INFORMATION TO USERS

This reproduction was made from a copy of a document sent to us for microfilming. While the most advanced technology has been used to photograph and reproduce this document, the quality of the reproduction is heavily dependent upon the quality of the material submitted.

The following explanation of techniques is provided to help clarify markings or notations which may appear on this reproduction.

1. The sign or “target” for pages apparently lacking from the document photographed is “Missing Page(s)”. If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting through an image and duplicating adjacent pages to assure complete continuity.

2. When an image on the film is obliterated with a round black mark, it is an indication of either blurred copy because of movement during exposure, duplicate copy, or copyrighted materials that should not have been filmed. For blurred pages, a good image of the page can be found in the adjacent frame. If copyrighted materials were deleted, a target note will appear listing the pages in the adjacent frame.

3. When a map, drawing or chart, etc., is part of the material being photographed, a definite method of “sectioning” the material has been followed. It is customary to begin filming at the upper left hand corner of a large sheet and to continue from left to right in equal sections with small overlaps. If necessary, sectioning is continued again—beginning below the first row and continuing on until complete.

4. For illustrations that cannot be satisfactorily reproduced by xerographic means, photographic prints can be purchased at additional cost and inserted into your xerographic copy. These prints are available upon request from the Dissertations Customer Services Department.

5. Some pages in any document may have indistinct print. In all cases the best available copy has been filmed.
PLEASE NOTE:

In all cases this material has been filmed in the best possible way from the available copy. Problems encountered with this document have been identified here with a check mark √.

1. Glossy photographs or pages ______
2. Colored illustrations, paper or print ✓
3. Photographs with dark background ✓
4. Illustrations are poor copy ______
5. Pages with black marks, not original copy ______
6. Print shows through as there is text on both sides of page ______
7. Indistinct, broken or small print on several pages ✓
8. Print exceeds margin requirements ______
9. Tightly bound copy with print lost in spine ______
10. Computer printout pages with indistinct print ______
11. Page(s) __________ lacking when material received, and not available from school or author.
12. Page(s) __________ seem to be missing in numbering only as text follows.
13. Two pages numbered __________. Text follows.
14. Curling and wrinkled pages ______
15. Other__________________________________________________________________________

University
Microfilms
International
THE RELATIONSHIP OF PROSPECTIVE TEACHERS' NEURAL PROCESSING, COGNITIVE STYLE AND PERSONALITY TYPE TO CLASSROOM LEARNING AND TEACHING BEHAVIORS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in the Graduate School of The Ohio State University

By

Carol A. Lyons, B.S., M.A.
The Ohio State University

1982

Reading Committee:
Dr. Marlin Languis
Dr. C. Ray Williams
Dr. Philip Clark

Approved by:
Advisor:
Department of Early and Middle Childhood Education
DEDICATION

For my husband Fran and son Ken
without whose encouragement, patience, understanding
and love this dissertation would not have been possible.
ACKNOWLEDGEMENTS

Many individuals have given direction and support throughout the dissertation process. I am deeply indebted to my advisor, Dr. Marlin Languis, who continually offered assistance, expert guidance, and inspiration. As an academic mentor, he provided a climate which promoted personal and professional growth. As an educator, he had an open, inquisitive mind which allowed him to become a guide, resource person, and collaborator in the learning process.

I am also deeply indebted to Dr. C. Ray Williams, who has provided constant support and counsel throughout my Masters and Ph.D. programs of study. He provided learning situations which stimulated, facilitated, and fostered my growth as a teacher educator and researcher.

Special thanks is also due Dr. Philip Clark, who offered needed criticism and counsel. His enthusiasm and support for the project was encouraging.

I am deeply grateful to Dr. Paul Naour, who advised me throughout the EEG portion of the study. He wrote the original proposal which funded the project and developed the framework to follow it through. Without his assistance, the research project would never have been possible.

In addition, I would like to thank the following individuals who helped with the data collection and analysis. Cheryl Strayer,
James Cowen, Dr. Paul Naour, Dr. Marlin Languis, Dave Caverly, Barb Caverly, and my husband Fran Lyons. Special thanks is due my father, who constructed the response box for the EEG portion of the study.

I am most grateful to my parents, Rodger and Betty Mueller, and my mother-in-law, Mrs. Margarite Lyons, who encouraged my pursuits by offering spiritual and emotional support.

Finally, a very special thanks to the students in the learning style program of study, who made the project an enjoyable learning event for all of us and to Barbara Fincher, who typed the entire manuscript.
VITA

March 25, 1942

Born - Milwaukee, Wisconsin

1964

B.A., Elementary Education
Mercyhurst College
Erie, Pennsylvania

1964-1967

Teacher, Stadium Drive Elementary School, Boardman, Ohio

1967-1969

Teacher, Manitou Elementary School
Tacoma, Washington

1969-1971

Teacher, Franklin Elementary School
New Britain, Connecticut

1978-1979

M.A., The Ohio State University
Columbus, Ohio

1978-1982

Teaching Associate, Dept. of Early and Middle Childhood Education,
The Ohio State University,
Columbus, Ohio

FIELDS OF STUDY

Reading and Language Arts Education
Learning Processes
Teacher Education
Early and Middle Childhood Education

PUBLICATIONS

# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEDICATION</td>
<td>ii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>iii</td>
</tr>
<tr>
<td>VITA</td>
<td>v</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>viii</td>
</tr>
<tr>
<td>CHAPTER</td>
<td></td>
</tr>
<tr>
<td>I. THE PROBLEM</td>
<td>1</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Purpose of the Study</td>
<td>5</td>
</tr>
<tr>
<td>Rationale and Hypothesis</td>
<td>7</td>
</tr>
<tr>
<td>Proposed Learning Style Model</td>
<td>8</td>
</tr>
<tr>
<td>Definition of Terms</td>
<td>9</td>
</tr>
<tr>
<td>Objectives of the Study</td>
<td>11</td>
</tr>
<tr>
<td>Alternative Hypotheses</td>
<td>13</td>
</tr>
<tr>
<td>Assumptions</td>
<td>14</td>
</tr>
<tr>
<td>Limitations</td>
<td>14</td>
</tr>
<tr>
<td>The Sample</td>
<td>15</td>
</tr>
<tr>
<td>Description of the Study</td>
<td>15</td>
</tr>
<tr>
<td>Summary</td>
<td>20</td>
</tr>
<tr>
<td>II. LITERATURE REVIEW</td>
<td>22</td>
</tr>
<tr>
<td>Introduction</td>
<td>22</td>
</tr>
<tr>
<td>Quantitative Literature Review</td>
<td>22</td>
</tr>
<tr>
<td>Neural Processing</td>
<td>22</td>
</tr>
<tr>
<td>Gender Differences</td>
<td>32</td>
</tr>
<tr>
<td>Handedness</td>
<td>36</td>
</tr>
<tr>
<td>Cultural Differences</td>
<td>40</td>
</tr>
<tr>
<td>Occupation</td>
<td>41</td>
</tr>
<tr>
<td>Personality Theory (Jungian Typology)</td>
<td>47</td>
</tr>
<tr>
<td>Cognitive Style</td>
<td>64</td>
</tr>
<tr>
<td>Hemispheric Correlates and Cognitive Style</td>
<td>65</td>
</tr>
<tr>
<td>Personality Correlates and Cognitive Style</td>
<td>70</td>
</tr>
<tr>
<td>Qualitative Literature Review</td>
<td>74</td>
</tr>
<tr>
<td>vi</td>
<td></td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Comparison of the Means and Standard Deviations by Group</td>
<td>101</td>
</tr>
<tr>
<td>2. Intercorrelations by Sensing/Intuitive, Thinking/Feeling, and Total Group</td>
<td>102</td>
</tr>
<tr>
<td>3. GEFT, CFT, RFT Relationship to MBTI</td>
<td>111</td>
</tr>
<tr>
<td>4. EEG Relationship to MBTI</td>
<td>112</td>
</tr>
<tr>
<td>5. Subtasks of EEG Protocol - Overall Mean EEG Asymmetry for Individuals Identified as Dominant Sensing, Intuitive, Thinking, Feeling</td>
<td>114</td>
</tr>
<tr>
<td>6. EEG Task Performance - Mean % of Correct Responses for 20 Subjects</td>
<td>115</td>
</tr>
<tr>
<td>7. The Baseline Overall Mean Activation and Task Performance Overall Mean Activation for 20 Subjects</td>
<td>117</td>
</tr>
<tr>
<td>8. Baseline Mean Overall Activation in Relation to Mean Activation for Easy and More Difficult Spatial Tasks and Easy and More Difficult Analytic Tasks</td>
<td>118</td>
</tr>
<tr>
<td>9. Multiple Regression Analysis of Sensing/Intuitive Scale on MBTI and EEG, GEFT, RFT, CFT, QWT</td>
<td>121</td>
</tr>
<tr>
<td>10. Self Analysis Agreement with MBTI, 3 Cognitive Style Assessments, and EEG</td>
<td>124</td>
</tr>
<tr>
<td>11. Laterality Scale</td>
<td>139</td>
</tr>
<tr>
<td>12. Relationship Between Task Performance and Degree of Lateralization</td>
<td>141</td>
</tr>
</tbody>
</table>
CHAPTER I
THE PROBLEM

Introduction

The educational literature is replete with rhetoric petitioning teachers to individualize instruction to insure optimal learning environments for their students. Cronbach and Snow (1977) surveyed research on instruction over a twenty year period and concluded:

Instructional decisions must be based on a whole complex of student characteristics and teacher actions. There is no such thing as a homogeneous group of students or a specifiable "method" of instruction. Educational practice over the next decade or two - if not eternally - will have to make its adaptations informally and judiciously, not by an actuarial technology of cutting scores and regression equations. But with greater knowledge the adaptations can profitably be more radical than they have been in the past (p. vii).

The educator must continually devise and apply new instructional treatments or strategies hoping for improved results. Since learners differ, however, the search for the most appropriate instructional method should be supplemented by a search for ways to fit the instruction to each kind of learner. Several books have been written which offer teachers and curriculum planners a range of approaches for creating environments for effective learning (Joyce and Weil, 1980; Brophy and Good, 1974). According to Joyce and Weil (1980), "... strength in education resides in the intelligent use of this powerful
variety of approaches -- matching them to different goals and adapting them to the student's styles and characteristics" (p. xxiii). There is, however, a prerequisite to individualizing instruction. In order for teachers to intelligently use any information provided regarding teaching methodology, they must be aware of and comprehend the complexity of the learning process itself.

Since pre-service teachers are just beginning to develop a rationale for educational practices, a logical place to begin raising a level of awareness concerning individual differences in learning and teaching processes is with them.

A strong conviction motivated the design of this study. The writer believed that if pre-service teachers are sensitized to and grow in their understanding of individual differences, they will possess that prerequisite of becoming professional decision makers capable of competently determining the learning processes of students, developing instructional strategies to meet individual learning needs, and adapting their teaching style to accommodate those individual learning needs.

The writer believes that the most effective way to accomplish this goal was to have the preservice teachers begin to understand themselves as both learners and teachers. Arthur Combs (1965) strongly emphasized the development of the teacher's "self as instrument" in a teacher education program in order to facilitate the prospective teacher's understanding of their own learning and teaching style.
Therefore a three quarter teacher education program was developed and implemented (Autumn Quarter, 1981 through Spring Quarter, 1982) which offered prospective teachers an opportunity to become aware of their own perceptions, feelings, attitudes, and beliefs concerning the nature of learning and teaching, and most importantly perceptions about themselves as learners (their own learning processes). By providing pre-service teachers an opportunity to know, understand, and accept their own learning strengths, they would begin to develop a healthy respect for the uniqueness of others learning processes. This in turn would sensitize them to the individual learning processes of their classmates and the pupils they would work with during the field participation component taken in conjunction with their methods courses.

The vehicle by which these prospective teachers began to develop insights concerning their own learning processes was a learning style model which juxtaposed neural processing, cognitive style (field dependent and field independent), and personality components (Appendix A). This model was not constructed, but developed during several years of reading and reflecting on the various learning style dimensions perceived in students. Three observable and distinct constructs emerged as integral components of an individual's learning style: an underlying personality dimension, a more identifiable cognitive style dimension (field dependent/field independent) and a neural processing dimension.
Pilot Study

In order to test that hypothesis, a pilot study was conducted Spring Quarter, 1981 in which ninety-two cooperating teachers and ninety-two student teachers were asked to respond to a two item questionnaire which stated: Describe as fully as possible how you learn best. Describe as fully as possible how you teach best (Appendix B).

A teaching style component was incorporated into the questionnaire because the writer believed that a teacher's teaching style was a substrate of his/her learning style. Teachers teach the way they "think" students learn best and their assumptions concerning how students learn best are rooted in their own learning style.

In order to determine if the three constructs emerged and were consistently related (the rationale for the hypothesized relationship will be established later in this chapter), coding categories were developed prior to the data collection. Specific words and phrases which could be characterized as personality, neural processing, and cognitive style dimensions were identified and classified according to established cognitive information processing dichotomies (Appendix C). A reliable and valid theory based on empirical evidence (neural functioning, Bogen, 1969; cognitive style, Witkin, 1962; and personality type, Jung, 1923) was used to develop the coding categories. Each category served a purpose and delineated a meaningful dimension of the variables under study. These coding categories were evaluated by two knowledgeable colleagues.
Words or phrases from the written protocols were then identified and matched with the appropriate number representing the established dichotomies to determine if the individuals preferred right or left information processing modalities. Congruency between preferred learning style and teaching style was determined by calculating the percentage of responses for each modality.

The results of this pilot study confirmed the hypotheses. With a rate of return of 51%; 72% respondents' self-report learning styles were congruent with their self-report teaching styles, 22% of the respondents self-report learning styles were moderately congruent with their teaching style, and 5% reported learning styles were not congruent with their teaching styles.

This preliminary study supported the writer's contention that the three constructs investigated were valid indicators of an individual's preferred learning process. By having naive individuals respond to an open-ended questionnaire concerning how they preferred to learn and teach and then finding that reference was made to personality, neural processing and cognitive style dichotomies, the writer felt a stable model had been developed.

Purpose of the Study

For several years scholars in a wide variety of fields have been exploring how individuals learn. Research in brain functioning provides a basis for understanding the development of human cognition; the internal processing involved when individuals organize, encode, and store information (Bogen, 1969). Research in cognitive style
provides a basis for understanding how individuals approach learning encompassing perceptual and intellectual activities (Witkin, 1962). Personality theory suggests that much apparently random variation in human behavior is actually quite orderly and consistent, being due to certain basic differences in the way individuals prefer to use perception and judgment (Jung, 1923). It conceptualizes the learning process in such a way that differences in individual learning styles can be identified (Myers, 1980).

A number of studies have explored hemispheric correlates of an individual's cognitive style (DeRenzi and Spinnler, 1966; Kimura, 1963; Berlin and Languis, 1981). These studies have shown that field dependence and visuo-spatial task performance are related to functioning of the simultaneous hemisphere, which is usually the right hemisphere (Das, Kirby, Jarmen, 1979).

Currently studies are being conducted which explore the relationship between individuals cognitive style and personality type (Novak, 1982) and hemispheric functioning and personality type (Newman, 1981).

The primary purpose of this present study is to explore the relationship between the three variables identified: neural functioning, cognitive style and personality. A secondary purpose of this study is to document how subjects who have been given the opportunity to learn about learning processes and to investigate and understand their own learning processes, attempt to translate that information into more appropriate learning and teaching behaviors.
Rationale and Hypothesis

The rationale for the study was based upon the following propositions drawn from hemispheric, cognitive style and personality theory. (1) Individuals have the capacity to engage in and employ two modes of processing experiences on a continuum which may be characterized as sequential-simultaneous, analytic-holistic, symbolic-spatial. (2) Individuals differ in forms of cognitive functioning - the articulated-global dimension which runs through the perceptual and intellectual domains, as well as domains commonly conceived of as "personality" - social behavior and body concept. (3) As a result of heredity, particular past life experiences, and the demands of the present environment, individuals develop learning styles based on basic differences in the way they prefer to perceive and process (judge) what has been perceived.

It is reasonable to assume that individuals have a characteristic hemispheric mode of processing information, a preferred mode of perceiving information and experience (i.e., field dependence/field independence) and a relative preference and expertise in regard to perception and judgment. This leads to the general hypothesis that there is a relationship between neural functioning dichotomies, cognitive style dichotomies, and personality polarities.

Proposed Learning Style Model

The proposed learning style model (Appendix A) suggests the hypothesized relationship between these three variables. The basic personality differences developed by Jung (1923) and interpreted by
Myers (1962) are the core of the model. Isabel Briggs Myers (1980) wrote:

The theory is that much seemingly chance variation in human behavior is not due to chance; it is in fact the logical result of a few basic, observable differences in mental functioning. These basic differences concern the way people prefer to use their minds, specifically the way they perceive and the way they make judgments. Perceiving is here understood to include the processes of becoming aware of things, people, occurrences, and ideas. Judging includes the processes of coming to conclusions about what has been perceived (p. 1).

The proposed model incorporates these basic personality differences and places them on a continuum represented by intersecting vertical (how individuals perceive) and horizontal (how individuals process-judge) lines. The Myers-Briggs Type Indicator (MBTI) contains separate indices for determining each of the four basic preferences which, according to the theory, structure the individual's personality. Of the four scales on the indicator only two will be used in this study: sensing-intuitive and feeling-thinking.

<table>
<thead>
<tr>
<th>Index</th>
<th>Preference as between</th>
<th>Affects individual's choice as to</th>
</tr>
</thead>
<tbody>
<tr>
<td>SN (MBTI)</td>
<td>Sensing or Intuition</td>
<td>Which of these two kinds of perception to rely on</td>
</tr>
<tr>
<td>TF (MBTI)</td>
<td>Thinking or Feeling</td>
<td>Which of these two kinds of judgment to rely on</td>
</tr>
</tbody>
</table>

The jagged line in the proposed model distinguishes the right hemispheric mode of processing information, which relates to field dependence from the left hemispheric mode of processing information, which relates to field independence. Studies employing perceptual measures of field dependence/independence (i.e., embedded figures or hidden figures, and the Rod and Frame Test) have been consistently
related to functioning of the right hemisphere. Support for this relationship is found in research using subjects with unilateral brain damage (DeRenzi and Spinnler, 1966; Kimura, 1963; Pizzamiglio and Carli, 1974).

The double line completes the model which now forms eight cells, each of which contains a predominant mode of processing information, a preferred cognitive style (i.e., field dependence/field independence), and a relative preference and expertise in regard to perception and judgment. These eight cells converge to form four basic personality types: Sensing/Thinking; Intuition/Thinking; Intuition/Feeling; and Sensing/Feeling.

Definition of Terms (based on Jung's functions of consciousness)

Sensing (S) personality type - Individuals who rely primarily on sensing for purposes of perception, centering their attention upon the concrete situation. Whatever comes directly from the senses is part of the sensing types' own experience and is therefore trustworthy. What comes from other people indirectly through the spoken or written word is less trustworthy. Words are merely symbols that have to be translated into reality before they mean anything, and therefore they carry less conviction than experience. The sensing individuals' native language is the reality spoken by the senses (Myers, 1980).

Intuitive (N) personality type - Individuals who rely primarily on intuition for purposes of perception. The intuitive's native language is the word, the metaphor, the symbol, spoken by the unconscious. Their greatest gifts come directly from their intuition and
are manifested on the conscious level through insight into relationships of ideas and meaning of symbols (Myers, 1980).

Thinking (T) personality type - Individuals who approach decisions (judge) through impersonal analysis, because what they trust is thinking, with its step-by-step logical process of reasoning from cause to effect, from premise to conclusion (Myers, 1980).

Feeling (F) personality type - Individuals who approach decisions (judge) with personal warmth, because they trust feeling, with its valuations in terms of how much things matter to themselves and others (Myers, 1980).

Dominant Process - The tendency for an individual to prefer one process (perception or judgment) to the point where it dominates and unifies one's life (Myers, 1980).

Field Dependence - The cognitive tendency to submit passively to influence of the prevailing background and the inability to keep an item separate from its surroundings (Witkin, 1962). The individual with a more field-dependent way of perceiving information tends to experience his surroundings in a relatively global fashion, passively conforming to the influence of the prevailing field or context.

Field Independence - The cognitive tendency to differentiate objects from their backgrounds (Witkin, 1962). The individual with a more field-independent way of perceiving information tends to experience his surroundings analytically, with objects as discrete from their backgrounds.

Neural Functioning - Right or left hemisphere activation as measured by R/L alpha-beta activation during one minute task
performance. To measure this asymmetry in amplitude of alpha/beta between the two hemispheres, a laterality score was calculated from the individual hemisphere scores.

\[
\text{Laterality} = \frac{\text{alpha (8-12 Hz)}}{\text{beta (12-16 Hz + 16-20 Hz + 20-24 Hz)}}
\]

Laterality = \( \frac{RH}{LH} \)

A laterality score > 1.00 indicates greater right hemisphere activation. A laterality score < 1.00 indicates greater left hemisphere activation.

Objectives of the Study

This study has a quantitative and qualitative component. The first purpose of the study (quantitative component) is to investigate the relationship between neural functioning dichotomies, cognitive style dichotomies, and personality polarities. The following research hypotheses were formulated for the first objective:

1. There is a significant (\( \leq .05 \)) correlation between the functioning of the right hemisphere and field dependence and the functioning of the left hemisphere and field independence.

2. There is a significant (\( \leq .05 \)) correlation between a dominant sensing personality type and field dependence and a dominant intuitive personality type and field independence as measured by the Rod-and-Frame Test (RFT), Group Embedded Figures Test (GEFT) and Concealed Figures Test (CFT).
3. There is a significant (< .05) correlation between a dominant thinking personality type and field independence and a dominant feeling personality type and field dependence as measured by the Rod-and-Frame (RFT), Group Embedded Figures Test (GEFT) and Concealed Figures Test (CFT).

4. There is a significant (< .05) correlation between a dominant sensing personality type and right hemisphere activation and a dominant intuitive personality type and left hemisphere activation as measured by R/L alpha/beta activation across tasks determined by EEG.

5. There is a significant (< .05) correlation between a dominant thinking personality type and left hemisphere activation and a dominant feeling personality type and right hemisphere activation as measured by R/L alpha/beta activation across tasks determined by EEG.

The second purpose of this study (qualitative component) is to document how subjects who have been given the opportunity to learn about learning processes and to investigate and understand their own learning processes, attempt to translate that information into more appropriate learning and teaching behaviors. The following research hypotheses were formulated for this second objective:

1. Individuals provided information concerning their own learning processes (personality, neural processing, and cognitive style) will be better able to determine their preferred way to learn.

2. Individuals provided information concerning their own learning
processes will be better able to determine how their learning style affects their teaching style.

3. Individuals provided information concerning their own learning processes will be better able to understand the learning processes of others.

4. Individuals provided information concerning their own learning processes will be better able to develop processing strategies to more effectively learn something (whether it be in the academic, athletic and/or arts, etc., field).

5. Individuals provided information concerning their own learning processes will be better able to develop language arts, reading, math, science, social studies, etc., programs to meet the learning needs of children, thus stretching into using and developing teaching strategies that accommodate different learning needs.

**Alternative Hypotheses**

The major hypotheses for this study suggests: 1) There is a significant (< .05) correlation between a dominant sensing personality type and/or a dominant feeling personality type; field dependent cognitive style; and right hemisphere strategies for processing experiences.

2) There is a significant (< .05) correlation between a dominant intuitive personality type and/or a dominant thinking personality type; field independent cognitive style; and left hemisphere strategies for processing experiences. There is, however, an extraneous variable which may be related to this hypothesized relationship and may account for some of the variability - subject's intelligence.
Data associated with this extraneous variable will be collected to determine if the subject's I.Q. is directly related to his personality type, cognitive style, and/or neural processing. The Quick Word Test will determine the subject's I.Q.

Assumptions

1. There are three substrates of an individual's learning process: neural functioning, cognitive style and personality variables.

2. The instruments selected to measure each of these substrates are the most valid and reliable measures used today.

3. The statistical procedures employed are appropriate for this data collection and the analysis desired.

4. The subjects possessed and exhibited an appropriate degree of honesty and openness in responding and recording their learning processes.

5. The subjects possessed the ability and willingness to adequately follow written and oral directions necessary to complete the activities in the study.

Limitations

1. The population to which the results of this study can be generalized is limited by the size and make-up of the sample.

2. Subjects were not selected at random but on the basis of their willingness to participate in the study.

3. Subjects were female elementary education majors.
The Sample

Eighteen female right-handed adults and two female left-handed adults enrolled in a three quarter learning style block at the Ohio State University volunteered for this study. The writer/researcher served as the strand coordinator, classroom teacher for three quarters, and student teaching supervisor for the senior elementary education majors enrolled in this learning style strand.

Description of the Study - Quantitative Component

In order to investigate the relationship between neural functioning dichotomies, cognitive style dichotomies, and personality polarities (purpose one), an open-ended self-report questionnaire, a paper and pencil personality instrument, three cognitive style paper and pencil instruments, psychometric tests of left and right hemisphere performance, and EEG studies to determine levels of use laterality were administered. The data was collected during the first three quarters of the study in the following sequence.

During the first quarter, the same open-ended self-report questionnaire administered to the ninety-two cooperating teachers and ninety-two student teachers in the pilot study, was administered to obtain data from the subjects concerning their preferred learning style before any information was provided concerning learning processes. The Myers-Briggs Type Indicator was also administered. This paper and pencil instrument determined the personality dimension of the proposed learning style model.

During the second quarter, the Group Embedded Figures Test (GEFT - Witkin et. al., 1971) and the Concealed Figures Test (CFT -
Thurstone and Jeffrey, 1965) were administered to determine how the subjects approach learning encompassing perceptual and intellectual activities. Flexibility of closure appears to be related to the cognitive style called "field independence." These two psychometric cognitive tests were selected as measures of field dependence and field independence. The portable Rod and Frame Test (RFT), developed by Oltman (1968) was also used to measure field dependence and field independence. A nonverbal administration of the test was implemented because right hemisphere processing appears to take place only during nonverbal administration of the test for females (Berlin and Languis, 1981).

During the third quarter, an individual electroencephalogram was recorded while each subject performed sequential-analytical and simultaneous-holistic (spatial) cognitive tasks associated with the left and right cerebral hemispheres respectively. Performance associated with the left hemisphere is typically verbal and logical-analytic, which is interpreted as a propositional mode of thought. To operationalize this definition, performance in the propositional mode was empirically indicated by selected items from two tests -- Inference Test and Deciphering Languages Test (Kit of Factor Referenced Cognitive Tests - Ekstrom, French, and Harman - 1976). These tests require thinking which is verbal-categorical, logical-deductive and analytic.

Performance associated with the right hemisphere is typically nonverbal, spatial, gestalt-synthetic, which is interpreted as an simultaneous mode of thought. To operationalize this definition,
performance in the simultaneous mode was empirically indicated by selected items from two tests — The Mooney Faces Test (Mooney, 1957) and the Mental Rotations Test (Vandenberg, 1978). These tests require thinking which may be characterized as gestalt-visual closure and spatial synthetic.

These performance tests which may involve greater participation of one hemisphere, i.e., that are lateralized to one hemisphere, were selected using four criteria. 1) The tasks could be supported in the literature as indicators of performance laterality. 2) The tasks could be easily administered in a uniform manner with an attempt to control for stimulus characteristics. 3) A standard response mode could be developed for each task, thereby eliminating the need for limb movement or vocalization. 4) The tasks were feasible for the established response mode (subjects pushed a button to indicate their response from alternative responses).

In addition to these four cognitive tasks, which were administered to determine the functional specialization of the left and right cerebral hemispheres, the EEG protocol contained items to indicate the subjects field dependent and independent cognitive style and its relationship to hemispheric processing. Selected items from the Hidden Figures Test (Ekstrom et al., 1976) were presented to the subjects to measure their ability to disembed a simple figure from a more complex context.

Correlation and regression analyses were designed to verify the constructs in the proposed model by evaluating the relationship between the subject's predominant neural mode of processing information, preferred
mode of perceiving information and experience (field dependence/field independence) and relative preference and expertise in perceiving and processing information as measured by the Myers-Briggs Type Indicator.

Description of the Study - Qualitative Component

In order to document how subjects who had been provided the opportunity to learn about learning processes and to investigate and understand their own learning processes attempt to translate that information into more appropriate learning and teaching behaviors (purpose two), subjects kept detailed self-analysis journals. They were asked to respond to the following open-ended questions periodically throughout the three quarter sequence.

1) Identify something you would like to do better or accomplish in your lifetime. This personally defined goal did not have to be associated with an academic area, but may be related to athletic and/or the arts, music, etc., fields.

2) Determine how you learned the content for the other courses you were enrolled in throughout the three quarter sequence.

3) Explain how knowledge of learning style and learning processes enabled you to better understand how individuals learn.

4) Explain how you will proceed to teach children with different learning styles.

5) Develop a specific curriculum program to meet the individual learning styles and needs of children.

During the second quarter, the cognitive style instruments were administered (CFT, GEFT, RFT). Immediately upon completion of each instrument, the subjects were asked to record what processing strategies they used to perform the task.
During the third quarter, the EEG was recorded while each subject performed a series of cognitive tasks. The subjects were asked to rank order the cognitive tasks from most difficult to least difficult and indicate (explain) the type of processing strategies (verbal and/or visual) they attempted to use in order to perform the task.

At the close of the third quarter, subjects who were now aware of the various learning process dimensions, were provided information concerning their specific learning processes (personality as determined by the MBTI; cognitive style as determined by the three measures of cognitive style - RFT, GEFT, CFT; and neural processing as determined by the EEG assessment). They were to reflect on each of these learning process dimensions and determine if they strongly agreed, moderately agreed, or strongly disagreed with their assessment, substantiating their self-analysis with introspective accounts based on personal experiences.

The final entry in the journal asked the subjects to reflect on what relationship they saw between their own learning style and their teaching style. In other words, did they prefer to teach in the same way they preferred to learn.

Content analysis was designed to analyze the open-ended, one item self-report questionnaire administered during the first quarter to subjects naive to learning process, as well as the last two entries recorded in the self-analysis journals by subjects who now had an understanding of learning processes. The same procedure and coding scheme generated and used in the 1981 pilot study was used for the content analysis in this study. By using content analysis in a pre-
post open-ended questionnaire, the writer was able to determine if the three substrates identified (neural processing, cognitive style, and personality) emerged and were consistently related as suggested in the proposed learning style model both prior to and after information concerning learning processes was provided.

The entire self-analysis journal served to document how subjects attempted to translate learning process information into appropriate learning and teaching behaviors.

Summary

Chapter One began with an introduction to the general problem area, and explained a pilot study which was a preliminary effort to design a learning style model. The purposes for the study, rationale and hypothesis for juxtaposing the three variables (neural processing, cognitive style, and personality) identified as substrates of an individuals learning style were then presented, followed by an explanation of the proposed learning style model. The definition of terms, objectives of the study, alternative hypotheses, assumptions and limitations, sample, and general description of the quantitative and qualitative components of the study completed the chapter.

This study is innovative in the sense that it is the first known attempt to juxtapose the theories of three distinct constructs (neural functioning, cognitive style, and personality typology) in order to explain how individuals learn. It is exploratory because it attempts to ascertain if providing individuals information about their own learning processes as determined by the substrates identified, has any impact on their learning behavior. Finally this case study has a
heuristic focus in that it is an initial attempt to establish a learning style program of study to foster prospective teachers' understanding of individual differences in learning and translate that information into more appropriate teaching behaviors to accommodate individual learning needs.

Given the interdisciplinary scope of this inquiry, it is emphasized at the onset, that the theory presented here is as yet an incomplete structure which still is in progress. Some theoretical bases for the present study, however, derive from traditional research and theory. The selected studies presented in chapter two are shown to support the theory, and constitute a preliminary step in its empirical validation.
CHAPTER II
LITERATURE REVIEW

Since this study has both a quantitative and qualitative component, the literature review is divided into these two major sections. The quantitative portion is subdivided into three parts each representing a substrate of the proposed learning style model: neural processing, personality theory (Jungian Typology) and cognitive style. The cognitive style section is further subdivided into hemispheric correlates and cognitive style and personality correlates and cognitive style, thus establishing a theoretical and empirical bases supported in the literature for juxtaposing neural processing dichotomies (right/left hemispheric processing), cognitive style dichotomies (field dependent/independent) and personality polarities (Jungian Typology) in order to describe an individual's learning processes.

The literature reviewed for the qualitative component addresses transference of knowledge; specifically how individuals attempt to translate information provided about themselves into appropriate learning and teaching behaviors.

Quantitative Literature Review

Part 1 - Neural Processing

Paul Broca (1861) was the first to discuss a hemispheric brain model. While working with stroke and brain-damaged patients, Broca discovered that language deficits were associated with damage to a
localized area in the frontal lobe of the left hemisphere. This discovery led Broca to conclude that the faculty of articulate language was localized in the left hemisphere, or at least that it depends chiefly upon that hemisphere (Springer and Deutsch, 1981). Subsequent research provided evidence that damage to Broca's area due to injury or stroke resulted in an individual incapable of producing smooth, well-articulated speech -- although the content and meaning were normal (Teyler, 1977).

Karl Wernicke (1870) found that damage to the back part of the temporal lobe of the left hemisphere could produce difficulties in understanding language. Further research provided evidence that damage to Wernicke's area resulted in well-articulated speech almost totally devoid of content. These observations and others have led to the notion that Broca's area is primarily concerned with language production whereas Wernicke's area is primarily concerned with semantic aspects of language. It was therefore determined that the left hemisphere played a major role in language functions in general and not just in speech per se.

Over the next several decades, extensive research of brain damaged patients consistently confirmed these early findings (Wittrock, 1980). The left hemisphere processed information deductively - analyzing input sequentially, abstracting out the relevant details and associating these with verbal symbols (Nebes, 1977). Because damage to the right, non-dominant hemisphere seldom led to significant impairment of these verbal-analytical functions, researchers
generally concluded that the right hemisphere played no specific role in higher cognitive processing.

This notion concerning the lack of a specialized role in cognition attributable to the right hemisphere dramatically changed with the split-brain research of Sperry and his associates (Sperry, Gazzaniga & Bogen, 1969). This research clearly demonstrated that both hemispheres of the brain were involved in higher cognitive functioning and that the two hemispheres employed different methods or modes of processing information. Sperry and his associates discovered this phenomena after surgically severing the corpus-callosum (the communicative network connecting the two hemispheres) of epileptic patients. Since the hemispheres of the brain are connected to the opposite sides of the body for sensory input and motor control, the information presented to one hemisphere could not travel across the corpus callosum to inform the other side of the brain. Thus the epileptic seizures of these split-brain patients stopped.

After considerable research involving these split-brain patients engaging in a variety of experimental tasks, Sperry and his colleagues could provide salient evidence for the specialized role of the right and left hemispheres (Sperry, 1968; 1974; Sperry, et al., 1969). The left hemisphere was superior in performing verbal/analytic tasks, while the right hemisphere was superior in performing visuospatial tasks.

Bogen (1977) summarizes the activities of the right and left hemispheres as follows:
What distinguished one hemisphere from the other was not so much certain specific kinds of material (e.g., words for the left, faces for the right) but the way in which the material was processed. Hemispheric differences are more usefully considered in terms of process specificity rather than material specificity (p. 138).

Bogen (1977) further cites Levy, Trevarthen, and Sperry (1972) who wrote:

All four of the present tests confirmed in different ways the presence of a fundamental difference in the way the right and left hemisphere perceive things. More than a slight preference in a competitive situation, the results suggest a strong differentiation. Where the kind of task being tested could be performed by either the left or right hemisphere, the two hemispheres accomplish the same task by characteristically different strategies (p. 74).

After several years of testing commissurotomy patients, Sperry and his colleagues (Sperry, 1968, 1974; Sperry, et al., 1969) could confidently delineate the cognitive processing modalities of the right and left cerebral hemispheres.

Bogen (1969) wrote:

The type of cognition proper to the right hemisphere has been called appositional, a usage parallel to the common use by neurologists of propositional to encompass the left hemisphere's dominance for speaking, writing, calculating, and related tasks. The word appositional is thus an abbreviation for: according to the rules of information processing which we infer to be typical of the right hemispheres of well-lateralized right-handers (p. 138).

Sperry (1974) further delineated the activities for which the right hemisphere was dominant as follows:
Though predominantly mute and generally inferior in all performances involving language or linguistic or mathematical reasoning, the minor (right) hemisphere is nevertheless clearly the superior member for certain types of tasks... First, of course, as one would predict these are all non-linguistic, nonmathematical functions. Largely, they involve the apprehension and processing of spatial patterns, relations, and transformation. They seem to be holistic and unitary rather than analytic and fragmentary, and orientational more than focal, and to involve concrete perceptual insight rather than abstract, symbolic, sequential reasoning (p. 11).

Extensive research has expanded our knowledge and understanding concerning the specialized roles of the two cerebral hemispheres. The general consensus among researchers who have studied hemispheric and lateral specialization may be summarized as follows:

1) The two cerebral hemispheres function as one: Various parts of each hemisphere are conjointly active. Each cerebral hemisphere receives the same information and processes it in its own specialized mode. Therefore we have two different modalities for processing information (Bogen, 1969).

2) The two cerebral hemispheres are capable of functioning independently in some degree. By having two independent problem-solving organs, we increase the prospects of a successful solution to a difficult problem, but we risk the possibility of having conflicting solutions (Bogen, 1969).

3) The two cerebral hemispheres may be logically incompatible. The right hemisphere synthesizes over space, while the left hemisphere analyzes over time. The right hemisphere notes visual similarities to the exclusion of conceptual similarities, while the left hemisphere
does the reverse. The right hemisphere codes sensory input in terms of images, while the left hemisphere codes in terms of linguistic descriptions (Levy, 1974).

4) Individuals are capable of engaging in both modes of information processing, however, the mode the individual actually uses depends on other variables (i.e., personal intention, salient features of the experience, instruction, habitual reliance on one type of processing (Languis, Saunders, & Tipps, 1980).

The research reviewed provided substantial evidence to support the notion that the two cerebral hemispheres employed specialized and possibly incompatible cognitive modes. This awareness led the writer to consider whether in certain groups of people, one particular style of cognition might be more habitually relied upon, developed, or preferred than the other. In other words, is it possible to determine differing hemispheric organizations among individuals?

In investigating and developing this notion, it was necessary to limit the literature review to studies involving adult subjects with intact cerebral hemispheres. This was because observed changes in hemispheric processing are associated with movement along a developmental life span. There is considerable evidence to suggest lateral asymmetry is present at birth (Levy, 1977), and that lateralization of function in the brain is complete by puberty (Lenneberg, 1967). It was reasonable, therefore, to assume that hemispheric specialization would be established in adult subjects.

The rationale for investigating only those studies which established hemispheric specialization in normal subjects was based on the fact that
it was theoretically possible to deny each hemisphere a specialized role in higher cognitive function using brain damaged patients. According to Levy (1980) "any behavior consequence of a neurological lesion could always be explained as reflecting disinhibition of intact neural tissue" (p. 246).

Even though the findings of the commissurotomy patients generally confirmed the lesion study findings, there are always dangers inherent in making inferences and assumptions about the cognitive processing of normal populations from non-normal populations. It is also possible that the perceptual requirements of certain spatial tasks are beyond the capabilities of the left hemisphere in isolation, even though normal subjects may, through choice and/or habitual reliance of one hemisphere, solve a task using predominantly left or right hemisphere processing strategies. The results of the EEG portion of this study confirmed this point.

Methods of assessing hemispheric lateralization or specialization using normal subjects have included dichotic listening tests (Kimura, 1963, 1967; Broadbent, 1954); visual laterality tests (Bryden, 1965; Kimura, 1969;Filbey & Gazzaniga, 1969; McKeever & Huling, 1970); and the electroencephalogram (Galin & Ornstein, 1972; Doyle, Ornstein, Galin, 1974). This research continually supported the inference that the intact normal brain did in fact make use of lateral specialization.

Kimura (1967) using a dichotic listening technique (subjects are simultaneously presented with stimuli to the left and right ears through head phones, and are asked to report what they heard), found
normal subjects had better recall for verbal material presented to the right than to the left ear. Nonverbal material was recalled better when presented to the left ear.

Another technique, used extensively to assess degree of functional lateralization in normal subjects, is the tachistoscopic presentation of visual stimuli to the right or left visual hemifield after fixation of a central point. The general hypothesis is that if the hemispheres are differentially equipped to process certain kinds of information, asymmetries in accuracy of report would be expected. The general finding among right-handed subjects has been that verbal material is reported more accurately when presented to the right visual hemifield, and spatial information is more accurately processed when presented to the left visual hemifield.

Filbey and Gazzaniga (1969) measured the delay required for information presented to one hemisphere to be acted upon by the other hemisphere. The results indicated that a verbal reaction to information presented to the nonverbal right hemisphere took longer than a nonverbal response. McKeever and Huling (1970) found faster tachistoscopic word recognition for words projected to the left hemisphere.

During the 70's more precise measures were used to study asymmetry. David Galin and Robert Ornstein of the Langley Porter Neuropsychiatric Institute were two of the first investigators to study these asymmetries in detail using the electroencephalogram (EEG) and to relate them to the nature of the task performed by the subject while the EEG was being recorded.
Galin and Ornstein's rationale for beginning their EEG work was based on the premise that in most ordinary activities, normal subjects alternate between cognitive modes rather than integrating them. Therefore, in a subject performing a verbal or a spatial task, they expected to find electrophysiological signs of differences in activity between the appropriate and inappropriate hemispheres (Galin & Ornstein, 1972).

Galin and Ornstein recorded EEG activity from symmetrical positions on either side of the head while subjects performed verbal tasks such as writing a letter and spatial tasks such as constructing a memorized geometrical pattern with multicolored blocks. Results were analyzed in terms of the ratio of right hemisphere EEG power to left hemisphere EEG power. These researchers were successful in showing a relationship between the amount of EEG activity in the hemispheres and the type of task performed by the subject.

Subsequent studies using adult subjects with intact brains supported these initial findings (Galin & Ellis, 1974; Doyle, Galin & Ornstein, 1974; Galin, Johnstone & Herron, 1978; Ornstein, Johnstone, Herron & Swencionis, 1980). The results of this research with normal subjects also supported the earlier conclusions provided by Sperry and his associates using split-brain subjects.

Laterality studies using EEG as a measure of hemisphere asymmetry have been severely criticized (Donchin, Kutas & McCarthy, 1977; Gevin, 1979; Hardyck & Haapanen, 1979; Stone, 1980). A good case has been made for inadequacies in design, conduct, and analysis.
Problems range from methodological shortcomings such as the tasks assigned the subject may not in fact differentially engage the hemisphere to subject individual-differences variables were not considered. Donchin, Kutas and McCarthy (1979) state, "... attention should be paid to the independent validation of the behavioral effects of experimental instructions, to the greater sensitivity of within-group repeated measures designs, to the choice of EEG parameters for study, and to the measurement and analysis of data" (p. 353).

Gevin (1979) found that when he controlled for efferent activities (limb movement) and when stimulus characteristics and performance related differences between tasks were relatively controlled, the analytical procedures did not uncover EEG patterns of any sort that could significantly distinguish between logical and spatial cognitive tasks.

In an attempt to address some of these criticisms, the tasks assigned the subjects were supported in the literature as differentially engaging the specialized cerebral hemispheres, agreed upon by two knowledgeable colleagues as theoretically engaging the right or left hemisphere, and pilot tested to determine if they did in fact differentiate between the hemispheres. Three of the five tasks selected were supported in the literature as difficult tasks, in an attempt to legitimately conclude that the cerebral hemispheres were cognitively asymmetrical. Levy (1980) states, "... if cognitive differences exist between the hemispheres, they would be expected to be revealed only by tasks sufficiently difficult to challenge the specialized and superior hemisphere" (p. 250).
To control for limb movement and vocalization, the tasks were presented in booklet form with individual directions read by the subject for each item. The items were of a forced choice variety ranging from one to five choices for each response. The subject indicated her response by pushing one of five buttons which illuminated the response for recording.

Ten subjects performed the protocol tasks in a specified order. The remaining ten subjects performed the same tasks in the reverse order in an attempt to control for cognitive sensitivity related to repeated measures. Chapter 3 contains a detailed description of the EEG tasks.

While reviewing the laterality literature which looked at the hemispheric organization of normal adult individuals, it became apparent that specific variables were proposed as having predictive value in determining cerebral organization (i.e., gender differences, handedness, cultural differences, and occupation). Each of the variables will be discussed in more detail.

Gender Differences

Kimura (1963) found that the localization of perception and production of speech in the left hemisphere and spatial perception and perception of nonverbal sounds in the right hemisphere had been developed by age 5 among girls, but not until a later data among boys. Wilelson (1976) and Reid (1980) found that in right-handed children, the right hemisphere of boys matured earlier than that of girls as seen in greater left-sided perceptual asymmetries of spatial material at younger ages. Van Duyne and D'Alonzo (1976) and Reid (1980) found
earlier and more pronounced left hemisphere maturation in girls, as evidenced in greater right-sided perceptual superiorities for verbal material. This apparent differing maturation rate of the two sides of the brain in boys and girls was concordant with the sex differences in the maturation of verbal and spatial function (Levy, 1980).

There is extensive evidence in the literature suggesting male superiority in spatial ability resulting from the more functional lateralization of the right hemisphere in males (Harris, 1978). Buffery and Gray (1972) argue that this male/female sex difference in spatial ability can be understood only as a consequence of sex differences in left hemisphere lateralization, not in right hemisphere lateralization as is more frequently suggested. They proposed that the left hemisphere is more developed in the female than in the male brain at the same age so that lateralization of language function occurs earlier in females than males. This distinction between the lateralization of the male and female cerebral hemispheres leads to female superiority in verbal tasks and male superiority in spatial tasks (Buffery & Gray, 1972).

Sperry and his associates (1969) found that localization of verbal functions in the left hemisphere and spatial functions in the right hemisphere was weaker in women. Levy (1980) believed that strong cerebral dominance facilitates performance for spatial abilities and reported that left handed men (in whom cerebral lateralization is weak) are similar to women in obtaining low scores in spatial abilities. Thus Levy and Sperry feel that male superiority in spatial tasks stems
from greater specialization of the two hemispheres among men than among women.

Harris (1978) in a comprehensive review of the laterality research concludes that adult males are indeed more lateralized than adult females. However, there have been very few EEG studies which look at this laterality question which used adult females for subjects. I would speculate that the reason females were not used as subjects stems from the fact that the laterality research strongly supports the notion that females are less lateralized, therefore, if the investigator is attempting to demonstrate the brain's lateralization specialization, it would be better to employ adult male subjects.

There have, however, been a few studies which included normal female subjects. Witelson (1976) correlated the degree of EEG alpha asymmetry with the speed of performance on different tasks thought to engage the left and right hemispheres differentially. For males, a significant correlation was found between magnitude of the asymmetry and performance in the right-hemisphere task. The correlation for the left hemisphere "vocabulary" condition approached, but did not quite reach, statistical significance; a task believed to engage both hemispheres did not show any correlation with performance. In females, however, none of these correlations were significantly different from zero. These results provided evidence for some differences in laterality as a function of sex.

A comparison of right and left EEG hemispheric activity in males during verbal and musical tasks (Herron, 1974) and in females during a speech task (Johnson, 1973) disclosed a higher incidence of
lateralization among males. Shucard, Shucard, and Cummins (1981) obtained auditory evoked potentials (AEP's) to probe tones which were delivered during the presentation of complex verbal and nonverbal auditory stimulation to 3 month old male and female infants. The results of their study indicated significant sex-related differences in left verses right temporal AEP amplitude measures obtained to auditory probe stimuli when 3-month old infants were receiving verbal and musical stimulation. During both the verbal and music conditions female infants showed higher amplitude left-hemisphere bipolar responses as compared with the right hemisphere, whereas males showed higher right hemisphere responses as compared with the left hemisphere. In previous studies Shucard and his colleagues (1979) found adults had differential activation of areas of the cerebral cortex in relation to the mode of cognitive processing. The relationships obtained in the more recent study using male and female infants suggests that differential cerebral activation is more dependent on the sex of the infant than on the type of stimulus the infant is receiving.

There are a few EEG studies which used female adult subjects along with male adult subjects (Ornstein, et al., 1980; Galin, et al., 1978; Willis, Wheatley & Mitchell, 1979), however, in none of these studies was there a reference to gender differentiation. This EEG study is unique in that it uses adult females as subjects.

In a comprehensive review of the literature concerning sex-related differences in cerebral organization (Bryden, 1979) cites similarities
and differences among leading researchers in the area. The generally accepted notions among researchers investigating the laterality question and gender differences are that males are superior to females on tests of spatial ability, females acquire language skills earlier than males, and the incidence of left-handedness is somewhat higher in males than females.

According to Bryden (1979) what distinguishes some researchers from others is the theoretical conceptualizations which underlie these assertions. He states:

Buffrey and Gray (1972) have concluded that females are more lateralized than males. They argue that the early acquisition of language in females is a sign of an earlier specialization of the left hemisphere for speech in females. They therefore conclude that speech and spatial skills become more completely lateralized in females, and more bilaterally represented in males. It is their assumption that it is better and more beneficial to have language processes lateralized in one hemisphere, and likewise beneficial to have spatial abilities bilaterally represented, since males are generally better at spatial skills and females at verbal ones.

Levy (1972) on the other hand, argues that the female is less lateralized than the male because left hemisphere subjects and females perform better on tests of verbal ability than on tests of spatial ability. The rationale behind her contention is that females are more likely to have bilateral speech representation, hence they are less lateralized (p. 464).

Generally speaking there are more arguments in support of the less lateralized female than the more lateralized female.

Handedness

Since two of the subjects are left-handers (one with and one without a history of familial sinistrality), this variable has particular
relevance to the study. There are some generally accepted notions concerning the relationship between handedness and functional asymmetry.

Ninety-five percent of the right-handers have speech localized to the left hemisphere, and seventy percent of the left-handers show the same pattern. Of the remaining thirty percent of the left-handers, half show right-hemisphere control of speech and half have speech represented bilaterally (Springer & Deutsch, 1981). These generalizations were made through sodium amytal testing at the Montreal Neurological Institute. Through the sodium amytal procedure, one hemisphere is temporarily anesthetized at a time, allowing the neurosurgeon to determine which half of the brain controls speech in a given patient about to undergo brain surgery (Rasmussen & Milner, 1977).

It has been found that individuals who have massive damage to the speech hemisphere are quicker to recover if the undamaged hemisphere can easily take over (Luria, 1970). If this is the case, it would appear that language functions may be bilaterally represented in more than just the fifteen percent of the left handers identified by the sodium amytal data.

Dichotic listening tests and lateralized tachistoscopic studies, which have compared the performance of left-handers and right-handers, have shown less evidence of asymmetry in left-handers (Bryden, 1979). It has been suggested that any asymmetry found with right handers will be smaller and perhaps in the opposite direction than studies with left-handers.
In perusing the literature which looks at the relationships between handedness and functional asymmetry, it is apparent that there are at least two kinds of left-handers — those with a history of familial sinistrality and those without left-handers in the immediate family. Studies which have looked at the effect of familial sinistrality on performance found that in a dichotic listening task, left-handers without a history of familial sinistrality showed a right-ear superiority, and familial left-handers showed no left-right difference (Zurif & Bryden, 1969).

Another study however, (McKeever and VanDeventer, 1972) provided evidence that the left hander with left handed relatives seemed to show the largest right sided asymmetry, and the left-hander without left-handed relatives showed signs of bilateral or right-hemisphere speech.

Other researchers (Bryden, 1973; Hines & Satz, 1974) found no difference in asymmetry between familial and nonfamilial left-handers. The general consensus concerning the role of family sinistrality and left handedness is that those left-handers with left-handed relatives differ in cerebral organization from those without; however, how they differ is not clear or empirically demonstrated.

Levy and Reid (1978) argue that you can tell a great deal about the brain organization from an individual’s handedness alone. Their model suggests that the position of the hand provides information about which hemisphere is controlling speech and language. The inverted hand posture suggests that the speech hemisphere is ipsilateral to the preferred hand. In other words, the speech of a left-handed
inverter would be controlled by the left hemisphere, whereas the speech of a right-handed inverter would be controlled by the right hemisphere. The speech of noninverted writers would be controlled by the hemisphere opposite to the preferred hand (Levy & Reid, 1976).

In an EEG study, Butler and Glass (1974) compared the alpha asymmetries of left and right handed adults during four experimental conditions: eyes closed, relaxed; eyes open, relaxed; doing mental arithmetic with eyes closed; doing mental arithmetic with eyes opened. The tasks were given verbally and the subjects responded verbally. The data showed no reversal due to handedness of alpha asymmetry in relation to cognitive function. On the contrary, in occipito-parietal recordings, left-handers tended to show the same asymmetry as right-handers. The total EEG, however, did show a tendency for reversal of the asymmetry between the two groups. Butler and Glass suggested that the results support the interpretation that alpha asymmetries reflect lateralization of verbal processing whereas asymmetries in total EEG may be more directly related to handedness.

In a review of human handedness, Hicks and Kinsbourne (1978) concluded that virtually any lateralized dimension in right-handers appeared more symmetrical in left-handers; the mean relative asymmetry score being closer to zero in left-handers. In addition, they reported that left-handers appeared to be more heterogeneous than right-handers on most lateralized dimensions; the between-subject variance being larger in left than right-handed populations.

To summarize, it is obvious that the role handedness plays in cerebral lateralization, as well as the role gender plays in laterality
dimensions is extremely complex. There is much disagreement among noted researchers in both areas concerning the relationships these two variables have with cerebral organization.

Cultural Differences

Cultural differences in hemispheric specialization have also been examined. Bogen, DeZare, Ten Houten and March (1972) measured Hopi Indians, urban blacks, and urban and rural whites hemispheric engagement while subjects performed "left" (Wechsler Adult Intelligence Scale Similarities Subtest) and "right" (Street Gestalt Completion Test) tasks. A comparison of the different groups right/left performance scores found that Hopis had the highest right hemisphere performance ratio, followed by urban black women, urban black men, rural whites and urban whites. These findings led the authors to conclude that the Hopi Indians and blacks relied relatively more on the right hemisphere than the other groups.

Shade (1982) indirectly supports the notion that Afro-Americans prefer right hemisphere strategies in processing information. As the theory suggests, right hemispheric processing strategies are associated with field dependency (the rationale for this relationship is provided at the close of this chapter). Shade concluded that the reason that Afro-Americans are at the lower end of the success continuum is not due to their inferior potential, but is rather a result of the curriculum demands of the American schools. In a comprehensive theoretical review on Afro-American cognitive style specialization, Shade argued that successful functioning within the current school context required the cognitive strategies that may be described as sequential, analytical,
or object-oriented (characteristics of left-hemisphere, field independent processing modalities). She further postulates that in examining the culture, lifestyle, and world view of Afro-Americans, there is a preference for cognitive strategies designed for survival which tend to be universalistic, intuitive, and very people-oriented (characteristics of right-hemisphere, field dependent processing modalities).

Several investigators have found that subcultures within the United States are characterized by a predominant cognitive mode. The middle class are more likely to use the verbal-analytic mode for processing information, while the urban poor are more likely to prefer the spatial-holistic mode (Cohen, 1969; Lesser, Fifer & Clark, 1965). This dichotomy results in a cultural conflict of cognitive style which may explain in part the difficulties of urban poor children in a school system oriented toward the middle class.

Occupation

In perusing EEG lateralization literature, it became apparent that several researchers (Galin & Ornstein, 1974; Dumas & Morgan, 1975; Doktor & Bloom, 1977) had used the subject's vocational choice as a dividing criterion for assigning individuals to experimental groups (i.e., spatial/holistic, verbal/analytic). Galin and Ornstein (1974) recruited 18 lawyers (verbal/analytic group) and 17 ceremicists (spatial/holistic) group for their study. These 35 male adult subjects were evaluated using EEG and reflective eye movement measures. Their performance was also compared on five cognitive tasks (2 verbal, 2 spatial, and 1 neutral). The results showed no significant differences
for lateral eye movement between groups, however, the groups did differ in the vertical direction; more up movements for ceremicists than for the lawyers. The effects of question type were studied in this population and in a group of non-specialized adult subjects (N = 19). The results confirmed a previous finding (Galin & Ornstein, 1972), verbal questions evoked more right movements and more down movements than spatial questions. The major hypothesis that the asymmetry ratios of the two occupational groups would differ significantly was not supported. A more detailed analysis of the alpha power within each hemisphere did reveal that the lawyers consistently showed a greater change in left hemisphere alpha than ceremicists, but these findings did not reach statistical significance.

Nine male artists and eight male engineers were tested for asymmetry of occipital alpha as a function of occupation, lateral specificity of task, and difficulty of the task (Dumas & Morgan, 1975). The "right hemisphere" tasks were facial recall and the Nebes' ring test (a "tactile test of the perception of part-whole relationships"). The "left hemisphere" tasks were a linguistic listening exercise and mathematical calculations. Results found no significant differences on the bases of occupation or difficulty, but significant results were found for task laterality. This disclosure led Dumas and Morgan to conclude that individuals have a dominant, preferred cognitive style based on their occupation. They further postulated that when a person has a dominant cognitive style, he does not necessarily use one hemisphere for the tasks appropriate to the other hemisphere, but rather has differential aptitudes in
lateralized functions and perhaps seeks out environments in which the more developed mode is utilized more. Therefore, the artists reported visualization strategies on the difficult math tasks, while the engineers reported that they had poor visual memories and verbally coded the facial memory tasks. The EEG measures, however, indicated that the artists used their left hemisphere for all the math items, and the engineers used their right hemisphere for the facial memory tasks despite their verbal reports.

The results of the Dumas and Morgan study supported the earlier results of the Galin and Ornstein study - asymmetry ratios of the two occupational groups did not differ significantly. A possible explanation for the lack of statistical significance between the asymmetry ratios of the two occupational groups may have been the type of "right" and "left" hemisphere tasks selected. In both studies the tasks were simple. Donchin, Kutas, and McCarthy (1977) state "... to reveal lateral dominance for study, one must use techniques which require high resolving power" (p. 344).

Another methodological problem associated with the Dumas and Morgan study concerned the electrode placement. Not only can differences between hemispheric utilization be minute, they are also likely to be localized rather than generalized. Luria (1973) states that the principle of lateralization of higher functions in the cerebral cortex begins to operate only with the transition to the secondary, and in particular, the tertiary zones. These zones are located in the posterior half of the cortex, generally where the occipital, temporal, and parietal lobes merge into each other. Yet Dumas and
Morgan used only the occipital regions for their electrode placement. It seems that this electrode placement would be least suitable for observing lateral asymmetries.

A study which did support the notion that selective lateralization of cognitive style is related to occupational group was conducted by Doktor and Bloom (1977). The frequency analysis of hemispheric EEG asymmetries in 14 right-handed subjects performing two difficult cognitive tasks was examined. Eight of the subjects were Presidents or Chief Operating Officers of large corporations and the remaining six subjects were Operations Researchers. The researchers hypothesized that the two groups would differ in problem solving approaches. They speculated that the Operations Researchers, having more analytical training, would approach the tasks by attempting to build mathematical models to solve the complex problem. The Presidents or Chief Operating Officers on the other hand, having a more "intuitive" problem solving style, would approach the tasks more spatially. Doktor and Bloom did not define the term "intuitive," however, they considered it synonymous with spatial processing. Therefore, the executives were thought to approach tasks with a more right hemisphere preference, whereas the researchers were expected to approach the same difficult tasks with a more left hemisphere preference or orientation.

The results showed a consistent shift from the verbal/analytic task, which consisted of a false premise test requiring a verbal-analytic approach, to the spatial/intuitive task, which involved gestalt completion, such that the expected dominant hemisphere (verbal/analytic) of the Operations Researchers was relatively more active.
during the verbal/analytic task. No such consistency in shift was exhibited by the executive group. There was no relationship between performance measures and EEG output between the two groups. The authors findings, therefore, supported earlier results of lateral specialization of cognitive mode with regard to occupational groups. There was a statistically significant difference between the two occupational groups, Mann-Whitney U Test (6/8) = 6, p < .01, with respect to shift response. The Operations Researchers demonstrated more left hemisphere relative to right hemisphere ratios of activity for both cognitive tasks compared to the Presidents or Chief Operating Officers. An interesting finding demonstrated by the executives in the sample was that half of them shifted in one direction as they moved from the verbal/analytical task to the spatial task, while the remaining half of the sample shifted in the opposite direction. No explanation was given for this finding.

The major methodological shortcoming in this study was that the analog EEG output had to be manually digitized. Therefore, only two minutes of EEG output per test per subject could be analyzed. In the other two studies cited, the EEG output was automatically analyzed over the entire period of each subject's task activity. The electrode placement (temporal lobes T3, T4) seemed acceptable.

Newman (1982) makes an interesting comment regarding this particular study. He suggests that the reason this study, in spite of its methodological drawbacks, showed significant differences in EEG results between two occupational groups, was because these particular groups chosen by Doktor and Bloom represented, to a greater degree than the
other studies, individuals with truly representative "left and right hemisphere styles." The groups selected had similar areas of interest, but very antagonistic approaches to these areas. In addition, the tasks selected by Doktor and Bloom had a higher level of difficulty than the tasks selected by Galin et al. (1974) and Dumas and Morgan (1975).

While it is an oversimplification to state that certain occupational groups have "right" or "left" hemisphere processing styles, it is the assumption of this writer that certain groups of individuals do have "antagonistic" or opposite cognitive styles or modes (i.e., right/left hemisphere processing modalities, field dependent/field independent cognitive style). Therefore if an instrument existed which could assess individual differences in cognitive and perceptual preference based on the processing dichotomies suggested in the hemispheric specialization literature, the researcher would have a more reliable and valid way for determining "antagonistic" subject populations.

I have now reached the point in this discussion where the juxtaposition of the hemispheric model and the Myers-Briggs Type Indicator is appropriate. The MBTI can assess individual differences in human behavior and attribute these differences to inherent psychological structures, just as the hemispheric model clearly establishes a theoretical framework for identifying individual differences in learning style. It is for this very reason that the proposed learning style model incorporates these dissimilar but compatible perspectives in understanding an individual's learning processes. The next section
of this paper will present the hypothesized relationship between Jungian typology as implemented in the MBTI and the hemispheric model of cognitive processing.

Part 2 - Personality Theory (Jungian Typology)

The holistic and essentially synthetic approach of the right hemisphere is in sharp contrast to the analytic, linear, and reductive aspect of left hemisphere functioning. This dichotomy is also apparent when one considers how Jung differentiated his views of the synthetic or constructive methods from the analytical - causal reductive approach of Freud (Jung, 1971).

Jung postulates two attitudes, extraversion and introversion, which indicate the focus of cognitive activity and four functions, intuition and sensation - perceptual functions and thinking and feeling - judging functions. It is assumed that both perceptual and judging processes are involved in varying degrees in most conscious functioning, however, the two forms of perceiving (intuition and sensation) and the two forms of judging (thinking and feeling) are mutually exclusive and in some instances may be incompatible forms of perception and judgment. These same notions are conveyed in the hemispheric specialization literature (Levy, 1974).

Jung does postulate, however, that all four functions and two attitudes do exist in any individual. What actually determines the individual's type is the degree to which the attitude or function is preferred or differentiated. Hence, the function which stands in an oppositional or complimentary relationship to the preferred function still operates in the individual's psychology, but in a more
undifferentiated or unconscious manner (Jung, 1971). The learning style model was developed around the perceptual (intuition/sensation) and judging (thinking/feeling) functions, therefore, a rationale is provided for relating neural processing to these bipolar dimensions.

The two perceiving functions (sensing and intuition) most directly relate to individual differences in learning style and left/right hemispheric modalities. The writer hypothesized that individuals who rely primarily on sensing for purposes of perception, prefer to approach learning events using right hemisphere strategies for perceiving and processing information, while individuals who use intuition for purposes of perception, prefer to approach learning events relying on left hemisphere strategies for perceiving and processing information. This notion that the sensing function should be associated with right hemisphere processing while intuition (a term commonly used to represent right hemisphere characteristics) should be associated with left hemisphere processing strategies may need additional clarification.

The rationale for postulating that intuition be identified with perception and processing associated with left hemisphere processing strategies is rooted in extensive research (Myers, 1962, 1980; McCaulley, 1976). In numerous studies which accumulated over a thirty year period, these researchers found that intuitives had higher scholastic aptitudes and interests than any other group in most academic fields.

The reason presented for the intuitives' higher scholastic ability related to their capability of performing specific cognitive
activities very quickly on an unconscious level. Myers (1980) states "... intuitives routinely use the unconscious to translate symbols into meaning or meaning into symbols as they talk, listen, read, and write" (p. 137).

In type terminology, intuition is perception of the result of one's own unconscious processes. The intuitive uses his intuition to perceive the unconscious in search of relationships, interpretations, and possibilities and then translates that information into words, ideas, and symbols. Myers (1980) writes:

Communication from teacher to student begins with the spoken word in the classroom, where the student must be able to listen effectively, and later includes the written word in textbooks, which the student must be able to read. Because words, the necessary medium of education, have to be translated from symbols into meaning by the listener's intuition, the translation is naturally easier for intuitives than for sensing types (p. 147).

The characteristics associated with an intuitive personality type are similar to the characteristics associated with left hemisphere processing modalities, therefore, intuition was viewed as belonging on the left hemisphere continuum for information processing preference. Intuition represents the manifestation of the unconscious on the conscious level.

Since the Myers Briggs Type Indicator, Jungian Typology, hemispheric specialization research, cognitive style research, and the learning style model proposed in this study are all based on a bipolar model, it is reasonable to suggest that the sensing personality type be identified with perception and processing strategies associated with right hemisphere modalities. Myers (1980) writes:
The sensing types, by definition, depend on their five senses for perception. Whatever comes directly from the senses is part of the sensing types' own experience and is therefore trustworthy. What comes from other people indirectly through the spoken or written word is less trustworthy. Words are merely symbols that have to be translated into reality before they mean anything, and therefore they carry less conviction than experience (p. 57).

The sensing individual's native language is the reality spoken by the senses, while the intuitive's native language is the metaphor, the word, the symbol spoken by the unconscious. Since most mental tests are of necessity couched in the intuitive's language, the sensing individual has more translating to do - a time consuming task - which hinders completion of a timed test. Therefore sensing individuals generally make lower scores on scholastic and intelligence tests than their "opposite" the intuitive.

The intuitive individual relies on verbal symbols to perceive information, while the sensing type relies on nonverbal concrete realism to perceive and process information. Two characteristics of right mode processing strategies are nonverbal and concrete processing. Nonverbal has been described as an awareness of things, but minimal connection with words (Edwards, 1979). Concrete has been defined as relating to things as they presently are (Edwards, 1979). Hence, sensing was viewed as belonging on the right hemisphere continuum for perceiving and processing information.

Further support for a sensing individual to prefer right hemisphere strategies for processing information and the intuitive individual to prefer left hemisphere strategies for processing information is evident through an item analysis of the MBTI. There are
seven items (five word pair and two phrases) where the individual is forced to choose between a response indicative of a sensing or intuitive personality type. Upon closer examination of these seven items, it is apparent that half of the responses are associated with theoretical ideas or concepts which are symbolic (figurative) and abstract in nature -- all characteristics of left hemisphere processing modalities and identified in the MBTI as characteristics of the intuitive personality type. The dichotomous response refers to individuals who don't like theories, prefer certainty, and literal (concrete) statements -- all characteristics of right hemisphere processing modalities and identified in the MBTI as characteristics of the sensing personality type.

<table>
<thead>
<tr>
<th>Sensing</th>
<th>Intuitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gets more annoyed at fancy theories.</td>
<td>Gets more annoyed at people who don't like theories.</td>
</tr>
<tr>
<td>If they were a teacher would prefer to teach fact courses.</td>
<td>If they were a teacher would prefer to teach courses involving theory.</td>
</tr>
<tr>
<td>Certainty</td>
<td>Theory</td>
</tr>
<tr>
<td>Facts</td>
<td>Ideas</td>
</tr>
<tr>
<td>Concrete</td>
<td>Abstract</td>
</tr>
<tr>
<td>Statement</td>
<td>Concept</td>
</tr>
<tr>
<td>Literal (concrete)</td>
<td>Figurative (symbolic)</td>
</tr>
</tbody>
</table>

The Webster's New Collegiate Dictionary defines the following words which have been referred to in the preceding list.

**Theory** - abstract thought or idea

**Concept** - an abstract idea generalized from particular instances

**syn** - idea
Figurative - of or relating to graphic representations (symbolic; emblematic). Expressing one thing in terms normally denoting another with which it may be regarded as analogous.

These three definitions are related to left hemisphere processing modalities and represent the intuitive personality type on the MBTI.

Certainty - the existence of objective unquestionable data

Concrete - formed by concretion or coalescence of separate particles into one whole body or mass; characterized or belonging to immediate experience of actual things or events.

Statement - a report of facts or opinions

Literal - adhering to ordinary construction or primary meaning of a term or expression - concrete representation.

These four definitions are related to right hemisphere processing modalities and represent the sensing personality type on the MBTI.

A word of explanation may be in order for associating the word 'fact' with a right, rather than a left hemisphere processing modality. Webster defines 'fact' as the quality of being actual; something that has actual existence; a piece of information presented as having objective reality. This definition of the word 'fact' is congruent with the term concrete, which refers to relating to things as they are, at the present moment. In the hemispheric specialization literature, the word 'concrete' is associated with right hemisphere processing modalities.

To summarize, the findings of hemispheric specialization research suggest that cognitive processes may well be divided along the lines of concrete perception versus abstract thought. The Myers' research (1980) suggests that the two ways of perceiving information (sensing/intuition) are also divided along divergent
lines. Relating this notion to the learning style model, the writer suggests that concrete perception represents the sensing types preference and orientation for using right hemisphere information processing strategies, while abstract thought represents the intuitive types preference and orientation for using left hemisphere information processing strategies.

In developing the learning style model, the writer conceptualized that thinking represented a left hemisphere orientation or preferred way of making judgments and feeling represented a right hemisphere orientation or preferred way to make judgments. It seemed obvious why thinking should be associated with left hemisphere processing. The characteristics of the left hemisphere modes for processing and judging information were traditionally identified as rationale, logical and analytical (Edwards, 1979). These same notions have been identified by Jung (1971) and Myers (1980) as characteristics of the thinking personality type.

According to Myers (1980), the thinking type is usually able to organize facts and ideas into a logical sequence that states the subject, makes points, comes to a conclusion, and stops without repetition. Thinking types value logic above sentiment. Jung (1971) stated, "I call directed thinking a rationale function, because it arranges the contents of ideation under concepts in accordance with a rationale norm of which I am conscious" (p. 481).

The characteristics of the right hemisphere modes for processing and judging information (i.e., nonrationale, synthetic) represented similar notions identified by Jung (1971) and Myers (1980) as
characteristics of the feeling personality type. In presenting the rationale for identifying feeling as a right-hemisphere function, two terms commonly associated with right hemispheric processing (non-rationale and synthetic) will be defined and support for these notions will be established through Jungs' and Myers' work.

Nonrationale may be defined as not requiring a basis of reason or facts, willingness to suspend logical judgment in favor of value judgment (Edwards, 1980). Jung (1971) suggests that passive feeling is irrational in so far as it confers values without the participation or even against the intentions of the subject. He states,

> Feeling is a kind of judgment, differing from intellectual judgment in that its aim is not to establish conceptual relations but to set up a subjective criterion of acceptance or rejection. While thinking organizes the contents of consciousness under concepts, feeling arranges them according to their value (p. 435).

The writer has interpreted Jung's statement as a referral to one's value judgment. This notion of value judgment is reflected in Myers' work. "Feeling types place value judgments and sentiment above logic" (Myers, 1980, p. 68).

Synthetic, the antithesis of analytic, is defined as putting things together to form wholes (Edwards, 1979). Jung (1971) describes the feeling mode, whether it be a general or only a partial feeling as a valuation, not of one definite, individual conscious content, but of the whole conscious situation at the moment. The complete feeling no longer coincides with a particular content and its feeling-value, but with the undifferentiated totality of all contents. Myers (1980) describes the extraverted feeling type as placing soundness
and value not within the individual, but outside in the collective ideals of the community. Myers also suggests that feeling serves as a guide to the emotional acceptance or rejection of various aspects of life.

This notion that feeling infers emotion is particularly relevant to this discussion of the feeling process belonging on the right-hemisphere continuum.

The thinking function concerns itself with principles, logical reasoning, order and meaning. The thinking type prefers to organize his life according to certain principles and formulae. The thinking personality type approaches decisions (judges) through impersonal analysis because what they trust is thinking, with its step-by-step logical process of reasoning from cause to effect, from premise to conclusion (Myers, 1980).

The feeling function is concerned with values and relationships, with the appreciation of situations, persons, objects, and psychological states. The feeling type orders his life around relationships he has with external or internal situations or events, and orients himself around the feeling tone of these relationships. Individuals who approach decisions (judge) with personal warmth are feeling personality types who trust feeling, with its valuations in terms of how much things matter to themselves and others (Myers, 1980).

Myers (1980) distinguishes between the thinking/feeling ways of judging information in the following manner:

The child who prefers thinking develops along divergent lines from the child who prefers feeling, even when both
like the same perceptive process and start with the same perceptions. Both are happier and more effective in activities that call for the sort of judgments that they are better equipped to make. The child who prefers feeling becomes more adult in the handling of human relationships. The child who prefers thinking grows more adept in the organization of facts and ideas. Their basic preference for the personal or the impersonal approach to life results in distinguishing surface traits (p. 4).

The writer believes that there is a definite relationship between the two judging functions (thinking/feeling) and hemispheric specialization.

In earlier research conducted by Sperry (1968) using commissurotomy patients, the minor hemisphere was observed to demonstrate appropriate emotional reaction. When a pinup shot of a nude was interjected by surprise among a series of neutral geometric figures being flashed to the right and left visual fields at random, the subject characteristically said that he saw nothing when the nude appeared on the right side. However, the appearance of a sneaky grin, blushing and giggling on the next couple of trials belied the verbal contention of the left hemisphere. If asked what all the grinning was about, the subject's reply indicated that the conversant hemisphere had no idea at this stage what it was that had turned him on. It was thus suggested that the emotional responses are associated with right hemisphere processing.

Suberi and McKeever (1977) investigated whether hemispheric differences could be found in the speed of recognition of emotional, as opposed to non-emotional faces. Their subjects were 72 right-handed female adults. The subjects were asked to memorize two photographed faces and subsequently discriminate these "target" faces
from two "non-target" faces. The faces were presented unilaterally for 150 msec., and manual reaction times for the discriminations served as the dependent variable. The face stimuli were either "neutral" or "emotional" in facial expression, these attitudes having been shown, by a preliminary study, to be highly reliable. Faster reaction times were obtained for left visual field than for right visual presentation. Subjects who memorized emotional faces showed significantly faster discrimination of faces presented in the left than in the right visual field. The results were consistent with previous tachistoscopic evidence of right hemisphere superiority in face recognition speed and with diverse non-tachistoscopic evidence of preferential memory storage of affective material (Suberi & McKeever, 1977).

Arthur Benton (1980) has summarized the most recent research concerning the neuropsychological mechanisms underlying facial recognition.

Knowledge of the neuropsychological mechanisms underlying facial recognition has come from both experimental study of normal subjects and clinical investigation of patients who show defects in facial perception or memory. A basic difference exists between the identification of the faces of familiar persons and the discrimination of unfamiliar faces. Defects in these two forms of facial recognition have different anatomical correlates, and a patient with brain disease may show one type of impairment and not the other. The right hemisphere appears to play a primary role in mediating forms of facial recognition (p. 176).

In conclusion, the studies reviewed support the notion that thinking as a continuous variable belongs on the left-hemisphere
continuum, while feeling, also a continuous variable, belongs on the right hemisphere continuum. It is most important, however, that the reader regards the left/right dichotomies, as well as the personality polarities, as continuous variables.

To the writer's knowledge, two articles have been written which proposed the relationship between Jungian typology and hemispheric processing. The first article to postulate such a relationship was published in the Journal of Analytical Psychology (1977) by Ernest Rossi. After an extensive review of the recent research indicating the two basic ways of knowing based upon differences in the functioning of the cerebral hemispheres, Rossi proposed a number of relationships between major Jungian polarities and left/right hemispheric functioning. The following table represents the portion of Rossi's hypothesized correspondences which directly relates to my hypothesized relationship as represented in the proposed learning style model presented at the beginning of this paper.

<table>
<thead>
<tr>
<th>Left Hemisphere</th>
<th>Right Hemisphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rational functions</td>
<td>Irrational functions</td>
</tr>
<tr>
<td>Thinking</td>
<td>Intuition</td>
</tr>
<tr>
<td>Feeling</td>
<td>Sensation</td>
</tr>
</tbody>
</table>

Rossi's proposed relationship does not concur with my own. He suggests that Jung's rational functions of thinking and feeling represent left hemispheric processing while Jung's irrational functions of sensation and intuition are more closely associated with right hemispheric functioning. His rationale for building such a hypothesis stems from the notion that thinking and feeling are both
rational functions that require the use of the verbal and logical functions of the left hemisphere, while irrational functions of sensation and intuition are more perceptual and thus more closely related to the synthetic functioning of the right hemisphere.

One could argue that Rossi has developed his schematic relationship of cognitive processing by conceptualizing the right hemisphere as the perceptual hemisphere, and the left hemisphere as the analytic/logical hemisphere. This oversimplification of the cognitive processing capabilities of the two hemispheres has led some individuals to conclude that perceptual processes only occur in the right hemisphere while analytical/logical processes only occur in the left hemisphere.

It is an established fact that perceptual processing occurs, not in one, but in both hemispheres. Luria (1973) states:

The left hemisphere begins to play an essential role not only in the cerebral organization of speech, but also in the cerebral organization of all higher forms of cognitive activity connected with speech -- perception organized into logical schemas, active verbal memory, logical thought (p. 78).

Concerning the role of the right hemisphere in perception Luria (1973) says:

Within the last decade, work has been published which shows the parieto-occipital zones of the right hemisphere evidently play an important role in the most direct forms of perception and, in particular, in those forms in which the contribution of speech is minimal (p. 238).

Therefore, it is not the case that perceptual processing occurs only in the right hemisphere as commonly thought, but that perceptual processing occurs in both hemispheres, but in different forms: more
direct forms of perception (concrete or immediate perception) occurring in the right hemisphere and symbolic/analytic, logical perception occurring in the left hemisphere.

Further support for this contention is evident in the work of Luria (1973) *The Working Brain*. Luria has identified and divided the brain into three functional units. The first functional unit lies in the subcortex and brain stem and is responsible for regulating tone or waking. This functional unit is not relevant to this discussion.

The second functional unit of the brain, however, is very relevant to the notion that both cerebral hemispheres are involved in perception. This unit's primary function is the reception, analysis, and storage of information. This unit is located in the lateral regions of the neocortex on the convex surface of the hemispheres, of which it occupies the posterior regions, including the visual (occipital), auditory (temporal) and general sensory (parietal) regions (Luria, 1973). This functional unit receives and integrates inputs from all the sense modalities, stores these as memories and compares these memories with ongoing experience. The activities of this unit, however, extend beyond simple perception. Luria (1973) states:

> It is tertiary zones of this second brain system or, as they are generally called, the zones of overlapping of the cortical ends of the various analysers, which are responsible for enabling groups of several analysers to work concertedly (p. 73).
Luria (1973) further states:

This work of the tertiary zones of the posterior cortical regions is thus essential, not only for the successful integration of information reaching man through his visual system, but also for the transition from direct, visually represented syntheses to the level of symbolic processes—operations with word meanings, with complex grammatical and logical structures, with systems of numbers and abstract relationships. It is because of this that the tertiary zones of the posterior cortical region play an essential role in the conversion of concrete perception into abstract thinking, which always proceeds in the form of internal schemes, and for the memorizing of organized experience or, in other words, not only for the reception and coding of information, but also for storage (p. 74).

Thus, there is additional confirmation based on Luria's comprehensive understanding of the internal structure of mental activity, that perception is a function of both cerebral hemispheres.

Therefore, the writer agrees with Rossi that thinking represents a left hemisphere orientation for judging information and sensation represents a right hemisphere orientation for perceiving information, however, the intuitive individual relies more on left-hemisphere strategies for processing and perceiving information, while the feeling individual relies more on right-hemisphere strategies for judging this perceived information.

Support for this contention is presented in the work of James Newman (1982). Newman has developed a model juxtaposing Jung's four functions and the four quadrants of specialization in the cerebral cortex as evidenced in the work of Luria. Aside from the two-fold specialization of the cerebral cortex presented in the hemispheric
functioning literature, Newman has suggested another major dichotomy in cortical functioning - the anterior and posterior halves of the cortex. He cites Luria (1973) as providing the most convincing argument for making that vital distinction which is the basis for his model.

Utilizing two neuropsychological perspectives on cognitive specialization in the cerebral cortex (anterior/posterior distinction and hemispheric specialization left/right distinction), Newman suggests that the cortex can be usefully subdivided into four "quadrants of specialization." He has characterized the functions of these quadrants as follows:

**Left frontal quadrant (frontal lobe)** - Essential to the planning and regulation of mental activity involving logical, analytic, sequential reasoning. Necessary for verbal expression of propositional speech.

**Right frontal quadrant (frontal lobe)** - Essential to the planning and regulation of visuospatial processing, and of emotion; involving direct perceptual insight. Processing style is holistic and unitary.

These activities of the two frontal lobes correspond to thinking and feeling, respectively, the two Jungian functions of judgment (Newman, 1982). The activities of the two posterior quadrants correspond to the perceptual functions of sensation and intuition.

**Right posterior quadrant (parietal, temporal, occipital lobes)** - Essential to the processing of sensory information leading to direct perceptual insight. Necessary for direct (concrete) perception and recognition of emotional stimuli (internal and external). Processing style: orientational, simultaneous.

**Left posterior quadrant (parietal, temporal, occipital lobes)** - Essential to the conversion of concrete perceptions into symbolic images. Necessary for language comprehension in general. Processing style: focal, sequential.
These activities of the parietal, temporal and occipital lobes correspond to sensation and intuition, respectively, the two Jungian functions of perceiving (Newman, 1982).

Newman also makes mention of the commonly used term "intuition" in non-technical discussions. He notes that Myers (1980) makes reference to the ideational nature of intuition, and considers the opposition between the scientific and intuitive minds as reflecting an intrahemispheric tension between thinking and intuition. He cites support for this view of intuition as ideational from Myers (1962) research which indicates that individuals who show a preference for intuition on the Myers-Briggs Type Indicator are significantly more likely than any other type to be characterized as "liking to use mind," "good at analyzing" and "having a good grasp of the abstract."

Newman's work and the writer's understanding of the four Jungian functions and their relationship to neural processing are compatible. Both the Newman model and the proposed learning style model place these four functions in the same position with respect to lateralization orientation.

What has been established so far is a theoretical basis for juxtaposing the neural processing and personality components of an individual's preferred mode of perceiving and processing information. There is, however, another component of an individual's mode of functioning, cognitive style, which the writer suggests mediates and serves as the link between the personality and neural processing constructs. The next section of this chapter develops a rationale for suggesting a hypothesized relationship between these three dimensions in an
attempt to understand and interpret individual differences in learning processes.

Part 3 - Cognitive Style

Cognitive style is a hypothetical construct which refers to the characteristic ways in which individuals conceptually organize the environment. Common to all theory and research associated with the construct is an emphasis on the structure (how cognition is organized) rather than the content of thought (Witkin & Goodenough, 1981). This distinction concerning process specificity is congruent with hemispheric processing theory and research.

What distinguished one hemisphere from the other was not so much certain specific kinds of material (e.g., words for the left, faces for the right) but the way in which the material was processed. Hemispheric differences are more usefully considered in terms of process specificity rather than material specificity (Bogen, 1977).

Various dimensions of the construct cognitive style have been researched and are reported in the literature (i.e., reflective/impulsive - Kogan, 1971; differentiation/integration - Harvey, Hunt, Schroder, 1961; field dependence/field independence - Witkin and Moore, 1974). From this research, it becomes clear that cognitive style represents broad dimensions of individual differences that extend across perceptual and intellectual functioning.

One of the most widely investigated forms of cognitive style which has relevance to this discussion of individual differences in learning (learning style), is the field dependent/field independent dimension. An individual with a more field-independent way of
perceiving information tends to experience his surroundings analyti-
cally, with objects experienced as discrete from their backgrounds.
The individual with a more field-dependent way of perceiving infor-
mation tends to experience his surroundings in a relatively global
fashion, passively conforming to the influence of the prevailing
field or context.

Hemispheric Correlates and Cognitive Style

As established earlier, cognitive style and hemispheric process-
ing are viewed in process terms, therefore, their is a salient rationale
for suggesting a relationship between the field independent individ-
uals mode of perceiving information analytically and left hemisphere
processing strategies and the field dependent individuals mode of
perceiving information globally and right hemispheric processing
strategies. This relationship has been empirically demonstrated in
studies employing perceptual measures of field dependence and field
independence (Cohen, Berent, & Silverman, 1973; Berent, 1976; DeWitt &

Cohen et al. (1973) administered Rod and Frame Tests before and
after a single electroconvulsive shock treatment (ECT) was delivered
either to the left or right cerebral hemisphere of 24 normal patients
being treated for depression. These subjects were all right-handed
women between the ages of 19 and 59 years of age. The results showed
that all 12 patients who had left ECT were more field dependent on
the posttreatment Rod and Frame Test while all 12 patients who had
right ECT were less field dependent on the posttreatment Rod and Frame
Test. The researchers concluded that right ECT decreased a subject's
ability to respond to a stimulus field such that the more peripheral elements of the field were not attended to. In the case of the Rod and Frame task, it was the frame which was both peripheral as well as the major source of interference in performing the task. Thus, with the distracting influence of the frame attenuated, the rod could be more accurately brought to true vertical. Therefore, field dependence was seen to be associated with a relative right hemisphere dominance, rather than a left hemisphere dysfunction per se.

In a further attempt to examine the relationship between field dependency and lateralized cerebral functioning, Berent and Silverman (1973) administered two paired associate learning tasks (verbal and visual) to 50 female undergraduate students assigned on the basis of their scores on the Rod and Frame Test to extreme field dependent and field independent groups. The results showed no significant differences between performance by the two groups on the visuo-perceptive paired-associates. Compared to the field-independent subjects, however, the field dependent subjects showed impairment on the verbal task. The researchers concluded that the observed differences in performance between the field dependent and field independent subjects may reflect differences of dominance in cerebral organization between these subjects. While field dependent subjects performed disproportionately on the two learning tasks, field independent subjects performed in a more ambi-equal fashion. Berent & Silverman speculated that a decrease of left cerebral dominance (i.e., relative increase of right dominance) is associated with field dependence, while
increased left dominance may be characteristic in field independent subjects.

Berent (1975) provided further information concerning the relationship between field dependence and other functions of the left hemisphere. Fifty female patients, ranging in age from 15 to 50, who had no psychotic or neurological problems were administered a writing task followed by the Rod and Frame Test. The writing task required the individual copy on a blank sheet of paper a 75 word printed passage taken from a standard intelligence test. The results showed that the field dependent individual performed more poorly on the writing task than the field independent individual suggesting a relationship between field dependence and right hemisphere processing modalities.

Besides writing, another ability said to be lateralized more to the left than the right cerebral hemisphere is arithmetic calculation. Berent (1976) administered a timed serial sevens calculating task and the Rod and Frame Test to forty right-handed female patients ranging in age from 15 to 50, who had no psychotic or neurological problems. The serial sevens task required the subjects to count backwards as quickly as possible from 100, subtracting by sevens. The individual's score was determined by number of errors and/or total performance time. The results indicated a poorer performance by field dependent individuals than field independent individuals; further support for establishing a relationship between field dependence and right hemisphere processing capabilities.
The previous studies mentioned, used the Rod and Frame Test as the measure of field independence. This study also used the Rod and Frame Test (RFT) along with the Group Embedded Figures Test (GEFT) and the Concealed Figures Test (CFT) as a measure of field dependence/independence. Oltman, Ehrlichman, & Cox's study (1977) is particularly relevant to this report for these researchers used two of the three measures - GEFT and the RFT in order to develop and investigate the possibility of a link between extent of psychological differentiation (field dependence/independence) and one or another manifestation of individual differences in extent of lateralization.

Twenty-eight male college students were administered the RFT and the GEFT as well as the Articulation of Body Concept Scale. The composite score based on these three instruments determined the extent of field independence performance. In addition to these three tests, the subjects were administered a set of 40 face stimuli and asked to determine which of two composite faces more closely resembled the original frontal picture of a human face. The hypotheses stated that in right-handed individuals under free viewing conditions the composite picture made from that half of the original face which fell in the observer's left visual field (which projects more directly to the right hemisphere) was seen by the observer as being most similar to the original. The researchers hypothesized that the number of slides on which the subject chose the left visual field component as being most similar to the target face was taken as an index of the extent to which his perception of the faces was lateralized. The results of this study showed that relatively field dependent
individuals showed minimal visual-field preference while relatively field independent subjects showed the expected lateralization by consistently selecting left visual-field composites.

In order to verify these results, Oltman, Ehrlichman and Cox (1977) conducted a second experiment using samples of 16 female and 10 male right-handed college students. Only the GEFT was administered to assess field dependence/independence. The researchers also used 14 left-visual field effect face items, along with several additional face items as "fillers" in order to test lateralization. They again found that field-independent subjects showed a significantly stronger tendency to select the left-visual field composites than did relatively field-dependent individuals. The researchers concluded that the results are consistent with the differentiation hypothesis in that relatively field dependent subjects, who, according to Witkin and his colleagues (1962-1974) are less differentiated psychologically, are also less differentiated in terms of the extent of left-visual field lateralization in their perception of faces.

A more recent study by Zoccolotti and Oltman (1977) confirmed and extended the preceding results with a tachistoscopic technique. In this study field independent subjects showed significantly faster reaction times to faces exposed for 100msec. in the left visual field and significantly faster reaction times to verbal stimuli presented for 100 msec. in the right visual field, while field dependent subjects showed no significant hemifield effects in these tasks.

The overall results of these studies relating field dependency and field independency to laterality suggest that field dependence/
independence is related to the extent of differentiation of function of the two hemispheres. In other words, relatively field independent individuals show the generally expected pattern of cerebral organization, processing configurational material primarily in the left, while relatively field-dependent individuals show more cerebral ambilaterality.

Personality Correlates and Cognitive Style

What has been established so far is a rationale for relating neural processing to personality type as evidenced in the MBTI and neural processing to cognitive style (field dependence/independence). This final section provides the rationale for relating personality type to cognitive style.

Extensive research Witkin, Price-Williams, Bertini, Christiansen, Oltman, Ramirez, and Van Meel (1974); Witkin, Moore, Goodenough, and Cox (1977); Witkin and Goodenough (1977) has provided evidence that individual differences in perceiving are related to differences in overall psychological organization -- that is, personality. Witkin, Lewis, Hertzman, Machover, Meissner and Wapner (1972) have categorized specific personality characteristics as having particular relevance to performance on perceptual tasks: the nature of the individual's relation to his environment (including other people), the way in which he manages his impulses and strivings, and the kind of conception he has of himself.

The one characteristic which most effectively discriminates among people with different modes of perception, and thus is pertinent
to this study, is the nature of the individual's relation to his environment and other people. Witkin et al. (1972) state:

The attitudes and behavior involved represent two more-or-less opposite trends: one, passivity, is associated with field dependent perceptual performance; the other, activity, is associated with independent or analytical perceptual performance (p. 465).

Witkin and his colleagues (1972) describe passivity (field dependence) as the "inability to function independently of environmental support, an absence of initiating activity, and a readiness to submit to forces of authority" (p. 465). This description of a field dependent perceptual performance is congruent with Isabel Briggs Myers (1980) descriptions of a sensing and feeling personality type:

Sensing types desire chiefly to possess and enjoy, and being very observant, they are imitative, wanting to have what other people have and do what other people do, and are very dependent upon their physical surroundings (p. 63).

Feeling types are likely to agree with those around them, thinking as other people think, believing them probably right. They are usually personal, being more interested in people than things (p. 68).

Witkin et al. (1972) describe activity (field independence) as the "ability to function with relatively little support from the environment, a capacity for initiating and organizing, and the power to struggle for mastery over social and other environmental forces" (p. 465). This description of a field independent perceptual performance is congruent with Myers (1980) descriptions of an intuitive and thinking personality type:
Intuitive types desire chiefly opportunities and possibilities, and being very imaginative, they are inventive and original, quite indifferent to what other people have and do, and are very independent of their physical surroundings (p. 63).

Thinking types are able to organize facts and ideas into a logical sequence that states a subject, makes the necessary points, comes to a conclusion, and stops there without repetition. They are usually impersonal, being more interested in things than in human relationships (p. 68).

Therefore, field dependent individuals are characterized as having a dominant "S" function (relying primarily on sensing for purposes of perception), and/or a dominant "F" function (preferring feeling for purposes of judgment). Field independent individuals are characterized as having a dominant "N" function (relying primarily on intuition for purposes of perception), and/or a dominant "T" function (preferring thinking for purposes of judgment).

Several researchers have examined the relationship between cognitive style (field dependence/independence) and personality type as determined by the Myers Briggs Type Indicator (Helson, 1966; Bissiri, 1971; Deines, 1974; Eggins, 1979; Novak, 1982).

While investigating the degree of creativity in women, as determined by the MBTI Intuitive and Perceptive scales, Helson (1966) found a correlation between an Intuitive Personality Type and field independence. Adolescents and adults were subjects in a study conducted by Bissiri (1971), who also reported a relationship between an Intuitive Personality Type and field independence.

Deines (1974) investigated the relationship between three categories of college majors and selected cognitive styles, one of which
was the field dependent/independent dimension, and found a significant relationship between field independent and intuitive perceptive inclinations among science majors.

Four hundred grade six children were subjects in a study conducted by Eggins (1979), who examined the interaction between the structure of learning materials and the personality type of learners. Eggins' study has particular relevance to this study because the Group Embedded Figures Test (GEFT) as well as the sensing-intuitive scale and the judging-perceptive scale of the Myers Briggs Type Indicator (MBTI) were used as personality determinants. The correlation reported between the GEFT and MBTI (sensing/intuitive scale) had a significance level of .001, however, the shared variance between the GEFT and MBTI was only 4%.

Novak (1982) investigated the relationship between field dependent/independent cognitive styles (assessed by the GEFT) and personality types (determined by the MBTI) of 144 secondary high school students enrolled in physical science, physics, and chemistry classes. He found a significant positive correlation (.01) between a dominant sensing personality type and field dependence and a dominant intuitive personality type and field independence. No significant positive correlations were reported between the GEFT and other indices on the MBTI.

In summary, several research studies have supported the relationship between a Sensing Personality Type and field dependence and an Intuitive Personality Type and field independence, but to this writer's
knowledge, there are no studies which have reported positive correlations between a Feeling Personality Type and field dependence and a Thinking Personality Type and field independence.

Qualitative Literature Review

A secondary purpose of this study was to document patterns which suggested how prospective teachers, who had been given the opportunity to learn about learning processes and to investigate and understand their own learning processes, attempt to translate that information into more appropriate learning and teaching behaviors. The writer was interested in determining if prospective teachers could document how the theory underlying learning processes could facilitate their ability to understand and identify specific learning behaviors in others, thereby enabling them to develop and implement instructional strategies to accommodate individual learning needs. To the writer's knowledge, there are no studies which directly address this issue.

There were studies, however, which indirectly addressed the issue. Copeland (1975; 1979), Copeland and Doyle (1973), and Peterson (1973) attempted to verify prospective teachers' ability to persist in using university training skills in their student teaching classroom. These researchers generally agreed that persistent use of skills by student teachers subsequent to training may depend not only on the initial training, but on the ecological system in which the skills are to be used. In other words, if student teachers are expected to continue to use the teaching skills which are the targets of their training programs, teacher educators should identify classroom
environments which are congruent with the use of those particular methods of instruction and skills.

A follow-up study is presently underway to determine if the preservice teachers, who are now doing their student teaching, are actively involved in assessing individual learning processes, developing appropriate teaching methodologies to accommodate individual learning needs, and adjusting their teaching style to support individual learning styles. The student teaching cites were carefully chosen so that there was congruency between the experienced teachers' classroom ecosystem and the training goals of the learning style teacher education program.

Another line of research which is related to transference of knowledge and training concerns in-service teacher training. Joyce and Showers (1980) examined the research on teachers' abilities to acquire teaching skills and strategies and concluded that teachers consistently are able both to "fine-tune" existing skills and to learn new ones, if the combination of three training elements are evident: the study of the theory underlying the skill, the opportunity to observe multiple demonstrations, and practice and feedback either under simulated conditions or in the classroom is provided. In a more recent article, Joyce and Showers (1981) argue that an additional further step, on-site coaching, is most important for acquisition of a new teaching strategy into the teacher's active repertoire.

Studies have also been conducted which looked at in-service teacher training and curriculum implementation. Fullan and Pomfret
(1977) found that a low degree of curriculum implementation could be expected if explicit characteristics and rationale for the innovation were not explained. They also found that teachers were more likely to alter their curriculum rather than their teaching style.

Joyce, Brown, and Peck (1981) demonstrated that a teachers' ability to acquire new models of teaching was improved if they had already mastered two or more models. In other words, cumulative practice in learning a series of models of teaching led to increased facility in learning how to learn.

Longitudinal studies have shown that lengthy follow-up feedback after initial training resulted in greater transference of knowledge and skills at the classroom level. Feldens and Duncan (1978) found that observation, feedback, and goal-setting increased the effect of training, while Borg, Langer and Kelley (1971) concluded that teachers incorporated their newly acquired training skills into their active teaching repertoire after an initial training which included presentation, modeling, practice, and feedback. Good and Brophy (1974) demonstrated the effectiveness of feedback after four months of classroom observation. Karen, Snow, and McDonald (1971) documented the efficacy of modeling for redirecting teacher behavior.

In conclusion, it appears that if prospective teachers are to become skillful decision-makers, who can determine individuals learning processes and develop appropriate instructional strategies to meet individual learning needs, the theory underlying learning processes must be well presented, teaching approaches to accommodate individual learning preferences must be demonstrated, practice must
be provided under simulated conditions with careful and consistent feedback, and that practice must be followed by application in the classroom. In addition, in-service and continual feedback and support should be provided throughout the first few years of teaching, so that the teacher is comfortable and skillful in her ability to assess individual learning processes.
CHAPTER III
PROCEDURES

Three major sections comprise this chapter. The initial section, entitled Preliminary Procedures discusses the sequence of events which gave direction to this investigation. Research Procedures, the second section of the chapter, describes the population sampled, the instruments used to determine the personality and cognitive style components in the proposed learning style model, the tasks utilized for the EEG portion of the study, the experimental EEG procedures and the qualitative data collection. A description of the data analysis for both the quantitative and qualitative components of the study complete this chapter and is presented in the section entitled Analysis of Data.

Preliminary Procedures

Chapter I presented a description and results of the 1981 pilot study which was the basis for developing the learning style model. Once the hypothesized substrates of an individual's learning processes had been identified, careful consideration was given to selecting instruments to assess each of the three dimensions. Knowledgeable colleagues agreed that the MBTI and the RFT, CFT, and GEFT were the most reliable and valid instruments in use today for assessing the personality and cognitive style substrates of an individual's learning process.

78
A critical factor to consider when designing an EEG study concerns electrode placement. Research conducted by Nunez (1981) and Naour (1982) supported the use of bipolar electrode pairs as a more reliable means to assess cortical activation along a line connecting the two electrodes of each pair. According to Luria (1973), the principle of lateralization of higher functions in the cerebral cortex begins to operate only with the transition to the secondary, and in particular, the tertiary zones. These zones are located in the posterior half of the cortex, generally where the occipital, temporal and parietal lobes merge into each other. The bipolar placement P3-T5 (left) and P4-T6 (right) is located at the junction of this tertiary zone and therefore was selected as the most appropriate cite for the electrode placement.

An EEG pilot study was conducted at The Ohio State University during Spring Quarter 1982. Subjects were three adult female education majors in the learning style block program who had not elected to participate in the entire research project, but agreed to take part in the EEG portion of the study. The purposes of the pilot study were as follows:

1. To completely familiarize the investigator with all procedures proposed in the study from data analysis to frequency analysis.

2. To select appropriate cognitive tasks that demonstrate in the pilot study the potential to discriminate between spatial and analytical cognitive processing modalities. Tasks under consideration included: a Gestalt face discrimination, a mental rotations
task, an arithmetic computation task, a deciphering language task, an inferencing task, and an embedded figures task.

3. To assess the efficiency of a protocol task booklet which provided written instructions for task performance, a one item example of each task for practice, and selected items reflecting difficult and easy spatial and analytical tasks which should each take one minute to perform.

4. To monitor the effectiveness of a response box which indicated the subjects response, thereby controlling for limb movement and vocalization.

The results of the EEG pilot study provided a basis for determining that the arithmetic computation task was less likely to demonstrate laterality than the other five cognitive tasks, therefore, it was eliminated from the main study task protocol. Chapter I discusses the four criteria used in determining the cognitive tasks (p. 17).

It was also demonstrated that vocalization was not necessary when the directions for performing the task were individually read by each subject and they completed a practice item before the EEG recording was started. Limb movement was curtailed because the tasks were presented in booklet form with the investigator turning the pages. In addition, the tasks were of forced choice variety with the subject indicating her answer by pushing one of five buttons which illuminated the response for recording. These precautions
were suggested by Gevins (1979) if the investigator in attempting to infer cognitive processing from EEG data.

In a pilot study conducted by Naour (1982), a different EEG pattern was consistently reported midway through the protocol, suggesting the formation of a cognitive set or warm-up effect. In order to control for this cognitive sensitivity, the protocol items were doubled with half the subjects performing the tasks in a specified order, the remaining subjects performing the same tasks in the reverse order.

Research Procedures

Eighteen right-handed and two-left handed adult female elementary education majors enrolled in a learning style program of study at The Ohio State University volunteered for this study. Data was collected throughout the Autumn, Winter, and Spring Quarters in the 1981-1982 academic year in the following sequence.

Form F of the Myers-Briggs Type Indicator (1976) was administered during the first quarter. This 166 item, forced-choice, self-report inventory was developed by Myers and designed "to implement Jung's theory of type" (Myers, 1962, p. 1). This particular instrument was used to determine the personality substrate in the learning style model for several reasons:

1. The instrument was designed to be used with normal subjects, and thus was not considered a personality measure of psychopathology.

2. The instrument was not designed to assess aptitude, but rather to indicate how much an individual relies on and employs one
function or another. This capability of the MBTI allows the investigator to plot the personality dimensions on a continuum, which was an important consideration in selecting all the instruments for this study.

3. The MBTI was designed to determine a subject's type preference of four bi-polar indices. This study only used two of those indices: sensing/intuition and feeling/thinking. Thus the MBTI indicated the degree of preference between two dichotomous functions, which is exactly what the EEG and cognitive style (field dependent/field independent) instruments determined.

4. The reliability of the instrument has been investigated (Mendelsohn, 1970; Stricker and Ross, 1962; Carlyn, 1977). Carlyn (1977) assessing the stability of type-category and continuous scores (N = 1371) using test-retest data found higher than would be expected by chance correlations. She concluded that the reliability for the MBTI seemed reasonable for a self-report inventory (Carlyn, 1977). Most of the reliability tests conducted using Form F of the MBTI involved high school and college students. It appears that the stability of type preference increases with age, and therefore the Form F version of the MBTI is less reliable with junior-high students.

5. Numerous studies of construct validity summarized by Carlyn (1977), suggest that the individual scales of the MBTI measure important dimensions of personality which appear very similar to those postulated by Jung. Findings indicate that MBTI scores relate
meaningly to a large number of variables including personality, ability, interest, value, and performance measures (Mendelsohn, 1965).

To summarize, within the realm of what can be expected of a theoretically based, self-report questionnaire, the MBTI represents a well-tested instrument to measure an extremely complex dimension. It was therefore decided that the MBTI would serve as the dependent variable in this study.

During the second quarter, three assessment measures of cognitive style were administered: the portable Rod and Frame Test (RFT), the Group Embedded Figures Test (GEFT) and the Concealed Figures Test (CFT). These instruments served as three independent variables in this study.

The Rod and Frame Test (RFT) is an individually administered measure of field dependence/independence (Witkin, et al., 1962). The portable version of the RFT (Oltman, 1968) was used because it is less cumbersome. An experimental nonverbal procedure (Berlin and Languis, 1981) of the RFT was administered in order to assess spatial right-hemisphere cognitive processing. The subject is required to determine the true vertical of a rod despite the conflicting visual clues from a titled frame. In the non-verbal administration, the investigator moved the rod from its set position of 28° right or left of the true vertical in intervals of 2° to 3° until the subject told the investigator that the perceived vertical was reached. Raw scores on the Rod and Frame Test indicate the sum, over 8 trials, of the absolute deviations of a rod from true vertical when surrounded
by a frame titled 28°. The lower the score on the sum of deviations from the true vertical, the more field independent the subject is; the higher the deviated score, the more field dependent the subject is. Test-retest reliabilities for the RFT have been consistently high. Witkin, Goodenough, and Karp (1967) computed reliability scores for 10 to 24 year olds in an extensive longitudinal study and reported .81 (N=24, p < .01) for females.

The Group Embedded Figures Test (GEFT) is a group administered measure of field dependence/independence modelled as closely as possible on the individually administered Embedded Figures Test (EFT) (Witkin, et al., 1962). It contains 18 complex figures, 17 of which were taken from the EFT. The subject is required to dis-embed an item from an organized field of which it is a part, however, there is no body-field juxtaposition or perception of the upright as in the RFT. To locate the simple figure it is necessary to break up the organized pattern so as to expose the figure. The time limit of 5 minutes for each of two sections was set on the basis of pre-testing which indicated that, for college samples, this time constraint permitted a portion of subjects to attempt every item and also yielded a normal-appearing frequency distribution with a wide range of test scores. It was found that subjects who had difficulty separating the sought-after simple figure from the complex design were the ones who could not easily keep the rod separate from the frame in the orientation test -- in other words, were the ones who were field dependent. Conversely, people who were field independent
in the orientation test found it easy to overcome the influence of the organized complex design in locating the simple figure within it. Gardner, Jackson and Messick (1960) reported a .95 reliability for college women on the EFT, from which the GEFT was modeled. Correlations between the RFT and versions of the EFT were statistically significant and generally in the .30-.65 range (Goldstein & Blackman, 1978).

The Concealed Figures Test (CFT) developed by Thurstone and Jeffrey (1965) was designed to measure the subjects ability to hold a configuration in mind despite distraction and then visualize that configuration within a more complex drawing, diagram, or figure. The CFT is a ten minute timed paper and pencil group administered instrument which contains 49 items. Each item consists of a figure, presented on the left of the page, followed by a row of four, more complex, drawings to the right. Some of these four, more complex, drawings contain the given figure in its original size and orientation. The subject is instructed to look for the original figure in each of the complex drawings and to put a check under each drawing which contains it and a zero under each which does not. The raw score is the number of correct answers minus the number of incorrect answers and represents the usual correction for guessing. The maximum raw score is 196 which would indicate an individual who can quickly and correctly see a given configuration in a complex drawing and therefore is considered field independent. Low scores on the CFT would indicate a relatively field dependent individual. Thurstone (1944) reports a split-half reliability coefficient of .78, for adult males. Trent (1974) reported a statistically significant < .05 correlation between the CFT and RFT.
The Quick Word Test (QWT) developed by Borgatta and Corsini (1964) was also administered during this second quarter. The QWT was designed to measure the mental ability (I.Q.) of the subjects. While I.Q. was not considered an integral part of an individual's learning processes, as documented in the proposed learning style model, it was suggested that an individual's intelligence may explain some of the variability in the MBTI score. The 100 multiple-choice vocabulary items of the test consist of stem words of five letters followed by four four-letter alternatives, one of which has the same meaning as the stem word. The subject's task involved the identification of the correct synonym. The options given in each item were specially chosen to suggest plausible associations with the stem word so that attempts to either superficially recognize or logically guess the correct synonym often had a negative effect. The QWT raw scores correlated .80 with the Otis Mental Ability Test, .84 with the Lorge-Thorndike Intelligence Test, and .73 with the California Short-Form Test of Mental Maturity. Split-half reliability coefficients were .90 for college students.

During the third quarter, an individual electroencephalogram (EEG) was recorded while each subject performed sequential-analytical and simultaneous-holistic (spatial) cognitive tasks associated with left and right cerebral hemispheres respectively. The battery of tasks administered to each subject during the EEG portion of the study were as follows: two baseline relaxation, attention to breathing tasks; two ten item presentations of the Mooney Faces task; two,
three item presentations of the Hidden Figures Task; two, two item presentations of a deciphering languages task; two, four item presentations of the mental rotations task; and two, two item presentations of an inference task (See Appendix D for examples of task stimulus items).

(1) Baseline Tasks. Each subject's EEG was recorded while relaxing and focusing her attention on her breathing with eyes open and fixated on a piece of white paper tacked on the wall behind the experimenter. This "task" was included primarily to relax the subject, acclimate her to the situation, and check the quality of the recording. It was also a non-cognitive "neutral" task utilized as a measure of the subject's resting state prior to cognitive activation and then again after the EEG recording was in progress midway through the task protocol booklet.

(2) The Mooney Faces task, designed by Craig M. Mooney in the early 50's is a Gestalt Assessment of visual closure and therefore considered a test of spatial ability (right hemisphere processing). The stimuli are black and white drawings of the heads and faces of miscellaneous people presented with only the salient shadows or highlights, revealed in strongly lighted photographs. Such incomplete pictures required visual closure. Subjects were presented three photographs and asked to indicate by pushing one of three buttons if they saw an old man or woman; boy or girl; or grown-up man or woman. Each subject was administered thirty items during the first half and thirty items during the second half of the protocol.
There was a possibility of 20 points if each item was answered correctly.

(3) The Hidden Figures task, an adaptation of the Gottschaldt Figures test populatized by Thurstone (1944), was included in the EEG protocol booklet in an attempt to determine neural processing while subjects were engaged in performing items which measured field dependent and field independent cognitive styles. Subjects were asked to indicate, by pushing one of five buttons, which of 5 geometrical figures was embedded in a complex pattern. Each subject was administered three items during the first half and three items during the second half of the EEG protocol, allowing for a possibility of 6 points if each item was answered correctly.

(4) The Deciphering Languages task selected from the Kit of Factor Referenced Cognitive Tests - Ekstrom, French, and Harman - 1976, was designed to determine a subject's ability to reason from premise to conclusion (inferring left hemisphere processing). Subjects were presented an artificial language, with three expressions in English and their translations into the artificial language. They then had to determine which syllable or symbol in the language was equivalent to which English word. Subjects were asked to indicate, by pushing one of five buttons, the correct translation for two phrases during the first half and two phrases during the second half of the EEG protocol. There was a possibility of 4 points if each item was answered correctly.
Eight items from the Mental Rotations Test (Vanderberg, 1978) were selected to measure spatial visualization (right hemispheric processing). Each item consisted of a criterion figure, two correct alternatives, and two incorrect ones or distractors. Correct alternatives were always identical to the criterion in structure but were shown in a rotated position. For half the items in the test, the distractors were rotated mirror-images of the criterion, while distractors in the other items were rotated images of one or two of the other criteria. The subjects were asked to indicate which two of four objects to the right of the criterion object were the same. For each item two of the four buttons indicated the correct response. Subjects were presented four items in the first half and four items in the second half of the protocol. There was a possibility of 8 points for each item and only those items were considered correct if the subject had selected both correct alternatives.

The Inference task selected from the Kit of Factor Referenced Cognitive Tests - Ekstrom, French, Harmon - 1976, was designed to evaluate the correctness of a conclusion thereby inferring left hemisphere processing. Subjects were presented one or two statements such as they might see in a newspaper followed by five conclusions which might be drawn from the statement. The subject was required to indicate by pushing one of five buttons, which of the five conclusions might be drawn from the original statement. Two items were presented in the first half and two items were presented in the second half of the protocol, allowing for a possibility of 4 points.
if each item was answered correctly. Forty-two points were the maximum number of points an individual could attain for the entire protocol.

Data for the EEG portion of this study was collected at The Ohio State University during a two week period beginning April 26, 1982 and concluding May 7, 1982. The raw data was collected utilizing a portable Beckman Accutrace 8 channel EEG unit.

Subjects were seated in a straight-back chair at a small table in a sound-attenuated room. An electro-cap, a snug fitting expandable nylon cap which is prewired with the 19 electrode locations of the International 10-20 system (Jasper, 1958) was fitted to the subject's head. The four electrode wells (P3-T5 and P4-T6) were activated by injecting Electro-Gel into the hole on top of the electrode plug. The cap was securely held in place by connecting it to an elasticized chest band. The electrode placement procedure was complete after an ear clip ground was secured to the subject's right ear lobe.

Once electrode activation was determined, impedance levels were verified. An impedance meter, which is built into the selector panel of the EEG unit, assessed the quality of the contact. Impedance levels below 10,000 ohms were required. A lead terminator transmitted the signal to an adjoining room for recording via a connector cable which ran through a wall opening. An intercom enabled the experimenter and the recording assistant to communicate during the protocol administration.
The EEG signal was conveyed via the connector cable to the Beckman Accutrace unit for ink writing which produced a permanent hard copy. The EEG audio signal was also recorded on a Pioneer Model 555 stereo cassette recorder after it had been converted by a Vetter F.M. converter. Calibration of the EEG unit was checked prior to and after each recording session. Approximately one minute of EEG recording was observed during ink writing to assure the quality of the signal. Each of the ten tasks and the baseline data were isolated on the cassette by ten to twenty inches of blank tape to assure accurate location of tasks and frequency analysis. The recording assistant noted the numeric references that began and ended each task for a permanent written record.

There was very little limb movement and vocalization during the task presentation. Subjects could remain still because the tasks were presented in booklet form with the experimenter turning the pages. In addition the subjects were instructed to use their left hand when pushing the buttons on the response box. Vocalization was minimized because the instructions for each task were individually read by each subject prior to attempting the task.

Qualitative data were collected throughout the three quarters of the learning style program of study. Subjects kept detailed self-analysis journals which focused on varied aspects of the teaching/learning process.

During the first quarter, the self-analysis journals focused on self. The rationale for writing these introspective accounts stemmed
from the writer's belief that the subjects needed to reflect on and begin to understand their own learning processes before they could be expected to understand others learning processes. Therefore the first journal entry asked subjects to describe as fully as possible how they learned best and taught best. This entry, made during the first session of the learning style seminar before subjects had any formal instruction concerning learning processes, served as a benchmark to determine if these prospective teachers could describe their learning processes. These were the same questions asked of the student teachers and cooperating teachers in the 1981 pilot study discussed in Chapter 1.

Seminars were conducted during this first quarter which provided these students a theoretically sound learning processes framework, based on contemporary research in brain functioning. In addition, the pre-service teachers instructed students from kindergarten through fifth grade who were identified by their classroom teacher as learning disabled. These seminars, held in conjunction with the field component, provided a context in which neurological substrates of learning could be related to individual differences in learning style.

Once the students had developed a framework for understanding learning processes in general, they began to look at processing strategies. The second quarters journal entries focused on learning and teaching methodologies. The subjects identified a personal goal, not necessarily associated with academic work, which they
aspired to accomplish in their lifetime and discussed learning strategies which would facilitate accomplishment of that goal. In addition they indicated the processing strategies used to perform the CFT, GEFT, and RFT administered during this second quarter.

These prospective teachers were enrolled in Language Arts and Science Methods courses during this second quarter and spent two afternoons per week teaching in grades K-5. In designing their weekly lessons, they were required to develop alternative methods for teaching Science and Language Arts and then experiment with varied instructional strategies to meet individual learning needs. At the close of the quarter, the pre-service teachers journal entry was to discuss how knowledge of learning style and learning processes enabled them to better understand and develop alternative methodologies to meet individual learning needs.

The focus of the third quarters journal entries was on the prospective teachers estimation of the quantitative data analysis adequately reflected the qualitative data as written in their self-analysis journals. It must be established that no information was provided concerning the results of the quantitative measures (MBTI, CFT, GEFT, RFT, and EEG) until two weeks before the close of the third quarter. After the subjects were presented the results of the personality, cognitive style, and neural processing assessments, they were asked to strongly agree, moderately agree, or strongly disagree with each measure discussing their position in detail. The
final journal entry concerned what relationship the pre-service teacher saw between her learning style and teaching style.

Analysis of Data (quantitative component)

The 20 completed MBTI questionnaires were hand scored. Raw scores were converted to continuous scores employing formulas developed by Myers (1962). These continuous scores determined the dominant function of the subjects. Raw scores for the CFT, GEFT, RFT, and QWT were calculated according to specifications in their respective manuals.

Several processes were required in order to analyze the cassette record of the raw EEG data. First the output from the cassette recording was fed back through the F.M. converter, low pass filtered at 30Hz, high pass filtered at .5Hz and converted to a digital signal by the analog to digital converter custom designed and built for the Biomedical Hybrid Computer Facility at O.S.U. Next the digital signal was immediately sent to the PDP 11/45 (Digital Equipment Corporation) for storage on an RKO 5 hard disc. After the digitized EEG record was stored, the Fast Fourier Transform program was performed. The program was designed to analyze the percent of total activity per 4 Hz increment. In this study a ten second analysis increment with computer sampling of the digitized signal every .01 second was used. Therefore a total of 1024 samples per 10 second analysis was determined. An on-line print out of the data analysis was performed by the DEC writer (Digital Equipment Corporation). Print out was broken down into 4 Hz increments (.1
to 3.9, 4 to 7.9, 8 to 11.9, etc.) showing the percent of total power contained within each 4 Hz window. The print out displays one second epochs of analysis which is summed for the duration of the entire task. In this way, analysis of the electrical activity over the right and left hemispheres could be assessed while subjects performed each of the ten cognitive tasks. For this study, the sum of the activity in the alpha band (8-12 Hz) was divided by the sum of activity in three increments of the beta band (12-16 Hz, 16-20 Hz, and 20-24 Hz). Laterality was determined by computing the activity of the right hemisphere divided by the activity of the left hemisphere for each task.

Analysis of Data (quantitative component)

The main analysis of this study determined the degree of correlation between the three constructs investigated: personality—indicated by the MBTI, neural processing—determined by the EEG, and cognitive style—measured by the CFT, GEFT, and RFT. Significant associations or relationships between these five tests were calculated by means of the SPSS Pearson Product Moment correlation. These initial statistical procedures directly tested the hypotheses of this study.

There was one dependent variable: the MBTI score for subjects characterized as dominant sensing/intuitive personality types or dominant thinking/feeling personality types. There were four independent variables: the total EEG score, the CFT, GEFT, and RFT score.
Stepwise multiple regression analysis was designed to determine how much variance in the MBTI was explained or shared by five independent variables (total EEG, CFT, GEFT, RFT and the Quick Word Test (QWT). The QWT determined the subject's I.G. and represented an extraneous variable, which may be directly related to the subject's personality type, cognitive style, and neural processing.

Analysis of Data (qualitative component)

Content analysis was designed to analyze three entries recorded in the self-analysis journals. The same coding procedures and categories used in the 1981 pilot study (discussed in Chapter 1, p. 4) were utilized in this study. Three individuals, two males and one female, with varying professional backgrounds, were trained to code the three journal entries.

The writer conducted two training sessions to explain the procedures to follow for this analysis. In the first session the content areas of the study (neural processing, personality theory, and cognitive style) were defined "conceptually" and "functionally". The theoretical framework, which included the assumptions and perspectives the writer held, were delineated and the theory upon which the coding instrument was based was defined and outlined. Specific words and phrases which identified the constructs to be investigated (Appendix C) were examined.

In the second session, step by step procedures the three coders should follow in sorting the responses were outlined (Appendix G). Examples from pilot data (Appendix H) were provided to familiarize the
coders with the content analysis process. Rules for assigning the responses to the hypothetical coding categories were explained. Included in these rules were: (1) The degree to which coders should "read into" the responses; i.e., how much should the coder make inferences. (2) The criteria for determining uncodable responses. (3) Procedures to follow when a response does not seem to fit into a category. (4) Procedures for handling "problem" responses, including omissions, cryptic or undecipherable responses, responses which can be placed into more than one category, "I don't know"; "no comment"; "does not apply", etc. responses. (5) The scoring algorithm for determining the final coding score was explained (Appendix I).

Journal entries which were to be coded were duplicated and presented to the three raters along with the coding scheme, which delineated words or phrases for classifying the subjects' responses, coding procedures for content analysis of the twenty protocols, and a summary sheet (Appendix I) designed to summarize the data and determine if the subjects' preferred right or left hemisphere processing modalities to learn and teach.

The first journal entry was analyzed using the content analysis procedure. This entry was made during the first session of the learning style teacher education program, prior to the subject's having any formal instruction concerning learning processes. This entry served as a benchmark in determining what these prospective teachers thought their learning style was. The two item questionnaire stated: Describe as fully as possible how you learn best. Describe as fully as possible how you teach best (Appendix B).
The other two journal entries, which were analyzed through content analysis, were recorded during the last two weeks of the third quarter of the teacher education program. The subjects were not presented any information concerning the results of the quantitative measures until this time. After the subjects were presented the results of the personality, cognitive style, and neural processing assessments, they were asked to strongly agree, moderately agree, or strongly disagree with each measure discussing their position in detail (Appendix E). The final journal entry asked these prospective teachers to discuss what relationship they saw between their learning style and teaching style (Appendix F).
CHAPTER IV

ANALYSIS AND DISCUSSION OF THE DATA

This chapter is divided into two major sections: 1) analysis of the quantitative data; 2) analysis of the qualitative data. The quantitative analysis is further divided into reporting and discussing the statistical results as they relate to a) group data and b) individual differences for the five quantitative hypotheses. The qualitative analysis presents written documentation from the self-analysis journals which support the five qualitative hypotheses and reports the results of the content analysis used to analyze the three journal entries discussed in Chapter 3.

Quantitative Data Analysis

Part 1 - Analysis of Group Data

In order to clarify the hypothesized laterality direction (more right hemisphere or more left hemisphere activation) and the hypothesized cognitive style direction (more field dependent or more field independent orientation) and their relationship to the dominant MBTI functions (sensing, intuitive, thinking, and feeling), the following scales are presented.

When regressions of dependent variables (sensing, intuition, thinking and feeling) are plotted on the indices, the continuous scores (33 to 161) increase normally from left to right. Therefore a strong preference for sensing will be on the far left side of the
continuum; while a strong preference for intuition will be on the far right side of the continuum (Myers, 1962). Slight preferences will fall near the center of the continuum.

According to the theory presented in Chapter 1, a dominant sensing personality type is more likely to be field dependent and demonstrate greater right hemisphere activation during task performance, while a dominant intuitive personality type is more likely to be field independent and demonstrate greater left hemisphere activation during task performance.

\[
\begin{array}{ccc}
\text{(S) Sensing} & \text{to} & \text{(N) Intuition} \\
33 & 99 & 101 & 161 \\
\text{Right Hemisphere} & \text{to} & \text{Field Dependent} \\
\text{Field Independent} & \text{to} & \text{Left Hemisphere}
\end{array}
\]

When plotting the continuous scores (33 to 161) for the thinking/feeling personality types, a strong preference for thinking will be on the far left side of the continuum; while a strong preference for feeling will be on the far right side of the continuum (Myers, 1962).

According to the theory, a dominant thinking personality type is more likely to be field independent and demonstrate greater left hemisphere activation during task performance, while a dominant feeling personality type is more likely to be field dependent and demonstrate greater right hemisphere activation during task performance.

\[
\begin{array}{ccc}
\text{(T) Thinking} & \text{to} & \text{(F) Feeling} \\
33 & 99 & 101 & 161 \\
\text{Left Hemisphere} & \text{to} & \text{Right Hemisphere} \\
\text{Field Independent} & \text{to} & \text{Field Dependent}
\end{array}
\]
Table 1 lists the descriptive data (means and standard deviations) for each of the variables (MBTI, total EEG, GEFT, CFT, RFT, QWT), attained by the dominant sensing/intuitive personality type, dominant thinking/feeling personality type, and combined groups. Raw scores for each of these variables are presented in Appendix J.

**TABLE 1**

**COMPARISON OF THE MEANS AND STANDARD DEVIATIONS BY GROUP**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total Group</th>
<th>Sensing/Intuitive</th>
<th>Thinking/Feeling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=20</td>
<td>N=10</td>
<td>N=10</td>
</tr>
<tr>
<td>MBTI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>108.50</td>
<td>100.80</td>
<td>116.20</td>
</tr>
<tr>
<td>SD</td>
<td>26.81</td>
<td>33.72</td>
<td>15.78</td>
</tr>
<tr>
<td>Total EEG*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>1.10</td>
<td>.97</td>
<td>1.22</td>
</tr>
<tr>
<td>SD</td>
<td>.34</td>
<td>.17</td>
<td>.42</td>
</tr>
<tr>
<td>GEFT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>12.70</td>
<td>13.70</td>
<td>11.70</td>
</tr>
<tr>
<td>SD</td>
<td>5.01</td>
<td>5.41</td>
<td>4.64</td>
</tr>
<tr>
<td>CFT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>94.40</td>
<td>100.00</td>
<td>88.80</td>
</tr>
<tr>
<td>SD</td>
<td>18.23</td>
<td>14.63</td>
<td>20.45</td>
</tr>
<tr>
<td>RFT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>4.38</td>
<td>4.75</td>
<td>4.01</td>
</tr>
<tr>
<td>SD</td>
<td>5.31</td>
<td>5.29</td>
<td>5.59</td>
</tr>
<tr>
<td>QWT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>46.15</td>
<td>45.50</td>
<td>46.80</td>
</tr>
<tr>
<td>SD</td>
<td>17.16</td>
<td>19.64</td>
<td>15.32</td>
</tr>
</tbody>
</table>

*Refer to Chapter 1 for formula for calculating laterality.

Table 2 presents the intercorrelations among the variables for each of the three groups (combined, dominant sensing/intuitive, and
### TABLE 2

**INTERCORRELATIONS BY SENSING/INTUITIVE, THINKING/FEELING, AND TOTAL GROUP**

N = 20

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>N</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 MBTI</td>
<td>Total</td>
<td>20</td>
<td>1.00</td>
<td>-0.17</td>
<td>0.18</td>
<td>-0.07</td>
<td>-0.19</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>S/N</td>
<td>10</td>
<td>1.00</td>
<td>-0.29</td>
<td>0.37</td>
<td>0.35</td>
<td>-0.18</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>T/F</td>
<td>10</td>
<td>1.00</td>
<td>-0.56&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.01</td>
<td>-0.48&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.22</td>
<td>-0.29</td>
</tr>
<tr>
<td>2 Total</td>
<td>EEG</td>
<td>20</td>
<td>1.00</td>
<td>-0.37&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.20</td>
<td>0.53&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S/N</td>
<td>10</td>
<td>1.00</td>
<td>-0.33</td>
<td>-0.53&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.37</td>
<td>-0.17</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T/F</td>
<td>10</td>
<td>1.00</td>
<td>-0.38</td>
<td>0.02</td>
<td>0.76&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.03</td>
<td></td>
</tr>
<tr>
<td>3 GEFT</td>
<td>Total</td>
<td>20</td>
<td>1.00</td>
<td>0.42&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.77&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S/N</td>
<td>10</td>
<td>1.00</td>
<td>0.59&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.91&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T/F</td>
<td>10</td>
<td>1.00</td>
<td>0.22</td>
<td>-0.71&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 CFT</td>
<td>Total</td>
<td>20</td>
<td>1.00</td>
<td>-0.26</td>
<td>0.27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S/N</td>
<td>10</td>
<td>1.00</td>
<td>-0.60&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S/F</td>
<td>10</td>
<td>1.00</td>
<td>-0.10</td>
<td>0.35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 RFT</td>
<td>(Reflected)</td>
<td>20</td>
<td>1.00</td>
<td>-0.28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S/N</td>
<td>10</td>
<td>1.00</td>
<td>-0.47</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T/F</td>
<td>10</td>
<td>1.00</td>
<td>-0.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 QWT</td>
<td>Total</td>
<td>20</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S/N</td>
<td>10</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T/F</td>
<td>10</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup><sub>p < .05</sub>  
<sup>b</sup><sub>p < .01</sub>  
<sup>c</sup><sub>p < .001</sub>

(Observed significant levels reported are one-tailed)
dominant thinking/feeling respectively). In addition those correla-
tions which were significantly different from zero (.05, .01, or .001
level of significance) are indicated. It should be noted that since
the RFT scores were error scores, this variable was reflected.

Hypothesis 1: There is a significant ( < .05) correlation
between the functioning of the right hemisphere and field dependence
and the functioning of the left hemisphere and field independence.

When examining the neural processing and cognitive style (field
dependent/independent) constructs by placing them on a continuum, a
strong preference for greater left hemisphere activation and field
independence is on the far left side of the continuum; while a strong
preference for greater right hemisphere activation and field dependence
is on the far right side of the continuum.

<table>
<thead>
<tr>
<th>LH</th>
<th>1.00</th>
<th>RH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Independent</td>
<td>1.00</td>
<td>Field Dependent</td>
</tr>
</tbody>
</table>

The higher the scores on the GEFT and CFT the more field inde-
dependent the individual is, the lower the scores on these two instru-
ments the more field dependent the subject is. The opposite scoring
procedure is utilized for scoring the RFT. Low scores on the RFT are
associated with field independence, whereas higher scores are associated
with field dependence.

Discussion

In the total group (see Table 2), the correlations between total
EEG and GEFT (-.37) and total EEG and RFT (+.53) were significant in
the hypothesized direction. While the correlation between the total
EEG and the CFT (-.20) did not reach the .05 level of significance, it did correlate in the expected direction. This evidence suggests that all three measures of cognitive style administered to the total group in this study support the theory postulated in the proposed learning style model in the hypothesized direction.

There is support that field dependence and visuo-spatial tasks performance are related to the functioning of the right hemisphere in studies involving patients with unilateral brain disease (De Renzi & Spinnler, 1966; Kimura, 1963; Pizzamiglio & Carli, 1974), and studies involving children (Berlin & Languis, 1981). Renna & Zenhausern (1976) and Berent & Silverman (1973) provided additional support for the relationship between field dependence and right hemisphere processing using normal adult undergraduates.

A small body of research, however, found a significant involvement of only the left hemisphere in field dependence-independence. When female patients received an electroconclusive shock to the left hemisphere they showed more field dependence whereas when they received right ECT shocks they showed less field dependence (Cohen, Berent, and Silverman, 1973).

Table 2 shows that for the sensing/intuitive group (N=10), the total EEG was a significant correlate of the CFT (-.53); and for the thinking/feeling group (N=10) total EEG was a significant correlate of the RFT (.76). In both instances the cognitive style measures reflected the EEG lateralization in the hypothesized direction. These results indicate that for the sensing/intuitive group the CFT
is more likely to indicate neural processing activation, whereas for the thinking/feeling group, the RFT (non-verbal administration) tends to be a better predictor of neural processing.

The correlations between the GEFT and CFT were significant for the total group (.42) and the sensing/intuitive group (.59). The correlations between the GEFT and the non-verbal administration of the RFT were highly significant for the total group (-.77) and the sensing/intuition group (-.91) and moderately significant for the thinking/feeling group (-.71). These results suggest that the non-verbal administration of the RFT and the GEFT may be measuring the same factor, especially for the sensing/intuitive group. In addition, there was a significant correlation between the CFT and the RFT (-.60) for the sensing/intuitive group.

Hypothesis 2: There is a significant (< .05) correlation between a dominant sensing personality type and field dependence and a dominant intuitive personality type and field independence as measured by the RFT, GEFT, and CFT.

When plotting the raw scores on the GEFT and CFT on the sensing/intuitive scale of the MBTI, one would theoretically expect that a high score on the GEFT and CFT would correspond to a high MBTI (dominant intuitive) score and a low score on the GEFT and CFT would correspond to a low MBTI (dominant sensing) score, hence, these scores would be positively correlated. The results reported on Table 2 support this position. The sample correlation between the sensing/intuitive scale on the MBTI and the GEFT is +.37, and the CFT is +.35.
Since a low score on the RFT is associated with field independence, one would theoretically expect a low RFT score to correspond to a high MBTI (dominant intuitive) score, and a high RFT score to correspond to a low MBTI (dominant sensing) score. The sample correlation reported on Table 2 for the sensing/intuitive scale of the MBTI and the RFT is -.18.

Discussion

None of these correlations reached < .05 level of significance, however, two of the sample correlations (GEFT p=.14 and CFT p=.15) appear significant especially when one considers the small sample size (N=10). The results do, however, suggest specific trends and tendencies for subjects classified as dominant sensing personality types on the MBTI to have a field dependent orientation for perceiving information and experiences, while subjects classified as dominant intuitive personality types on the MBTI tend to have a field independent orientation for perceiving information and experiences.

There is support that a field independent cognitive style (determined by the GEFT) and an intuitive personality type (determined by the MBTI) are related in studies involving junior high school (Eggins, 1979) and high school (Novak, 1982) students.

Hypothesis 3: There is a significant (< .05) correlation between a dominant thinking personality type and field independence and a dominant feeling personality type and field dependence as measured by the RFT, GEFT, and CFT.
When plotting the raw scores on the GEFT, CFT, and RFT on the thinking/feeling scale of the MBTI, one would theoretically expect that a low score on the GEFT and CFT would correspond to a high MBTI (dominant feeling) score and a high GEFT and CFT score would correspond to a low MBTI (dominant thinking) score, therefore these scores should be negatively correlated. Conversely a high RFT score would correspond to a high MBTI (dominant feeling) score and a low RFT score would correspond to a low MBTI (dominant thinking) score, thereby establishing a positive correlation. Inspection of Table 2 reveals a significant correlation in the hypothesized direction between the thinking/feeling scale on the MBTI and the CFT (R=+.48; p < .01), however, the relationship was not supported on the GEFT (R=+.01) or RFT (R=-.22).

Discussion

A possible explanation for why the predicted relationship was not clearly supported may be the spread of the MBTI thinking/feeling scores (Appendix J). There were only 2 subjects identified as dominant "T" and both had MBTI scores close to the center on the continuum (99 and 93). There were 8 subjects identified as dominant "F" with one subject plotted at the far right (143) on the continuum.

Hypothesis 4: There is a significant (<= .05) correlation between a dominant sensing personality type and right hemisphere activation and a dominant intuitive personality type and left hemisphere activation as measured by R/L alpha/beta activation across tasks determined by EEG.

When plotting the EEG score on the MBTI continuum, one would theoretically expect that a higher EEG score, which indicates
greater right hemisphere activation, would correspond to a lower MBTI (dominant sensing) score and a lower EEG score, which indicates greater left hemisphere activation, would correspond to a higher MBTI (dominant intuitive) score. Therefore, these two scores would be negatively correlated. Note the sample correlation -.29 is negatively correlated, supporting the hypothesized relationship, but it did not reach a .05 level of significance.

Discussion

To the writer's knowledge, there are no studies which have attempted to relate neural processing modalities to personality dimensions as indicated on the MBTI. While there are no statistically significant results to substantiate the correlation between greater right hemisphere activation and dominant sensing personality types and greater left hemisphere activation and dominant intuitive personality types, there do seem to be trends which suggest this directional laterality (See Table 3).

Hypothesis 5: There is a significant (< .05) correlation between a dominant thinking personality type and left hemisphere activation and a dominant feeling personality type and right hemisphere activation as measured by R/L alpha/beta activation across tasks determined by EEG.

One would theoretically expect that the higher EEG score (indicating greater right hemisphere activation) would correspond to a higher MBTI (dominant feeling) score and a lower EEG score (greater left hemisphere activation) would correspond to a lower
MBTI (dominant thinking) score, thereby establishing a positive correlation. The results reported on Table 2 indicate that the thinking/feeling scale on the MBTI correlated significantly with the EEG in the opposite direction than expected (R=-56).

Discussion

Possible explanations for why this correlation was not supported may be that the sample distribution was small, contained a few very extreme scores, and was badly skewed (Appendix J).

In addition, the Pearson Correlation Coefficients were computed using the mean total activation score for 10 subjects across 10 cognitive tasks. Inspection of laterality trends reported on Table 5 for individuals as they engaged in individual tasks, demonstrate that the dominant feeling personality types consistently used greater right hemisphere activation when performing each task, which suggests support for the theory and model.

In Chapter 1, an alternative hypothesis was suggested which may be related to the variability of the MBTI scores - subject's intelligence.

The Quick Word Test (QWT), a verbal measure of intelligence, did not significantly correlate with any of the other variables (See Table 2). This finding was unexpected, since there is usually a high relationship between measures of cognitive style (i.e., CFT, HFT) and measures of intelligence (Trent, 1974).

The preceding analysis focused on group data which can conceal important individual differences. The next part of this quantitative
analysis will take a closer look at the data by focusing on the four dominant MBTI functions individually and their relationships to cognitive style and neural processing. In this way, a more thorough understanding of individual learning processes among learners who have specific personality characteristics may be identified.

Part 2 - Analysis of Individual Data

Table 3 reports the results of the three measures of cognitive style and their relationships to the four dominant MBTI functions.

According to the theory and proposed learning style model, individuals classified as dominant sensing (S) personality types will generally have a field dependent cognitive style, while individuals classified as dominant intuitive (N) personality types will generally have a field independent cognitive style. The results on Table 3 consistently reflect this pattern for subjects characterized as dominant intuitive types, but there can be no generalizations made concerning cognitive style patterns and dominant sensing personality types.

The theory and model also suggest that individuals classified as dominant thinking (T) personality types will generally have a field independent cognitive style, while individuals classified as dominant feeling (F) personality types will generally have a field dependent cognitive style. The results on Table 3 reflect this pattern for subjects characterized as dominant thinking personality types, but there can be no generalizations made concerning cognitive style patterns and dominant feeling personality types.
TABLE 3
GEFT, CFT, RFT RELATIONSHIP TO MBTI

<table>
<thead>
<tr>
<th>MBTI Dominant Function</th>
<th>GEFT</th>
<th>CFT</th>
<th>RFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISFJ</td>
<td>FD</td>
<td>FD</td>
<td>FD</td>
</tr>
<tr>
<td>ISFJ</td>
<td>FD</td>
<td>FD</td>
<td>FID</td>
</tr>
<tr>
<td>ISFJ</td>
<td>FID</td>
<td>FID</td>
<td>FID</td>
</tr>
<tr>
<td>ISTJ</td>
<td>FID</td>
<td>FID</td>
<td>FD</td>
</tr>
<tr>
<td>ESFP</td>
<td>FD</td>
<td>FD</td>
<td>FD</td>
</tr>
<tr>
<td>ENFP</td>
<td>FID</td>
<td>FID</td>
<td>FID</td>
</tr>
<tr>
<td>ENFP</td>
<td>FID</td>
<td>FID</td>
<td>FID</td>
</tr>
<tr>
<td>ENFP</td>
<td>FID</td>
<td>FID</td>
<td>FID</td>
</tr>
<tr>
<td>ENFP</td>
<td>FID</td>
<td>FID</td>
<td>FID</td>
</tr>
<tr>
<td>ENFP</td>
<td>FID</td>
<td>FID</td>
<td>FID</td>
</tr>
<tr>
<td>ENFP</td>
<td>FID</td>
<td>FID</td>
<td>FID</td>
</tr>
<tr>
<td>INTP</td>
<td>FID</td>
<td>FID</td>
<td>FID</td>
</tr>
<tr>
<td>ISTP</td>
<td>FID</td>
<td>FID</td>
<td>FID</td>
</tr>
<tr>
<td>ESFP</td>
<td>FD</td>
<td>FD</td>
<td>FD</td>
</tr>
<tr>
<td>ESFP</td>
<td>FD</td>
<td>FID</td>
<td>FID</td>
</tr>
<tr>
<td>ESFP</td>
<td>FD</td>
<td>FD</td>
<td>FD</td>
</tr>
<tr>
<td>ESFP</td>
<td>FD</td>
<td>FD</td>
<td>FID</td>
</tr>
<tr>
<td>INFP</td>
<td>FID</td>
<td>FID</td>
<td>FID</td>
</tr>
<tr>
<td>INFP</td>
<td>FID</td>
<td>FID</td>
<td>FID</td>
</tr>
<tr>
<td>ISFP</td>
<td>FID</td>
<td>FID</td>
<td>FID</td>
</tr>
<tr>
<td>ISFP</td>
<td>FID</td>
<td>FID</td>
<td>FID</td>
</tr>
</tbody>
</table>

FD - field dependent
FID - field independent

When examining each cognitive style measure separately and determining if the instrument reflected the field dependent/independent cognitive style in the hypothesized direction suggested by the MBTI dominant function, 16 GEFT scores, 16 CFT scores and 8 RFT scores did reflect the direction postulated in the learning style model.

Table 4 reports the results of the total EEG score and its relationship to the four MBTI dominant functions.
**TABLE 4**

**EEG RELATIONSHIP TO MBTI**

<table>
<thead>
<tr>
<th>MBTI Dominant Function</th>
<th>Overall Mean Alpha/Beta Activation</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISFJ</td>
<td>x 1.26</td>
<td>RH*</td>
</tr>
<tr>
<td>ISFJ</td>
<td>x 1.22</td>
<td>RH*</td>
</tr>
<tr>
<td>ESFP</td>
<td>x 1.01</td>
<td>RH*</td>
</tr>
<tr>
<td>ISFJ</td>
<td>x .92</td>
<td>LH</td>
</tr>
<tr>
<td>ISTJ</td>
<td>x .81</td>
<td>LH</td>
</tr>
<tr>
<td>ENFP</td>
<td>x .66</td>
<td>LH*</td>
</tr>
<tr>
<td>ENFP</td>
<td>x .93</td>
<td>LH*</td>
</tr>
<tr>
<td>ENFP</td>
<td>x .94</td>
<td>LH*</td>
</tr>
<tr>
<td>ENFP</td>
<td>x .97</td>
<td>LH*</td>
</tr>
<tr>
<td>ENFP</td>
<td>x .99</td>
<td>LH*</td>
</tr>
<tr>
<td>INTP</td>
<td>x .81</td>
<td>LH*</td>
</tr>
<tr>
<td>ISTP</td>
<td>x 1.73</td>
<td>RH</td>
</tr>
<tr>
<td>ESFJ</td>
<td>x 2.06</td>
<td>RH*</td>
</tr>
<tr>
<td>ESFJ</td>
<td>x 1.46</td>
<td>RH*</td>
</tr>
<tr>
<td>ESFJ</td>
<td>x 1.44</td>
<td>RH*</td>
</tr>
<tr>
<td>ISFP</td>
<td>x 1.07</td>
<td>RH*</td>
</tr>
<tr>
<td>ESFJ</td>
<td>x 1.02</td>
<td>RH*</td>
</tr>
<tr>
<td>INFP</td>
<td>x .93</td>
<td>LH</td>
</tr>
<tr>
<td>INFP</td>
<td>x .89</td>
<td>LH</td>
</tr>
<tr>
<td>ISFP</td>
<td>x .83</td>
<td>LH</td>
</tr>
</tbody>
</table>

*MBTI dominant function correlates in the hypothesized laterality direction.

The theory and model suggest that a dominant sensing and feeling personality type would demonstrate greater right hemisphere activation, while a dominant intuitive and thinking personality type would demonstrate greater left hemisphere activation during EEG task performance. The results presented on Table 4 indicate that fourteen subjects' MBTI dominant function (70% of the sample) reflect neural processing activation in the hypothesized direction.
The next logical questions to ask is do individuals have lateral differences as a function of task demands and task difficulties? Chapter 3 discussed the subtasks which made up the EEG protocol: an easy spatial task (Mooney Faces) and a more difficult spatial task (Mental Rotations); an easy analytic task (Inference) and a more difficult analytic task (Deciphering Languages). Table 5 reports the results of EEG asymmetry while individuals were engaged in easy and more difficult spatial and analytic tasks.

These results indicate that the degree of difficulty or the task demands had little effect on thirteen individuals. The 5 dominant intuitive personality types utilized greater left hemisphere activation for every task, and the eight dominant feeling personality types utilized greater right hemisphere activation for every task. This laterality direction supports the theory presented in the learning style model for both these groups.

One group, the dominant sensing personality types, made use of the functional lateralization of the brain. They utilized greater right hemisphere activation for both the easy and more difficult spatial tasks, and greater left hemisphere activation for the easy and more difficult analytic tasks.

The dominant thinking personality types demonstrated greater right hemisphere processing activation, however, these results may be spurious for there were only two subjects in this group, and one of these subjects (ISTP) had one of the most differentiated right hemisphere processing modalities of the sample (See Table 4).
### TABLE 5

**SUBTASKS OF EEG PROTOCOL**

**OVERALL MEAN EEG ASYMMETRY FOR INDIVIDUALS IDENTIFIED AS DOMINANT SENSING, INTUITIVE, THINKING, FEELING**

<table>
<thead>
<tr>
<th>MBTI Dominant Function</th>
<th>Easy Tasks</th>
<th>More Difficult Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MOFA</td>
<td>INFR</td>
</tr>
<tr>
<td>ISFJ</td>
<td>1.39</td>
<td>1.19</td>
</tr>
<tr>
<td>ISFJ</td>
<td>1.96</td>
<td>.97</td>
</tr>
<tr>
<td>ESFP</td>
<td>.95</td>
<td>.93</td>
</tr>
<tr>
<td>ISFJ</td>
<td>.85</td>
<td>1.03</td>
</tr>
<tr>
<td>ISTJ</td>
<td>1.16</td>
<td>.77</td>
</tr>
<tr>
<td><strong>Total 5 &quot;S&quot;</strong></td>
<td><strong>1.26</strong></td>
<td><strong>.97</strong></td>
</tr>
<tr>
<td>ENFP</td>
<td>.90</td>
<td>1.33</td>
</tr>
<tr>
<td>ENFP</td>
<td>.83</td>
<td>.78</td>
</tr>
<tr>
<td>ENFP</td>
<td>.86</td>
<td>.63</td>
</tr>
<tr>
<td>ENFP</td>
<td>.90</td>
<td>.84</td>
</tr>
<tr>
<td>ENFP</td>
<td>.82</td>
<td>1.04</td>
</tr>
<tr>
<td><strong>Total 5 &quot;N&quot;</strong></td>
<td><strong>.86</strong></td>
<td><strong>.92</strong></td>
</tr>
<tr>
<td>INTP</td>
<td>.85</td>
<td>.96</td>
</tr>
<tr>
<td>ISTP</td>
<td>1.19</td>
<td>2.11</td>
</tr>
<tr>
<td><strong>Total 2 &quot;T&quot;</strong></td>
<td><strong>1.02</strong></td>
<td><strong>1.53</strong></td>
</tr>
<tr>
<td>ESFJ</td>
<td>1.01</td>
<td>1.09</td>
</tr>
<tr>
<td>ESFJ</td>
<td>1.58</td>
<td>1.19</td>
</tr>
<tr>
<td>ESFJ</td>
<td>1.83</td>
<td>2.10</td>
</tr>
<tr>
<td>ISFP</td>
<td>1.02</td>
<td>1.22</td>
</tr>
<tr>
<td>ESFJ</td>
<td>1.22</td>
<td>1.57</td>
</tr>
<tr>
<td>INFP</td>
<td>.92</td>
<td>1.25</td>
</tr>
<tr>
<td>INFP</td>
<td>1.06</td>
<td>.80</td>
</tr>
<tr>
<td>ISFP</td>
<td>.76</td>
<td>.84</td>
</tr>
<tr>
<td><strong>Total 8 &quot;F&quot;</strong></td>
<td><strong>1.17</strong></td>
<td><strong>1.25</strong></td>
</tr>
</tbody>
</table>

**MOFA** - Mooney Faces  
**INFR** - Inference Task  
**MERO** - Mental Rotations  
**LANG** - Deciphering Languages  

> 1.00 greater RH activation  
< 1.00 greater LH activation
While the difficulty level of the task may not have significantly effected the subjects' neural processing modality, it did effect the subjects' task performance (See Table 6).

**TABLE 6**

**EEG TASK PERFORMANCE -**

**MEAN % OF CORRECT RESPONSES FOR 20 SUBJECTS**

<table>
<thead>
<tr>
<th></th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spatial Tasks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mooney Faces</td>
<td>91%</td>
<td>94.5%</td>
<td>93%</td>
</tr>
<tr>
<td>Mental Rotations</td>
<td>49%</td>
<td>53%</td>
<td>51%</td>
</tr>
<tr>
<td><strong>Analytic Tasks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inference</td>
<td>82.5%</td>
<td>85%</td>
<td>84%</td>
</tr>
<tr>
<td>Deciphering Languages</td>
<td>60%</td>
<td>32.5%</td>
<td>46.2%</td>
</tr>
<tr>
<td><strong>Cognitive Style Task</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hidden Figures</td>
<td>39%</td>
<td>32.3%</td>
<td>35.7%</td>
</tr>
</tbody>
</table>

As expected, the more difficult tasks (Hidden Figures, Mental Rotations, and Deciphering Languages) had fewer correct responses than the easier Mooney Faces and Inference Tasks. There was also no evidence of a practice effect induced by the order of the task presentation. This was controlled by having half the sample perform the tasks in the prescribed order as indicated in the task protocol booklet, and the remaining ten subjects perform the tasks in the
reverse order. Chapter 5 will discuss the relationship between task performance and degree of lateralization and suggest implications of classroom instruction based on this notion.

The trends or internal coherences reported in Tables 5 and 6 seem to suggest that certain individuals have a characteristic way of processing information. In other words, it did not matter if they were performing a spatial or analytic task, they seemed to have a cognitive set, a preferred way of processing information no matter what the task demands. In order to determine if individuals have a habitual reliance on one hemisphere or another for processing information, baseline data was recorded before both administrations of the task protocol. The baseline condition requires the subject to concentrate on her breathing with eyes open and presumably does not involve differential hemispheric activation.

Table 7 presented on page 117 reports the results of the baseline overall mean alpha/beta activation and the overall mean alpha/beta activation for each subject during task performance.

These results suggest that a hemisphere assumes control of processing prior to actual information processing, and that it remains in control throughout the activity. In addition, it appears that the natural brain functioning pattern of 15 subjects (75% of the sample) was remarkably consistent during task performance, even when the task demands would suggest a change in neural processing.

Table 8 compares the baseline overall mean activation for easy (Mooney Faces) and more difficult (Mental Rotations) spatial tasks;
### TABLE 7

THE BASELINE OVERALL MEAN ACTIVATION AND TASK PERFORMANCE OVERALL MEAN ACTIVATION FOR 20 SUBJECTS

<table>
<thead>
<tr>
<th>MBTI Dominant Function</th>
<th>Baseline</th>
<th>Task Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISFJ</td>
<td>1.27</td>
<td>1.26*</td>
</tr>
<tr>
<td>ISFJ</td>
<td>1.08</td>
<td>1.22*</td>
</tr>
<tr>
<td>ESFP</td>
<td>1.15</td>
<td>1.01*</td>
</tr>
<tr>
<td>ISFJ</td>
<td>.93</td>
<td>.92*</td>
</tr>
<tr>
<td>ISTJ</td>
<td>.88</td>
<td>.81*</td>
</tr>
<tr>
<td>ENFP</td>
<td>1.24</td>
<td>.66</td>
</tr>
<tr>
<td>ENFP</td>
<td>1.06</td>
<td>.93</td>
</tr>
<tr>
<td>ENFP</td>
<td>1.05</td>
<td>.94</td>
</tr>
<tr>
<td>ENFP</td>
<td>.97</td>
<td>.97*</td>
</tr>
<tr>
<td>ENFP</td>
<td>.52</td>
<td>.99*</td>
</tr>
<tr>
<td>INTP</td>
<td>.95</td>
<td>.81*</td>
</tr>
<tr>
<td>ISTP</td>
<td>1.51</td>
<td>1.73*</td>
</tr>
<tr>
<td>ESFJ</td>
<td>1.70</td>
<td>2.06*</td>
</tr>
<tr>
<td>ESTJ</td>
<td>.86</td>
<td>1.46</td>
</tr>
<tr>
<td>ESFJ</td>
<td>1.07</td>
<td>1.44*</td>
</tr>
<tr>
<td>ISFP</td>
<td>1.38</td>
<td>1.07*</td>
</tr>
<tr>
<td>ESFP</td>
<td>1.18</td>
<td>1.02*</td>
</tr>
<tr>
<td>INFP</td>
<td>.64</td>
<td>.93*</td>
</tr>
<tr>
<td>INFP</td>
<td>.88</td>
<td>.89*</td>
</tr>
<tr>
<td>ISFP</td>
<td>1.36</td>
<td>.83</td>
</tr>
</tbody>
</table>

*The same laterality direction during baseline and task performance.*
easy (Inference) and more difficult (Deciphering Languages) analytic tasks.

**TABLE 8**

BASELINE MEAN OVERALL ACTIVATION IN RELATION TO MEAN ACTIVATION FOR EASY AND MORE DIFFICULT SPATIAL TASKS AND EASY AND MORE DIFFICULT ANALYTIC TASKS

<table>
<thead>
<tr>
<th>MBTI Dominant Function</th>
<th>Baseline</th>
<th>Spatial Tasks</th>
<th>Analytic Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Easy</td>
<td>Difficult</td>
</tr>
<tr>
<td>ISFJ</td>
<td>1.27</td>
<td>1.39&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.26&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>ISFJ</td>
<td>1.08</td>
<td>1.96&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.13&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>ESFP</td>
<td>1.15</td>
<td>.95</td>
<td>1.23&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>ISFJ</td>
<td>.93</td>
<td>.85&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.01</td>
</tr>
<tr>
<td>ISTJ</td>
<td>.88</td>
<td>1.16</td>
<td>.75&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>ENFP</td>
<td>1.24</td>
<td>.83</td>
<td>.70&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>ENFP</td>
<td>1.06</td>
<td>.87</td>
<td>1.10&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>ENFP</td>
<td>1.05</td>
<td>.90</td>
<td>.87&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>ENFP</td>
<td>.97</td>
<td>.82&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.93&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>ENFP</td>
<td>.52</td>
<td>.91&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.04</td>
</tr>
<tr>
<td>INTP</td>
<td>.95</td>
<td>.85&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.90&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>ISTP</td>
<td>1.51</td>
<td>1.19&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.49</td>
</tr>
<tr>
<td>ESFJ</td>
<td>1.70</td>
<td>1.83&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.95&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>ESFJ</td>
<td>.86</td>
<td>1.57</td>
<td>1.69</td>
</tr>
<tr>
<td>ESFJ</td>
<td>1.07</td>
<td>1.22&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.01&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>ESFJ</td>
<td>1.38</td>
<td>1.02&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.02</td>
</tr>
<tr>
<td>ESFJ</td>
<td>1.18</td>
<td>1.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.06</td>
</tr>
<tr>
<td>INFP</td>
<td>.64</td>
<td>.92&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.78&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>INFP</td>
<td>.88</td>
<td>1.06</td>
<td>.68&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>ISFP</td>
<td>1.36</td>
<td>.77</td>
<td>.86</td>
</tr>
</tbody>
</table>

12 subjects 14 subjects 9 subjects 12 subjects

<sup>a</sup>The same laterality direction during baseline and spatial and analytic task performance.

<sup>b</sup>Shift in EEG asymmetry indicating more integration between hemispheres.
The results presented in Table 8 indicate that generally speaking, more than half of the subjects in this study utilized the same hemisphere for processing the more difficult spatial (Mooney Faces) and analytic (Deciphering Languages) tasks as their baseline pattern, suggesting that when these individuals found the task material difficult, they relied on the hemisphere they habitually used.

In addition, as the difficulty level of the spatial tasks increased, eight subjects had a decrease in their EEG asymmetry; and as the difficulty level of the analytic tasks increased, nine subjects had a decrease in their EEG asymmetry. A possible explanation for this shift in asymmetry may be that for some individuals the opposite hemisphere may be called upon to provide complementary verbal-analytic strategies for the spatial problems or spatial-gestalt processing strategies for the analytic problems. Similar results have been reported by Galin, Johnson, Herron (1978).

Aside from the differences in difficulty level of the spatial and analytic tasks, the differences in EEG asymmetry may be due to the mode of information processing required. For example, Ornstein, Johnstone, Herron and Swencionis (1980) found that a complex task such as Mental Rotations requires both analytic and spatial processing strategies. Some "spatial" tasks such as Mental Rotations could be performed analytically, and if analytical processing is more a capacity of the left hemisphere than the right, a spatial task might be better processed in the left hemisphere. Chapter 5 reports that individuals who were more integrated in their neural processing during the Mental Rotations task, had a better overall task performance.
To summarize, it appears that difficulty level of the task is an important variable for some individuals, however, how far these results can be generalized is questionable. Greater or lesser effects might be seen with other analytic or spatial tasks, with greater ranges of difficulty, or other electrode placements. In order to expand our knowledge of the role hemispheric interactions play in neural processing, the difficulty parameters of the tasks must be carefully studied and controlled.

Although the hypotheses of this study are not based upon regression analysis, data analysis upon this classification seems relevant to warrant their inclusion. The results of the Pearson Correlation Coefficients presented at the beginning of this chapter suggest that in this sample, the more reliable scale for postulating neural processing and cognitive style orientations was the sensing-intuition scale. A possible explanation for why the sensing/intuition, rather than the thinking/feeling scale was more likely to suggest neural processing and cognitive style preferences may be that these dimensions are more directly related to how individuals perceive information, whereas the thinking/feeling scale is more directly related to how individuals judge information.

Therefore, multiple regression analysis was designed to determine how much variance in just the sensing/intuition scale on the MBTI (N=10) was explained by four independent variables (GEFT, CFT, RFT, total EEG) and one extraneous variable, the Quick Word Test (QWT). Table 9 reports the results.
TABLE 9
MULTIPLE REGRESSION ANALYSIS OF SENSING/INTUITIVE SCALE
ON MBTI AND EEG, GEFT, RFT, CFT, QWT

<table>
<thead>
<tr>
<th></th>
<th>R Square (variance)</th>
<th>RSQ Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>QWT</td>
<td>.17</td>
<td>.17</td>
</tr>
<tr>
<td>CFT</td>
<td>.23</td>
<td>.06</td>
</tr>
<tr>
<td>RFT</td>
<td>.27</td>
<td>.04</td>
</tr>
<tr>
<td>GEFT</td>
<td>.43</td>
<td>.16</td>
</tr>
<tr>
<td>EEG</td>
<td>.46</td>
<td>.03</td>
</tr>
</tbody>
</table>

The results indicate that in this sample (N=10), 46% of the variance in the sensing/intuitive scale on the MBTI was explained by the five variables identified, with the Quick Word Test and Group Embedded Figures Test explaining most of the variance.

These results suggest that the alternative hypothesis, subject's intelligence, does explain a good portion of the variability in the sensing/intuitive MBTI score. The Quick Word Test (QWT) is a highly verbal, 100 item vocabulary test which requires sequential processing, analytic, linear, and successive in nature. Krashen (1975) suggests, language may emerge as a function of the left hemisphere because the handling of linguistic stimuli, and the construction of syntax and grammatical relations (which the QWT requires for successful completion), are particularly suited to the sequencing and temporal processing style of that hemisphere. Table 4 reveals that 7 of the 10 dominant sensing or intuitive personality types had greater left
hemisphere activation during the EEG task protocol, supporting Krashen's hypothesis.

In light of these neurological findings, the QWT as well as the other variables included in an attempt to explain variance in the MBTI score, can only be generalized to the sensing/intuitive personality type.

To summarize the quantitative data analysis, it appears that when examining the statistical analysis there was moderate support for the theory postulated in the learning style model. Greater support for the theory and model, however, was gleaned when one examined the neural processing and cognitive style trends of learners with specific personality characteristics (sensing, intuitive, thinking or feeling). With such a small sample size, the fact that there were identifiable cognitive style and neural processing trends among individuals which consistently supported the theoretical assumptions underlying the learning style model, suggest that the hypotheses presented are reasonable.

It must also be remembered that within cognitive style models, individual differences (presented in the trend analysis), rather than group differences (presented in the statistical analysis) are more valuable for designing instructional strategies, especially as they relate to cognitive processes and structures. It is these process-oriented individual differences, not group differences, which have promise for understanding aptitude treatment interaction.

The next section of this chapter will present the qualitative data which documents the prospective teachers ability to translate
information concerning individual learning processes into appropriate learning and teaching behaviors.

Qualitative Analysis of the Data

Three journal entries were analyzed using content analysis (Appendix B, E, F). To ensure objectivity of coding these three entries for the twenty subjects according to the established coding categories (Appendix C), percentages of agreement were obtained from three raters -- two males and one female, who were experimentally naive. All raters scored the three entries independently of each other according to the established procedures (Appendix G). Total percentage agreement for all raters across the twenty subjects for the first and second entry was 85% and for the third entry was 90%.

Hypothesis 1: Individuals provided information concerning their own learning processes (personality, neural processing, and cognitive style) will be better able to determine their preferred way to learn.

In order to establish how knowledge about learning processes facilitated an individual's understanding of their own learning processes, it was necessary to have a pretest (Appendix B) administered at the beginning of the learning style program of study, and a posttest (Appendix E) administered at the close of the three quarter program of study. Both these journal entries were analyzed using content analysis.

Discussion

In responding to the pretest, fourteen subjects indicated they used more left hemisphere strategies, while six subjects indicated they
employed more right hemisphere processing strategies in learning material. The teaching style question was not coded because more than half of the subjects indicated they could not respond to the question due to lack of teaching experience.

As stated in Chapter 3, throughout the three quarter learning style program of study, the MBTI was administered to determine the personality construct, the CFT, GEFT, and RFT were administered to assess the cognitive style (field dependent/independent) construct, and the EEG was used to measure the subject's neural processing. No information was provided concerning the results of the quantitative measures until the final two weeks of the third quarter. Once the subjects were presented the results of the personality, cognitive style, and neural processing assessments, they were asked to strongly agree, moderately agree, or strongly disagree with each measure discussing their position in detail. Table 10 reports the results which indicate if the subjects' believed that the quantitative data adequately reflected what they believed their learning style was.

**TABLE 10**

**SELF ANALYSIS AGREEMENT WITH MBTI, 3 COGNITIVE STYLE ASSESSMENTS, AND EEG**

<table>
<thead>
<tr>
<th></th>
<th>MBTI</th>
<th>CFT, GEFT, RFT</th>
<th>EEG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>90%</td>
<td>55%</td>
<td>70%</td>
</tr>
<tr>
<td>Moderately Agree</td>
<td>10%</td>
<td>35%</td>
<td>30%</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>-</td>
<td>10%</td>
<td>-</td>
</tr>
</tbody>
</table>
The introspective journal accounts documented that of the three dimensions postulated as indicators of an individual's learning preference, the personality construct (determined by the MBTI), most clearly reflected and represented what these individuals perceived as their learning style, followed by the neural processing construct (assessed by the EEG), and the cognitive style construct (determined by the CFT, GEFT, and RFT).

The journal entries which described the prospective teacher's rationale for strongly agreeing, moderately agreeing, or strongly disagreeing with the quantitative assessment was independently analyzed by the three raters and served as a posttest for the first hypothesis.

At the close of the study, 13 subjects documented that they were more likely to be field dependent and prefer greater right hemisphere processing strategies for learning material (compared to 6 individuals at the onset of this study). Seven subjects indicated that they were more likely to be field independent, preferring greater left hemisphere processing strategies for learning material (compared to 14 subjects at the onset of the study). This discrepancy between the pretest and posttest data regarding what individuals think their learning style is, may be a testimonial to 16 years of public schooling - students learn to conform to the teaching style they are exposed to most. The three raters unanimously concluded that individuals provided information concerning their own learning processes were better able to understand individual differences from a neurological, personality, and cognitive style perspective.
Hypothesis 2: Individuals provided information concerning their own learning processes will be better able to determine how their learning style affects their teaching style.

This journal entry (Appendix F) was the last one the subjects' wrote on and the third entry analyzed by the independent coders. This particular question was asked in an attempt to ascertain if these prospective teachers were not only able to determine if there was congruency between their learning and teaching style, but more importantly if they would indicate their willingness to adapt their teaching style to accommodate individual learning preferences and needs they observed.

Discussion

Seventeen subjects reported teaching styles congruent with learning preferences. All twenty prospective teachers made reference to adapting their teaching style to accommodate individual learning needs, regardless of their own preferred learning and teaching style. This final journal entry provided substantial support for the writers contention that subjects who have been provided an opportunity to learn about learning processes and to investigate and understand their own learning processes can translate that information into appropriate learning and teaching behaviors.

The following section of this qualitative data analysis presents support for the remaining three hypotheses which were not analyzed using the content analysis procedure. Selected passages from the self-analysis journals will be presented to document how these
prospective teachers were able to apply learning process information. The entire collection of self-analysis journals will be available for your perusal at the Ohio State University Arps Library.

Hypothesis 3: Individuals provided information concerning their own learning processes will be better able to understand the learning processes of others.

Evidence that these prospective teachers could make the transference from knowledge to self to knowledge of others learning processes is presented in the following excerpts written by two different individuals.

I feel my understanding of learning processes has strengthened my ability to use alternative methods of instruction. In this learning style block, I have come to grips with how I learn best. Because I now understand my own learning style, I'm aware of my preferred teaching style. Some children may not learn the way I prefer to learn and teach.

Some children need day-to-day guidance, a list of work written on the board everyday. Other children would prefer receiving a list of what is expected for an entire week, month, etc. This is an example of specific (left hemisphere preference) versus holistic (right hemisphere preference) for organizing material.

When working with a child who prefers left hemisphere strategies for learning, the teacher may use the following techniques. Telling the child what the sequence of expectations is and providing many language cues -- both verbal and printed -- will be beneficial. To help the child who prefers right hemisphere strategies, the teacher should emphasize concrete experiences. Since the child's processing is not organized in a step-by-step fashion, it will be important to be very specific in instruction, providing directions pictorially if possible. The teacher should emphasize hands on experiences for learning, and make liberal use of audio-visual materials. She should use everyday
situations to motivate the learner, encouraging students to explore relevant aspects of their experiences.

Once the pre-service teachers had developed the framework for understanding learning processes in general, they began to look at processing strategies.

Hypothesis 4: Individuals provided information concerning their own learning processes will be better able to develop processing strategies to more effectively learn something (whether it be in the academic, athletic and/or arts, etc., field).

In order to address this hypothesis, the students were asked to identify a personal goal, not necessarily associated with academic work, which they aspired to accomplish in their lifetime and discuss learning strategies which would facilitate accomplishment of that goal. One student who tends to prefer left hemisphere processing strategies wrote:

In order to sew you need both left and right brain strategies, however, I feel inadequate in visualizing the results. I can follow the printed pattern directions and do the prescribed operations, but can rarely imagine what the outcome will be. Of course visualizing the completed results is critical in selecting a suitable pattern and material. Too often when I have attempted to sew, I have ended up with half-finished projects that I realized too late would not serve the intended use. Through knowledge of my own learning style, I am better able to identify the problem. I have available resources to use which I can apply to my personal situation. I expect the right brain drawing course I am enrolled in this summer will help me visualize better -- "seeing" from a right brain perspective.

Another student, who prefers right hemisphere information processing strategies stated:
I need to read the material and try to visualize and apply it while doing so. When I read, I need to reconstruct the material into my own words, scribbling pages of notes. I rarely refer back to these notes. It's the process of putting the information into my personal frame of reference which is the purpose of the note taking. However, sometimes this doesn't work. I can't put or don't want to put the information into my own words. This usually happens when the material in question is unappealing or irrelevant to me. Then I must use mnemonic devices. For example, I devise poems or catchy sentences with the first letters of list items. I may write the information down in real elaborate or weird handwriting.

Hypothesis 5: Individuals provided information concerning their own learning processes will be better able to develop language arts, reading, math, science, social studies, etc. programs to meet the learning needs of children, thus stretching into using and developing teaching strategies that accommodate different learning needs.

Evidence that these prospective teachers could do this was provided in the lesson plans they developed for Language Arts and Science methods courses they were enrolled in. It was not the content which was important, but the way that content was presented. One insightful pre-service teacher wrote:

Research indicates that hemispheric specialization tends to be more process specific rather than material specific. Examples of incorporating a student's learning style into the language arts curriculum are as follows.

Literature - The student who preferred right hemisphere processing modalities could act out a story he read, tape record it, illustrate a scene, make up a game, write a different ending, pantomime the most important part, write a poem that shows how the book made him feel, have a puppet show. The student
who preferred left hemisphere processing modalities could write a letter to the book's author or illustrator for further information concerning the book, make a booklet of favorite words or passages from the book; conduct a survey to find out what books students like most.

As a group these children could develop a newsletter containing book news (e.g., books read, reports of experiences with authors and illustrators, new insights concerning the books, book reviews, photos of ways of books had been shared in the classroom and design book advertisements.

In conclusion, this study was designed to sensitize prospective teachers to the complexity of the learning process, so that they would begin to observe and identify individual learning behaviors and preferences and understand what they were observing. It was then hoped that these pre-service teachers could develop instructional strategies based on these observed learning behaviors and adapt their teaching style to accommodate specific learning needs. The introspective journal accounts document that this end was achieved.

It must be kept in mind, however, that the researcher, as a participant observer, was an integral part of the entire study and therefore may have influenced the journal entries by having such a strong commitment and bias concerning the importance of a learning style teacher education program of study.

The learning style model was the means to this end. By understanding and investigating their own learning behaviors and preferences, these pre-service teachers could understand others learning behaviors and preferences.
CHAPTER V  
SUMMARY, IMPLICATIONS, FUTURE DIRECTIONS

The results of this study provide valuable insights concerning the learning/teaching process. The last chapter is divided into three sections. The initial section, entitled the Learning/Teaching Process discusses the a) personality, b) cognitive style, and c) neural processing substrates of the proposed learning style model and suggests implications for learning and teaching. Learning Process Application, the second section of the chapter, discusses direct application of the learning process concepts to educational practice. The third section, Future Directions, proposes recommendations for educational practice and research based on knowledge of the teaching/learning process.

Section 1 - Learning/Teaching Process  
Implications from Personality Research

The sensing/intuitive scale on the MBTI provide valuable insights concerning how individuals perceive information and experiences. Type theory indicates that S-N differences are related to varying interests and not necessarily a superiority of ability of one type over another. For example; individuals who prefer perception through sensing become aware of information and experiences directly through their five senses; they are interested in actuality around them. In contrast, individuals with a preference for the intuitive process rely upon
ideas and associations that the unconscious tacks onto perceptions coming from the senses; they are more interested in the possibilities suggested by incoming data, rather than the data themselves (Carskadon, 1981).

Another distinction between the sensing and intuitive personality types has been postulated by Isaac (1975). He examined the motivating forces behind these dichotomous preferences and suggested that the sensing personality type favors extrinsic motivation, i.e., response and its reinforcement, while the intuitive personality type favors intrinsic motivation, i.e., stimulus novelty and its exploration. In other words, a sensing individual is motivated by external rewards or penalties which are concrete and tangible whereas the intuitive individual is motivated by self-fulfilling experiences which invite exploration, inquiry, and experiencing in their own right.

In the present study, there were five individuals identified as dominant sensing personality types and five individuals identified as dominant intuitive personality types. Generally speaking, the five sensing individuals were less inventive in designing their lesson plans, seemed to prefer the traditional approach in developing a lesson, and were very concerned with discipline, control, rewards and penalties. Their general response to classroom instruction was the teacher-in-charge, systematic, more traditional approach. In contrast the five intuitive prospective teachers were interested in developing alternative plans for teaching the material and seemed to be risk takers, who were not that concerned if the lesson failed. They liked
innovations, emphasizing creativity, discovery, and the more self-directing, child-centered curricula.

The writer believes that either of these two dichotomous approaches to learning carried to the extreme is nonproductive. Some individuals prefer and need a teacher directed approach, namely sensing individuals. Other individuals need and prefer the self-directed approach, namely intuitive individuals. Therefore, it would be advantageous to have a dominant sensing and dominant intuitive personality type work together in developing an integrated instructional program.

The thinking/feeling functions identify dichotomous ways individuals make decisions. Both thinking and feeling are considered rational processes because they use reasoning to arrive at conclusions.

Thinking types use both thinking and feeling but prefer to use thinking for making judgments. Expertise in thinking leads to powers of analysis and an ability to weight facts objectively including consequences, unintended as well as intended. Attitudes typically developed from a preference for thinking include objectivity, a sense of fairness and justice, impartiality, and skill in applying logical analysis (Lawrence, 1979).

Feeling types, on the other hand, while they use both thinking and feeling to make decisions, prefer to reach judgments through feeling. These individuals develop values and standards, and a knowledge of what matters most to themselves and other people. Attitudes typically resulting from a preference for feeling include an
understanding of people and wish to affiliate with them, a desire for harmony, and a capacity for compassion, empathy, and warmth (Lawrence, 1979).

In this study, there were two dominant thinking and eight dominant feeling personality types. Generally speaking, the thinking personality types developed lessons for individuals to work independently and preferred to test material learned objectively. The feeling personality types prepared group activities which were pupil centered and preferred a more informal evaluation of information gained.

The thinking/feeling functions show patterns of commitments and values of the learner. As in the sensing/intuition functions, some individuals prefer and need the thinking function for decision making while others prefer and need the feeling function. It would be advantageous to have a dominant thinking and dominant feeling type work together in planning instruction, thus developing a more integrated program.

Numerous researchers have used the Myers Briggs Type Indicator to assess the personalities of teachers in the field (Lawrence, 1974; Carlyn, 1976; Cage, 1975; McCaulley, 1974). A majority of the teachers sampled showed preferences for sensing (53% to 74%) and feeling (55% to 66%). In this particular study 13 of the 20 teachers (65%) of the sample fell into one of those two categories (See Table 4).

Lawrence (1979) reports that the types are not evenly distributed in the school population. It is estimated that type in the general American population, and in most school populations, is distributed
as follows: sensing - 70%; intuition - 30%; thinking (male) - 50%;
feeling (male) - 40%; thinking (female) - 40%; feeling (female) -
60%.

This data suggests that there are more sensing than intuitive
students and an uneven distribution between sexes in the judging
functions. These are crucial facts which teachers should be aware
of. It is possible to identify learning patterns in students in
order to develop instructional strategies to accommodate individual
learning needs. There seems to be utility in using the MBTI as a
means to this end - an efficient instrument which facilitates the
application of learning theory (based on personality research) for
classroom instruction.

Implications from Cognitive Style Research

Implications based on a field-independent or differentiated
cognitive style and a field-dependent or global cognitive style may
be summarized as follows. Field-independent learners are relatively
individualistic, insensitive to the feelings and reactions of others,
seem to be intrinsically motivated, less likely to respond to or
want social reinforcement and are more likely to follow internalized
values and beliefs than peer pressures or immediate contextual cues
(Wittrock, 1978). These same characteristics may be used to describe
the intuitive/thinking personality type.

In this study there were 5 individuals classified as dominant
intuitive personality types and 2 individuals classified as dominant
thinking personality types. In every case, on all three measures of
cognitive style (GEFT, CFT, RFT) these 7 individuals were identified as field independent (See Table 3).

Field-dependent or field sensitive learners are relatively more aware of spatial cues, more able to discern the feelings of others from observation of facial expression, more responsive to social reinforcement, and more sensitive to others for definition of their own values and actions (Wittrock, 1978). These characteristics may be used to describe the sensing/feeling personality type.

Three of the five dominant sensing individuals were characterized as field dependent and four of the eight dominant feeling types were classified as field dependent on the GEFT, CFT, and RFT (See Table 3). Interestingly, those subjects who were not characterized as field dependent on the cognitive style measures, disagreed with their assessment.

When one examines these dichotomous cognitive styles in relation to teaching styles, the field dependent teacher would tend to organize curricula more globally, emphasizing group methods of learning, projects, discussion groups which foster group interaction. The field independent teacher, on the other hand, would tend to structure the curricula logically in smaller segments. There would be more teacher directed interaction.

According to Witkin et al. (1977), classroom teachers tend to be field dependent. Therefore, field-independent students instructed by field dependent teachers are being taught strategies which are inappropriate to their cognitive style.
Cognitive style appears to be an important dimension for understanding individual differences in learning processes. Experiences related to the pupil's cognitive style will enable them to meet with success. Therefore, teachers should be sensitized to the role cognitive style plays in educational practice so that they can develop educational programs to accommodate alternative cognitive styles. One way to facilitate the teacher's ability to do this is to develop dyads comprised on field dependent and field independent teachers who would be responsible for developing programs to meet the varying cognitive style dimensions.

To summarize, knowledge and understanding of cognitive styles and their relationship to personality type is an important concept if one is to begin to understand learning processes. Through knowledge of these two substrates of learning, a more effective tool is provided educators for designing materials and programs to accommodate individual learning needs. Valuable insights have been gained from those investigating the relationship between cognitive style and personality type and educational materials and programs (Hand, 1972; McCaulay, 1976).

Implications from Neural Processing Research

As stated in Chapter 2, this study was unique because it used adult females as subjects and two of the twenty subjects were left handed. Due to the fact that there were only two left handers in the study, one with (INTP) and one without (ISTJ) a history of familial sinistrality, no generalizations could be made regarding the relationship between handedness and functional asymmetry.
There were, however, interesting results and implications suggested when one examined the functional lateralization of this female sample. Table 7 (Chapter 4) documented that certain female adult personality types demonstrated strong cerebral dominance or functional lateralization of either their right or left cerebral hemisphere. Yet an extensive body of laterality research postulates male superiority in spatial ability resulting from the more functional lateralization of the right hemisphere in males.

Sperry and his associates (1969) found that localization of verbal functions in the LH and spatial functions in the RH was weaker in women. Levy (1980) believed that strong cerebral dominance facilitates performance for spatial abilities and reported that left handed men (in whom cerebral lateralization is weak) are similar to women in obtaining low scores in spatial abilities. Thus Levy and Sperry believe that male superiority in spatial tasks stems from greater specialization of the two hemispheres among men than among women.

Very few EEG studies have included normal female subjects. In two studies sex was considered a variable. Herron (1978) compared right and left EEG hemispheric activity in males and females during verbal and musical tasks and found a higher incidence of lateralization among the males. In another study Johnson (1973) compared male and female subjects EEG activity during a speech task and found greater lateralization among the male subjects. There were no studies which included several "right" hemisphere tasks and several "left" hemisphere tasks to infer lateralization as a function of gender differences.
The writer believes that the primary reason women subjects have been eliminated from 95% of the EEG studies stems from the fact that the laterality research strongly supports the notion that females are less lateralized, therefore, if the investigator is attempting to demonstrate the brain's lateralization specialization (spatial tasks - RH; analytic tasks - LH), it would be advisable to use adult males as subjects.

Since this particular study used only adult female subjects, the EEG data was used to address the laterality question.

In order to determine if the females in this study were lateralized, a laterality scale was devised. By calculating the discrepancy between the mean of right and left hemisphere alpha/beta activation for the entire ten task protocol, it was possible to determine individuals who were clearly lateralized (more differentiated in their neural processing; moderately lateralized; and less lateralized (more integrated in their neural processing). Six subjects were classified as low laterality, more integrated in their neural processing), five subjects were classified as moderately lateralized, and nine subjects were classified as clearly lateralized (more differentiated in their neural processing (See Table 11).
TABLE 11
LATERALITY SCALE

Low laterality - more integrated hemispheric processing - (0.01-.03 discrepancy between RH and LH alpha/beta activation)

<table>
<thead>
<tr>
<th>Subject</th>
<th>RH</th>
<th>LH</th>
<th>Discrepancy</th>
</tr>
</thead>
<tbody>
<tr>
<td># 6 ESFP</td>
<td>6 tasks x .42</td>
<td>4 tasks x .41</td>
<td>.01</td>
</tr>
<tr>
<td># 3 ENFP</td>
<td>3 tasks x .21</td>
<td>7 tasks x .20</td>
<td>.01</td>
</tr>
<tr>
<td># 5 ENFP</td>
<td>3 tasks x .45</td>
<td>7 tasks x .47</td>
<td>.02</td>
</tr>
<tr>
<td># 20 ENFP</td>
<td>3 tasks x .51</td>
<td>7 tasks x .53</td>
<td>.02</td>
</tr>
<tr>
<td># 8 ESFJ</td>
<td>7 tasks x .43</td>
<td>3 tasks x .45</td>
<td>.02</td>
</tr>
<tr>
<td># 9 ISFP</td>
<td>8 tasks x .41</td>
<td>3 tasks x .38</td>
<td>.03</td>
</tr>
</tbody>
</table>

Moderate laterality - (0.04-.06 discrepancy between RH and LH alpha/beta activation)

<table>
<thead>
<tr>
<th>Subject</th>
<th>RH</th>
<th>LH</th>
<th>Discrepancy</th>
</tr>
</thead>
<tbody>
<tr>
<td># 14 INFP</td>
<td>4 tasks x .42</td>
<td>6 tasks x .46</td>
<td>.04</td>
</tr>
<tr>
<td># 7 ISFJ</td>
<td>3 tasks x .44</td>
<td>7 tasks x .48</td>
<td>.04</td>
</tr>
<tr>
<td># 19 INFP</td>
<td>2 tasks x .44</td>
<td>8 tasks x .49</td>
<td>.05</td>
</tr>
<tr>
<td># 15 ISFP</td>
<td>1 task x .40</td>
<td>9 tasks x .48</td>
<td>.08</td>
</tr>
</tbody>
</table>

Clear laterality - more differentiated hemispheric processing - (0.07-.30 discrepancy between RH and LH alpha/beta activation)

<table>
<thead>
<tr>
<th>Subject</th>
<th>RH</th>
<th>LH</th>
<th>Discrepancy</th>
</tr>
</thead>
<tbody>
<tr>
<td># 4 ENFP</td>
<td>1 task x .28</td>
<td>9 tasks x .38</td>
<td>.10</td>
</tr>
<tr>
<td># 13 ESFJ</td>
<td>9 tasks x .44</td>
<td>1 task x .33</td>
<td>.11</td>
</tr>
<tr>
<td># 1 ISFJ</td>
<td>10 tasks x .56</td>
<td>0 tasks x .44</td>
<td>.12</td>
</tr>
<tr>
<td># 11 INTJ</td>
<td>1 task x .49</td>
<td>9 tasks x .61</td>
<td>.12</td>
</tr>
<tr>
<td># 12 ESFJ</td>
<td>10 tasks x .59</td>
<td>0 tasks x .41</td>
<td>.18</td>
</tr>
<tr>
<td># 2 ISTP</td>
<td>10 tasks x .67</td>
<td>0 tasks x .38</td>
<td>.23</td>
</tr>
</tbody>
</table>
Subjects identified as clearly lateralized (more differentiated in their cognitive processing) seemed to have a cognitive set, a specific direction for information processing no matter what the task demands. Four of these subjects demonstrated left hemisphere processing modalities 90% of the time, while five of the subjects demonstrated right hemispheric processing strategies approximately 97% of the time in every task throughout the ten task protocol.

The more integrated (less lateralized) the individuals were in their neural processing modalities, the more likely they were to make use of the brain's lateralization specialization - spatial tasks processed in the right hemisphere; analytic tasks processed in the left hemisphere. No specific generalizations can be made about individuals classified as moderately lateralized.

The EEG task protocol was designed to measure the individuals' cognitive style (Hidden Figures), as well as their right and left hemisphere processing while engaging in a relatively easy spatial task (Mooney Faces) and a more difficult spatial task (Mental Rotations); and a relatively easy analytic task (Inference) and a more difficult analytic task (Deciphering Languages). The mean percent of correct responses was computed for the entire task protocol. The relationship between task performance and the degree of lateralization was then determined (See Table 12).
TABLE 12  
RELATIONSHIP BETWEEN TASK PERFORMANCE AND DEGREE OF LATERALIZATION

Less Lateralized (More Integrated)

<table>
<thead>
<tr>
<th>Task</th>
<th>Mean % of Correct Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inference</td>
<td>95%</td>
</tr>
<tr>
<td>Mooney Faces</td>
<td>94%</td>
</tr>
<tr>
<td>Deciphering Languages</td>
<td>80%</td>
</tr>
<tr>
<td>Mental Rotations</td>
<td>52%</td>
</tr>
<tr>
<td>Hidden Figures</td>
<td>50%</td>
</tr>
<tr>
<td>Overall</td>
<td>74%</td>
</tr>
</tbody>
</table>

Moderately Lateralized

<table>
<thead>
<tr>
<th>Task</th>
<th>Mean % of Correct Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mooney Faces</td>
<td>83%</td>
</tr>
<tr>
<td>Inference</td>
<td>70%</td>
</tr>
<tr>
<td>Mental Rotations</td>
<td>43%</td>
</tr>
<tr>
<td>Hidden Figures</td>
<td>37%</td>
</tr>
<tr>
<td>Deciphering Languages</td>
<td>20%</td>
</tr>
<tr>
<td>Overall</td>
<td>51%</td>
</tr>
</tbody>
</table>

Clearly Lateralized (More Differentiated)

<table>
<thead>
<tr>
<th>Task</th>
<th>Mean % of Correct Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mooney Faces</td>
<td>97%</td>
</tr>
<tr>
<td>Inference</td>
<td>82%</td>
</tr>
<tr>
<td>Mental Rotations</td>
<td>60%</td>
</tr>
<tr>
<td>Deciphering Languages</td>
<td>38%</td>
</tr>
<tr>
<td>Hidden Figures</td>
<td>27%</td>
</tr>
<tr>
<td>Overall</td>
<td>61%</td>
</tr>
</tbody>
</table>
As expected the more difficult tasks (Hidden Figures, Mental Rotations, and Deciphering Languages) had fewer correct responses than the easier Mooney Faces and Inference tasks.

The more integrated the subjects' hemispheric processing, the better their overall task performance, especially in the difficult analytic task, Deciphering Languages. The more clearly lateralized the individuals were, the better overall task performance they had in the difficult spatial task, Mental Rotations, which supports Levy and Sperry (1968) who argue that strong cerebral dominance facilitates performance of spatial abilities (See Table 10).

The mean percent of correct responses on the cognitive style task, Hidden Figures, was 35.7%. The rationale for including this particular task in the protocol was to ascertain if individuals classified as field dependent would have more cognitive activation in their right hemispheres while performing this task, whereas field independent individuals would have more cognitive activation in their left hemispheres during task performance.

The results indicate that there were no generalizations which could be made concerning the processing strategies of field dependent/independent individuals while performing the Hidden Figures task. A possible explanation for the inability to relate field dependency/independency to right/left cognitive processing may lie in the nature of the task itself. The subject must hold a configuration in mind despite distraction, to see a given configuration when it is hidden or embedded in a larger, more complex figure. Disturbances in this ability have been associated with unilateral left hemisphere lesions.
(Teuber and Weinstein, 1954), which suggests that the LH plays a role in successful performance of the task.

Additional research involving commissurotomized patients has been conducted in order to investigate the hemispheric laterality of the closure flexibility factor (Zaidel & Sperry, 1973). Using half-field occcluding lenses, Zaidel compared the split-brained patients' performance on a hidden figures task in the right and left visual fields. He found that commissurotomized patients were significantly better in the right visual field (left hemisphere) than in the left (right hemisphere). These results suggest that although the ability to form a gestalt from incomplete information may reside in the RH, the ability to discover a shape within an irrelevant background gestalt (as with the Hidden Figures task) resides in the left hemisphere.

Given this evidence, it is not surprising that those subjects who were more integrated in their neural processing had a better overall task performance on the Hidden Figures task. The results support the notion that Hidden Figures, a task designed to measure closure flexibility, requires the processing modalities of both hemispheres. The more differentiated the individuals are in their hemispheric processing skills, the less likely they are to successfully complete the task.

This notion that the more integrated the individual is in his neural processing, the better his task performance is not new. Clark (1967) suggested that balance in cognitive skills is necessary when tasks require complex functioning. Lopez, Clark, and Winer (1979)
and Clark and Frisby (1980) provide additional support for stressing the importance of the interrelationship between two cognitive stylistic processing dimensions, termed "analysis" and "synthesis," which are congruent with the notions of successive (left hemisphere) and simultaneous (right hemisphere) processing.

Implications from this laterality research suggest that the more integrated the student's neural processing the better his overall task performance, and that this ability to integrate the processing capabilities of the cerebral hemispheres would be facilitated if processing skills for the "right" and "left" hemispheres were learned at an early age.

In addition, when an individual confronts new verbal or new spatial-relational information, processing is more efficient when the information is presented to both hemispheres (Hardyck and Haapanen, 1979), suggesting that the acquisition of new information and skills which occupies a large percentage of a child's experience (particularly in a classroom) would require bilateral processes.

Lenneberg (1967) suggests that lateralization of function is complete at the onset of puberty. Epstein and Toepfer (1978) argue that most children of average and above average ability have 7 periods of brain growth spurts and plateaus, alternating every two years, with spurts permitting and plateaus ruling out advances in learning. They state that "in, perhaps, 85% of all youngsters between the ages of 12 and 14, the brain virtually ceases to grow" (Epstein & Toepfer, 1978). If these claims are true, the elementary school teacher has a major responsibility in creating a greater diversity of curricula,
instructional methods, and educational goals and values that will make it possible for students with a wide range of abilities and proclivities to meet with success in the classroom.

**Section 2 - Learning Process Application**

Learning style may be viewed as the characteristic approach the individual brings to the learning situation. As this study suggested, an individual's learning style is a composite constructed from personality, cognitive style, and neural processing components, as well as other variables. Learning style needs to be conceptualized in forms of deeply embedded structures within the individual, not as an individual's response to environmental conditions (e.g., light, sound) or other specific aspects of the learning environment (Languis, 1981). This notion that one's learning style is the result of deeply embedded structures suggests that it is somewhat stable, but not fixed (Bem & Allen, 1974).

Therefore, if prospective teachers understood the theoretical concepts about human learning, perception, and personality, they should be able to begin to identify behaviors reflecting these deeply embedded structures. The students in this learning style program of study demonstrated their ability to do this.

The next step is to design instructional strategies to accommodate individuals with varied learning styles. To the writer's knowledge, there is no text specifically designed delineating brain-based curricula. However, there is available the work of Sperry (1973), Kinsbourne (1978), Das, Kirby, Jarman (1979), Wittrock (1981), and Samples (1981) which examine the role played by each hemisphere in
humans' processing of verbal vs. spatial; auditory vs. visual; analytic vs. holistic, successive vs. simultaneous stimuli. In order to proceed to greater heterogeneity in curriculum planning, learning, and teaching, it is necessary to understand that hemispheric specialization tends to be process specific, rather than material specific. As these prospective teachers documented, the subject matter is far less important than its method of presentation.

Recent research has provided evidence that school achievement is dependent upon simultaneous (right hemisphere) and successive (left hemisphere) processing (Das, Kirby, and Jarman, 1979). However our schools today, and society in general, tend to overemphasize the values of the analytical attitude (logical deductive reasoning), thus focusing their resources on successive, left hemisphere instruction and methods of presentation.

The importance of the simultaneous right hemisphere's mode of cognitive processing has been established by Dr. Roger Sperry, who was awarded the Nobel Prize for medicine in 1981. Sperry demonstrated that the right hemisphere was superior to the left hemisphere in terms of concrete thinking, spatial consciousness and comprehension of complex relationships. He discusses how essential it is for educators and others to be aware of the important role of the nonverbal components and forms of the intellect (Sperry, 1982).

Instead of educators thinking in terms of the "one" best method of instruction, they should be thinking in terms of several diverse methodologies (teaching styles) to accommodate diverse individual
differences (learning styles). Educators must realize that all children do not learn best through the analytical mode.

For example, several investigators found that subcultures within the U.S. are characterized by certain predominant modes; the urban poor are more likely to use the spatial-holistic mode, while the middle class are more likely to use the verbal-analytic mode (Cohen, 1969; Lesser, Fifer, Clark, 1965). This dichotomy results in a cultural conflict of cognitive preference and may in part explain the difficulties of urban poor children in a school system oriented toward the middle class or being taught by middle class teachers who are not aware of the urban poor child's cognitive style.

As this study documented, the more integrated the individual's neural processing, the better her task performance. Therefore, the writer would suggest that teachers use instructional materials and teaching strategies to accommodate both the simultaneous (right hemisphere) and successive (left hemisphere) processing strategies individuals employ when engaged in a task. Students need to develop and integrate both simultaneous and successive processing skills in order to learn most effectively and efficiently specific curriculum tasks. This ability to learn utilizing both information processing modalities would enable the student to develop his full potential.

A booklet entitled Activities for Educating Both Halves of the Brain compiled by a university math instructor, students from the learning style program of study, and the writer offers guidelines in developing instructional strategies to meet individual needs of students in mathematics and reading. This booklet presents some general
recommendations and offers more specific activities for integrating instruction to accommodate varying needs. Lutz (1978) and Buzan (1976) provide additional suggestions for synthesis/gestalt and analytical/verbal strategies, instructional methodologies, and inducements.

Since this writer and others (Das, Kirby, and Jarmen, 1979) view simultaneous and successive processing as cognitive skills, rather than cognitive capacities, it is possible that remedial programs could be designed to encourage the development of improved processing abilities in students who were considered low in them.

One way of accomplishing this goal, would be to design programs that make use of the student's processing strength and then builds on his less efficient mode of processing. Such a program would present materials and strategies which were congruent with his preferred learning strategy, and then present materials and strategies for developing his less efficient mode.

For example, suppose a child, who prefers simultaneous (right hemisphere) processing skills, is asked to read a short story and then put the story into sequence. Usually she/he is presented with a series of four statements and asked to number them 1-4 in the proper sequence. A more appropriate teaching strategy for this particular child would be to present the numbered items in picture format, whereby the child manipulates the pictures into the proper sequence and then retells the story to the teacher using the picture stimulus as cues. The teacher has taught to the child's strength. To build on the child's less preferred process, the teacher would
then ask the child to write a sentence in his/her own words discussing each picture. The child is now ready to go to the original four statements and place them in the proper sequence. The teacher has taught to the "strength" and built on the "weakness" in order to establish a more integrated lesson.

This approach to remediation suggests that educators need better information concerning children's processing strengths, not elaborate explanations concerning their weaknesses. However, the most frequently used yardstick for determining children's mental ability and thus potential school achievement is the standardized intelligence test. Performance measures on the majority of these instruments have been associated with the verbal left hemisphere which specializes in sequential processing, analytic, linear, and successive in nature. The child who prefers and is more successful using right hemisphere processing modalities, which are simultaneous or holistic in nature, is at a disadvantage if he is assessed by the standardized intelligence tests most often used today (i.e., Stanford-Binet, Wechsler Full Scale IQ).

Sperry (1982) and Kaufman (1979) discuss the urgent need for educational tests and policy measures to identify, accommodate and serve the individual intellectual potentials of the child who employs simultaneous (right hemisphere) processing modalities. Kaufman (1979) challenges test developers to design an instrument which has pure scales of left hemisphere successive processing and right hemisphere simultaneous processing as well as scales specifically and systematically developed to reflect integration and cerebral organization of the two
hemispheres. Intelligence tests designed to assess cerebral specialization would provide vital information and valuable insights into the processing strengths of children.

In conclusion, in order for teachers to apply learning process information and concepts they must first study the learning process by observing children's behavior in various contexts (i.e., school, play, home, community activities). This notion has been developed by Urie Bronfenbrenner (1979) who suggests that when studying children's development the emphasis should be on what is perceived, desired, thought about, or acquired as knowledge.

This conceptualization of development suggests that children come to the learning environment with a particular learning style, which teachers should allow children to use. Teachers should then become "kid watchers," who are proficient in identifying children's learning processes (style) when they are not being directly taught. By watching children learn in various contexts, teachers can develop a good practical theory of learning based on the cognitive sciences. This theory of learning would be rooted in what the learner does, not how proficient he/she is in performing a task.

The next step is to develop a practical theory of instruction or teaching which would address how the teacher can facilitate the child's ability to gain more proficiency. This child centered approach to instruction suggests adjusting the curriculum to the children, not the children to the curriculum.

The writer believes that when designing instructional strategies to meet individual learning needs, a good theoretical perspective is
necessary. Every paper/pencil and psychometric test in this study was based on well established concepts concerning human learning. The problem of what to watch for in identifying individual learning behaviors is much easier and more reliable with a theory than without one.

From an instructional perspective, teachers must determine the child's learning behavior and then adapt their curriculum and teaching style to accommodate that learning style, always keeping in mind that the more integrated the individual's processing skills, the better his/her overall task performance.

Section 3 - Future Directions

The interpretation and discussion of the results of this study provide support for several applied recommendations. These recommendations fall into two categories: recommendations for future research and recommendations for educational practice. Since only a portion of the quantitative data was analyzed and interpreted as called for in the design of the study, the following questions could be considered in relation to the same quantitative data.

Specific recommendations for future research (quantitative data):

1) The pattern of theta activity during cognitive processing. Cursory inspection of the data showed a pattern of theta activity during the first ten seconds of activation which was related to the overall alpha/beta activation summed for the duration of the task.

2) The pattern of alpha/beta activation for total EEG and subtasks in the EEG protocol for the first ten second epochs.
3) The relationship of the one minute average of alpha/beta activity to the first two ten second epochs.

4) Statistical analysis of the alpha/beta activation for the right and left hemisphere during subtask performance.

Specific recommendations for future research (qualitative data):

1) Follow up studies to determine if these prospective teachers could continue to identify specific learning behaviors and develop instructional studies to meet individual learning needs, once the program was complete. (This study is underway).

2) Longitudinal studies to determine the effects of the learning style program of study in subsequent years.

When considering recommendations for educational practice, the major concern is that the teaching profession recognize how important it is that students become sensitized to individual substrates inherent in learning processes which contribute to individual differences (learning styles).

Specific recommendations for educational practice include:

1) Develop a teacher education program specifically designed to provide students information concerning the role of the cognitive sciences in education.

2) Develop a program of study or course which presents personality, cognitive style, and neural processing theories underlying learning processes.

3) Allow the students to develop and demonstrate specific teaching strategies to accommodate various learning styles.
4) Develop simulated learning conditions to identify specific learning behaviors.

5) Provide opportunities for prospective teachers to practice teaching strategies under these simulated conditions.

6) Follow up the practice sessions with application in the classroom.

7) Provide in-service and continual support for prospective teachers throughout their student teaching and first few years of teaching.

8) Establish a corpus of prospective teachers, trained in a learning style program of study to continue the program by serving as cooperating teachers, inservice facilitators, supervisors, and program developers in subsequent years.

The writer believes that one way to stop the serious erosion in public confidence in educational practices is by developing prospective teachers' ability to become professional decision makers. A program of study incorporating the preceding eight recommendations is a step in the right direction.

It is no secret that teaching is not considered a "true" profession (Ornstein, 1981). Every other "true" profession (attorney, physician, engineer, etc.) trains their undergraduates in such a manner that they develop an expertise in their field. A learning style program of study would provide prospective teachers a foundation for developing an expertise in the learning/teaching process. It is the opinion of this writer that then community leaders, etc., would be less likely
to dictate curriculum policy in opposition to the teachers' professional judgments.

True professionals have the knowledge and expertise to make judgments and the clients (parents and children) are not qualified to evaluate the services needed. What the teacher knows is the key to good instruction, not the text or the test (Shuy, 1981). It is not likely that educators will be given complete autonomy in setting standards for professional practice, however, a program of study like the one outlined may start a trend toward increased professionalism for teachers.

In addition, a program of study based on the eight recommendations, that sensitizes participants to the existence of individualized learning process constructs, creates an atmosphere of inquiry which should lead to an awareness of self and others as functioning as everyday scientists to a quest for appropriate learning strategies. This quest could potentially enhance one's own freedom to understand their own learning processes and subsequently teach children how to know, understand, develop and strengthen their learning processes.

Dr. Madeline Hunter, in her 1976 address to the National Institute of Education task force on curriculum development for teacher education programs stated:

Students everywhere are exerting effort to learn, but nowhere (to the writer's knowledge) are students systematically learning how to learn more efficiently and effectively. As a result, we find students routinely using assembly line learning procedures unaware that they could know their own best learning modalities, the strategies that work for them, the most productive way for them to become more motivated to learn,
learn more rapidly, remember longer, and transfer that learning successfully to new situations. In short, although individualization of instruction is preached, students are not learning the skills to deal with the idiosyncratic dimensions of their own learning behavior (p. 5).

The writer believes that the results of this quantitative and qualitative data analysis demonstrate that the basic teacher education "learning how to learn" curriculum which Madeline Hunter advocated in 1976 was successfully initiated and implemented in this study in 1982.
APPENDIX A

Neural Processing, Cognitive Style, Personality Type Learning Style Model

Sensing (MBTI) (S)
- Sensing - perceive
- Feeling - judge

Intuitive (MBTI) (N)
- Intuitive (N) - perceive
- Feeling - judge

dark red - right hemisphere
light red - field dependent

dark blue - left hemisphere
light blue - field independent

Carol Lyons
APPENDIX B

Self-Report Learning Style/Teaching Style Questionnaire

1. Describe as fully as possible how you learn best.

2. Describe as fully as possible how you teach best.
### APPENDIX C

**PROCESSING AND ORGANIZING INFORMATION**

<table>
<thead>
<tr>
<th>RH PREFERENCE</th>
<th>LH PREFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 non-verbal</td>
<td>101 verbal</td>
</tr>
<tr>
<td>02 synthetic</td>
<td>102 analytic (MBTI-thinking)</td>
</tr>
<tr>
<td>03 reasoning not as logical</td>
<td>103 reasoning logical (MBTI-thinking)</td>
</tr>
<tr>
<td>04 concrete (MBTI-sensing)</td>
<td>104 abstract (field independent)</td>
</tr>
<tr>
<td>05 divergent</td>
<td>104 convergent</td>
</tr>
<tr>
<td>06 inductive</td>
<td>105 deductive</td>
</tr>
<tr>
<td>07 non-temporal</td>
<td>106 temporal</td>
</tr>
<tr>
<td>08 experience/hands on learning (MBTI sensing)</td>
<td>107 symbolic learning (MBTI-intuitive)</td>
</tr>
<tr>
<td>09 non-rational</td>
<td>108 rational</td>
</tr>
<tr>
<td>10 gestalt-holistic</td>
<td>109 linear (MBTI-thinking)</td>
</tr>
<tr>
<td>11 spatial</td>
<td>110 digital</td>
</tr>
<tr>
<td>12 prefers imagery in learning</td>
<td>111 prefers language to learn</td>
</tr>
<tr>
<td>13 stores memories in images</td>
<td>112 stores memories in words (MBTI-intuitive)</td>
</tr>
<tr>
<td>14 prefers random exploration</td>
<td>113 prefers ordering and sequencing (field independent)</td>
</tr>
<tr>
<td>15 prefers to invent products</td>
<td>114 improves on others inventions</td>
</tr>
<tr>
<td>16 likes to fanticize</td>
<td>115 likes reality</td>
</tr>
<tr>
<td>17 prefers concepts and patterns</td>
<td>116 prefers details and facts</td>
</tr>
<tr>
<td>18 summarizes material</td>
<td>117 outlines material</td>
</tr>
<tr>
<td>19 looks for the main idea in reading material</td>
<td>118 looks for details and facts in reading material</td>
</tr>
<tr>
<td>20 concrete manipulation</td>
<td>119 abstract thinking (field independent)</td>
</tr>
<tr>
<td>21 infers from feelings</td>
<td>120 infers from facts</td>
</tr>
<tr>
<td>22 reads facial expression/gestures</td>
<td>121 listens to articulation of words</td>
</tr>
<tr>
<td>23 prefers non-structured environment</td>
<td>122 prefers structured environment</td>
</tr>
<tr>
<td>24 prefers to learn social material (field dependent) (MBTI-feeling)</td>
<td>123 prefers to learn impersonal material (field independent) (MBTI-thinking)</td>
</tr>
<tr>
<td>25 people oriented (field dependent) (MBTI-feeling)</td>
<td>124 prefers physical sciences (field independent)</td>
</tr>
<tr>
<td>26 prefers social sciences (field dependent)</td>
<td>125 practical application of ideas most important</td>
</tr>
<tr>
<td>27 practically not that important</td>
<td>126 prefers objective exam</td>
</tr>
<tr>
<td>28 prefers essay exam</td>
<td>127 does not read social reinforcement for behavior (MBTI-thinking)</td>
</tr>
<tr>
<td>29 social reinforcement needed-praise or criticism for behavior (field dependent) (MBTI-feeling)</td>
<td>128</td>
</tr>
</tbody>
</table>

158
APPENDIX D

MOONEY FACES

1

2

3
APPENDIX D

INFERENCE TEST

You will be given one or two statements such as you might see in newspapers or popular magazines. The statements are followed by various conclusions which some people might draw from them. In each case, decide which conclusions can be drawn from the statement(s) without assuming anything in addition to the information given in the statement(s). There is only one correct conclusion. Indicate your response by pushing button 1, 2, 3, 4, or 5.

Example: Bill, a member of the basketball team, is 6 feet, 2 inches tall and weighs 195 pounds. To qualify for the team, a person must be at least 5 feet, 10 inches tall.

1. The larger a man is, the better basketball player he is.

2. Basketball players are often underweight.

3. Some players on the team are more than 6 feet tall.

4. Bill is larger than the average man.

5. The best basketball players come from the ranks of larger-than-average men.

Only conclusion 3 may be drawn without assuming that you have information or knowledge beyond what the statements give. The statements say nothing about how good different players are, nothing about whether they are underweight, and nothing about average or taller-than-average men.
APPENDIX D

DECIPHERING LANGUAGES

An archeologist who discovers small fragments of some ancient language must do a lot of reasoning to put the language together. This is a test of your ability to do this kind of reasoning.

For each different artificial language, three expressions in English and their translations into the language are given. From these you will need to figure out logically which syllable or which symbol in the language is equivalent to which English word. Note that the order of the symbols is consistent for any language, but may be different in each language and different from English. Therefore, do not assume that the first word in the artificial language refers to the first word in the English phrase, although sometimes it does.

Example: Language A: black sheep = dag kip
          white dog = tin bud
          black cow = dag stam

Push button 1, 2, 3, 4, 5, to indicate the correct translation for the following phrases.

1. white sheep =
   1. dag kip
   2. tin kip
   3. stam dag
   4. bud tin
   5. tin bud

2. tin stam =
   1. white cow
   2. black sheep
   3. white sheep
   4. black dog
   5. black cow
HIDDEN FIGURES

This is a test of your ability to tell which one of the five simple figures can be found in a more complex pattern. At the top of each page in this test are five simple figures lettered A, B, C, D, and E. Beneath each row of figures is a page of patterns. Each pattern has a row of letters beneath it. Indicate your answer by pushing the button indicating the letter of the figure which you find in the pattern. Button #1 is A; button #2 is B; button #3 is C, etc.

Note: There is only one of these figures in each pattern, and this figure will always be right side up and exactly the same size as one of the five lettered figures.

Examples:
APPENDIX E

Throughout the second and third quarters of this learning style teacher education program, you have taken a variety of instruments to assess the personality construct (MBTI), the cognitive style construct (CFT, GEFT, RFT), and neural processing construct (EEG), which it is hypothesized are integral components of an individual's learning process. Based on the knowledge you have acquired through lectures, reading, and observation of various learning style dimensions, do you strongly agree, moderately agree or strongly disagree with each of these five assessment measures? Please discuss each of the three constructs independently using examples from your own experiences to make your point.
APPENDIX F

Please discuss what relationship you see between your own cognitive information processing preferences (learning style) and your classroom teaching style. In other words do you prefer to teach how you prefer to learn?
APPENDIX G

Learning Style/Teaching Style

Procedures for Content Analysis

Coding Directions:

1. Each word or phrase is numbered to represent a meaningful dimension of the personality, cognitive style and/or neural processing construct.

2. On items in which more than one response is possible, assign the more appropriate number based on your subjective interpretation.

3. When a response contains an idea previously recorded, the same code number given before may be reassigned.

4. If the concept is easily understood as written, but does not have the exact words as delineated on the coding category, it may be coded if congruent with the exact words on the coding category.

Example: "I always try to have a picture in my mind to remember things", means the same as "stores memories in images".

5. Circle and code with the assigned number any word or phrase which describes a right or left hemisphere preference for processing and organizing information.

6. Place that number in the appropriate box on the summary sheet and determine if the subject prefers right or left hemisphere processing modalities to learn material.

7. Place the number in the appropriate box on the summary sheet to determine if the subject prefers right or left hemisphere processing modalities to teach material.

8. Determine the congruency between learning style and teaching style by calculating the percentage of responses in the learning and teaching portions of the summary sheet.
APPENDIX H

Practice protocol for interrater reliability - pilot study Spring 1981

Protocol #12

Learn
My best learning occurs when I can experience the activity. I need concrete objects to manipulate. I think the best way to learn is through hands on experience.

Teach
I teach in a non-structured classroom where the children interact freely with each other. I watch them interact and can tell by their expressions if they are learning the material. I use praise often for reinforcement for good behavior.

Protocol #26

Learn
Written material is best remembered by hearing and touching objects. I depend also on visual images. I require a very quiet atmosphere.

Teach
I try and utilize the three senses of the learner as often as possible. For example, we see a word, may write it in the air, and say its name.

Protocol #33

Learn
I normally read out loud to myself and then take detailed notes of the material. Next, I memorize the notes and verbalize them back to myself out loud. Once in a while, I have a picture in my mind to help me learn something.

Teach
I try and have the learner take notes of the material. Children can't learn unless they know how to outline well. They must know the important information to look for in the text and then memorize it.
### APPENDIX I

<table>
<thead>
<tr>
<th>Learn</th>
<th>Predominant learning style</th>
</tr>
</thead>
<tbody>
<tr>
<td>right</td>
<td>left</td>
</tr>
<tr>
<td>Teach</td>
<td></td>
</tr>
<tr>
<td>right</td>
<td>left</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Predominant teaching style</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congruent</td>
</tr>
<tr>
<td>Moderately Congruent</td>
</tr>
<tr>
<td>Incongruent</td>
</tr>
</tbody>
</table>
### APPENDIX J

**MBTI, TOTAL EEG, GEFT, CFT, RFT, QWT, RAW SCORES**

#### Dominant "S"

<table>
<thead>
<tr>
<th>MBTI</th>
<th>TOTAL EEG</th>
<th>GEFT</th>
<th>CFT</th>
<th>RFT</th>
<th>QWT</th>
</tr>
</thead>
<tbody>
<tr>
<td>91</td>
<td>1.26</td>
<td>7</td>
<td>70</td>
<td>13.1</td>
<td>27</td>
</tr>
<tr>
<td>75</td>
<td>1.22</td>
<td>17</td>
<td>100</td>
<td>.5</td>
<td>72</td>
</tr>
<tr>
<td>85</td>
<td>1.01</td>
<td>2</td>
<td>90</td>
<td>16.0</td>
<td>31</td>
</tr>
<tr>
<td>53</td>
<td>.92</td>
<td>11</td>
<td>90</td>
<td>2.0</td>
<td>35</td>
</tr>
<tr>
<td>59</td>
<td>.81</td>
<td>16</td>
<td>112</td>
<td>3.0</td>
<td>31</td>
</tr>
</tbody>
</table>

#### Dominant "N"

<table>
<thead>
<tr>
<th>MBTI</th>
<th>TOTAL EEG</th>
<th>GEFT</th>
<th>CFT</th>
<th>RFT</th>
<th>QWT</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>.99</td>
<td>18</td>
<td>100</td>
<td>3.5</td>
<td>46</td>
</tr>
<tr>
<td>141</td>
<td>.66</td>
<td>17</td>
<td>102</td>
<td>2.2</td>
<td>73</td>
</tr>
<tr>
<td>125</td>
<td>.93</td>
<td>14</td>
<td>124</td>
<td>3.5</td>
<td>36</td>
</tr>
<tr>
<td>145</td>
<td>.94</td>
<td>17</td>
<td>110</td>
<td>2.5</td>
<td>74</td>
</tr>
<tr>
<td>133</td>
<td>.97</td>
<td>18</td>
<td>102</td>
<td>1.2</td>
<td>30</td>
</tr>
</tbody>
</table>

#### Dominant "T"

<table>
<thead>
<tr>
<th>MBTI</th>
<th>TOTAL EEG</th>
<th>GEFT</th>
<th>CFT</th>
<th>RFT</th>
<th>QWT</th>
</tr>
</thead>
<tbody>
<tr>
<td>93</td>
<td>1.73</td>
<td>18</td>
<td>119</td>
<td>3.0</td>
<td>60</td>
</tr>
<tr>
<td>99</td>
<td>.81</td>
<td>14</td>
<td>115</td>
<td>.7</td>
<td>72</td>
</tr>
</tbody>
</table>

#### Dominant "F"

<table>
<thead>
<tr>
<th>MBTI</th>
<th>TOTAL EEG</th>
<th>GEFT</th>
<th>CFT</th>
<th>RFT</th>
<th>QWT</th>
</tr>
</thead>
<tbody>
<tr>
<td>127</td>
<td>1.02</td>
<td>12</td>
<td>102</td>
<td>1.2</td>
<td>30</td>
</tr>
<tr>
<td>127</td>
<td>1.07</td>
<td>16</td>
<td>92</td>
<td>1.7</td>
<td>31</td>
</tr>
<tr>
<td>103</td>
<td>1.46</td>
<td>10</td>
<td>64</td>
<td>2.5</td>
<td>31</td>
</tr>
<tr>
<td>113</td>
<td>1.44</td>
<td>11</td>
<td>73</td>
<td>4.7</td>
<td>55</td>
</tr>
<tr>
<td>129</td>
<td>.93</td>
<td>7</td>
<td>94</td>
<td>1.5</td>
<td>61</td>
</tr>
<tr>
<td>121</td>
<td>.83</td>
<td>12</td>
<td>85</td>
<td>2.5</td>
<td>32</td>
</tr>
<tr>
<td>107</td>
<td>2.06</td>
<td>2</td>
<td>88</td>
<td>19.6</td>
<td>44</td>
</tr>
<tr>
<td>143</td>
<td>.89</td>
<td>15</td>
<td>56</td>
<td>2.7</td>
<td>52</td>
</tr>
</tbody>
</table>
REFERENCES


Bem, D.J., & Allen, A. Predicting some of the people some of the time: the search for cross-situational consistencies in behavior. Psychological Review, 1974, 81, 506-520.


Bogen, J.E. Some educational implications of hemispheric specializa-
tion. The Human Brain, M.C. Wittrock (Ed.), Englewood


Borgatta, E.F. & Corsini, R.J. Quick word test manual. New York:

Bowd, A.D. Absence of sex differences on the Children's Embedded

Broadbent, D.E. The role of auditory localization in attention and

Broca, P. Remarks on the seat of the faculty of articulate language,
followed by an observation of aphemia, 1861. In G. Von Bonin
(Ed.). Some Papers on the Cerebral Cortex. Springfield, Ill.:
Thomas, 1960. Cited by R.D. Nebes, Direct examination of
cognitive function in the right and left hemispheres. In
M. Kinsbourne (Ed.) Asymmetrical function of the brain.

Bronfenbrenner, U. The ecology of human development. Cambridge,

Brophy, J.E. & Good, T.L. Teacher-student relationships: causes and

Bryden, M.P. Tachistoscopic recognition, handedness, and cerebral

Bryden, M.P. Sex related differences in cerebral organization. In
M. Wittig & A. Peterson (Eds.), Sex-related differences in

Buffery, A.W., & Gray, J.A. Sex differences in the development of
spatial and linguistic skills. In C. Ounsted & D. Taylor (Eds.),
Gender differences: their ontogeny and significance. London:

Butler, S.R. & Glass, A. Asymmetries in the electroencephalogram
associated with cerebral dominance. Electroencephalography and
Clinical Neurophysiology, 1974, 36, 481-491.


Cage, B.N. Effect of personality on student/cooperating teacher
relationships. Paper presented at the First National Conference
on the Myers-Briggs Type Indicator, Gainesville, Florida,
October, 1975.


Carskadon, T.G. Research in psychological type. Vol. 3, Department of Psychology, Mississippi State, Mississippi, 1981.

Clark, P.M. Balance in cognitive skills as related to complex functioning. Psychology in the Schools, 1967, 4, 29-33.


Constantinople, A. Analytical ability and perceived similarity to parents. Psychological Reports, 1974, 35, 1335-1345.


Hand, J.D. Matching programmed instructional packages and an instructional setting to students in terms of cognitive style. (Doctoral dissertation, Michigan State University, 1972).


Helsen, R. Personality of women with imaginative and artistic interests: the role of masculinity, originality, and other characteristics in their creativity. *Journal of Personality, 1966, 34, 1-25.*


Koegh, B.K., & Ryan, S.R. Use of three measures and field organization with young children. Perceptual and Motor Skills, 1971, 33, 466.


Languis, M., Sanders, T., & Tipps, S. Brain and learning: directions for early childhood education. NAEYC, 1980.

Lawrence, G. MBTI responses from 661 elementary and middle school teachers. CAPT data bank, Gainesville, Florida: Center for Applications of Psychological Type, Inc., 1974.


Naour, P.J. Developmental components in cognitive processing: an EEG and eye movement study of learning disabled and normal boys in the third and sixth grade. (Doctoral dissertation, The Ohio State University, 1982).

Novak, J. Investigation of the relationship between levels of cognition development and personality type preferences of secondary school science students (unpublished manuscript). The Ohio State University, Columbus, Ohio, 1982.


Rosenberg, B.G. & Sutton-Smith, B. Sibling age spacing effects upon cognition. Developmental Psychology, 1969, 1, 661-668.


Shuy, R.W. What the teacher knows is more important than text or test. Language Arts, 1981, 58, 919-929.


