. It is a survey of the students in some of the design types of courses. This class has been selected for inclusion in the sample. Your participation is, however, entirely voluntary. Let me stress that should you choose to participate in this study, you will be without risk. Your grade in this course and your overall GPA will not be affected by the results of the test that is being administered this morning/afternoon. Your participation in the study will be appreciated very much.

On your drawing boards are manilla envelopes. Let me explain the contents of these envelopes. Inside, you will find two standardized test booklets, an answer sheet, a questionnaire and pencils that you may use. The first test is the Abstract Reasoning test section of the Differential Aptitude Tests. This test is designed to see if you can recognize a sequential pattern in the diagram. The second test is the Space Relations test section of the Differential Aptitude Tests. It is a test to see if you can mentally construct a three-dimensional object from a picture of the pattern.

Please take out the answer sheet and pencils and let's take a look at the answer sheet. You will notice that it is divided into four answer divisions. Answer the first test section, which has 50 questions, in the first 50 answer spaces. Answer spaces 1 through 40 are in division I and 41 through 50 are in division II. The questions in the test booklet are numbered 1 through 50. Please answer them in the corresponding 1 through 50 spaces on the answer sheet.

The second test section has 60 questions. Please answer these in division III and division IV on your answer sheet. Your answers should go in answer spaces 81 through 140. The questions in the test booklet have been renumbered. Instead of 1 through 60, they are numbered 81 through 140. This will help you to answer the questions in the correct answer spaces. These tests are timed at 25 minutes each.

After we finish the two tests, there is a questionnaire for you to answer. Please answer all the questions the best that you can. If you have questions, I'll be happy to try to answer them.

Now, if you would, please fill in your name, student number and course and section number on the answer sheet. This course is <u>(fill in appropriate course title and number)</u> and Section <u>(fill in section number)</u>. If you do not want to fill in your name and student number, that is all right. Just be sure that your answer sheet and questionnaire are put back in the envelope so that the correct answer sheet can be matched to its corresponding questionnaire.

Now, please take out the Abstract Reasoning booklet and open it to the first page. We'll read the instructions together. (Examiner reads instructions aloud.) Are there any questions? (Examiner sets stopwatch.) This test is timed at 25 minutes. Please begin. (Examiner starts stopwatch.)

(At the end of the allotted time.) Time. Please close your test booklets and replace them in the envelope. Now remove the Space Relations booklet and together we'll read the directions. (Examiner follows same procedure as above.)

Time. Please close your test booklets and replace them in the envelope. Now, there is only one thing left and that is the questionnaire. Please answer all the questions as best you can. When you have completed the questionnaire, please put it and the pencils back into the envelope. This will conclude the testing.

Thank you so much for your participation in this survey. Your professor will receive the anlaysis of the study close to the end of the semester. You'll be able to see which classes were in the study and what comparisons were made. Your anonymity will be preserved, however, so you'll only know how your class as a whole did compared to the other classes.

APPENDIX B

STUDENT BIOGRAPHICAL-DEMOGRAPHICAL BACKGROUND QUESTIONNAIRE

OSU DESIGN STUDENTS' BIOGRAPHICAL/

DEMOGRAPHICAL QUESTIONNAIRE

Name______________________________ Course__________________

(Please Make Your Responses on the Line to the Left of the Question)

1. What is your major? (Please check one)
   ___1. Interior Design
   ___2. Architecture
   ___3. Art
   ___4. Landscape Architecture
   ___5. Other (please specify)
   ____

2. What is your sex?
   ___1. Male
   ___2. Female

3. Why did you choose the major you did?__________________________
   ____
   ____

4. What is your level of student classification?
   ___1. Freshman
   ___2. Sophomore
   ___3. Junior
   ___4. Senior
   ___5. Other (please specify)
   ____
   ____

5. What is your age? ___________

6. Please indicate if you have had any of the following courses and at what level:

Course	Yes	No	High School	Summer Prog.	Vo-Tech Prog.	Junior College	College
A. Art							
B. Technical Drawing							
C. Freehand Drawing							
D. Painting							
E. Sculpture							

6. (Continued)

Course	Level						
	Yes	No	High School	Summer Prog.	Vo-Tech Prog.	Junior College	College
F. Woodworking							
G. Mechanical Operations							
H. Electrical Installations							

7. Please indicate if you have had any experience in any of the following:

	Yes	No
A. Technical Drawing		
B. Woodworking		
C. Mechanical Operations		
D. Electrical Installations		

8. Have you lived all your life in Oklahoma? ___1. Yes ___2. No

9. If answer to question 8 is "no," list the states and/or countries you have lived in.

____

10. What is your first or native language? ____________________

11. List the states you have traveled in the United States.

____

____

12. In what countries have you traveled outside the United States?

____

____

13. Where have you lived most of your life?

___1. urban area

___2. rural area

14. Where have your parents or guardians lived most of their lives?

Father	Mother	
________	________	urban area
________	________	rural area

15. What is the occupation of your father? ____________________

What is the occupation of your mother? ____________________

16. What is the level of education of your parents or guardians? (Please check appropriate response.)

Father	Mother	
______	______	1. 1-8 grade
______	______	2. 9-12 grade
______	______	3. 12 + some college or tech. school
______	______	4. college graduate
______	______	5. advanced degree

17. How often do you go to art museums? (Please circle your response.)

Very Often	Often	Occasionally	Seldom	Never
(less than 3 months)	(3-6 months)	(6 months to 1 year)	(1-2 years)	(more than 2 years)

18. What are your favorite leisure activities?

____

____

____

19. Please indicate by circling response on a scale of 5 (very confident) to 1 (not at all confident) where you feel your ability is.

	Very Confident	Somewhat Confident	Confident	Not Very Confident	Not at all Confident
A. mathematics	5	4	3	2	1
B. art or drawing	5	4	3	2	1
C. English/writing	5	4	3	2	1
D. working with people	5	4	3	2	1
E. working with things	5	4	3	2	1
F. working with numbers	5	4	3	2	1

20. Please indicate by circling response your level of ability on a scale of 5 (very competent) to 1 (not at all competent) in each of the following areas:

	Very Competent	Somewhat Competent	Competent	Not Very Competent	Not at All Competent
A. typing	5	4	3	2	1
B. playing a musical instrument	5	4	3	2	1
C. drawing	5	4	3	2	1
D. sports using a ball	5	4	3	2	1
E. working jigsaw puzzles	5	4	3	2	1
F. speaking a foreign language	5	4	3	2	1

21. Have you previously taken either one or both of the tests you have just completed?

___1. Yes--please circle: Space Relations Abstract Reasoning Both

___2. No

APPENDIX C

ADDITIONAL TABLES

TABLE XXVIII

COMPARISON OF THE ABSTRACT REASONING SECTION MEAN SCORES ACHIEVED BY RESPONDENTS' REPORTED SKILL LEVEL ON SELECTED ACTIVITIES

Skill	Level	Interior Design N	Interior Design Mean Score	Interior Design Std. Dev.	Art N	Art Mean Score	Art Std. Dev.	Architecture N	Architecture Mean Score	Architecture Std. Dev.	Landscape Architecture N	Landscape Architecture Mean Score	Landscape Architecture Std. Dev.	Control Group N	Control Group Mean Score	Control Group Std. Dev.
Mathematics	5	2	46.00	1.41	0	--	--	38	41.03	11.45	4	39.50	3.51	11	43.05	4.95
	4	9	43.78	5.87	4	46.58	1.73	46	42.85	6.69	11	44.36	2.46	21	41.95	4.04
	3	14	37.71	5.18	6	40.17	4.79	41	41.37	6.46	4	41.50	2.38	26	41.54	5.11
	2	20	39.00	6.70	10	38.30	4.55	12	42.58	3.26	7	36.29	6.52	30	39.87	5.57
	1	4	38.25	6.13	4	36.25	2.22	0	--	--	0	--	--	9	39.11	3.55
Art or Drawing	5	7	41.71	5.94	10	39.10	3.21	31	41.13	8.68	3	37.33	2.51	12	40.06	6.24
	4	17	39.65	7.65	9	40.33	5.48	39	41.85	8.46	8	41.50	4.62	30	40.36	4.82
	3	17	38.24	6.01	3	35.67	6.43	37	43.00	6.60	9	41.89	3.55	30	41.00	5.57
	2	11	41.71	5.12	2	47.00	0.00	28	41.46	8.41	6	37.67	7.39	25	42.36	3.96
	1	0	--	--	0	--	--	5	42.60	7.40	2	46.00	1.41	5	42.20	3.42
English or Writing	5	8	36.87	6.10	6	40.83	3.97	16	44.12	3.87	7	40.42	4.15	14	40.85	4.88
	4	21	41.85	4.56	7	38.14	4.91	38	43.92	3.70	5	42.00	5.29	24	40.16	5.48
	3	14	37.50	7.41	5	42.60	7.23	44	41.40	7.32	9	40.55	4.47	45	41.08	4.72
	2	9	38.33	8.50	6	38.83	3.66	39	41.30	8.47	7	40.14	7.24	18	42.00	5.22
	1	0	--	--	0	--	--	5	28.80	21.75	0	--	--	2	45.00	0.00
Working with People	5	26	38.26	7.21	11	39.63	3.41	36	42.19	6.37	16	38.56	5.29	40	41.07	5.14
	4	16	40.50	5.71	6	40.00	5.29	48	41.02	8.63	5	43.80	3.24	36	40.88	5.17
	3	3	38.33	4.16	6	41.33	6.77	44	42.70	6.74	7	43.28	3.45	24	41.33	4.65
	2	5	41.00	7.84	1	31.00	0.00	14	41.78	11.83	0	--	--	3	41.33	4.50
	1	0	--	--	0	--	--	0	--	--	0	--	--	0	--	--
Working with Things	5	14	37.35	5.13	9	40.77	3.37	46	43.17	7.07	13	39.23	5.76	36	39.83	5.25
	4	21	40.42	7.46	10	39.10	5.23	72	41.45	7.56	10	40.80	4.66	44	42.18	4.97
	3	17	39.52	6.48	5	39.40	7.16	22	40.68	8.32	4	44.25	2.50	21	40.90	4.31
	2	0	--	--	0	--	--	2	43.00	7.42	1	44.00	0.00	2	41.00	1.41
	1	0	--	--	0	--	--	0	--	--	0	--	--	0	--	--
Working with Numbers	5	3	46.00	1.00	0	--	--	43	44.25	4.37	7	41.85	3.97	14	43.28	3.91
	4	10	42.40	4.99	5	44.80	2.49	56	41.19	9.20	9	43.00	3.96	29	41.75	5.28
	3	21	37.00	7.19	6	39.50	6.12	38	40.21	8.81	6	37.00	6.13	28	40.03	4.78
	2	16	39.37	6.24	9	38.77	4.54	5	42.80	3.96	6	39.50	5.39	25	40.80	5.28
	1	2	37.50	3.53	4	36.25	2.21	0	--	--	0	--	--	7	39.00	3.91

TABLE XXVIII (Continued)

Skill	Level	Interior Design N	Interior Design Mean Score	Interior Design Std. Dev.	Art N	Art Mean Score	Art Std. Dev.	Architecture N	Architecture Mean Score	Architecture Std. Dev.	Landscape Architecture N	Landscape Architecture Mean Score	Landscape Architecture Std. Dev.	Control Group N	Control Group Mean Score	Control Group Std. Dev.
Typing	5	11	39.18	7.27	0	--	--	4	45.00	2.44	1	39.00	0.00	12	41.08	3.36
	4	10	41.70	5.14	2	37.50	9.19	21	44.28	3.97	4	43.50	4.72	26	41.26	4.87
	3	20	35.65	6.12	11	40.09	5.80	39	43.05	7.08	13	40.84	4.45	29	42.58	3.95
	2	9	37.66	8.06	4	40.75	1.50	42	41.47	9.13	5	40.70	3.89	22	39.09	5.69
	1	2	32.00	4.24	6	39.83	5.03	36	39.57	8.75	5	38.80	8.40	13	40.15	6.20
Playing a Musical Instrument	5	10	40.80	7.31	0	--	--	12	46.08	2.53	3	43.00	4.00	12	43.16	4.13
	4	9	38.80	5.38	5	39.60	6.22	19	41.26	3.91	2	45.50	2.12	12	44.00	3.81
	3	9	40.11	5.66	2	43.50	4.94	24	44.08	4.27	5	39.60	7.82	13	41.23	4.67
	2	12	38.58	8.25	5	40.20	3.27	36	40.05	11.22	7	41.28	3.98	39	40.30	4.92
	1	11	39.09	6.62	12	39.08	5.40	20	41.42	6.34	10	39.60	4.94	27	39.88	5.42
Drawing	5	7	41.71	5.12	8	39.00	3.38	29	40.77	8.86	4	38.75	3.50	12	40.16	6.04
	4	21	39.38	6.28	11	40.18	5.03	53	42.73	6.60	12	41.00	4.24	30	40.73	4.83
	3	9	42.88	7.21	2	37.00	8.48	32	40.59	10.64	7	40.00	7.08	35	41.05	5.07
	2	15	35.73	6.08	3	42.33	8.08	25	43.40	4.26	3	40.00	6.24	26	42.15	4.95
	1	0	--	--	0	--	--	3	40.00	9.26	2	46.00	1.41	6	41.16	3.31
Sports Using a Ball	5	8	39.75	4.80	4	40.75	5.18	41	42.92	3.95	7	38.71	7.06	31	40.51	5.23
	4	12	40.50	5.68	9	38.55	5.50	49	40.73	10.00	8	43.12	2.53	19	41.94	5.72
	3	21	37.57	7.63	4	39.50	5.19	28	41.57	8.26	7	38.85	5.49	30	41.10	4.02
	2	9	40.77	5.93	7	41.00	4.93	20	44.05	7.72	5	42.80	3.27	21	41.04	5.45
	1	2	42.00	11.31	0	--	--	4	37.75	5.73	1	37.00	0.00	2	41.50	3.53
Working Jigsaw Puzzles	5	17	40.52	6.63	6	40.67	3.50	31	44.54	3.35	7	39.85	6.71	25	42.52	5.38
	4	15	40.70	5.64	8	40.87	4.73	50	42.66	7.10	9	40.55	5.17	38	39.84	5.21
	3	16	38.56	6.01	8	38.12	6.74	50	41.60	9.11	12	41.25	4.35	30	41.40	3.97
	2	11	33.75	10.75	2	39.50	2.12	8	38.00	8.75	0	--	--	9	42.00	4.76
	1	0	--	--	0	--	--	3	26.67	11.37	0	--	--	1	34.00	0.00
Speaking a Foreign Language	5	1	33.00	0.00	0	--	--	7	36.14	8.43	1	26.00	0.00	0	--	--
	4	3	38.33	8.50	0	--	--	10	37.70	12.90	4	41.50	1.91	8	42.25	5.25
	3	6	34.83	7.80	4	37.50	4.79	17	41.64	10.18	6	38.33	4.32	8	39.25	4.46
	2	20	39.95	6.07	8	41.75	4.80	50	43.20	6.92	9	42.44	4.82	26	41.61	5.57
	1	22	40.36	6.41	12	39.25	5.15	58	42.21	6.40	8	41.87	4.15	61	40.93	4.75

Note: Skill level: 5=Very Competent; 4=Somewhat Competent; 3=Competent; 2=Not Very Competent; 1=Not at all Competent

TABLE XXIX

COMPARISON OF THE SPACE RELATIONS SECTION MEAN SCORES ACHIEVED BY RESPONDENTS' REPORTED SKILL LEVEL ON SELECTED ACTIVITIES

		Interior Design			Art			Architecture			Landscape Architecture			Control Group		
Skill	Level	N	Mean Score	Std. Dev.	N	Mean Score	Std. Dev.	N	Mean Score	Std. Dev.	N	Mean Score	Std. Dev.	N	Mean Score	Std. Dev.
Mathematics	5	2	44.50	0.71	0	--	--	38	47.87	8.40	4	46.75	9.69	11	48.73	8.47
	4	9	45.33	3.71	4	46.75	5.91	46	48.13	8.90	11	45.77	5.60	21	41.14	7.48
	3	14	36.86	8.26	6	42.67	6.44	41	45.34	9.81	4	42.00	6.45	26	41.46	8.48
	2	20	38.10	8.74	10	38.10	9.05	12	44.75	7.45	7	36.57	8.62	30	39.30	9.07
	1	4	38.00	4.08	4	35.75	6.70	0	--	--	0	--	--	9	41.00	7.26
Art or Drawing	5	7	43.43	8.18	10	40.70	7.51	31	47.29	6.92	3	40.00	2.65	12	39.58	10.30
	4	17	37.94	9.13	9	39.44	8.65	39	47.08	8.74	8	43.13	8.10	30	41.80	8.22
	3	17	40.94	6.18	3	35.33	8.14	37	46.84	9.93	9	43.00	4.61	30	42.53	8.06
	2	11	36.82	7.86	2	49.50	4.95	28	47.46	8.86	6	43.00	14.38	25	40.28	8.78
	1	0	--	--	0	--	--	5	38.00	13.23	2	42.50	7.78	5	42.20	9.60
English or Writing	5	8	39.00	3.70	6	41.06	5.70	16	45.00	7.00	7	43.00	5.91	14	40.57	9.26
	4	21	41.76	7.45	7	38.00	9.45	38	48.13	8.50	5	38.40	8.01	24	41.66	7.86
	3	14	37.35	9.41	5	44.00	10.46	44	46.09	9.48	9	45.66	4.03	45	41.46	7.94
	2	9	37.55	9.07	6	39.00	7.18	39	46.87	9.75	7	41.57	12.80	18	40.94	10.66
	1	0	--	--	0	--	--	5	50.60	2.88	0	--	--	2	48.00	2.82
Working with People	5	26	39.42	9.00	11	38.72	5.81	36	44.55	8.81	16	40.87	9.37	40	41.97	8.26
	4	18	40.00	6.06	6	40.00	13.19	48	46.60	8.74	5	45.20	4.43	36	40.83	9.02
	3	3	36.00	3.60	6	44.50	5.16	44	47.59	8.04	7	45.00	6.37	24	41.58	8.55
	2	5	39.00	11.26	1	34.00	0.00	14	51.64	10.75	0	--	--	3	40.00	8.00
	1	0	--	--	0	--	--	0	--	--	0	--	--	0	--	--
Working with Things	5	14	38.92	8.09	9	42.33	5.78	46	49.34	7.59	13	40.15	9.10	36	41.83	8.54
	4	21	40.00	8.15	10	37.50	10.29	72	46.00	7.55	10	45.30	6.99	44	41.31	8.94
	3	17	39.11	8.03	5	42.20	6.30	22	44.86	13.43	4	41.75	4.64	21	41.38	8.05
	2	0	--	--	0	--	--	3	36.33	18.23	1	53.00	0.00	2	37.00	4.24
	1	0	--	--	1	20.00	0.00	0	--	--	0	--	--	0	--	--
Working with Numbers	5	3	43.00	2.64	0	--	--	43	48.65	7.57	7	45.28	6.99	14	47.71	7.61
	4	10	42.00	5.59	5	42.20	7.19	56	46.12	10.19	9	44.33	6.78	29	41.68	9.87
	3	21	39.23	7.92	6	42.50	8.54	38	46.63	8.31	6	39.66	11.67	28	39.14	7.32
	2	16	37.81	9.90	9	38.66	8.63	5	42.20	6.68	6	40.06	7.13	25	40.56	7.68
	1	2	36.00	5.65	4	35.75	6.70	0	--	--	0	--	--	7	40.00	6.85

TABLE XXIX (Continued)

Skill	Level	Interior Design N	Interior Design Mean Score	Interior Design Std. Dev.	Art N	Art Mean Score	Art Std. Dev.	Architecture N	Architecture Mean Score	Architecture Std. Dev.	Landscape Architecture N	Landscape Architecture Mean Score	Landscape Architecture Std. Dev.	Control Group N	Control Group Mean Score	Control Group Std. Dev.
Typing	5	11	40.72	8.53	1	35.00	0.00	4	46.50	5.19	1	40.00	0.00	12	43.50	7.82
	4	10	40.60	5.87	2	36.50	3.53	21	47.66	6.96	4	39.75	6.07	26	41.58	7.89
	3	20	39.40	8.09	11	37.18	9.74	39	48.28	7.42	13	42.61	6.70	29	41.82	7.69
	2	9	39.33	8.30	4	46.75	1.50	42	47.26	8.30	5	42.20	4.76	22	39.22	9.64
	1	2	27.00	7.07	6	43.83	5.30	36	44.52	11.79	5	43.20	15.38	13	42.23	10.61
Playing a Musical Instrument	5	10	41.10	8.21	0	--	--	12	48.16	7.67	3	41.66	5.68	12	45.25	9.61
	4	9	40.33	3.80	5	42.60	7.70	19	48.63	7.03	2	48.50	2.12	12	43.16	5.79
	3	9	39.22	6.15	2	46.00	0.00	24	49.20	8.53	5	37.50	12.66	13	42.00	6.77
	2	12	39.75	8.71	5	35.80	12.09	36	46.83	9.19	7	43.28	7.15	39	40.12	9.25
	1	11	37.09	11.58	12	40.25	6.74	50	45.00	9.60	10	44.50	7.21	27	40.55	8.46
Drawing	5	7	43.42	8.18	8	41.25	8.31	29	46.75	6.96	4	43.00	6.37	12	40.58	10.37
	4	21	38.52	8.59	11	39.27	7.82	53	47.83	7.46	12	41.33	6.34	30	43.26	8.51
	3	9	42.77	2.81	2	33.50	10.60	32	46.68	11.10	7	42.71	12.88	35	40.82	6.75
	2	15	36.80	8.23	3	46.00	7.00	25	46.92	8.97	3	41.66	4.72	20	40.20	10.22
	1	0	--	--	0	--	--	3	33.33	16.25	2	42.50	7.77	6	41.50	8.75
Sports Using a Ball	5	8	37.37	4.98	5	35.60	10.43	41	48.48	6.40	7	47.75	11.76	31	39.58	7.93
	4	12	41.66	5.64	9	41.88	8.88	49	46.16	9.32	8	46.25	6.60	19	43.21	8.84
	3	21	38.23	8.34	4	39.00	9.83	28	48.64	8.67	7	37.85	4.74	30	42.70	7.48
	2	9	40.77	11.86	7	39.42	8.42	20	47.00	10.70	5	46.00	5.14	21	42.42	10.24
	1	2	40.50	6.36	0	--	--	4	37.75	12.84	1	37.00	0.00	2	44.50	9.19
Working Jigsaw Puzzles	5	17	40.82	7.69	6	35.66	7.14	31	48.70	6.24	7	40.57	12.24	25	43.96	10.01
	4	15	38.96	8.28	8	46.62	4.92	50	48.22	7.69	9	41.77	6.24	38	40.57	8.32
	3	16	39.00	6.86	8	39.87	7.62	50	46.80	8.97	12	41.58	6.52	30	41.06	7.46
	2	4	38.75	13.64	3	27.00	7.54	9	38.44	10.74	0	--	--	9	40.77	6.83
	1	0	--	--	0	--	--	3	21.66	8.32	0	--	--	1	27.00	0.00
Speaking a Foreign Language	5	1	34.00	0.00	0	--	--	7	39.59	10.95	1	17.00	0.00	0	--	--
	4	3	32.00	14.42	0	--	--	10	39.70	13.61	4	42.25	6.65	8	43.25	11.09
	3	6	33.16	8.97	4	37.75	5.56	17	48.11	7.10	6	43.33	8.38	8	39.37	6.47
	2	20	40.30	4.48	9	40.37	9.41	50	47.32	7.75	9	46.11	6.23	26	41.96	8.06
	1	22	41.59	8.38	12	41.08	8.36	58	48.27	8.33	8	41.75	5.23	61	41.22	8.67

Note: Skill level: 5=Very Competent; 4=Somewhat Competent; 3=Competent; 2=Not Very Competent; 1=Not at all Competent

VITA

Louise Steinbrink Harris

Candidate for the Degree of

Master of Science

Thesis: A STUDY OF THE ANALYTICAL SPATIAL PERCEPTION ABILITY OF SELECTED STUDENTS IN ART, ARCHITECTURE, LANDSCAPE ARCHITECTURE AND INTERIOR DESIGN

Major Field: Housing, Design and Consumer Resources

Biographical:

Personal Data: Born in Galveston, Texas, November 28, 1940, the daughter of Mr. and Mrs. L. H. Steinbrink.

Education: Graduated from Ursuline Academy, Galveston, Texas, in May, 1958; received Bachelor of Science degree in Home Economics from San Houston State University in 1961; received Bachelor of Arts degree in Interior Design from Mount Vernon College in May, 1978; completed requirements for Master of Science degree at Oklahoma State University in May, 1981.

Professional Experience: Dietetic Intern, Veterans' Administration Hospital, Houston, Texas, 1962-63; Pediatric Dietitian, Texas Childrens Hospital, Houston, Texas, 1963-65; Visiting Instructor, Department of Home Economics, University of Houston, Houston, Texas, 1963-64; Chief Dietitian, Shriners' Burn Institute, Free-lance Commerical Kitchen Designer, Galveston, Texas, 1965-70; Captain, United States Air Force, Biomedical Sciences Corps, Biloxi, Mississippi and San Antonio, Texas, 1970-72; Consultant Dietitian in private practice, Free-lance Commercial Kitchen Designer, San Antonio, Texas, 1972; Art Instructor, U. S. Air Force Special Services, Japan, 1972-75; English Instructor, Japanese Self-Defense Force Academy, Japan, 1973-75; Interior Design Intern, Veterans' Administration, Washington, D.C., 1977; Interior Design Intern, The Smithsonian Institution, Washington, D.C., 1978; Graduate Teaching Assistant, Department of Housing, Design and Consumer Resources, Division of Home Economics, Oklahoma State University, 1979-81.

Professional Organizations: American Dietitic Association, Registered member; American Society of Interior Designers, associate member.