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AN INVESTIGATION OF THE RELATIONSHIPS BETWEEN DEGREE OF BRAIN
DOMINANCE AND STUDENT PREFERENCE FOR SPATIAL
DIMENSIONALITY IN THE PRODUCTION OF ART
AT THE HIGH SCHOOL LEVEL

by
Darlene Ann Gates

A THESIS

Submitted in partial fulfillment of the requirements for the Master of Arts
in Subject Matter Teaching: Art Graduate Division
of Rowan College of New Jersey
1995

Approved by

Professor

Date Approved

4/18/95

ABSTRACT

Darlene Ann Gates

AN INVESTIGATION OF THE RELATIONSHIPS BETWEEN DEGREE OF BRAIN DOMINANCE AND STUDENT PREFERENCE FOR SPATIAL DIMENSIONALITY IN THE PRODUCTION OF ART AT THE HIGH SCHOOL LEVEL

1995

Thesis Advisor: Dr. Lili Levinowitz

Master of Arts in Subject Matter Teaching: Art
Graduate Division of Rowan College
of New Jersey

The purposes of this study were to investigate relationships between hemisphericity and preference for spatial-dimensionality in the production of art and to determine whether cognitive processes are different in students who prefer different spatial activities. Specifically, this study investigated the relationships between students' preference for two and three-dimensional art projects and their scores on *Excell's Hemispheric Mode Indicator (HMI)* test.

The total population of eighty-five art students from a rural, regional New Jersey high school were included in this study. Two instruments were administered. Scores from the teacher-made survey served as data for criterion measure one and determined spatial-dimensionality preference. Scores from the *HMI* determined each subject's degree of brain dominance and became data for criterion measure two.

A 3x2 crossbreaks design was organized and a chi-square computed.

The Cramer's Phi coefficient determined the strength of the association. A Pearson r investigated correlations between degrees of dimensionality preference and hemisphericity.

A statistical significance of $\chi^2=6.963$ at the $p<.05$ level was found between hemisphericity and dimensionality preference. Based on the findings of this study, brain dominance and spatial-dimensionality preference can be considered not independent. Specifically, a strong relationship appears to exist between left brain dominance and three-dimensional preference.

MINI-ABSTRACT

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CHAPTER ONE

INTRODUCTION AND PROBLEM

The fine arts in public education have always had a precarious and vaguely defined position within the required curriculum. Historically, as the educational pendulum has swung back and forth, the study of art has been viewed as either therapy for the fractious child, as a frill, a “fringe” benefit for the talented few, or as a means for allowing creative, personal expression. Whatever these benefits, they did not seem to compare with the benefits of “higher order” thinking skills as provided by the study of more rigorous academic subjects, namely math and science.¹

This idea that some skills are more valued than others is not limited to the domain of education. Within the art community itself, certain skills, namely drawing and painting, are viewed as more prestigious than other skills, such as pottery and crafts. Art teachers often value drawing and painting, abilities associated with visual perception, over more tactile and spatial approaches, which are seen as less intellectual pursuits.² But is this view valid? Are there cognitive differences in the way artists think as they create different forms of art and, if so, does current research support the idea that the various cognitive styles are of equal weight and importance when educating a well-rounded student? If a variety of cognitive styles are present in the art room, then art

¹ Arthur D. Efland, *A History of Art Education* (New York, NY: Teachers College Press, 1990), 241.

² Viktor Lowenfeld, “Tests for Visual and Haptical Aptitudes,” in *Readings in Art Education*, ed. Elliot Eisner and David Ecker (Waltham, Massachusetts: Blaisdell Publishing Company, 1966), 99.

educators need to evaluate their programs to ensure that the needs of their students are met. As an added benefit, research in the cognitive and creative approaches to art may help secure a place for the arts in education.

While it has long been known that creativity plays an important role in the productivity of our most brilliant mathematicians, scientists, inventors and artists,³ the phenomenon of the creative process has remained outside the realm of scientific quantification. However, recent research in brain hemisphericity and the concept of multiple intelligences has come to challenge the view that the study of art lies outside the realm of scientific study.

Current medical and psychological studies have proven that the two hemispheres of the brain process information differently and that the study of art may engage the right hemisphere, the half of the brain long ignored by traditional educational strategies. We now recognize that both the left hemisphere and the right hemisphere must be involved to produce an integrated approach to thinking and problem solving.⁴

The brain is composed of two hemispheres, left and right, each exhibiting areas of specialization. Early attempts at ascribing specific abilities to areas of the brain involved research with brain-damaged patients. As early as 1836, observations of patients with damage to the left hemisphere indicated that such damage would severely limit speech and language abilities while similar damage to the right hemisphere did not affect language.⁵ Because of the

³ Howard Gardner, *Frames of Mind. The Theory of Multiple Intelligences* (New York, NY: Basic Books, Inc. Publishers, 1985), 190.

⁴ Betty Jean Eklund Shoemaker, "Education 2000 Integrated Curriculum," *Phi Delta Kappan* (June 1991), 793-797.

⁵ Jane K. Cooke and Mildred Hapt, "Thinking with the Whole Brain," *National Education Association Professional Library* (Washington D.C.: National Education Association, 1986), 8-15.

importance attached to speech and language and their relationships to reasoning and thinking, the left side of the brain became viewed as the dominant side while the right side was seen as more primitive and subordinate, aided by the more capable left.⁶

It was not until the 1940s, with the work of Roger Sperry in split-brain research, that right hemispheric functions were recognized as having cognitive complexity. Sperry studied individuals whose corpus callosum, the bundle of nerve fibers that allows for interactive behavior between the halves of the brain, had been severed in order to reduce the occurrences of epileptic seizures. Sperry's work led him to conclude that, in most individuals, language and analytical, sequential, reasoning skills were centered in the left hemisphere while visual, sensory, spatial and intuitive skills were centered in the right.⁷

Additional studies confirmed the specialized qualities of the two hemispheres. According to Jeffrey Cummings,

Each hemisphere performs a variety of tasks of which the other is incapable or able to accomplish with only marginal facility. The left hemisphere is specialized for language comprehension and execution, verbal memory, and the numerical aspects of calculation, whereas the right hemisphere is specialized for visual-spatial and visual-perceptual function and non-verbal memory and comprehension.⁸

⁶ Mark Beals, Ph.D., *The Right Brain: An Emerging Frontier in Education*, Paper presented as part of the symposium "Education and Contemporary America" at Boise State University, 8-10 October 1981, 99. ERIC, ED 211 518

⁷ Jane E. Cooke and Mildred Hapt, 10.

⁸ Jeffrey L. Cummings, MD, "Hemispheric Asymmetries in Visual-Perceptual and Visual-Spatial Function," in *The Dual Brain*, ed. D. Frank Benson (New York, NY: The Guilford Press, 1985), 238.

Brain research conducted by Robert Ornstein supports Sperry and Cummings. Ornstein described left brain function as predominantly associated with math, speech and language, with information processed in a logical and sequential manner, while right brain function involves artistic and musical endeavors, spatial orientation and non-verbal reasoning, with information processed as holistic and intuitive.⁹

Specialized functionality however, is not exclusive. As Cooke and Haipt report, "the right and left hemispheres of the brain complement, interact and collaborate with each other via commissures or fibers that connect them. This interaction contributes to integrated human thought and behavior."¹⁰

The *Hemispheric Mode Indicator* (HMI), developed by Excel, Incorporated, is one of many self-report tests that record hemispheric mode preferences on a continuum, from left-brain through whole-brain to right-brain preference.¹¹ These tests use a continuum scale for measurement as it appears that an individual prefers one mode over another to a degree; that is, individuals differ not only as to left, right or integrated brain preference, but also in the extent of that preference.

While many individuals use both the right and left mode depending on the task to be completed,¹² numerous studies have shown that many individuals

⁹ Doris B. Matthews, Ph.D., *Cerebral Dominance: Its use in Understanding Learning Styles and Behavioral Patterns*, Paper presented at the American Personnel and Guidance Annual Convention in Detroit, Michigan, 17-20 March 1982, 3. ERIC ED 218 559.

¹⁰ Jane K. Cooke and Mildred Haipt, 14.

¹¹ Marcus G. Lieberman, Ph. D., *The Hemispheric Mode Indicator Technical Notes* (Barrington, Illinois: Excel, Inc., 1988.)

¹² Jeffrey L. Cummings, 233.

show a marked preference for processing information in either the left or right mode. For example, Mark McGee notes that recent literature suggests a difference exists:

between males and females in precisely those areas of cognitive functioning that are believed to be differentially represented by the two cerebral hemispheres. For example, males tend to show performance advantages over females on various (right hemisphere) tasks requiring spatial abilities, whereas females tend to show performance advantages over males on various (left hemisphere) task requiring verbal abilities.¹³

In a report with similar findings by Matthews, girls were shown "to be more auditory and verbal, styles characteristic of left hemispheric dominance. Boys were shown to prefer visual and manipulative styles, as one would predict for right-brain dominance."¹⁴

Other studies have found significant correlations between college discipline choice and hemispheric preference. A survey developed by Monfort indicates that right-brained university students were more likely to choose areas of study that are associated with the arts.¹⁵ In a similar study, Bakan's results on hemisphericity in college students showed "differences in the degree to which

¹³ Mark G. McGee, "Spatial Abilities: The Influence of Genetic Factors," in *Spatial Abilities*, ed. Michael Potegal (New York, NY: Academic Press, 1982), 208.

¹⁴ Doris B. Matthews, 14.

¹⁵ Mary Monfort, Samuel A. Martin and William Frederickson, "Information-Processing Differences and Laterality of Students from Different Colleges and Disciplines," *Perceptual and Motor Skills* (February 1990): 70, 168-172.

individuals in different occupational studies utilize each cerebral hemisphere.”¹⁶

These finds have been of significant implications for educators. Traditional educational practices place emphasis on left brain activities or what are known as “the basics”— reading, writing and mathematics. According to Guckes and Elkins:

Most currently prevailing patterns of education are heavily biased toward left cerebral functioning and are antithetical to right cerebral functioning. Our society appears to value logic, reasoning and analysis far more than it does visualization, creativity, imagination and sensory/perceptual abilities.¹⁷

Additionally, Monfort suggests that:

The differential effects of hemispheric processing in an educational system emphasizing the left-hemispheric activities of structured logic and sequential processing suggests repression of the intellectual development of those students who may be genetically favorable to right-hemispheric processing.¹⁸

Therefore, research in hemisphericity indicates that both sides of the brain should be developed. Many currently popular educational theories and curriculum designs, such as Bernice McCarthy’s *4MAT System*, focus on whole

¹⁶ Sally Springer, 243.

¹⁷ Lucille Guckes and Robert Elkins, *Implications of Brain Research for Educational Practice*, Paper presented as part of the symposium “Education and Contemporary America” at Boise State University, 8-10 October 1981, 138. ERIC, ED 211 518.

¹⁸ Mary Monfort, et. al., 163.

brain learning with an emphasis on perceptual and art-related activities.¹⁹ Educators now realize what neuropsychologists have known for decades: the study of art offers a unique insight toward understanding right brain thinking. Neuropsychologists, examining the relationship between art and perception and brain research, recognized that the artistic process differed significantly from language functions in part from studies of brain-damaged artists.²⁰

However, while it is now generally agreed that the two hemispheres are different in their cognitive functioning, it is less clear as to which right-brained skills function independently. Clinical studies of artists suffering from visual agnosia, a rare condition in which the ability to recognize objects visually presented is impaired, showed that the patients still exhibited some basic perceptual skills and were able to perceive objects tactually presented.²¹ In studies of the blind by Landau, it was shown that visual and tactile spatial intelligences did not share a relationship but operated separately.²² These findings suggest that specific right-brain processes can function as separate entities. Just as right-brain and left-brain skills are seen to be of equal importance to the intellect, visual perception is viewed to be just as important as tactile perception; nowhere in the literature has it been suggested that one form of spatial ability is of higher cognitive value than another.

In fact, the foundation for artistic endeavor lies in both visual and tactile perception. Howard Gardner points out:

¹⁹ Bernice McCarthy. *The 4MAT System* (Barrington, Illinois: Excel, Inc. 1987.)

²⁰ Howard Gardner, *Art Mind and Brain: A Cognitive Approach to Creativity* (New York, New York: Basic Books, Inc., Publishers, 1982), 320.

²¹ *Ibid.*, 323.

²² *Ibid.*, *Frames of Mind. The Theory of Multiple Intelligences*, 186.

The enterprises of painting and sculpture involve an exquisite sensitivity to the visual and spatial world as well as an ability to recreate it in fashioning a work of art. Certain other intellectual competences, such as facility in the control of fine motor movement, contribute as well; but the *sine qua non* of graphic artistry inheres in the spatial realm.²³

Therefore, it is in the interest of art educators to more fully understand the various functions of the right brain. As Avraham Scheiger states, "the question arises as to the similarities and differences in the cerebral organization for different forms of art."²⁴ Art-related abilities unique to the right brain have been difficult to define; however, as suggested earlier, spatial ability is strongly implicated. Such implications have led researchers such as La Pierre to investigate artists' thinking styles, perception and manipulation skills. She concluded that artistic thinking styles differed from those of other populations.²⁵

A single definition for spatial ability is not found in the literature and is the basis for much of the difficulty in measuring spatial ability. Various tests have been constructed to measure spatial ability as defined by the researcher. In general, spatial test items include drawings that must be mentally rotated on a flat plane, drawings of cubes and three-dimensional shapes that are mentally rotated in space and the physical manipulation of flat shapes and three-

²³ *Ibid.*, 196.

²⁴ Avraham Scheiger, "Harmony of the Spheres and the Hemispheres: The Arts and Hemispheric Specialization" in *The Dual Brain*, ed. D. Frank Benson, (New York, NY: The Guilford Press, 1985), 263.

²⁵ Sharon La Pierre, *The Professional Artist's Thinking Style: An In-Depth Study*, Paper presented at the National Art Education Association Conference in Phoenix, Arizona, April 1992, ERIC ED 349 219.

dimensional cubes.²⁶ Spatial ability has been defined as manipulo-spatial, possessing the ability to manipulate spatial patterns and relationships;²⁷ visuoconstructional, associated with perceptual-motor skills;²⁸ and as separate abilities, namely visual-perceptual and spatial-perceptual.²⁹ Still other researchers, such as Koussy³⁰ and Yen³¹ separate spatial skills into two and three-dimensional abilities. Moreover, the results of a study investigating motor-free perception and visual-motor integration by Leonard, Foxcroft and Kroukamp supports the hypothesis that visual perception, involving two-dimensional ability, is a separate process from those of three-dimensional motor-perceptual skills.³²

Parallel findings were made by Viktor Lowenfeld in 1947. Lowenfeld, a pioneer in the field of perception and art, defined and classified two perceptual modalities in an effort to account for the character of children's art. He labeled these two modalities as haptic and visual. According to Lowenfeld, those whose perception is visually oriented tend to see the world as spectators rather than participants and rely on sight to perceive the world. Such children have a

²⁶ Michael C. Corballis, "Mental Rotation: Anatomy of a Paradigm," in *Spatial Abilities*, ed. Michael Potegal (New York, NY: Academic Press, 1982), 176-177.

²⁷ Sally Springer and George Deutsch, *Left Brain, Right Brain* (San Francisco, CA: W. H. Freeman and Company, 1981), 272.

²⁸ Arthur Benton, "Spatial Thinking in Neurological Patients: Historical Aspects," in *Spatial Abilities*, ed. Michael Potegal (New York, NY: Academic Press, 1982), 270.

²⁹ Sally Springer and George Deutsch, 268.

³⁰ Howard Gardner, *Frames of Mind. The Theory of Multiple Intelligences*, 175.

³¹ Nora Newcombe, 227.

³² Penelope Leonard, et al., "Are Visual-Perceptual and Visual-Motor Skills Separate Abilities?" *Perceptual and Motor Skills* (October 1988): 426.

tendency in art toward objectivity, two-dimensional perspective and detail. Haptic individuals perceive subjectively through tactile sensations and desire physical involvement; they have difficulty comprehending two-dimensional concepts such as perspective.³³

To define his modes, Lowenfeld suggested that an extreme haptic type would, if sight were denied him, be able to function comfortably based on his preferred tactile and spatial mode while a true visual type would be lost without his vision. However, just as right/left brain preferences seem to present themselves on a continuum, Lowenfeld remarked that extremes of this nature were very rare, that most individuals "fall between these two extreme types."³⁴ Lowenfeld was careful to point out that one type was not superior to the other, each was simply a different approach to problem-solving.

There are other parallels that link the visual/haptic theory to theories on right brain specialization. Psychologists have found that in very young children the right hemisphere develops first; Lowenfeld found that young children often begin life as haptic individuals. Lowenfeld also discovered that haptic children have more difficulty learning to read, a finding consistent with studies of right-brain dominant children taught with traditional left-brain strategies. It is interesting to note that recent studies indicate that right-brain dominant children, when presented with three-dimensional letter forms, have greater success in reading and letter recognition,³⁵ findings that parallel the haptic definition.

Although visual/haptic theories appear to have been overshadowed in the

³³ Viktor Lowenfeld, 102-103.

³⁴ *Ibid.*, 97.

³⁵ Howard Gardner, *Art, Mind and Brain. A Cognitive Approach to Creativity*, 227.

early 1960's by hemisphericity studies, work by Locher in 1982 on visual/haptic processing, in which subjects assembled cut out puzzle pieces, reaffirms that haptic perception operates independent of visual perception and that haptic individuals prefer handling test stimuli. He also concluded that haptics prefer to rely upon tactile means for gathering information.³⁶

What do these findings imply for art educators? Art programs rarely expand the concept of art beyond the visual static arts, particularly drawing and painting.³⁷ Yet, if two-dimensional and three-dimensional cognitive processes are different abilities existing within the right-brain and vary from one individual to another, then in order to design an art curriculum that meets students' needs, art teachers need to identify those abilities in their students. Although implications can be drawn between the spatial tests, visual/haptic studies, and two-dimensional and three-dimensional spatial abilities mentioned above, a valid test designed to measure such abilities has yet to be developed, according to Kay.³⁸

As has been shown, the evidence suggests a strong relationship between artistic perception and right-brain cognition; however, within the right brain, different perceptual-spatial modes appear to exist. Since brain dominance is measured on a continuum, we may well ask if there is a relationship between degree of brain dominance and student preference for visual-spatial tasks. If preference, arrived at by examining choice of course work and rating activities associated with working in two and three-dimensions, can be linked to degree

³⁶ Paul Locher, "Influence of Vision on Haptic Encoding Processes," *Perceptual and Motor Skills* (August 1982): 55, 60.

³⁷ Roger Gehibach, "Art Education: Issues in Curriculum and Research," *Educational Researcher* (October 1990): 20.

³⁸ Sandra Kay, 14.

of brain dominance using a reliable hemispheric mode test, then art teachers will have the necessary data to form a basis for curriculum design and reform. This in turn may help lessen the stigma associated with three-dimensional arts and crafts long held by the majority of fine artists and of educators. In addition, if degree of brain dominance can be linked to two and three-dimensional preference, such a link may lend support to research indicating that these areas are separate spatial abilities.

The purpose of this study was to investigate relationships between degree of brain dominance and student preference for spatial-dimensionality in the production of art to determine if cognitive processes are different in students who prefer different spatial activities. The relationships were examined to determine whether or not brain dominance should be a factor when art teachers select teaching strategies and topical units for classroom study within their curriculum.

PROBLEM

This study tested eighty-five art students, who represented the total population of tenth, eleventh and twelfth graders at Cumberland Regional High School in Seabrook, New Jersey, for brain dominance and surveyed their attitudes toward two-dimensional and three-dimensional art projects to determine what relationships exist between left brain/right brain dominance and spatial dimensionality preference. In addition, the strengths of such relationships were examined.

CHAPTER TWO

INTRODUCTION

Although many studies link brain dominance with academic and occupational preferences, they tend to be broad in scope, surveying a wide spectrum of academic majors and vocations. In these studies, art was defined as a single entity with no distinction made between the various disciplines within the visual arts.^{1 2,3} Only one study was found linking hemisphericity with discrete discipline choices in the fine arts.⁴

Of the studies that have sought to find relationships between brain dominance and specific disciplines, many examine the benefits gained from using right-brained teaching strategies within traditionally left-brained subject matter domains, examples of which include math and science.⁵ Fewer studies were found that examined academic areas within the realm of the right brain for the purpose of defining specific abilities,⁶ although two studies did attempt to determine whether or not two-dimensional, visual encoding processes were separate from those of three-dimensional, haptic perception.^{7,8}

¹ Susan King Roth, "Visualization in Science and the Arts." In *Art, Science and Visual Literacy*, Readings from the Annual Conference of the International Visual Literacy Association, Pittsburgh, Pennsylvania, 30 September-4 October 1993.

² Betty Jean E. Shoemaker, 793-797.

³ Sally Springer, 243.

⁴ Mary Monfort, Samuel A. Martin and William Frederickson, 163-172.

⁵ Colin MacKinnon, *Implications of Right Brain Research on Curriculum Development*, Paper presented as part of the symposium "Education and Contemporary America" at Boise State University, 8-10 October 1981.

⁶ Lucille Guckes and Robert Elkins, 137-145.

⁷ Paul Locher, 59-74.

⁸ Penelope Leonard, Cheryl Foxcroft and Tertia Kroukamp, 423-426.

As no studies were found that specifically addressed the relationship between right brain dominance and dimensionality preference in creating works of art, the three studies singled out above will be discussed, as each parallels the major components of this study.

The Montfort, Martin and Frederickson Study⁹

In this study, Montfort, Martin and Frederickson explored relationships between choice of college major and patterns of brain hemispheric dominance in college students from two Oklahoma universities. The following research question was asked: Can students who have chosen specific majors be differentiated significantly by their scores on the *Human Processing Information Survey*, which determines processing preferences associated with brain dominance? At the same time, biographical data were gathered to analyze additional relationships with brain dominance.

The sample was made up of 1023 students from Central State University in Edmond, Oklahoma and the University of Oklahoma, Norman and representing six colleges: Education, Liberal Arts, Business Administration, Mathematics and Science, Architecture and Special Arts and Sciences. Of the 1023 students, 608 were women and 406 were men. Six individuals did not report gender. Selection criteria stipulated that subjects must have had upperclassmen and/or graduate status and had declared a major matching the majors included in the study.

The *Human Processing Information Survey*, designed to infer left, right or integrated brain preference and consisting of 40 forced-choice items, was

⁹Mary Montfort, Samuel A. Martin and William Frederickson, 163-172.

administered along with a self-report questionnaire containing items on biographical events, medical history and handedness. Both instruments were administered by the same examiner.

The data were analyzed in a variety of ways. First, each subject's responses were scored; the resulting scores were categorized as either left, right or integrated brain preference. These scores were then combined with five colleges to form a 3 x 5 within- and between- groups factorial design and analyzed using a MANOVA procedure. Choice of school was used as the dependent measure. Mean scores for college major indicated, in general, integrated brain processing. Students in Liberal Arts, however, scored higher in right-brain processing while students in Business Administration scored higher in left-brain processing. Students enrolled in the college of Education and Special Arts and the college of Sciences were found to process information using both right and left hemispheres more or less evenly. Mathematics and Science majors showed a slight preference for left brain processing.

A second analysis was undertaken on the three areas of brain dominance and the 22 departments within the colleges. These items were combined in a 3 x 22 within- and between-groups factorial design for college department. The analysis of scores from students enrolled in Departments of Advertising, Art, English, Journalism, Music, Oral Communications and Interior Design indicated a significant preference ($F_{8,1938} = 15.81$) for right brain processing at the $p < .001$ level. Students enrolled in Architecture were also found to show a preference for right brain processing. The researchers noted that, with the exception of majors in Art, Journalism, Interior Design and Architecture, results indicated that integrated processing dominated the remaining departments.

A third analysis using a chi-square combining students determined to be

right or left brain dominant with classification for college was found to be significant ($\chi^2=96.75, p <.001$.) This analysis, with results similar to the first analysis, provided validity for those findings.

The researchers also analyzed various biographic information and found “hand dominance, reported difficulty with mathematics, incidence of ear infections, hyperactivity, and presence of allergies were correlated with scores categorized for brain dominance.”¹⁰ The self-report questionnaire used to gather this information was not included in the published study.

Germane to this study, the researchers concluded that students who tested right brain dominant tended to choose compatible majors such as Art, Interior Design and Architecture--majors requiring “spatial/temporal visualization.”¹¹ When colleges and departments were analyzed with inferred brain dominance scores, the right brain mean score for Art majors was found to be 19.8, with a standard deviation of 9.0. The right brain mean score for Interior Design majors was 15.4 ($SD = 4.4$), and for Architecture majors, 15.3 ($SD = 4.4$.) The difference between the mean scores for Art majors and those of Interior Design and Architecture majors, both majors that are based on three-dimensional concepts, may indicate that, within the study of art, students have degrees of right-brainedness. The researchers further concluded that students’ aptitudes and interests appear to be genetically influenced and that the traditional emphasis on left-brained educational approaches require many students to work and learn in a non-preferred style of learning.

The Monfort, Martin and Frederickson study differs from the current study in several ways. The Montfort, et al. study gathered brain dominance data on

¹⁰ *ibid.*, 170.

¹¹ *ibid.*, 171.

students enrolled in various colleges and departments using the *Human Information Processing Survey*; the present study conducts brain dominance research using the *Hemispheric Mode Indicator* on students enrolled in post Art I level art courses at the high school level. In addition, while the Monfort, et al. study sought to determine whether or not choice of college major could be related to brain dominance, the present study seeks to determine whether or not preferences within the study of art, specifically between two and three-dimensional preferences, are related to brain dominance.

The Locher Study¹²

This study investigated the influence of vision on haptic perception to determine whether or not visual and haptic encoding systems are separate perceptual operations. The research questions asked were as follows: (1) To what extent does haptic perception rely on visual perception? (2) Does vision dominate touch? and (3) Are encoding processes and memory representations for the haptic and visual systems linked or are there processes which are modality-specific for haptic perception?

The sample consisted of fifteen right-hand dominant undergraduates who volunteered to be subjects for the study. No information is included in the published article as to the school in which the students were enrolled or the major they had declared. Subjects were reported as having had no special tactile abilities such as sewing or playing musical instruments. The researchers felt that such abilities might have created a confounding variable during the haptic testing.

¹² Paul Locher, 59-74.

Subjects were tested individually and instructed to assemble four different gray-colored, 6-piece jigsaw puzzles, under varying conditions. All subjects participated in the control condition first, which required the subjects to assemble the puzzle, with eyes opened, using any strategy they chose. The visual and haptic responses used by each subject was recorded on videotape. Then each subject assembled the three remaining puzzles in random order under the following conditions: (1) *Picture condition*--Subjects were asked to assemble a second puzzle while viewing a line drawing of the completed puzzle. The researcher placed a screen between the drawing and the subjects' hands and the puzzle pieces, preventing the subject from looking at the pieces or the assembly process. (2) *Imaged condition*--Subjects were asked to study a third, assembled puzzle for one minute. They were then asked to assemble the puzzle from memory and again prevented from seeing the pieces or the assembly process. (3) *Haptic condition*--Subjects were asked to assemble a fourth puzzle using their sense of touch alone and were again prevented from seeing the pieces of the puzzle or the assembly process. After each puzzle session, subjects were interviewed by the researcher as to how he or she completed the task.

Times for assembly and haptic scanning strategies, constituting the dependent measures, were recorded for each subject under each of the testing conditions. Assembly times were averaged and reported with corresponding standard deviations given. These averages were analyzed using a within-subjects analysis of variance and were found to be significantly different from each other ($F_{3,42} = 77.62, p < .01$).

Scanning strategies, assessed by the researcher after reviewing the videotapes and described in detail in the published article, were determined to

be the same for all subjects during the control and picture conditions. Strategies employed during the Imaged condition were reported as "very similar for all but one subject."¹³ Strategies for the haptic condition were reported as very similar.

The significant differences in solving times for each of the assembly conditions led the researcher to conclude that each condition necessitated a different form of perceptual response. The similarities in subject scanning strategies during each of the imposed conditions led the researcher to suggest that the study indicated that perception of visual and haptic information is brain-based, stating that "a cognitive component is involved during visual-tactual form perception."¹⁴ The researcher further concluded that when haptic perception is used independently from visual perception, subjects can successfully complete tasks using only tactile information, supporting the hypothesis that processes do exist that are modality-specific to haptic perception.

The study has several flaws when viewed in the light of current research on perception. Gender has been reported as making a difference when examining tactile skills; in general, it has been reported that males are better at haptic/tactile activities than are females.¹⁵ The study fails to report the genders of its subjects. With a total sample of fifteen volunteers, it is highly possible that a disproportionate number of males or females may have skewed the results. Data pertaining to scanning strategies were gathered by observation and through interviews, however, the researcher did not report whether he conducted the research himself or used trained observers and interviewers.

¹³ *ibid*, 66.

¹⁴ *ibid*, 73.

¹⁵ Nora Newcombe, 226.

This leaves the study suspect to the threat of bias by the researcher.

Although both this study and the current study examine differences between spatial-perceptual modalities, the forced performance design of the Locher study, determining skill rather than preference and conducted in a laboratory setting, coupled with the videotaped observations and oral interviews, may have created conditions that made the subjects self-conscious and thus may have affected the accuracy of the responses.

The current study employs a teacher-made self-report survey to determine preference rather than skill. The survey instrument included in the current study is designed to elicit accurate responses by means of the self-report format. Administered in the subjects' regular classroom settings, the study seeks to lessen the possible confounding effects of artificial experimental conditions.

The Leonard, Foxcroft and Kroukamp Study¹⁶

This correlational study assessed scores on five perceptual and motor ability tests to determine whether or not tests for visual perception, visual-motor integration and motor ability measure different skills. The researchers sought to support the premise that visual perception and motor development are associated with separate spatial abilities.

The sample was made up of 16 boys and 24 girls ranging in age from 6 years to 6 years, 9 months and was taken from kindergarten classes in the Port Elizabeth area in South Africa. Both private and government schools were included in the study. The researchers reported that the sample was made up

¹⁶ Penelope Leonard, Cheryl Foxcroft and Tertia Kroukamp, 423-426.

of "fairly equal numbers of upper-, middle- and lower-class children"¹⁷ and were classified as having normal central nervous system development based on their scores on a biographical questionnaire, a neurological checklist and the *Quick Neurological Screening Test*.

Two tests measuring visual-motor integration were administered along with two tests that measured motor ability. The visual-motor integration tests given were as follows: (1) the *Developmental Test of Visual Motor Integration*, reported in the study as having test-retest reliability coefficients ranging from .63 to .92; and (2) the *Copying Test* from the *Junior South African Individual Scales*, which has Kuder-Richardson Formula 8 reliability coefficients ranging from .84 to .91. As stated in the study, "both tests consist of a number of geometric forms, arranged in order of increasing difficulty, that are copied by the child."¹⁸ The two tests for motor ability were taken from the *Reitan-Indiana Neuropsychological Test Battery*. These two tests were: (1) the *Finger Tapping Test*, which uses an electrically operated tapping device and measures fine motor functions, reliability .76; and the *Marching Test*, reliability .68. methodology for this test was not given, however, it was reported that the test measures gross skeletal motor function.

The scores from the four tests outlined above constituted the quantifiable variables that were correlated to the results of a fifth test that was administered, the *Motor-free Visual Perception Test*. This test, consisting of multiple choice items, was used as the non-motor measure of visual-perceptual ability and, according to the study, has a test-retest reliability of .81 and split-half reliability of .88. While the tests for visual-motor integration and motor ability required

¹⁷ *ibid.*, 423.

¹⁸ *ibid.*, 424.

either copying line drawings or fine and gross physical movement, the extent of physicality involved in the *Motor-free Visual Perceptual Test* was that subjects were required to point to the answer of his or her choice. The researchers reported that all tests were administered by two experienced testers.

The Pearson r was used to correlate the scores on the motor-free test and scores from the four visual-motor and motor ability tests. For each test, the mean and standard deviation were given. As reported by the researchers, a significant correlation ($r = .36$, with a coefficient of determination (r^2) indicating common variance was 13% at the $p < .05$ level) was found between scores on the motor-free test and the visual-motor integration test. Also found to be significant was the correlation of scores on the motor-free test and *Copying Test* ($r = .54$, with a coefficient of determination (r^2) indicating common variance was .29% at the $p < .001$ level.) A correlation between scores from the *Finger Tapping Test* and the *Marching Test* with those from the motor-free test showed no relationships.

The researchers interpreted the “small, but significant associations”¹⁹ found between the motor-free test and the two visual-motor integration tests as indicating that the motor-free test does measure a small component measured by the visual-motor integration tests. However, the study also reported that the motor-free measure showed a significant amount of unique variance (87% and 71%, respectively) which the researchers felt supported their hypothesis that the tests measured separate abilities, even though some overlap occurred. In addition, the lack of correlation between the motor-free test and the two tests for motor ability was interpreted as further supporting evidence that visual perception and motor skills are separate abilities.

¹⁹ *ibid.*, 425.

These conclusions support the premise within the present study that spatial perception is a separate function from those of manipulo-motor abilities. A further similarity between the Leonard, et al. study and the current study is that both attempt to determine differences in spatial perceptual processes through a comparison of measures, although the current study also asks whether or not brain dominance can be considered a factor.

The current study differs from the Leonard, et al. study in that preference rather than performance is examined. Additional differences lie between the ages and number of subjects in each study, 40 kindergarten students for the Leonard, et al. study and 95 high school students for the current study and between the spatial-specific criterion measure employed--the motor-free test, used in the Leonard, et al. study, which measured perceptual ability and the teacher-made survey used in the current study, which measures perceptual preferences while creating works of art.

CHAPTER THREE

DESIGN OF THE STUDY

Sample

Subjects for this study were drawn from a mid-sized, rural, regional high school located in Cumberland County, New Jersey. Cumberland County is a low to middle class socioeconomic area. Although funding for school programs is derived primarily through state aid, the high school's cost per pupil falls below the state average. Of the school's total enrollment of 1236 during the 1994-95 school year, 64.9% were white, 28.3% were black, 2.8% were Hispanic, 2.5% were Asian and 1.5% were native American.

Eighty-five study participants, representing the total population of tenth, eleventh and twelfth grade students currently enrolled in post-introductory, Art I level art courses were cluster sampled. Of these, 35 (10 males, 25 females) were enrolled in Pottery/Crafts, 11 were enrolled in Commercial Art/Basic Drawing (8 males, 3 females), 9 were enrolled in Studio Art (2 males, 7 females), 13 were enrolled in Puppetry/3D Art (3 males, 10 females), and 37 were enrolled in Art II (20 males and 17 females). Adding the enrollment figures yields a total of ninety-five, however, ten students were enrolled in two or more classes at the post Art I level and were counted once then omitted from subsequent class tallies. Of the eighty-five students, 17.5% were identified as perceptually impaired and 4.2% were identified as special education students.

Instruments

For this study, two measuring instruments were administered. They were as follows: (1) a teacher-made survey (see Appendix) to determine student preference for either two or three dimensional art projects, and (2) the *Hemispheric Mode Indicator (HMI)*, published by Excel, Inc., which measures degree of brain dominance.

The teacher-made survey, criterion one for this study, was designed as a likert scale with the following categories: *strongly agree, agree, no difference, disagree, strongly disagree*. Twenty statements, which were based on ten concepts, were developed to yield information regarding students' preferences between working in two or three-dimensions.

Survey items were modelled after similar test items found in the related-literature research and focused on visual-perceptual and spatial-perceptual skills. For example, the survey item "When I buy a kit that needs to be assembled, I prefer to try and fit the pieces together rather than look at the diagrams," was constructed to reflect a similar spatial test by Corballis¹, in which a subject is asked to physically manipulate flat shapes. This survey item identified a spatial-perceptual skill and indicated a preference for working in three-dimensions. Mental rotation tests were used to pattern the survey item "When I want to draw a box, to show it in correct perspective, it would be easier for me to draw from memory than study a real box." This survey item identified a visual-perceptual skill and indicated a preference for working in two-dimensions. Three preference categories were established as follows: *preference for two-dimensional projects, preference for three-dimensional*

¹ Michael C. Corballis, 176-177.

projects and little to no preference.

For the purpose of this study, two-dimensional projects were defined as those involving media worked on a flat surface, including drawing, painting and graphic design. Three-dimensional projects were defined as those involving media that must be manipulated in space, such as media found in the study of puppetry, sculpture, crafts and pottery. While most of the survey items focused on art activities, several items addressed more general spatial preferences, such as preference for assembling a kit or giving directions. These items were designed to parallel tests found in studies on spatial ability, and were included to provide insight into content validity through comparison of those answers with answers on the art-related spatial survey items.

The statements in the survey were designed as pairs in which one statement presented the two-dimensional preference first, the other presented the three-dimensional preference first. For example, in the statement "When I have an art project to do for another class, I would rather create a model than make a poster," the preference for the third dimension was stated first. The parallel statement was "If I were an architect, I would rather be involved with drawing the blueprints than building the scale model." This statement, which mirrored the model building versus drawing format of the first example, listed the preference for two-dimensionality first.

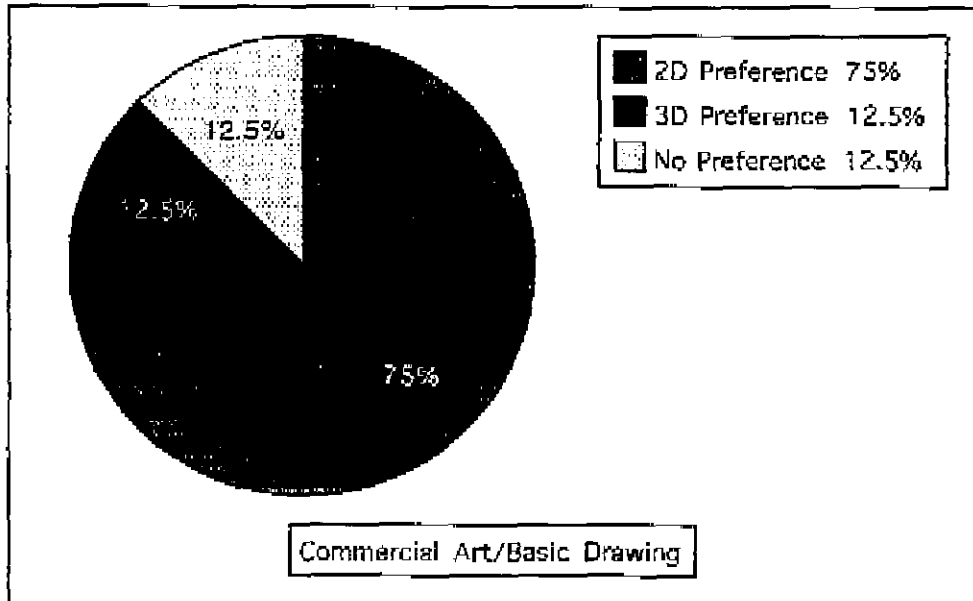
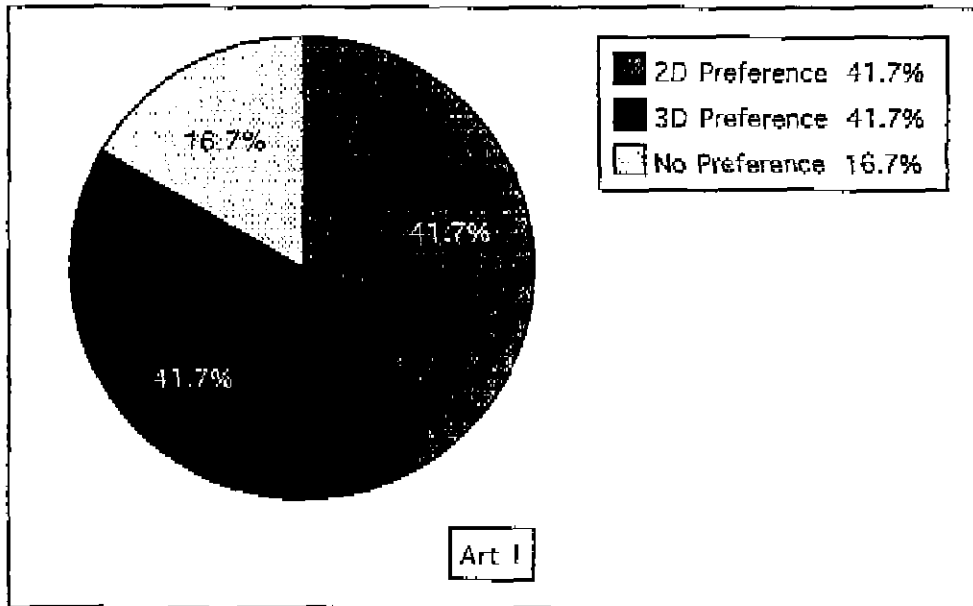
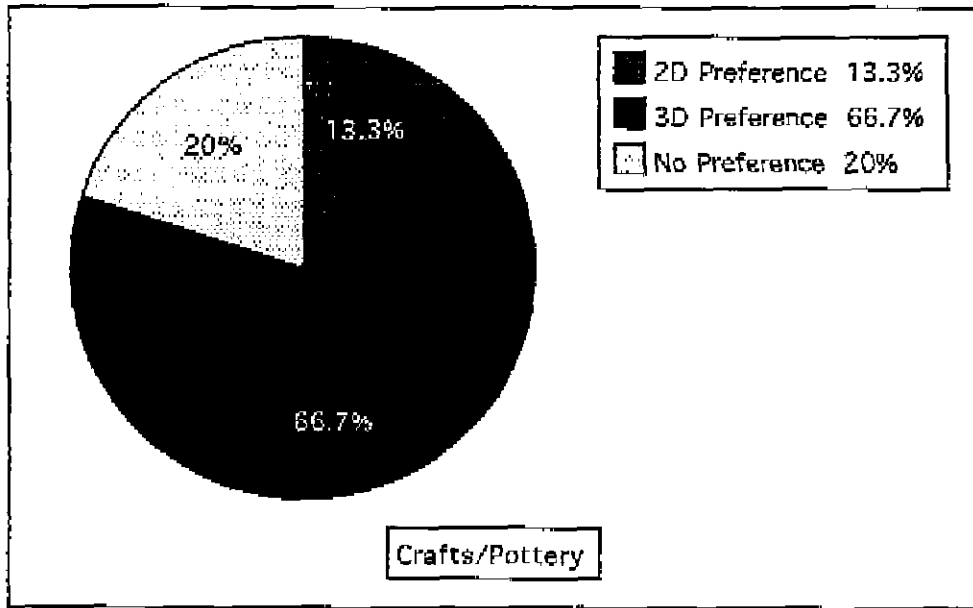
The ranking items: *strongly agree, agree, no difference, disagree and strongly disagree*, were assigned the numerical values of five through one, respectively. The survey was scored using a tally sheet (see Appendix C) which listed the two-dimensional statements in one column and three-dimensional statements in another column. Individual columns were totalled yielding two scores. Two-dimensional scores were assigned a negative value,

three-dimensional scores were assigned a positive value. Single scores were then calculated by computing the differences in scores for each subject, resulting in either a negative number indicating *two-dimensional preference* or a positive number indicating *three-dimensional preference*. Scores that resulted in -1, 0, and +1 values were placed in the category *little or no preference*.

The survey was piloted with 35 students randomly selected from three specific courses. Twelve students were enrolled in Art I, an introductory course in which a variety of two and three-dimensional projects were presented. Eight students were drawn from Commercial Art/Basic Drawing, a two-dimensional media course, and fifteen students were surveyed from Crafts/Pottery, a three-dimensional media course. Analysis of the piloted data for the twenty survey items showed a reliability of 0.41; however, when two sets of statements were eliminated (statements 8 and 9, and statements 2 and 15), reliability was determined at 0.55 for the remaining sixteen survey items.

A case for content validity was established through careful examination of the data. As both Commercial Art/Basic Drawing and Crafts/Pottery were elective courses chosen by students after successful completion of Art I, it was reasonable to expect that most students at the post Art I level would have selected media specific courses that matched their preference for working in either two or three-dimensions. The pilot survey results, presented in Figure 1, indicated that most Commercial Art/Basic Drawing students surveyed preferred working in two-dimensions (75%) while most Crafts/Pottery students preferred working in three-dimensions (66.7%). Art I students were more evenly distributed in preference, as was expected. These results indicated that the survey measured what it was intended to measure.

Figure 1 - Dimensional Preference Survey Pilot Results



The other measuring instrument used in this study was the *HMI* which determined degree of brain dominance. The *HMI* comprises thirty-two items arranged in pairs allowing for responses to fall between two opposites. For example, item one asked the respondent to choose between *bases decisions on facts* and *bases decisions on feelings*. Responses were recorded as: *a lot* and *somewhat* on one side and *somewhat* and *a lot* on the other side, for a total of four possible responses. Results were tallied using the scoring sheet provided with the *HMI* and were reported numerically, on a continuum scale from negative numbers, indicating left brain preference; through zero and zero plus or minus two, indicating whole brain preference; and positive numbers, indicating right brain preference.

Excel reports that the *HMI* has internal consistency reliability of 0.72 and test-retest reliability of 0.77. Concurrent validity has been established. The *HMI* scores were used as criterion two in this study.

Method

The two instruments for the study were administered over the course of two days. The survey instrument was given on March 15, 1995 to each student enrolled in the classes listed for the sample. Five minutes were allowed for instructions explaining the survey; students then had as much time as was necessary to complete the survey. The *HMI* was administered on the following day, or, in the case in which a student was absent, the first day he or she returned. Seven minutes were allotted for instructions for the *HMI*. Students were then given the remainder of the class period to complete the test. After scoring, students were allowed to review the results of their individual tests and

received a fact sheet as to the significance of those results.

Reporting the Data

The data were organized into a 3 x 2 crossbreaks design (dimensional preference x brain hemisphere.) The data were then analyzed using a chi-square statistic to determine whether or not relationships exist between brain dominance and dimensional preference. To determine the strength of the association, Cramer's Phi coefficient was computed. Finally, the raw, uncategorized data for the left and right brain dominant subjects only were subjected to a Pearson-Product Moment Correlation analysis to further understand the relationships between hemisphericity and dimensional preference.

CHAPTER FOUR

RESULTS AND INTERPRETATIONS

Test of Independence

Table I represents the contingency table for the frequency of occurrence of brain dominance and spatial dimensionality preference. The chi-square statistic was significant at the $p < .05$ level. That is, brain dominance and spatial dimensionality preference can therefore be considered not independent.

TABLE I

THE CONTINGENCY TABLE FOR THE FREQUENCY OF OCCURRENCE OF BRAIN DOMINANCE AND SPATIAL DIMENSIONALITY PREFERENCE

Brain Dominance	Dimensional preference		
	(2D)	(No Preference)	(3D)
Left Brain	3	1	13
Right Brain	24	16	28

$$\chi^2 = 6.963 *$$

$$* p < .05$$

Strength of Association

The calculated value for Cramer's Phi coefficient was .29. This number indicates the degree of association on a scale from 0 - 1.00.

Relationships for Degree of Brain Dominance and Degree of Spatial Dimensionality Preference

The correlations between degree of brain dominance and degree of spatial dimensionality preference are reported in Table II. No statistically significant correlations were found.

TABLE II

CORRELATIONS BETWEEN DEGREE OF BRAIN DOMINANCE AND DEGREE OF SPATIAL DIMENSIONALITY PREFERENCE

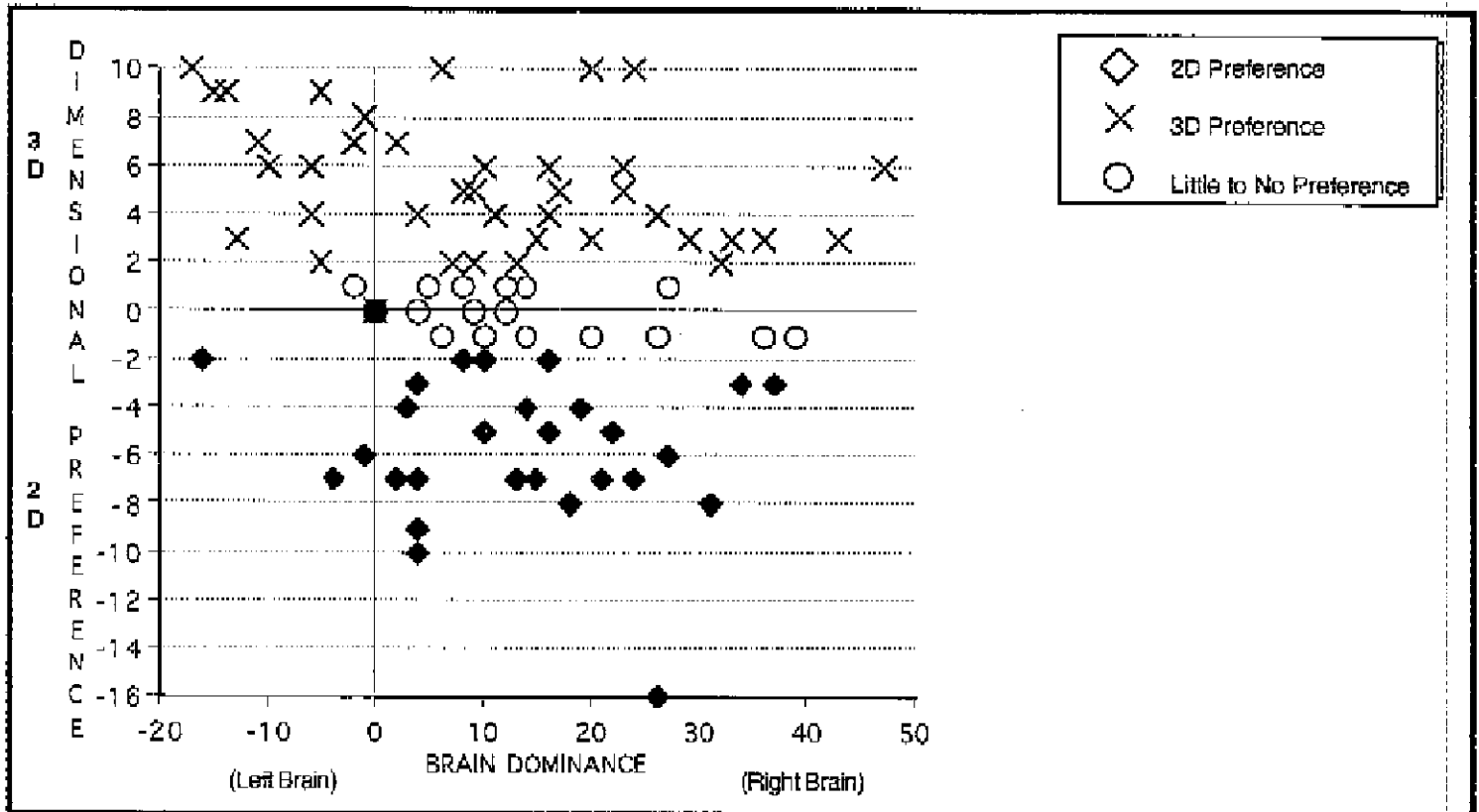
	<i>r</i>
Left Brain Dominance and Two-Dimensional Preference	-.929
Left Brain Dominance and Three-Dimensional Preference	-.263
Right Brain Dominance and Two-Dimensional Preference	-.043
Right Brain Dominance and Three-Dimensional Preference	-.079

Interpretations

The significant chi-square and its corresponding index of strength was most probably due to the left brain dominant subjects only. As shown in Figure II, 17 left-brain dominant subjects were found in the total population of eighty-five art students, making up approximately 20% of that population, of those 17, 13 or approximately 76% preferred working in three-dimensions, 3 or approximately 18% preferred working in two-dimensions and 1 or .06% showed

FIGURE II

SCATTERGRAM FOR DEGREE OF BRAIN DOMINANCE
AND DIMENSIONAL PREFERENCE



no dimensional preference.

Although the left-brain dominant population was small, the chi-square statistic was a valid measure because, in all cases, expected values exceeded 1.

As shown in Table II, the degree to which an individual is right or left brained does not correlate significantly with the degree of his or her preference for spatial dimensionality. However, examination of the data presented in Table I suggests that left-brain dominant subjects, as a whole, appear to prefer projects that are three-dimensional, involving manipulative and tactile skills over projects involving the translation of a three-dimensional reality into a flat, two-dimensional image. That is, left-brain dominant subjects prefer spatially concrete, hands-on experiences in producing art over more abstract applications as would be found in drawing and painting, where such subjects would be required to demonstrate skills involving perspective and shading with values.

Further examination of Table I reveals little association between right-brain dominance and dimensionality preference, thus suggesting that dimensionality preference is not a factor for right-brained subjects when creating works of art. That is, right-brain dominant subjects do not, as a whole, appear to prefer a specific dimensionality preference. In the current study, 24 or approximately 35% of the right-brain dominant subjects preferred working in two-dimensions, 28 or approximately 41% preferred working in three-dimensions and 16 or approximately 24% had no preference (see Figure II.)

CHAPTER FIVE

SUMMARY AND CONCLUSIONS

Purpose and Problem of the Study

The purposes of this study were to investigate relationships between hemisphericity and student preference for spatial-dimensionality in the production of art and to determine whether or not cognitive processes are different in students who prefer different spatial activities. Specifically, the problem of this study was to investigate the relationships between students' preference for two and three-dimensional art projects and their scores on the *Hemispheric Mode Indicator (HMI)* test.

Design and Analysis

The total population of eighty-five art students from a rural, regional New Jersey high school were included in this study. All students were enrolled in post introductory level art classes.

Scores from the teacher-made survey which determined spatial-dimensionality preference served as data for criterion measure one. Preferences were divided into three categories as follows: 1) two-dimensional preference, 2) three-dimensional preference and 3) little to no preference.

Serving as criterion measure two were the scores from the *Hemispheric*

Mode Indicator (HMI), published by Excell, Inc. The *HMI* was administered to determine, for each subject in the study, his or her degree of brain dominance, measured on a continuum scale from left brain through integrated to right brain. The *HMI* has internal consistency reliability of 0.72 and test-retest reliability of 0.77. Concurrent validity has been established.

To interpret the relationships between degree of hemisphericity and dimensional preference, data from the criterion measures were organized into a 3 x 2 crossbreaks design (dimensional preference x hemisphere.) A chi-square analysis was then computed to determine relationships. To determine the strength of the association, a Cramer's Phi coefficient was calculated. The Pearson r correlation was calculated on the raw, uncategorized data from criterion one (minus the data from the little to no preference category) and data from criterion measure two.

Results of the Study

A statistical significance of $\chi^2 = 6.963$ at the $p < .05$ level was found between hemisphericity and dimensional preference. The moderate strength in the association that can be interpreted from the Cramer's Phi was most probably due to the strength of the relationship between left brain dominance and dimensional preference. Little association between right brain dominance and dimensional preference was found. No statistical significance was found for correlations between degree of brain dominance and degree of hemisphericity.

Conclusions and Recommendations

Based on the findings of this study, brain dominance and spatial dimensionality preference can be considered not independent. Specifically, a strong relationship appears to exist between left brain dominance and dimensional preference, leading support to current brain dominance theories that maintain that 1) cognitive thought processes are different for left and right brained individuals and 2) that two and three-dimensional skills are separate spatial abilities which may, for certain individuals, reside in different parts of the brain.

Germane to the current study, although it appears that right brain dominant art students show no predominant dimensionality preference, left brain dominant students do. That is, left brain dominant students appear to prefer to work on three-dimensional projects rather than two-dimensional projects. Therefore, it is of particular importance for art teachers to include opportunities for students to work with three-dimensional media across all art curricula, not just in crafts or sculpture classes.

Furthermore, considering that left brain dominant students may often be in the minority in the art room (in this study, only 20% of the total population of art students were left brained), providing for three-dimensional experiences and experimentation may serve to validate the left brained student's preferred cognitive style. Additionally, the relationship between left brain dominance (associated with analytical and reasoning skills¹) and preference for working in three-dimensions may help to diminish the bias against crafts, traditionally viewed by art educators as a less intellectual pursuit. For, as stated in Chapter

¹Jane E. Cooke and Mildred Haibt, 10.

I, art teachers often value drawing and painting, abilities associated with visual perception, over more tactile and spatial approaches, which are seen as less intellectual pursuits.²

Less than one-third of the right brain dominant subjects were found to have no dimensionality preference, meaning that they worked equally comfortably in two or three-dimensional media. The remainder preferred to work in either two or three-dimensions, again suggesting that the incorporation of three-dimensional projects would allow more students to experience success and satisfaction when creating works of art.

Finally, the recognition that spatial-dimensionality skills, as are found in the study of art, are reflected in both left and right brain cognition may strengthen the position of art in education.

² Viktor Lowenfeld, 99.

APPENDIX

STUDENT ART SURVEY

Name _____

Class _____

DIRECTIONS: Please read the following statements and put a checkmark in the column that most accurately reflects your feelings about each statement.

1. **STRONGLY DISAGREE**
 2. **DISAGREE**
 3. **NO DIFFERENCE**
 4. **AGREE**
 5. **STRONGLY DISAGREE**

1. I prefer to sketch rather than create crafts.
2. It would be easier for me to sculpt a face out of clay than draw a face.
3. When I have an art project to do for another class, I would rather create a model than make a poster.
4. When planning a composition, it would be easier for me to cut out shapes from paper and move them around rather than work out the composition with pencil and paper.
5. When I buy a kit that needs to be assembled, I prefer to try to fit the pieces together rather than look at the diagrams.
6. I would rather take a course in Craft and Sculpture than a course in Drawing and Painting.
7. I solve problems in art better by sketching and drawing rather than by making models.
8. When I want to draw a box, to show it in correct perspective it would be easier for me to draw from memory than study a real box.
9. Color theory is easier for me to understand when I experiment by mixing paints rather than looking at a color wheel.
10. If I were an architect, I would rather be involved with drawing the blueprints than building the scale model.
11. I prefer to work with two-dimensional projects rather than three-dimensional projects.
12. When I play with maze games, I prefer flat mazes that are solved by tracing a path with a pencil rather than the kind in which a ball bearing is rolled through a three-dimensional maze.
13. When I put a zigsaw puzzle together, I usually consider the shape of each piece before I consider the picture on each piece.
14. In my art projects, I feel that I have a better sense of three-dimensional space rather than two-dimensional space.
15. I would prefer to design jewelry pieces rather than actually making the pieces.
16. When I examine an object, I prefer to be an observer, looking at the object rather than touching it.
17. When I am trying to figure out how an object works, I prefer to learn by studying the pictures in a manual rather than taking the object apart.
18. When I need to explain to someone how something works, I usually find myself explaining with hand gestures rather than drawing a diagram.
19. When I examine an object, I prefer to pick it up and turn it around in my hands to experience it from all angles rather than examine it by looking.
20. When I give a person street directions, I usually draw a map rather than use my hands to show left and right turns.

	1. STRONGLY DISAGREE	2. DISAGREE	3. NO DIFFERENCE	4. AGREE	5. STRONGLY DISAGREE

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