A MULTIVARIATE ANALYSIS OF THE RELATIONSHIP OF FIELD DEPENDENCE-FIELD INDEPENDENCE COGNITIVE STYLE TO LEARNING OF GEOGRAPHICAL CONCEPTS AND INFORMATION AMONG COLLEGE STUDENTS

By

JOHN GARTH HERNING

Bachelor of Science
University of Wisconsin - Madison
Madison, Wisconsin
1965

Master of Science
University of Wisconsin - Madison
Madison, Wisconsin
1968

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of the Oklahoma State University
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Thesis Approved:

J. F. Rooney Jr.
Thesis Adviser

Richard D. Hecock

Kenneth St. Clair

Thomas A. Karman

James H. Stine

N N Durham
Dean of the Graduate College

PREFACE

This study is concerned with analysis of the relationship between field dependence-field independence cognitive style and learning of specified geographic concepts and cartographic patterns among two groups of college geography students. The primary objective of the research is to attempt to learn how geographic instruction might be improved in light of the known psychological characteristics of persons possessing a field dependent or field independent cognitive style.

This investigation grew out of the increasing sense of frustration I experienced in attempting to teach fundamental geographic concepts to large groups of introductory college geography students at Oklahoma State University. I gradually came to the realization that some aspect of individual differences among students might be responsible for the fact that some students readily grasp geographic ideas, while other students seem more or less unable to assimilate information presented in map form, or to comprehend the implications of such fundamental geographic concepts as areal association, regional differentation, spatial interaction, or distance decay. I became aware that if these latter students were ever to develop an appreciation for the influence of geography on their lives, some more effective means of communicating spatial concepts and information had to be devised, taking into consideration basic individual differences among students such as cognitive style, sex, and focus of interests. In the final analysis, I

thought perhaps the results of this research might make my job as a geography teacher more rewarding, and the results of my attempts at geographic instruction more long-lasting and beneficial to my students.

The work reported in this investigation was performed under the graduate teaching assistantship program of the Department of Geography at Oklahoma State University. The writer is grateful to the taxpayers of the State of Oklahoma for financial support and to the students employed as research subjects for cooperation in helping me gather the data needed to do this study.

Thanks go also to Dr. John F. Rooney, Jr., Chairman of my advisory committee, for advice and continuing support during the course of my studies. Special gratitude is expressed to Dr. Thomas Karman for help in formulating the plan of the study and for many suggestions offered to help improve the final product. Sincere appreciation is also expressed to Professor James H. Stine for help in the design of criterion tests, and to Dr. Richard D. Hecock, and James St. Clair for serving on the writer's advisory committee.

Much thanks are also expressed to Dr. Imry Quastler of San Diego State University for help in evaluation of criterion instruments and experimental procedures, and to Dr. Richard Robl for providing the initial inspiration for the study during the teaching effectiveness workshop presented at Western Hills State Lodge during February, 1974. Dr. John Hampton is also thanked for providing me with a copy of the psychometric test used in the study.

This acknowledgment would not be complete without expression of very special appreciation and thanks to Jeanette Schmidt, the writer's sister, for encouragement and material support given freely over the long years necessary to complete my formal education. And, of course, this investigation could never have been brought to fruition without the patience, moral support, and massive assistance of Marge Herning who complained little (though suffering much!) while helping with preparation of research materials and manuscript drafts. Appreciation is also expressed to Carol Taylor for typing of the final draft of the dissertation.

Finally, the writer would like to extend thanks to those friends and associates in the Department of Geography at Oklahoma State University who gave their encouragement and advice quite freely over the years, including especially Vince Robinson, for protection in Milwaukee; Eric Weiland, for a good time at Whiterock; Burrell Montz, for a night in Tulsa; Pat Treadway, for coffee at Sambo's; Mary Kay Audd, for a swim at Branson; James Renner, for fiddle music at parties; Gary Lauver, for sharing my desk; Jerry Williams, for crucial insight at Gundersen; T. R. Keynose, for lots of laughs; and Dr. George Carney, for freedom to grow, make mistakes, and learn, with confidence!

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NOMENCLATURE

p	probability term indicating level of statistical significance or confidence level
A	symbolic identification of pilot study analysis and results
B	symbolic identification of principal study analysis and results
FDI	term used to signify field dependence-field independence cognitive style continuum
FD	term used to signify field dependence cognitive style
FI	term used to signify field independence cognitive style
CS	cognitive style symbol; refers exclusively to field dependence-field independence dimension
RCT	symbolic representation for regional concept criterion instrument
MALM	term for map of Africa learning module psychometric instrument
GVR	term for geographic verbal recognition ability
VMR	term for visual map recognition ability
HFT	Hidden Figures Test used to measure cognitive style organismic variable
r	Pearson's product-moment correlation coefficient
F	critical ratio of between to within group variance in analysis of variance F-test of statistical significance
df	degrees of freedom for determination of probability level in F-test
MS	mean square term for determination of critical ratio of between to within group variance
SS	sum of squares of between groups variance employed in F-test
N	number of observation employed in the population or sample

pot — symbolic representation of posttest of criterion score

XX' or X'Y — symbolic representation of X-recessive gene for spatial ability carried on male or female X chromosome

$>$ — symbol for indication of a term which is greater than subsequent term

$<$ — symbol used to identify a quantity which is less than subsequent quantity

EFT — Embedded Figures Test similar to the Gottschaldt Figures Test and the Hidden Figures Test

CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

Bacon and Kennamer (1967, p. 42), in a study of research possibilities in geographic education, have pointed to the need for studies which relate the findings of cognitive psychology to learning problems in geography. As Bacon and Kennamer observed:

> The psychologist concerned with cognitive learning has knowledge of the learner to share with the geographer. The geographer, obviously, has knowledge of the structure of the discipline to share with the psychologist. One of the frontiers in geographic education has been the lack of personnel in geography with special skills in educational and/or psychological research. Programs leading to a break-through of this barrier are certainly one of the real challenges to the graduate departments of geography in Anglo-America (Bacon and Kennamer, 1967, pp. 42-44).

Others have also pointed to the need for studies of the cognitive processes involved in geographic learning. John Eliot (1972), for example, has categorized research priorities in geographic education in terms of a matrix in which Pattison's "Four Traditions of Geography" (1964) interact with three traditional concerns of the educational psychologist to suggest a number of research possibilities in geographic learning (Figure 1). Eliot's intent in presenting the matrix was to "suggest a number of possible forms of inquiry without specifying the nature of their precise content" (Eliot, 1972, p. 202).

In terms of Eliot's matrix, the present study appears to lie

Cognitive Behavior Dimension	Geographical Traditions Dimension			
	Spatial	Area Studies	Land/Man	Earth Science
Perception	1. A. Developmental theorists B. Individual differences C. Learning theory	2. A. Objective-picture perception B. Personal space and relating viewpoints	3. A. Children as agents of change B. Filming possibilities C. Man-made and natural hazards	4. A. Time construction B. Directional orientation
Language	5. A. Transformations and ability to abstract B. Pictorial grammar	6. A. Understanding place through maps B. Cross-sectional description	7. A. Neutralized language B. Stereotypical language	8. A. Language sequences in auto-instruction B. Cultural differences in concepts
Thinking	9. A. Spatial tests B. How ability impedes learning	10. A. Criteria B. Egocentrism as attitude system	11. A. Interactive and concrete thought B. Simulation of relationship	12. A. Existing literature B. Problem-focused systems

Figure 1. Eliot's Matrix of Psychological Research Problems in Geographic Education

Source: Eliott, 1972, p. 203.

partially within the cell defined by the intersection between the cognitive behavior dimension of "thinking" and the geographic "spatial" tradition, and partially within the cell defined by the interaction between the spatial tradition and the cognitive domain of perception. The intent of the present study was to investigate certain aspects of the interaction between cognitive style and geographic learning. Eliot saw the need for such a study in noting that:

> A third opportunity for research activity is the study of spatial visualization. Spatial visualization, or the ability to perceive and to imagine spatial arrangements from different viewpoints, may be fundamental to learning to make and to read maps (Eliot, 1972, p. 211).

Of course, it is not possible to describe the thrust of the present investigation completely in terms of Eliot's matrix. As Eliot was the first to admit "matrices portray arbitrary classifications within potentially misleading semantic boundaries" (Eliot, 1972, p. 211). However, the matrix does provide a referent for locating the foci of the present study relative to the more general concerns of geography and psychology and is therefore of some value.

Significance of the Study

Ausubel (1963, pp. 4-6) has pointed out that most educational research has had a quite limited impact on applied classroom learning or the solving of educational problems. Similarly, Anderson (1969) has emphasized that educational research needs to go beyond the psychology laborabory and get into the classroom. In this connection, J. E. Hill (1971) has proposed the synthesis of a new academic discipline to be called the "educational sciences" (Hill, 1971, p. 14). According to Hill, the educational sciences would consist of a series of related applied fields of scientific study, analogous in role, organization, and purpose to the medical sciences. Among the new educational sciences recommended by Hill is one which he tentatively identified as the "Educational Science of Cognitive Style" (Hill, 1971, p. 14). The proposed task of the science of cognitive style would be to diagnose elements of the learner's cognitive style and to prescribe learning activities and strategies which would increase the probability of successful learning for that individual. It would be necessary, therefore, to consider the interaction between aspects of cognitive style and the intellectual demands of various learning tasks. Hill states:

> It should be noted that the cognitive style of an individual is a relative concept, and depends not only upon the educational level and cultural background of the individual, but also upon the symbolic condition of the task to be accomplished. In this context, the derivation of an appropriate style for an individual demands that the diagnostician analyze the student as well as the substance of the educational task to be considered. Under these circumstances, the construct of cognitive style provides a means of analyzing, interpreting, and evaluating educational endeavors in a manner relatively different from those usually employed (Hill, 1971, p. 15).

Others have made similar suggestions. Goldman and Hudson (1973) for example, have investigated differences in learning strategy among college students enrolled in various disciplines of American higher education. Their findings indicate that major differences exist in the type of learning strategy that is successful in different academic fields. With regard to the task structure of academic disciplines Goldman and Hudson note:

> If college classes are considered as tasks, it is likely that they have different task structures. Different major fields present different types of problems to the student. Clearly there is little surface resemblance between the solution of mathematical equations and the writing of literary critiques (Goldman and Hudson, 1971, p. 364).

It is possible, therefore, that findings of the present study could be employed to suggest more fruitful ways of organizing and implementing geographic instruction at the college level. In addition, findings of the present study may prove useful in helping to predict learning problems of students encountering geography for the first time and may serve as a basis for future research concerning the relationship of individual differences in cognitive style to geographic education.

The goal of this research is to seek a better accommodation between individual differences in cognitive style among students of geography and the teaching methods and materials employed in college level courses. While research findings should be interpreted with care when attempting to apply them to populations of college geography students other than those studied, the results of the present study may help to provide a more definitive conceptual framework and greater economy of thought regarding the interaction between cognitive style and geographic education.

Statement of the Problem

The present study accepts the probability that individual differences in FDI cognitive style can influence academic achievement through interaction with subject matter and instructional strategy. A review of the literature relevant to this possibility revealed that no previous research has been conducted with regard to the specific nature of the interaction between tasks involved in geographical learning, and individual differences in the field dependence-independence cognitive style of students of college age. The purpose of the present study, therefore, was to attempt to determine whether two groups of students who differed in field dependence-field independence cognitive style, also differed significantly in their ability to learn academic subject matter of a geographical nature. A secondary but supporting purpose of the study was to determine whether college age students who differed in cognitive style also differed in their response to a deductive as opposed to an inductive style of lecture organization.

Theoretical Orientation of the Study

Over the years researchers in psychology have used the term 'cognitive style' to identify at least nine separate aspects or dimensions of individual differences in cognitive functioning (Coop and Sigel, 1971, p. 152). Figure 2 lists some of the dimensions of cognitive style discovered to date. So many interpretations have been given the term cognitive style that its use has become investigator specific. According to Coop and Sigel:

> A number of different investigators have used this same label to represent quite different cognitive processes. Even within the area of cognitive style, specific lables are used by two or more writers in describing different dimensions of a particular construct of style. For example, Witkin uses the term analytic to denote a person who is field independent in his perceptual orientation, while Kagan, Moss, and Sigel (1963) use analytic as a label for those people who tend to categorize environmental stimuli on the basis of objective parts of that environment rather than on the whole of the environment. These identical lables rarely denote the same perceptual operations, since each investigator utilized different experimental tasks and materials to elicit the behavior on which he classifies his Ss (Coop and Sigel, 1971, p. 153).

The dimension of cognitive style employed in the present study is that originally investigated by Witkin and associates (1954) and terms "field dependence vs. field independence."

Field dependence is generally defined in terms of performance on a

Field independence vs. field dependence: an analytical, in contrast to a global, way of perceiving which entails a tendency to experience items as discrete from their backgrounds and reflects ability to overcome the influence of an embedding context.

Scanning: a dimension of individual differences in the extensiveness and intensity of attention deployment.

Breadth of categorizing: consistent preferences for broad inclusiveness, as opposed to narrow exclusiveness.

Conceptualizing styles: individual differences in the tendency to categorize perceived similarities and differences among stimuli in terms of many differentiated concepts.

Cognitive complexity vs. simplicity: individual differences in the tendency to construe the world, and particularly the world of social behavior in a multidimensional and discriminating way.

Reflectiveness vs. impulsivity: individual consistencies in the speed with which hypotheses are selected and information processed.

Leveling vs. sharpening: reliable individual variations in assimilation in memory.

Constricted vs. flexible control: individual differences in susceptibility to distraction and cognitive interference.

Tolerance for incongruous or unrealistic experiences: a dimension of differential willingness to accept perceptions at variance with conventional experience.

Figure 2. Nine Cognitive Styles

Source: Lesser, Fifer, and Clark, 1965.

number of perceptual tasks intended to measure the subject's degree of dependence on the prevailing visual field (Fitzgibbons, Goldberger, and Eagle, 1965, p. 16). For example, Witkin et al., (1954) defined field dependence-independence cognitive style in terms of characteristic ways in which individuals organize their perceptual environment. To Witkin, the core of field independence involves the ability "to overcome the influence of an embedding context" (Witkin et al., 1954). Keogh and Donlon have summarized the perceptual differences between field dependent and field independent individuals as follows:

> Stated simply, the field dependent person is strongly influenced by global aspects of his perceptual world; the field independent person is better able to perceive and utilize discrete elements of the field, is less influenced by overall characteristics of the background, is better at tasks which require identification of stimuli surrounded by embedded figures in complex backgrounds. Field dependence-independence is considered to be the perceptual expression of a more generalized dimension of individual differences, the global-analytic cognitive style. Field dependent persons are primarily global in perceptual and cognitive strategies they bring to problem-solving situations (Keogh and Donlon, 1972, p. 331).

Although the theoretical orientation of the present study is predominantly toward the definition of cognitive style employed by Witkin et al. (1954), where research on closely related cognitive styles and learning abilities is relevant, it will also be reviewed and incorporated in the study.

Clarification of Terms

The following terms and abbreviations have specific meanings in this study:

1. <u>Cognitive Style</u>. This refers to a psychological construct that represents a domain of observable behaviors or consistencies in mode of

perceptual functioning in a variety of behavioral situations (Witkin, 1962). In the present study the domain of observable behaviors referred to by use of the term "cognitive style" will be exclusively that identified by Witkin and termed "field dependence vs. field independence."

2. Field Dependence-Independence (FDI). This term was coined by Witkin et al. (1954) and refers to individual differences in ability to separate a two-dimensional figure from an embedding context; it is equivalent in meaning to "field dependence vs. field independence" cognitive style.

3. Field Dependent (FD). This term is used to identify test subjects who exhibit a relatively low level of ability to separate figures from an embedding context on the Hidden Figures Test.

4. Field Independent (FI). This term is used to identify test subjects who exhibit a relatively high level of ability to separate figures from an embedding context on the Hidden Figures Test.

5. Student. This term refers to any person enrolled in Geography 1113 and included in the present study during the 1973-74 and 1974-75 academic years.

6. Hidden Figures Test (HFT). A Gottschaldt type embedded figures test used to determine FDI cognitive style of students in the present study.

7. Spatial Ability. A group factor connected with intelligence testing frequently identified by the letter "k" due to association with mental kinoesthetic and visual imagery processes. Spatial ability is widely considered the psychological equivalent of FDI cognitive style, and will be so considered in the present study.

8. Geographical Information. This term will be used to refer to

knowledge and materials which deal with spatial patterns or spatial arrangements presented on maps and in verbal descriptions or areal associations.

9. Map of Africa Learning Module. This refers to the instructional module of geographic information consisting of a political base map of the African continent and associated learning tasks employed as a learning stimulus in Study B.

10. Pilot Study. This refers to the preliminary study, also termed "Study A" in this report, conducted during the second semester of the 1973-74 academic year.

11. Principal Study. This refers to the major study, also termed Study B in this report, conducted during the second semester of the 1974-75 academic year.

12. Pretest. This refers to administration of a criterion test prior to experimental treatment.

13. Posttest. This refers to the second administration of a criterion test after experimental treatment.

14. Deductive Lecture Method. This refers to the logical method of lecture organization used as the learning stimulus in section two of Geography 1113 in connection with the pilot study; the lecture material is organized so as to proceed from generalization to specific instance.

15. Inductive Lecture Method. This refers to the logical method of lecture organization employed in section one of Geography 1113 in connection with the pilot study; the lecture material is organized so as to proceed from specific instance to generalization.

16. Geographic Verbal Recognition Test (GVR). This refers to the first of the two criterion test instruments employed in Study B; the

multiple-choice type test items consist of a stem and four responses, one of which is considered the best and only correct answer. This test is also referred to as the "Geographic Verbal Recognition" (GVR) Test since it relies heavily on reading comprehension ability.

17. Visual Map Recognition Test (VMR). This refers to the second of two criterion tests employed in Study B; this test employs a cartographic format and relies primarily on visual rather than verbal cues. This instrument is referred to as the Visual Map Recognition (VMR) Test.

Basic Assumptions

This study assumes that individual college-age students differ significantly in FDI cognitive style and that each individual's cognitive style can reliably be determined with the aid of the Hidden Figures Test (HFT). It is also assumed that individual differences in learning attainment related to certain geographical information can be measured using paper and pencil tests designed by the researcher.

It is assumed that students enrolled in Geography 1113 and used in this study are representative of the more general student body at Oklahoma State University, and are also representative of students enrolling Geography 1113 over time, due to the selection procedure employed in enrolling students in the course.

While degree of sophistication in test taking, and prior knowledge of the instructional materials employed in the study was undoubtedly varied among the subjects employed, the method of selection used in choosing members of cognitive style and treatment groups and employment of pretest scores as a control are assumed to have produced approximate homogeneity of the groups compared.

Finally, it is assumed that the statistical analysis programs implemented by the System 360/65 IBM computer at Oklahoma State University were properly designed and properly implemented by the appropriate computer programs stored on magnetic tape.

Limitations of the Study

Application of the results of this study are necessarily limited to the population of students employed in the study. Results, therefore, are strictly applicable only to those students enrolled in Geography 1113 at Oklahoma State University who participated in either Study A or Study B, as the case may be. However, certain conclusions or inferences drawn from Study A or Study B may also be applicable to students in classes of similar composition at similar educational institutions, if interpreted with care.

Overview

This study is composed of five chapters. Chapter I is the introductory chapter and contains sections relating to the general background and significance of the study, the statement of the problem, classification of terms used in the study, and the assumptions and limitations of the study. Chapter II is a review of certain literature relevant to the study, primarily that relating to the relationship between cognitive style, spatial ability, sex, and classroom learning in geography and other subject areas. Chapter III is concerned with the hypotheses, experimental procedure, and statistical methodology employed in Study A and Study B. Chapter IV is a summary of the results of the statistical analysis and includes findings with regard to the stated hypotheses of

Study A and Study B, plus a brief report of certain incidental findings. Chapter V contains the summary, conclusions, implications, and recommendations of the study.

CHAPTER II

REVIEW OF SELECTED LITERATURE

Introduction

The relationship between cognitive style and learning has been under investigation for more than a decade. This review of the literature is basically an account of those proceedings. It begins with studies of the nature of field dependence-independence (FDI) cognitive style, and its relationship to intellectual functioning and spatial ability, and proceeds to a review of selected literature dealing with the educational implications of cognitive style. Experiments dealing with attempts to match student's cognitive style with preferred mode of instruction are reviewed together with studies of the relationship of FDI cognitive style to laboratory and classroom learning. The latter include studies of cognitive style and school learning by Satterly and Brimer, the effect of cognitive style and teaching method on achievement by Coop and Brown, and the implications of cognitive style for learning and instruction by Coop and Sigel. Previous studies are summarized and their implications for theoretical conclusions and practical applications are discussed. It is shown that: (1) previous research suggests the need for additional study of FDI cognitive style in relation to geographic learning, and (2) previous research supports the theoretical basis of the present study.

The Nature of FDI Cognitive Style

H. A. Witkin, among the first to investigate the nature of cognitive style, has provided the following definition of the term:

> The characteristic self-consistent modes of functioning found pervasively throughout an individual's cognitive activities (perceptual and intellectual) (Witkin, 1967, p. 234).

Most inquiries relating to cognitive style have focused on its perceptual manifestations characterized by Witkin as the "field dependence vs. field independence" continuum. Witkin defined the polar extremes of this perceptual continuum as follows:

> Field Dependence: a style of cognitive functioning that involves submission to the dominant organization of the field and the tendency to experience items as 'fused' with their background.
> Field Independence: a style of cognitive functioning which involves the ready ability to overcome an embedding context and to experience items as discrete from the field in which they are contained (Witkin, 1962, p. 80).

Witkin's conceptualization of the nature of FDI cognitive style changed as he accumulated research findings on the subject. For example, in his earlier work with the Rod and Frame Test (RFT), Witkin stressed the importance of the distinction between persons who were dependent on immediate visual cues in determining the vertical, and those who showed greater independence of visual cues, prefering to rely more on internal proprioceptive cues (Witkin, 1954). However, when it later became apparent that nonproprioceptive tests such as the Embedded Figures Test (EFT), Kohn Blocks, and the Hidden Figure Test (HFT) were also good indicators of FDI cognitive style, Witkin shifted his emphasis to Werner's (1940) theory of cognitive development according to which individuals move from a relatively primitive "global" level of functioning to a more articulated "analytic" type of cognitive functioning

(Faterson, 1962).

Gardner (1960) has argued that the essential feature of field independence in perception and cognitive functioning is selective attention to detail. According to this interpretation, the person who performs poorly on an embedded figures test, for instance, is unable to pick out and articulate the relevant figure, rather than dependent on the surrounding field. Vernon (1972, p. 370) has noted that this conceptualization of the nature of FDI cognitive style is very similar to that of Macfarlane Smith (1964) who concluded after an extensive survey of the nature of spatial ability, that the "crucial component of the 'k' factor (spatial ability) is the capacity to perceive and hold in mind the structure and properties of a form or figure grasped as a whole."

Other investigators, including Karp (1963), Witkin, Goodenough, and similarly, Karp (1967), and Cabe (1968) have reported finding substantial positive correlation, usually in the .3 to .6 range, between scores on FDI cognitive style tests (EFT, RFT, HFT) and tests of spatial ability such as Draw-a-Person (DAP), Picture Completion, Kohs Blocks, and the Object Assembly subtests of the Wescher Intelligence Scale for Children (WISC) and Weschler Adult Intelligence Scale (WAIS). Performance curves for both field independence and spatial ability tests show a general pattern of relative stability from age 8 to age 24 with maximum ability developing by about age 17 (Witkin, Goodenough, and Karp, 1967, p. 298). As a result of these similarities, and his own analysis of test results for over 600 8th grade subjects, Vernon (1972, pp. 381-82) concluded that "there is no evidence, in the tests used of a perceptual independence ability distinct from Thurstone's 'S' or the British 'k' factor" (for spatial ability).

Smith (1964, p. 27) has argued that modern industrial society is highly dependent on skilled technicians, craftsmen, technologists, and research scientists and that a high level of spatial ability is required in all of these areas. Smith further argued that most teacher-made tests are based on verbal comprehension and therefore discriminate in favor of the person of high verbal (but not necessarily spatial) ability. Said Smith, with respect to the British educational system: "It is difficult to avoid the conclusion that the educational system has been slow to adapt to the rapidly changing needs of a society which is being transformed by the application of scientific discovery. School authorities have been slow to make use of spatial tests in their selection procedures, and have tended to rely almost exclusively on tests of linguistic and numerical ability.... We must beware of thinking that thought can take place only by means of words" (Smith, 1964, p. 38).

Smith (1964, p. 98) characterized spatial ability as "form perception" or the ability to perceive and retain in mind a mental image of a figure as an organized whole.[1] This notion resembles a central concept of the German Gestalt School of psychology known as the "law of Pragnanz." According to this psychological "law," there is a strong tendency for the mind to organize experience in terms of configurations which are as "complete" as experience will permit. Gestalt psychology also recognized the existence of a related phenomena characterized by the phrase "in die augen sprigen." This phrase, meaning literally "to

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[1]Similarly, Smith noted that "high spatial ability is shown by the child who can draw the letter R as it would appear reflected in a pool of water without having to think explicitly about it (Smith, 1964, p. 266).

spring to the eye," refers to an intuitive sense of the completeness or "wholeness" with regard to a perceptual or cognitive experience. Smith (1964, p. 49) noted that persons who exhibited considerable success on spatial tests involving perception of embedded figures reported experiencing this phenomena. In doing spatial tests they reported that they would simply look at a figure on the left and then at the embedded figure on the right and suddenly the hidden figure would simply "spring out" at them.

The ability to perceive and retain in the mind a "Gestalt," or total spatial configuration, is characteristic of persons of high spatial ability. According to Smith, (1964), holistic visual thinking is the mental process associated with the formulation of abstract concepts (Smith, 1964, p. 214). Smith noted that the process of abstraction involves the perception and retention in mind of the overall pattern or structure of a series of related ideas or events. This process is in contrast to the mental process wherein the details of an event or structure are the center of focus. Smith characterized the latter process as a "diffusive" mode of cognition as opposed to the "fixitive" mode characteristic of persons of high spatial ability. The diffusive mode of attention is characterized by a low degree of selectivity in "filtering" the stimuli being transmitted to the brain by the senses. Low selectivity in filtering incoming stimuli enables the individual to assimilate information from a wide field, but impairs the process of abstraction by reducing concentration of attention and mental energy needed in identification of structure or pattern in the multitude of incoming stimuli. Higher selectivity in filtering incoming stimuli, therefore, enhances the ability to detect organization and retain structure in mind by inhibiting attention to detail. Thus, a "fixitive" mode of attention results in some loss in the richness of experience, but also results in a gain in ability to perceive and retain in mind the pattern organization, and overall structure abstracted from experiences.

Personality Correlates of Cognitive Style

Psychometric studies have resulted in the identification of a number of personality correlates of field dependence and field independence. For example, Elliott (1961) found that subjects scoring below the mean on the Embedded Figures Test were significantly more likely to choose conventional personality traits to describe themselves, whereas field independent subjects more often rated themselves as touchy, intellectual, and solitary. Interestingly enough, White and Kernaleguen (1971) found that women students who wore extrashort skirts rated themselves as nonconformist, and scored significantly higher in field independence than did women students who wore more conventional dress!

It has been suggested by some (Smith, 1964, Vernon, 1972) that FDI cognitive style is the perceptual reflection of the introvert-extrovert dicotomy in personality type. According to this view, the extrovert personality is perceptually characterized by field dependence, while the introvert personality is perceptually characterized by field independence (Vernon, 1972, p. 376). Macfarlane Smith (1964) amassed a great deal of evidence in support of his claim that an important link exists between introversion vs. extroversion (termed schizothyme vs. cyclothyme by Smith), and spatial as opposed to verbal ability, respectively.

The cyclothyme personality, according to Smith (1964, p. 259) is normally associated with persons of higher in verbal than spatial ability and more FD than FI in cognitive style. Smith (1964, p. 256) noted, with regard to the personality of the cyclothyme:

> The comfortable cyclothyme tends to be engrossed in his surroundings and lives in the immediate present; he is not given to abstract or profound thinking about ultimate issues. Such persons often make efficent organizers and administrators.

Smith described the physically mature cyclothyme as tending to be round bodied, baldheaded, full framed, mobile, sociable, lively, humorous, emotional, tender hearted, friendly, a good mixer, and, of course, a better "talker" than "thinker" (Smith, 1964, p. 206).

The average schizothyme, on the other hand, is an introvert who generally has a greater degree of spatial than verbal ability. He tends to fix his attention on the forest and pays little attention to the individual trees. He tends to have a mind which is abstract, dissociative and analytic. Smith further described the schizothyme in the following terms:

> The person with high spatial ability has a marked tendency to seek for and recognize regularities and patterns in his experience. He tends to experience tension when he becomes aware of a lack of completeness in any of these patterns and he continues to search until he achieves the most satisfactory 'closure.' It might be expected that such a person would be attracted to scientific research because in this occupation a tendency to recognize problems and to seek their solution would be recognized as valuable and appropriately awarded (Smith, 1964, p. 229).

Physically, Smith noted that the typical mature schizothyme tends to be lean, with a narrow face and sharply drawn features. Temperamentally, the schizothyme tends to be rather unsociable, serious, rather humorless, and is frequently severe, aloft, suspicious, cool, reticent, a misanthrop, self-centered and calculating. And, of course, the schizothyme is usually higher in spatial than verbal ability, and exhibits a field independent cognitive style. Smith noted that notable engineers, inventors, and scientific thinkers of the past, such as Isaac Newton, tend to fit the characteristics of the average schizothyme better than the average cyclothyme, while notable entertainers, writers, composers, and politicians, such as Winston Churchill, tend to fit the description of the cyclothyme (Smith, 1964, pp. 302-12). Some persons, such as DaVinci, may fit both, however.

Spatial Ability in Relation to Visual Thinking

Visual thinking (and therefore spatial ability) is known from E.E.G. studies to be centered in the nondominant hemisphere of the cerebral cortex of the brain (usually the right hemisphere in right-handed persons). In case of damage to the right hemisphere of the brain the individual usually suffers some loss of spatial ability. Evidence based on factor analytic studies of the results of psychometric testing has indicated that verbal and spatial abilities are bipolar, or inversely correlated (Smith, 1964, p. 67). Smith, for example, noted that persons high in verbal ability are not normally high in spatial ability and vice versa. In addition, Smith (1964, p. 67) reported that persons high in spatial ability make frequent use of visual imagery in their thought processes.

Spatial ability, and related visual thought processes, may link-up with advanced mathematical and geometrical reasoning ability. Vernon (1950), for example, found a significant relationship between spatial ability and mathematical reasoning ability among a group of college seniors. Smith noted a similar relationship:

> Much of the difficulty in teaching mathematics may arise from a need to communicate abstractions relating to configurations to persons who do not think readily in terms of mental or visual imagery. Even in elementary mathematics many spatial concepts such as length, squareness, area angle, direction, congruence, parallelism, volume, gradient, vector, symetry, and dimension have to be assimilated. These and many other abstract spatial concepts may be conveyed most effectively by means of geometric illustrations (Smith, 1964, p. 133).

Werdelin (1961) studied the relationship between spatial ability and achievement in a college level course in geometry. Werdelin found that when a verbal (i.e., written) geometry test was used as the criterion, geometry achievement was most highly correlated with <u>verbal</u> ability scores. However, when a nonverbal geometry achievement test which emphasized the mental manipulation of two-dimensional geometrical figures was employed as the criterion, learning achievement was more highly correlated with spatial ability. Werdelin (1961) concluded that the capability of a person to assimilate geometrical concepts is related to general intelligence, but also involves an ability to "apprehend and manipulate spatial relations and to utilize visual imagery." Likewise, Smith (1964, p. 170) reported finding negative correlations between spatial ability and test scores in college level chemistry and biology. He concluded that "spatial ability seems to be inversely related to success in subjects which depend on the acquisition of factual information" presented through verbal media.

Arnheim (1970) has also reviewed the relationship of spatial ability to visual thinking. In a paper entitled, "Essays for the Left Hand," Arnheim (1970) noted that verbal thought may be said to represent the symbolic transformation of primary visual images (Arnheim, 1970, p. 18) into more symbolic form. Arnheim noted that use of nonsymbolic visual thought is not limited to artists and designers, but is used by all persons to some extent. Arnheim also stated, however, that traditional education does not sufficiently stress the development of visual thinking in order to enhance creativity. Arnheim noted:

> Given a one sided education in the 3 R's, most people possess a large unrealized potential for visual thinking. Almost everyone can learn to "see" more fully, to imagine more productively, and to express their visual ideas by means of drawing (Arnheim, 1970, pp. 23-24).

Visual thinking, therefore, may lead to increased creativity, according to Arnheim, because thinking based on the use of words tends to be "linear" as opposed to the more "holistic" thought possible through the use of visual imagery. Verbal thinking requires that thought be translated into language and is therefore a "derived" or secondary mental process. Visual thinking, on the other hand, does not rely on translation into words and is therefore more "primary" and unencumbered by conventional assumptions. Finally, Arnheim (1970, p. 24) emphasized that reliance on verbal thinking can make the world a more practical, more efficient, and more rational place, but not necessarily a more original, more beautiful, more humane place in which to live.

Greater reliance on visual thinking, and a corresponding deemphasis on verbal thought, can be encouraged in students. Arnheim notes (1970, p. 40), for example, that maps could be used to encourage greater reliance on visual thinking and creativity in geographic instruction. Little training in the use of visual thought now takes place. Most emphasis is placed on verbal thinking. Geographic instruction is one area where greater emphasis of visual thinking might well increase geographic learning and creativity in students. Arnheim notes that externalizing visual thought through two- or three-dimensional creativity is vital to learning to think visually. In geographic instruction, for example, greater use could be made of sketch maps prepared by students in an effort to get them "in touch" with the spatial character of geographic materials (Arnheim, 1970).

Cognitive Style and Intellectual Functioning

Guilford (1967) has suggested a "Structure of the Intellect Model" which can be used to show how individual differences in FDI cognitive style are related to theory of the functioning of human intellect (Figure 3). In Guilford's (1967) model, one to five intellectual operations may be performed upon four types of cognitive content to produce six kinds of learning products. The model proposed that a total of 120 (5x4x6) different kinds of intellectual acts are possible. Williams (1969) suggested that Guilford's model of the intellect may be used to explain individual differences in perceptual and cognitive functioning.

According to Williams' interpretation of Guilford's model of the intellect (Figure 3), field dependent individuals prefer, or are more adept at, divergent intellectual operations emphasizing memory and cognition, behavioral and semantic content, and learning products chiefly characterized by transformations and implications. Field independent individuals, on the other hand, seem to prefer a mode of cognitive functioning emphasizing convergent and evaluative mental operations, figural and symbolic content, and learning products characterized by units, classifications, and systems (Williams, 1969, p. 11).

Support for Williams' interpretation of cognitive operation was provided by Goldman and Warren (1973) in an investigation of the study

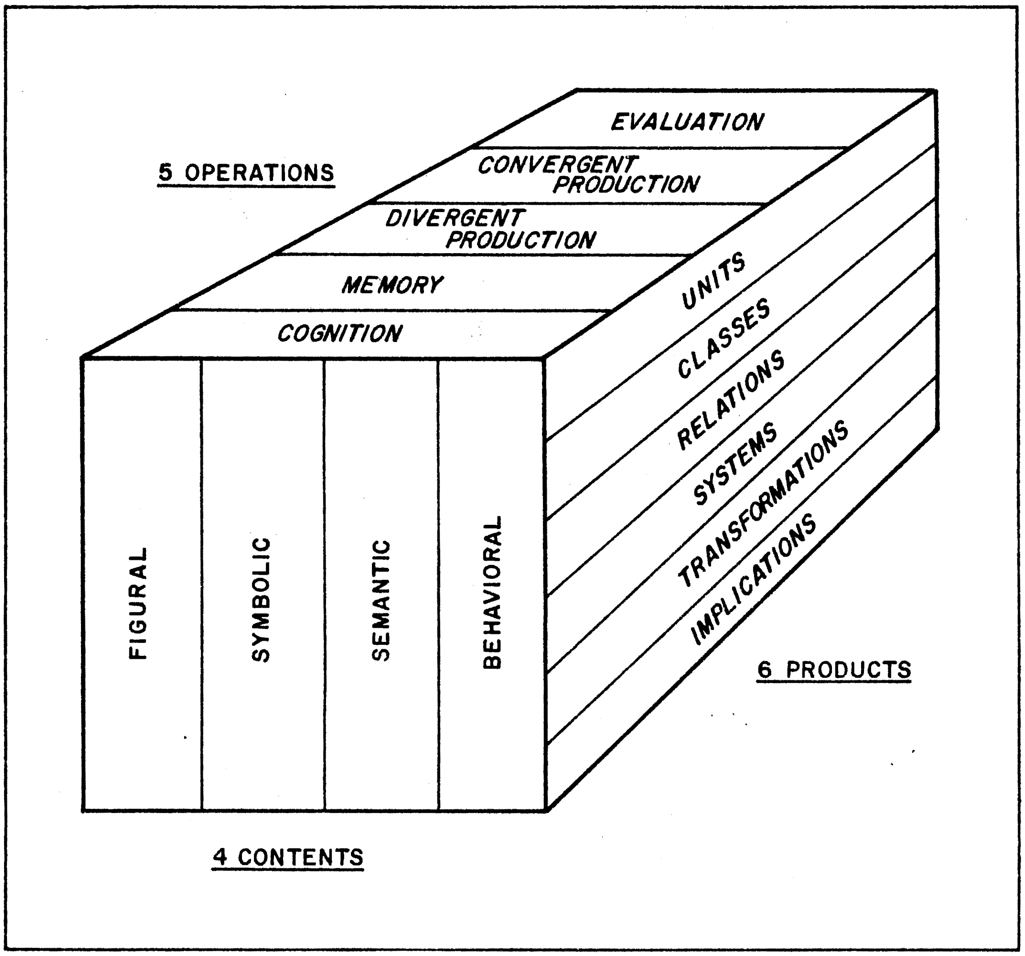

Figure 3. Guilford's "Structure of the Intellect Model" of Cognitive Abilities.

Source: Williams, 1969, p. 11.

strategies connected with college grade success in different major fields. Multivariate analysis of variance was employed to compare the self-reported study strategies of students with above and below average grades in four major fields. The primary difference in study strategy between students with above average and below average grades in all four major fields was found to be in the area of "clerical diligence" (note taking, neatness of assignments, completeness of homework, etc.) and "cognitive activity" (tendencies to transform information into a different, more personally meaningful context).

As indicated in Figure 4, Goldman and Hudson (1973) employed discriminant analysis to "map the task structure" of four academic fields (physical science, biological science, social science, and humanities). It was found that the four major fields could be "mapped" along two orthogonal discriminant functions in terms of the personality and academic ability characteristics of students majoring in those fields (Figure 4). According to Goldman and Hudson:

> One function seemed to reflect mathematical-logical thinking while the other reflected applied-subjective thinking. The major field groups formed a science-nonscience continuum on the first function but not on the second (Goldman and Hudson, 1973, p. 45).

Discriminant function I, therefore, appeared to represent a continuum of formal reasoning, while discriminant function II appeared to represent a continuum of personal and practical application of scholastic material.

Goldman and Hudson were supported by a study by Elton and Rose (1967) in which seventy-three female freshman college students were divided into eight vocational choice categories on the basis of their choice of academic major. Scores on the Omnibus Personality Inventory

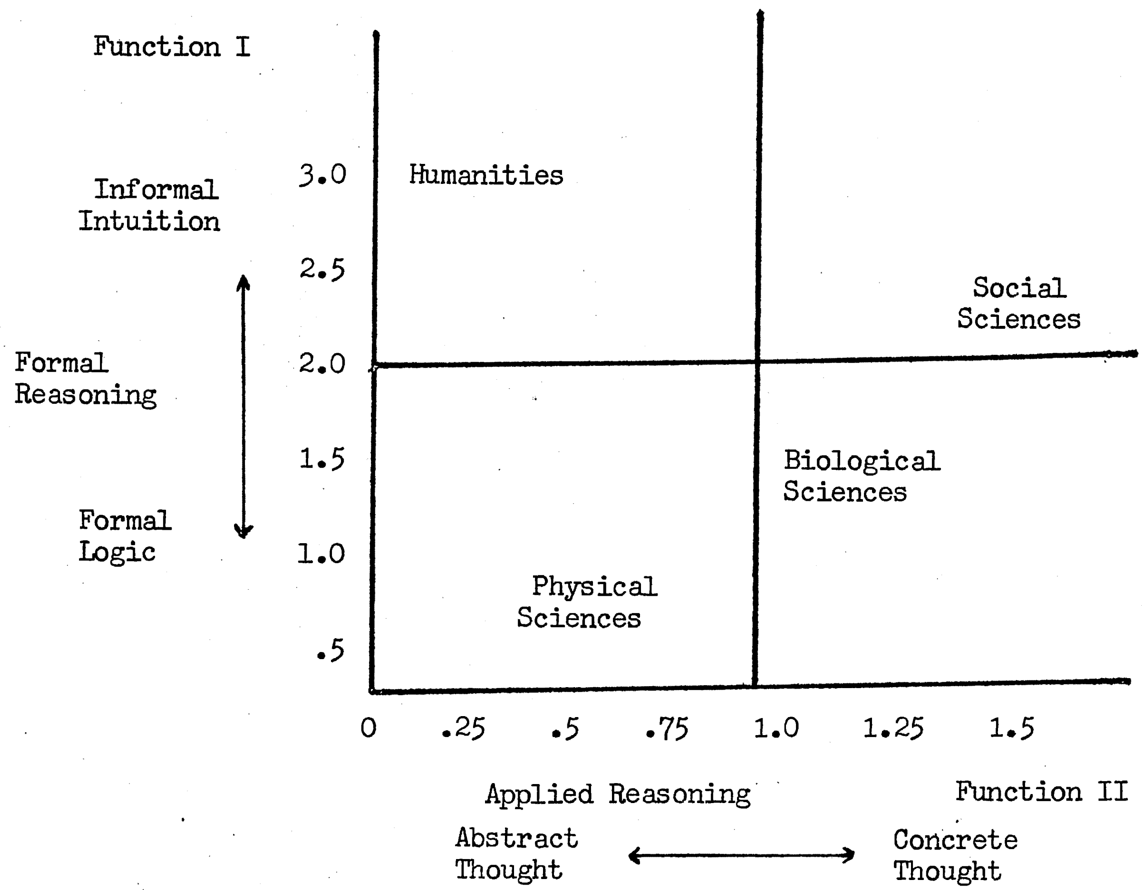

Figure 4. Centroids of Four Major Field Groups in Two-Factor Discriminant Space.

Source: Goldman and Warren, 1973, p. 44.

(OPI) and American College Test (ACT) were grouped by discriminant function analysis resulting in a two-dimensional discriminant space. One dimension discriminated Business from Arts-Humanities students largely on the basis of ACT scores and degree of scholarly orientation. A second dimension, composed largely of the masculine role scale of the OPI, discriminated "soft" vocations involving political, persuasive, social, religious, and educational content from "hard" vocations emphasizing engineering, physical science, and mathematics. As a result, Elton and Rose concluded that there are major personality differences between students in different major fields of academic study (Elton and Rose, 1967, p. 40). This finding supports Witkin (1962) who noted that field independent subjects tended to prefer major fields of study in the sciences, while field dependent students were generally more inclined toward majors in education, art, and the humanities.

There is evidence, therefore, that the "task structure" of an academic discipline may interact with personality factors which are correlated with FDI cognitive style, resulting in learning problems for students whose cognitive style does not match the demands of the task structure of the discipline. Hunter has commented on the task structure of the spatial tradition in academic geography as follows:

> Apart from educational geography, which is concerned with applications of teaching and learning theory, and with the general need for communication, the tools of geography are designed and used for spatial analysis (cartography, air photography, remote sensing, and computer graphics), and for quantitative analysis (statistical techniques, often computer-assisted). Geographic theory is spatially founded: central place theory, location theory, diffusion theory, game theory, field theory, gravity models, potential models, and so on. Tested against empirical field data, spatially-ordered theory provides us with vital insights and understandings (Hunter, 1971, p. 336).

It is clear, therefore, that a significant portion of the task structure of academic geography focuses on spatial analysis. To the extent, therefore, that an introductory college level course in geography emphasizes spatial analysis, and to the extent that tools especially designed for spatial analysis are employed geographic instruction, geographic learning may pose learning problems for some students owing to individual differences in perceptual, cognitive and/or personality factors related to FDI cognitive style.

Certain of the findings of the French psychologist Jean Piaget (1957) support this possibility. Piaget has proposed a theory postulating the existence of universal stages in human intellectual development which may help to explain why some individuals have greater difficulty learning from maps than other individuals (Figure 5). According to Piaget's model of cognitive development, human beings progress from a "sensory motor" stage of cognition through "preoperational" and "concrete" stages, to a "formal operations" stage of thought, however, all individuals do not simultaneously and ultimately arrive at the same level of cognitive development. As Inhelder noted:

> Piaget has ... for a long time, freely conceded that not all "normal" adults, even within one culture, end up at a common genetic level. Adults will show adult thought only in those content areas in which they have been socialized. It is clear that the knowledge acquired at school and exhibited in diagrammatic layouts is integrated with the whole body of concepts whose development has been revealed in the course of the preceding experiments. For in truth, no learning can take place except by assimilation to existing schemata. Just as the child can draw long before he receives drawing lessons, so in the course of his daily life, he develops a body of concepts dealing with coordinates, perspectives, and similarities or proportions. It is this which enables him, at a particular age, to crystallize this system of practical operations around various new ideas which he encounters at school (Piaget and Inhelder, 1957, pp. 445-446).

Formal Operations Stage: 11 to 14 years ↑	Abstract-conceptual thinking Reasoning generalized Evaluation Hypothesizing Imagining Synthesizing
Concrete Operations Stage: 7 to 11 years ↑	Analyzing Conscious of dynamic variables Measures Classifies things in groups or series
Pre-Operational Stage: 2 to 7 years ↑	Symbols and representations Acts on preceptive impulses Self-centered Status-irreversible thinking
Sensory-Motor Stage: Birth to 2 years ↑	Mute--no use of verbal symbols Learns to perceive--discriminate and identify objects

Figure 5. Piaget's Stage Theory of Intellectual Development

Source: Williams, 1969, p. 8.

Since individuals undoubtedly differ with respect to the "particular age" and degree of clarity with which they "crystallize" their system of spatial reasoning ability, they may also differ in their ability to deal with information presented in cartographic form, i.e., geographic information presented as two-dimensional "shapes" or patterns.

There is some evidence that FDI cognitive style is closely associated with the ability to perceive shape. The Embedded Figures Test (EFT) frequently employed in identifying FDI cognitive style, for example, is based on individual differences in the ability to perceive a shape embedded within another figure. One factor which can change perception of shape is rotation. Rock (1974), for example, has shown that many familiar shapes do not look the same when rotated even slightly. Failure to recognize a familiar figure was found to be a function of degree of rotation of the figure, because rotation caused a change in perceived shape. In addition, perception of internal geometrical relationships was also important. As Rock noted:

> A triangle can be altered in size, color, and various other ways without any change in its perceived shape. Perception of a visual form is based primarily on how parts of a figure are related to one another geometrically. We owe a debt to the Gestalt psychologists for emphasizing the importance of perception of relations rather than of absolute figures (Rock, 1974, p. 78).

Gould (1966) has further suggested that geographic shapes may be perceived and retained in mind as "mental maps." Gould (1966) studied individual variation in people's stated preference for places; however, Gould did not investigate individual variation of actual mental images of geographic shapes and the internal geometric structure of geographic places. Sanders and Porter (1974) have described these actual mental maps as follows:

> There is another mental map, however, which people carry around with them. Indeed everyone carries about a whole atlas of mental maps. These maps are, in varying degrees, vague and precise, complex and highly schematic arrangements of lines, points, and outlines. The central feature of these mental maps is that they are pictorial, not preferential (Sanders and Porter, 1974, p. 258).

Sanders and Porter (1974) attempted to compare individual variation in the shape of the "revealed" or actual mental map image of Africa of American and Tanzanian students. In their conclusion, Sanders and Porter noted that a student's revealed map of Africa may vary from reality for one of two reasons: strength of mental image, and ability to draw. They did not attempt to distinguish which factor was the greater source of error. However, the authors did find that maps drawn by both groups of students preserved an uncomplicated shape of Africa and were largely lacking in detail. This was taken as evidence that the mind retains a "cognitive-cartographic view of empirical shapes" greatly influenced by individual and cultural variation in perception of place (Sanders and Porter, 1974, p. 267). The fact that "mental maps" are <u>not</u> actual but perceptual has also been noted by Waldo Tobler (1963) with respect to mental images of the U.S. Tobler has shown that mental images are largely pictorial, with deformations introduced into the mental image by ethnocentricity and knowledge.

Mental maps, then, may be considered a subclass of pictorial mental image that can be learned for the specific purpose of storage and retrieval of geographic information. Yi Fu Tuan (1975) has suggested that individual differences in the strength and clarity with which mental maps are learned may influence the degree to which they are employed as a guide in abstract thought and spatial behavior. Tuan noted that the idea of mental or cognitive maps was first introduced into the psychological literature to account for the ability of rats and man to learn the spatial structure of an entire environmental field and to act on that information (Tuan, 1975, p. 206). Piaget (1971) was of the opinion that only man has the mental capability to imagine objects or events which are not immediately available. Even in man the capacity for abstract visual thought does not develop until late in the process of cognitive development, according to Piaget (1971, pp. 263-264). Therefore, animals and young children are not apparently as capable of forming a "total picture" in the mind as a draftsman or cartographer must in designing a blueprint or map (Piaget, 1971, pp. 263-264). Tuan is in agreement with Piaget in noting that the ability to "form a total picture" varies between individuals and the necessity of doing so varies considerably between academic disciplines and vocations. Tuan states:

> Some people claim dependency on images when they think, others on words. Scientists may be visualizers or verbalizers; some make use of both images and words when the cogitate, and a few claim to use neither. One study of scientists (Rose, 1951, pp. 459-470) shows that anthropologists and psychologists tend to be verbalizers, whereas biologists and physicists tend to be visualizers. Geographers were not included in the study. With their liking for pictures and maps, they are perhaps good visualizers (Tuan, 1975, pp. 208-209).[1]

One purpose of the present study was to determine whether students need be "good visualizers" in order to successfully learn geographic concepts,

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[1]It is the writer's opinion that geographers may be either "visualizers" or "verbalizers" depending somewhat on the tradition of geography study preferred. Those geographers who prefer the man-land or earth science tradition of geographic study may perhaps be verbalizers while geographers who prefer the regional or spatial tradition, on the other hand, may be visualizers!

and information related to the regional and spatial traditions of geographic study.

FDI Cognitive Style in Relation to Laboratory Learning

> What is the relationship between perception and the imaginative faculty that enables us to envisage places we have not directly experiences? How is it possible to give street directions to another person? How can the geography of strange lands be taught? If the questions sound naive, it may be because, like the blunt queries of precocious children, they are deep (Tuan, 1975, p. 213).

As of yet, there are no good answers for Tuan's questions. One reason suggested by Coop and Brown (1970, pp. 400-401), is that most studies seeking to differentiate the effectiveness of teaching methodologies fail to consider, with the general exception of intelligence, organismic variables related to the subjects used in the studies. With regard to this problem, Coop and Brown (1970, p. 401) note that:

> No one teaching method could be best for all students since students vary greatly in their cognitive functioning. Some teaching methods might facilitate high level achievement by one type of student while another teaching method might facilitate achievement by a different type of student (Coop and Brown, 1970, p. 401).

It has been suggested that one reason for the differential effectiveness of a given instructional methodology with different students is that FDI cognitive style interacts strongly with the method and content of instruction. For example, Snowman (1975) in a review of the research on how adults learn from pictures, noted that one of the most consistent findings of this research is that pictures are indeed "worth a thousand words" when it comes to learning concrete information.

However, all images are apparently not of equal value as learning stimuli. Snowman found that the greater the "image arousal value" of the pictorial stimuli the more valuable the picture is as an instructional device. Since the image arousal value of a picture (or map) depends on the prior experience and conditioning of the learner, different responses from different learners can be expected with use of the same stimulus (Snowman, 1975, p. 2). It is possible, therefore, that individuals who exhibit a field dependent cognitive style may react quite differently to information presented on maps than will individuals exhibiting a field independent cognitive style.

Snowman (1975) has also presented evidence that pictorial information is mentally encoded in accordance with anticipated task expectations. He noted that there is a significant relationship between the form in which nonverbal information is mentally encoded and whether it is to be used for recognition or recall at a later time. If nonverbal information (such as a map) is used primarily for purposes of selecting the correct verbal response on an objective type test, Snowman noted, only those partial "cues" needed to recognize the information in verbal form will be encoded. If, on the other hand, the subject anticipates the need for more than total recall of nonverbal information in a nonverbal format (as in recreating spatial patterns or map locations) the information will be encoded in a more complete nonverbal format in the mind of the learner (Snowman, 1975, p. 8). Since individuals differ in the facility with which they are able to encode verbal vs. visual information, differences in measured learning achievement may be related to the type of test employed. Use of a visual format test such as a "map test" may facilitate learning achievement by persons high in spatial ability (FI cognitive style). On the other hand, use of a verbal format test such as an objective multiple-choice test may facilitate achievement by students who are higher in verbal than spatial ability.

Much of the research on how adults learn from pictures supports what is already known about the effects of cognitive style on learning of information presented in the form of visual images. For example, Witkin, Dyke Faterson, Goodenough, and Karp (1962, pp. 147-148) were among the first to suggest a theoretical basis for relating cognitive style to accuracy in the recall of names and faces. They suggested that field dependent (FD) persons are more attentive to facial expressions which provide clues to the mood of other people because such individuals are in greater need of support and guidance from others than are field independent persons. Research by Messick and Damarin (1964) offers some support for this possibility. Messick and Damarin investigated the relationship between FDI cognitive style and memory for faces. They hypothesized that field dependent Ss would be more attentive than field independent Ss to the facial characteristics and expressions which provide clues to the inner state of mind of other persons. Subjects were 40 male and 10 female volunteers from a psychology class at a large university. Average age was 21.7 years. A group Embedded Figures Test (EFT) was administered to the sample as a measure of field dependence. Subjects were also given a photo judging test designed to measure a bias toward belief that "the face is familiar." In addition, memory for faces was made incidental to a focal learning task in order to offset the superior analytic learning set of the field independent Ss.

Results of the experiment varified the research hypothesis: field dependent subjects were significantly more able than FI subjects to recognize photos of persons seen only briefly before. This finding is something of an anomoly in the literature dealing with the learning correlates of FDI cognitive style. In most studies involving learning difference between FD and FI subjects, it is the field independent subjects who are shown to possess superior ability on perceptual and cognitive tests. The authors were therefore obliged to conclude that "field dependent subjects did better in the present experiment because they were asked to remember socially relevant stimuli such as faces rather than abstract designs or other impersonal material" (Messick and Damarin, 1964, p. 316). Because geographic maps involve abstract designs and other "impersonal material" it is probable that field dependent Ss would show no superiority in recall or recognition of such material, unless some way could be found to make map content "personally and socially relevant." Messick and Damarin have therefore suggested the following:

> Future research might also determine whether field dependent memory abilities are limited to the human face or whether they extend to other sorts of spatial configurations.... (Messick and Damarin, 1964, p. 316).

Other research has also tended to confirm that persons who exhibit a field dependent cognitive style are particularly sensitive to social and interpersonal aspects of the environment. For example, Fitzgibbons, Goldberger, and Eagle (1965) investigated the relationship between field dependence and recall of words having a clear relevance for social interaction as opposed to recall of neutral words. Subjects were 27 undergraduate and 3 graduate students at a large university; mean age of the Ss was 20. Subjects were engaged in an incidental learning task while a list of 30 socially relevant and neutral words were being read in the background. Subjects were lead to believe the words being read were not related to the learning task at hand. Afterward, Ss were asked to recall as many of the words as possible. Field dependent subjects were able to recall a significantly larger portion of socially relevant words such as "girl, talk, leader, marry, and kiss" than were the subjects who exhibited a field independent cognitive style on a group Embedded Figures Test. Interestingly, field dependent subjects were also able to recall a significantly larger number of socially significant visual objects from the room where the experiment was conducted than were field independent subjects (Fitzgibbons, et al., 1965, p. 746). However, field dependent subjects performed significantly slower on the focal learning task than did the field independent subjects, leading the authors to conclude that:

> All the evidence taken together suggests that an important aspect of the field dependent-field independent dimension can perhaps best be understood as reflecting a social orientation vs. a task orientation. That is, within a given experimental situation, the field dependent Ss are more likely to be interested in and distracted by the many social cues present (e.g., characteristics of and relationship with E), while field independent Ss are more likely to attend solely to task relevant cues (Fitzgibbons, Goldberger, and Eagle, 1965, p. 744).

FDI Cognitive Style in Relation to Classroom Learning

Recent studies have tended to confirm that FDI cognitive style interacts significantly with achievement on school learning tasks. Witkin (1965), for example, suggested that FDI cognitive style be taken into account in the design of educational materials and methods as well as in educational placement, and evaluation of learning. Other investigators have found evidence of a significant relationships between reading success and field independence among school children in the primary grades (Gill, Herdtner, and Lough, 1968; Wineman, 1971). Keogh and Donlon (1972, p. 334) reported finding that hyperactive children with learning and behavioral problems are almost universally extremely field dependent in cognitive style. The authors noted that:

> Successful school learning probably requires both accurate field differentiation and ability to control or delay speed of response .... It seems reasonable that a field dependent perceptual strategy, characteristically global and undifferentiated, would produce ambiguity in school learning situations (Keogh and Donlon, 1972, p. 334).

Beller (1967) attempted to determine whether use of an instructional strategy designed to be congruent with the perceived cognitive style of nursery school children would significantly improve achievement on a simple learning task. Beller found that when children exhibiting a field dependent cognitive style were taught the names of certain objects using a nonanalytical, more personalized instructional approach they learned the names of certain common objects significantly faster than similar field dependent children taught using an analytical approach (Beller, 1967, p. 331). Similarly, when field independent children were taught using an analytical instructional strategy assumed to be more congruent with their cognitive style, significant improvement in learning resulted.

However, when Coop and Brown (1970) attempted to replicate the findings of Beller using a population of college age subjects, negative results were obtained. In their experiment, Coop and Brown employed two teaching methods. With one group of forty students a "teacher structured" method of instruction was employed. With a similar group of forty students an "independent problem solving" method of instruction was employed. A 2x2 factorial design was used to determine the effects of cognitive style and teaching method on three measures of achievement: factual, information concept-generalization, and total content. Results of the study indicated that, for all three types of learning the teacher structured method of instruction was superior to the independent problem solving method. There was no significant difference in achievement in any category of learning between students with an "analytic cognitive style" (FI) and those with a "nonanalytic cognitive style" (FD), and there was no significant interaction between cognitive style and teaching method (Coop and Brown, 1970, pp. 403-404).

As a result, Coop and Brown concluded that a teacher-structured method of instruction resulted in greater learning achievement than an unstructured, independent problem solving method of instruction. They also concluded that it made no significant difference what teaching method was used relative to cognitive style. The reasons given by Coop and Brown for this finding are significant with respect to the present research:

> This finding may have resulted, in part, from the inability of the experimenter to design teaching methods which were specifically analytic or specifically nonanalytic in the manner Beller (1967) did. The two teaching methods did not specifically relate to a particular cognitive style nor were they primarily designed to facilitate a specific cognitive style. The methods were designed to teach the content and skills of a particular body of knowledge to a relatively heterogeneous student population, cognitively speaking. In the interest of the students in the class, very few modifications could be made (Coop and Brown, 1970, p. 404).

Thus, it is possible that if one were to design instruction materials more nearly congruent with one or the other FDI cognitive style, significant interaction between instructional method and cognitive style might result.

A study by Haskell (1971) on the interaction of certain personality characteristics with instructional methods has shed some additional light on the question of the relationship between cognitive style, and differentially effective instructional treatments. Subjects of Haskell's study were eighty-nine students of college age; one-half of the subjects were assigned to be taught introductory psychology by a conventional lecture-discussion mode of instruction. The other half were randomly assigned to participate in a programmed-learning environment in which they were able to progress at their own rate.

All subjects were tested using three instruments: (1) the Guilford Zimmerman Temperament Survey (GZTS), used to obtain scores on 10 personality variables; (2) the Wonderlic Personnel Test (WPT), used to measure general level of mental ability, and (3) a 72-item multiple-choice test designed to measure academic achievement in psychology (Haskell, 1971, p. 291). Mental ability test scores were used as a covariate to test for significant differences in achievement; scores on the psychology achievement test served as the criterion variable. Duncan's multiple range test for ordered means was employed as a follow-up test when differences significant at the .05 level were found.

Two personality variables were found to interact significantly with method of instruction when academic ability had been controlled. The programmed-learning environment tended to favor slow and methodical learners who were characterized as being "agreeable" and "easy to get along with" (extroverted). Those students who were characterized as "aggressive," and "low in friendliness" (introverted) were found to perform better under a more conventional lecture-discussion type of instruction (Haskell, 1971, p. 193).

Two personality variables were also identified which were reliable predictors of academic success. Students high in emotional stability and restraing performed significantly better under <u>either</u> form of instruction (programmed vs. lecture discussion) than did subjects who were in the low or middle range on those variables (Haskell, 1971, p. 294). Haskell commented on the significance of his findings as follows:

> The interaction between instructional method and levels of General Activity and Friendliness suggests that the effectiveness of the method of instruction utilized will vary as a function of certain student personality characteristics. These findings suggest that the characteristics of students could be specified in such a way that one could increase the effectiveness of learning by prescribing the instructional method to which the learner would be exposed (Haskell, 1971, p. 294).

Certain of the personality characteristics found by Haskell to interact significantly with instructional method have been identified as correlates of FDI cognitive style. Vernon, (1972, p. 384) for example, noted that "in both sexes spatial tests tend to correlate negatively with ticking extreme responses in a personality questionnaire." Likewise, Macfarlane Smith (1964, p. 220) noted that "absence of neurotic tendency is the common factor among persons high in spatial ability." Smith also noted that emotional stability and self-confidence are personality traits generally exhibited by persons of high spatial ability. Taken to the extreme, however, such traits result in depression and withdrawal symptoms of emotional disturbance (Smith, 1964, pp. 236-238).

Other research has tended to support the notion that cognitive style interacts significantly with certain aspects of the classroom learning environment. Satterly and Brimer (1971, p. 302), for example, noted that specialization in the later stages of secondary schooling and higher education is probably constrained by cognitive style. They also noted that knowledge of the cognitive style of the learner could help to ensure exposure of the student to educational settings which do not reinforce a particular cognitive style, especially if the cognitive style is disadvantageous from an educational standpoint. Knowledge of cognitive style might then be used to alert the learner to the fact that while use of a certain cognitive style is effective in some areas of the academic curriculum, it is not effective in other areas. Kagan (1964) has argued, for example, that students with an "analytic" (FI) cognitive style may prosper in academic disciplines such as mathematics and science, but not in art or the humanities where a more "synthetic" (FD) style may be more adaptive. Much, however, remains to be learned concerning the education impact of cognitive style. As Satterly and Brimer have pointed out, the adaptive learning properties of different cognitive styles are largely unknown and speculative at present:

> For at present there is no convincing empirical data relating predisposition to a style of thinking with the characteristics of a learning situation or with educational objectives. Potentially, research into cognitive styles is as profitable to the guidance of learning as studies of any other individual differences in cognition (Satterly and Brimer, 1971, p. 302).

Cognitive Style and Geographic Education

Relatively little has been written regarding the relationship between FDI cognitive style and problems in geographic education. This may be due to the tendency of educational researchers to group academic disciplines together under general headings such as "science" or "humanities" when investigating the learning problems. For example, Ogunyemi (1973) recently investigated the relationship between cognitive style and science achievement among nine groups of students in Nigeria. One-hundred-seventy low and high science achievers from grades 7 through the second year of college were given a cognitive style preference test and several tests of science learning achievement. Ogunyemi (1973) found a significant statistical relationship between science achievement and cognitive style among males. Males who were high achievers in science were significantly more likely to possess a cognitive style characterized by a tendency to group stimuli together on the basis of inferences about similarities between stimuli. In addition, Ogunyemi noted that differences in cognitive style between low and high science achievers appeared to increase as students increased in age and amount of exposure to science. Ogunyemi (1973, p. 62) pointed to the obvious conclusion that if a consistent relationship between low science achievement and a particular cognitive style could be demonstrated, such information might be used to search for ways to match science teaching to cognitive style in an attempt to increase achievement levels. However, Ogunyemi did not suggest specific instructional strategies which might be used with students of different cognitive style to test his hypothesis.

Two other studies, which produced conflicting results, have dealt more specifically with questions of <u>geographic</u> learning in relation to perceptual abilities. Taylor (1959) studied the relationship between spatial ability and attainment in geography among 200 third year pupils at Newcastle-on-Tyne in the United Kingdom. Average age of the group was 14 years 4 months. Subjects were given a battery of tests of spatial and verbal ability and attainment in geography, including three geography tests designed by the researcher (two in map form and one in verbal form).

Taylor found a marked sex difference in spatial ability in favor of males, and in verbal ability in favor of females, but also found that when tests of spatial ability were scored for memory for <u>detail</u> (as opposed to structure), females were found to achieve higher scores than males. Therefore, Taylor restructured Smith's conclusion (1954) concerning the nature of spatial ability as follows:

> The results are consistent with the view that spatial ability ('k' factor) involves a capacity to perceive and retain mentally an impression of the structure or form of a shape or pattern as a whole. Tests designed to emphasize this capacity show the largest sex-difference in favor of boys. The most striking result of marking the memory for Designs Test for accuracy of detail is a substantial reduction in the first-factor loading ('g'). This method of marking also caused the sex-difference to "swing" in favor of girls (Taylor, 1959, p. 269).

Concerning the tests of geographic learning, however, Taylor found no significant difference in achievement between males and females on any of the geography tests. In addition, factor analysis gave no evidence that spatial ability enters into attainment in geography. No measure of geographic attainment, including school examinations, objective tests prepared by the researcher or class grades, were loaded on the 'k' (spatial ability) factor; rather all measures of geography attainment were loaded on the v:ed (visual-education) factor of intelligence indicating that attainment in geography among third year pupils in the schools of Newcastle-on-Tyne was more dependent on verbal-educational ability than on spatial ability (Taylor, 1959, p. 270), as indicated in Figure 6. Taylor did not, however, specifically compare the geographic learning attainment of high spatial (FI) as opposed to high verbal (FD) ability students. It is possible that had he done so he may have found more positive results. In addition, use of a relatively youthful group of test subjects in whom spatial ability (and therefore cognitive style preference and ability) had not yet fully developed may have affected his results.

For example, a more recent study by Grieve and Davis (1971)

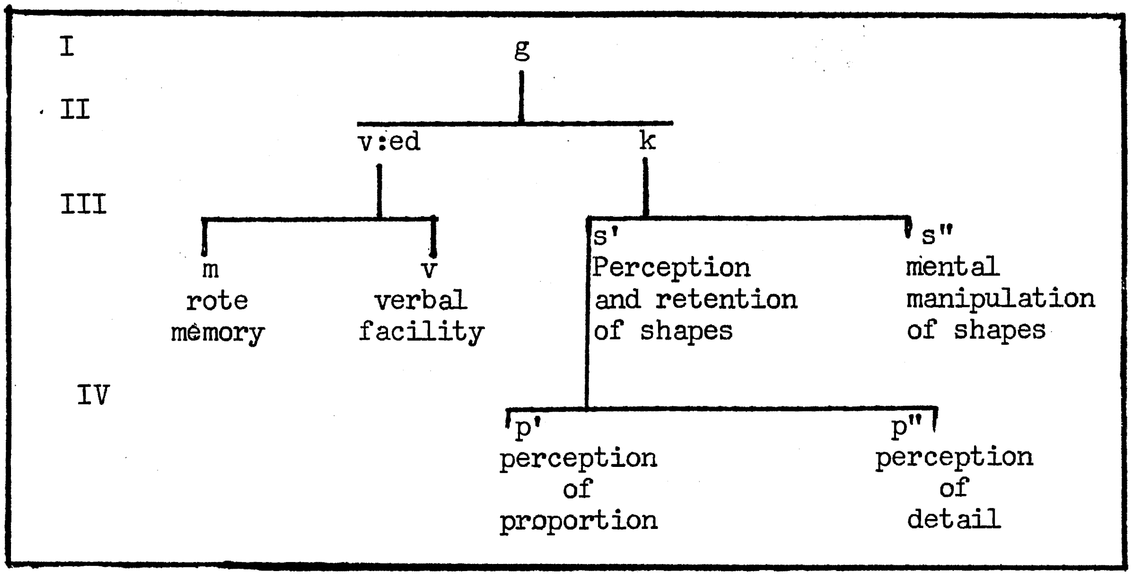

Figure 6. **Factors Commonly Identified in Intelligence Testing. (Factor I: general intelligence (g); Factor II: verbal-education ability (v:ed) vs. spatial ability (k); Factor III and Factor IV represent other aspects of verbal and spatial ability sometimes identified in the literature.)**

Source: Taylor, 1959, p. 269

produced findings which conflict in some aspects with those of Taylor. Grieve and Davis attempted to determine whether the method of instruction employed in a ninth grade geography class would interact significantly with FDI cognitive style in terms of achievement on tests of geographic learning. Subjects of the study were 127 ninth grade geography students in two public schools in San Francisco. Two methods of instruction (expository and discovery) were combined with two cognitive styles (global and analytic) to produce a 2x2 factorial research design. Students were given 11 hours of instruction in the geography of Japan. The discovery and expository teaching methods differed primarily in the placement of the generalization being taught. In the discovery method of instruction the geographic principles and generalizations to be learned were placed at the conclusion of eleven hours of geographic instruction; in the expository sequence the geographic generalizations being taught were delivered at the beginning of the eleven hours instructional sequence. Cognitive style was determined by use of an Embedded Figures Test. Learning performance was measured with the aid of two researcher designed criterion tests. Two dependent variables were employed: (1) knowledge of Japan's geography, and (2) higher-learning of geographic concepts and generalizations.

Results indicated that "extreme global males receiving expository instruction experienced significant difficulty in acquiring knowledge of Japan's geography" (Grieve and Davis, 1971, p. 141). The authors therefore suggested that an expository method of instruction should be avoided in teaching extreme global (field dependent) males "unless sufficient time is devoted to establishing those discriminations which are basic to the generalizations being learned" (Grieve and Davis, 1971,

p. 141). A second major conclusion of the study was that cognitive style can influence the learning of geographic concepts and generalizations. Analytic subjects (FI) were better able to recall and apply knowledge and geographic concepts in new situations. Subjects exhibiting a global cognitive style (FD), on the other hand, experienced significant difficulty in applying previously learned geographic generalizations to new situations (Grieve and Davis, 1971, p. 141).

Sex Differences in Cognitive Style

A major difficulty in attempting to interpret the effects of FDI cognitive style on learning arises from the fact that female subjects consistently score lower than male Ss on visuospatial and proprioceptive tasks. Sex differences have been found when using a variety of field independence tests and for subjects ranging in age from 8 to 24 years old (Vernon, 1972, pp. 370-372). Writers such as Sherman (1967), Fiebert (1967), and Vaught (1965) have ascribed sex differences in cognitive style primarily to differences in cultural norms. Boys are expected to be more active and independent from very early in life, while girls are encouraged to be more conforming and docile (Sherman, 1967, pp. 294-295). Difference in cognitive style becomes greatest in late adolescence when sex role development becomes most pronounced. Vaught suggests that the male sex role in Western culture is more clearly defined than the female role and that this in itself is one reason why females tend to be more field dependent than males (Vaught, 1965, p. 273). Fiebert (1967) presented evidence linking masculinity vs. feminity to field dependence vs. field independence respectively.

Kagan, Rosman, Albert, and Phillips (1964), using the Analytic

Categorization Test (ACT) designed by Kagan, also found that female Ss consistently achieved significantly lower spatial ability test scores than male Ss. The authors attempted to explain their finding by noting that boys have greater opportunity to check their spatial ability competences against external criteria by manipulating objects in the environment, whereas girls depend more on social feedback from adults and peers. Kagan (1964) noted that even at a preschool age boys display a more objective, analytic attitude toward the environment than do girls. Because girls consistently learn to talk at an earlier age, Sherman (1967) ascribes sex differences in cognitive style to the visual-practical emphasis found in male child rearing as against the social-verbal emphasis common to female child rearing practices. While Sherman admitted no difficulty in accepting the fact of sex related differences in spatial visualization ability, she rejected any implication that sex differences in spatial ability might lead to sex differences in intellectual functioning, particularly with regard to analytical ability as claimed by Witkin, et al., (1954). Noted Sherman:

> Key measures of analytical cognitive approach are substantially related to space perception and are therefore sex biased. Consequently a conclusion of sex differences in analytical ability based on these data appears unwarranted. Controls for differential spatial skill are needed in these studies and in studies of sex differences in geometric and mathematical problem solving. The question of the degree to which spatial skill can be learned has a potential significance beyond explaining results of studies in analytical cognitive approach. To the extent to which it is a factor in more complex mental functions, the way may be opened for improved remedial education (Sherman, 1967, p. 297).

Whether spatial ability is a fixed or variable cognitive attribute is somewhat open to question. There is evidence, for instance, that most individuals and particularly females can develop greater spatial ability given practice in relevant tasks (Sherman, 1967, p. 296). Whatever the cause, Sherman is correct in pointing to the need to control for sex related differences in spatial visualization and perception ability when doing research involving tasks requiring spatial ability. As Sherman herself noted:

> Generally speaking, male sex-typing would promote field independence; female sex-typing would promote field dependence. Individuals low in analytical field approach do in fact show characteristics more typical of women than men. These include less achievement motivation, more dependency, less aggressiveness, more interest in people, and poorer performance on the Block Design subtest of the Wechsler tests than on the Vocabular subtest (Witkin et al., 1962). It appears highly likely that these relationships are mediated by sex-typed spatial learning, and would be greatly reduced by controlling for spatial ability, or as Blade and Watson (1955) prefer to say, achievement in spatial preception (Sherman, 1967, p. 298).

The fact that girls learn to talk earlier, and thus tend to use the verbal medium for need satisfaction, while boys find need satisfaction through use of their superior musculature has been offered as supporting evidence for a genetic origin to sex differences in cognitive style (Vernon, 1972). Hartlage (1970, p. 610) noted that "studies involving the inheritance of primary mental abilities in twins have generally shown that spatial ability is the ability most influenced by hereditary factors." A study by Stafford (1961) is cited in which it was demonstrated that a sex-linked recessive gene may be the cause of sex differences in spatial ability. In his own study, Hartlage (1970) attempted to replicate Stafford's experiment using the spatial subtest of the Differential Aptitude Test (DAT), considered to be a reasonably pure measure of spatial visualization ability. One hundred Ss representing 25 families consisting of mother-son, mother-daughter, father-son, father-daughter, mother-son, and mother-daughter pairs. The highest correlation ($r = .39$, $p < .025$) was obtained between mothers and sons;

a correlation of r = .31, $p < .05$ was obtained between father-daughter pairs. No other correlations reached significance. Hartlage noted that these figures were close to the .31 predicted by Stafford (Hartlage, 1970, p. 610).

Genetically, a son's X-chromosome comes only from the mother; the father's X-chromosome only go to a daughter or a son. Therefore, Hartlage (1970, p. 610) suggested that the significant correlation between the mother-son and father-daughter pairs supports contention that spatial ability is transmitted by a recessive gene located in the X-chromosome. As indicated in Figure 7, therefore, in female children who receive an X-dominant gene from the mother (perhaps for verbal ability?), and an X-recessive gene for spatial ability from the father, no unusual degree of spatial visualization ability will develop. Similarly, if a male child receives the X-dominant gene from the mother, no unusual degree of spatial ability will develop. However, there is a higher probability that male children will exhibit spatial ability because the Y-chromosome does not appear to be involved in the transmission of spatial ability (Hartlage, 1970, p. 610). Since the female child always receives two X-chromosomes, only in cases where two X-recessive genes are inherited will spatial ability develop.

In terms of genetic theory, Figure 7 attempts to make clear why spatial visualization ability is more prevalent among males than among females. Assuming, the father's X-chromosome does not carry the recessive gene for spatial ability, for example, but that the mother does, the female child will always inherit at least one X-dominant (non 'k') gene and thus will not display high spatial ability. Male children, on the other hand, who inherit the X-recessive gene for spatial ability

(1)

Mother		Father	
XX'		X'Y	
Daughter	Son	Daughter	Son
XX'	XY	X'Y' 'k'	X'Y 'k'

(2)

Mother		Father	
XX'		XY	
Daughter	Son	Daughter	Son
XX	XY	X'X'	X'Y 'k'

(3)

Mother		Father	
XX		X'Y	
Daughter	Son	Daughter	Son
XX'	XY	XX'	XY

(4)

Mother		Father	
X'X'		X'Y	
Daughter	Son	Daughter	Son
X'X' 'k'	X'Y 'k'	X'X' 'k'	X'Y 'k'

(5)

Mother		Father	
XX		XY	
Daughter	Son	Daughter	Son
XX	XY	XX	XY

Figure 7. Genetic Transmission of X'-Recessive Gene for Spatial Visualization Ability. [Case 1: Both parents carriers of 'k' (spatial ability) gene; Case 2: Mother only a carrier of 'k' gene; Case 3: Father only a carrier of 'k' gene; Case 4: Both parents carriers of 'k' gene; Case 5: Neither parent carrier of 'k' gene. Only offspring underlined will have genetic potential for high spatial ability.]

from the mother will receive a Y'chromosome from the father which will not interfere with the development of spatial ability. However, only when the father is a carrier of an X-recessive gene for spatial ability, and when an X-recessive gene is inherited from the mother will female children possess the genetic potential tend to exhibit high spatial ability.

If both parents are carriers of an X-recessive gene for spatial ability, both a daughter and a son would inherit the genetic potential to develop high spatial ability. However, if only the mother is a carrier of the gene for spatial ability, then only a son would inherit the genetic potential for high spatial ability. If only the father is a carrier of the gene, no children, male or female, will inherit the genetic potential for high 'k'. Thus, in sum, of twenty offspring, seven will possess the genetic potential to develop high 'k'; of these, four will be male and three female. Sex-typed behavior in males to develop spatial abilities, as against cultural pressure on females not to participate in activities demanding the application of high spatial ability (fixing cars, model building, map reading, mechanical drawing, and school shop courses) is also apparently related to the fact that relatively few females characteristically display high levels of spatial ability in academic tasks.

Summary of the Literature Review

FDI cognitive style is now recognized as an important dimension of individual difference among learners which can significantly influence educational achievement. Witkin (1948) was among the first to suggest the possibility that FDI cognitive style, first revealed by Gottschalt type tests of ability to separate a figure from an embedding context, might interact significantly with instructional strategy and certain aspects of the learning task to the detriment of individuals exhibiting either FD or FI cognitive style.

Smith (1964), Vernon (1972), and others subsequently noted the existence of a strong correlation between tests of field independence and 'k', a widely recognized subfactor of general intelligence emphasizing spatial visualization ability. In addition, Smith (1964), Witkin (1962), Vernon (1950, 1972), and others pointed out significant relationships between field dependence-field independence cognitive style and certain personality variables such as introversion-extroversion, and visual vs. verbal preferences in intellectual operation. Arnheim (1970) noted the importance of visual thinking to creativity, the under-emphasis in traditional education upon development of visual thought, and a corresponding over-emphasis on use of verbal thought. Williams (1969) also noted the importance of spatial ability to visual thought and creativity, and noted differences in intellectual functioning between field dependent and field independent individuals in terms of Guilford's "Model of the Intellect" theory of the functioning of the mind which helps to account for differences in preferred learning patterns.

In a 1967 study, Elton and Rose reported finding significant differences in the task-structure of major fields of academic study based on personality index and academic ability scores of students. Goldman and Warren (1973) also found that four major fields of academic study (physical sciences, biological sciences, social sciences, and humanities) could be differentiated on the basis of the personality and academic interests of students majoring in those fields. Several of the personality and interest variables used in these studies were found to be significantly correlated with measures of FDI cognitive style.

Hunter (1971) analyzed the task structure of geography, and noted that the successful study of geography demands the use of many spatial concepts, analytical tools (especially maps), and techniques for representation of spatial relationships, many of which involve either embedded figures (maps) or visual thinking (areal association) or both. Piaget and Inhelder (1957) had earlier theorized that individuals progress through a series of developmental stages of intellectual growth, culminating in a "formal-operations" stage of mental operations characterized by the ability to generalize and think abstractly in both visual and verbal terms. However, Piaget also pointed out that individuals differ significantly in the degree to which they ultimately achieve this final stage of development and full development requires complementary socialization practices emphasizing visual thought and abstract generalization which may influence vocational choice, academic interests, and academic ability. In this connection Peter Gould (1966), Sanders and Porter (1974), and Yi Fu Tuan (1975) have noted that it is necessary to create "mental maps" and images in order to store, process, and reproduce geographic information, and all suggested the probable importance of spatial ability to success in such an endeavor. The possibility, therefore, presented itself that cognitive style might interact significantly with the instructional strategy and the learning tasks presented in an introductory level human geography course.

Tuan (1975) wondered how geography should be taught in light of this probable relationship. Several studies seeking to answer this question, including those by Coop and Brown (1970), Messick and Damarin

(1964), Fitzgibbons, Goldberger, and Eagle (1965), Beller (1970), Haskell (1971), Taylor (1959), and Grieve and Davis (1971) have produced conflicting results, in part because use of different definitions of cognitive style, and in part because of use of instructional strategies not always designed to interact with a specific cognitive style. Taylor (1959), for example, found no significant relationship between tests of spatial ability and tests of geographic knowledge among public school pupils in England. Grieve and Davis (1971), on the other hand, found significant differences in achievement on tests of geographic knowledge and concept generalization between FD and FI ninth grade students. In addition, however, Grieve and Davis (1971) suggested the possibility that cognitive style might interact significantly with the logical sequencing of instructional materials utilized in geographic instruction, and produced some evidence in support of their suggestion for a group of ninth grade geography students.

Finally, Sherman (1967), Hartlage (1970), and Vaught (1965) have noted that tests of spatial ability and field dependence-independence cognitive style are sex biased due to differential socialization practices and perhaps genetic influences, and strongly suggest that sex be employed as a control variable in studies seeking to determine learning correlates of FDI cognitive style or spatial ability.

CHAPTER III

RESEARCH METHODOLOGY AND STATISTICAL DESIGN OF THE STUDY

Introduction

The purpose of this exploratory psychometric investigation was to determine whether college students who differed significantly in field dependence-independence cognitive style also differed significantly in their capacity to learn geographic concepts and information when such material was presented in verbal, written, and cartographic form. A secondary, but supporting, purpose of the investigation was to determine whether field dependence-independence cognitive style interacted significantly with method of lecture organization and presentation employed in a college-level geography course.

Chapter III of the study will include a discussion of the nature of psychometric as opposed to experimental research, a list of the hypotheses to be tested, a summary of the research design of the pilot and principal studies, and a description of the test instruments employed. In addition, dependent, organismic, and covariates are enumerated and discussed, and the data collection procedure outlined. Finally, the design of the statistical analysis is presented.

The Nature of Psychometric Research

The present study made use of a psychometric rather than an experimental research design. Therefore, no attempt was made to select a random sample of subjects from among a well-defined larger population. Rather, in psychometric research a psychometric test is employed to measure individual variation in the independent variable of interest. In the present case, for example, the Hidden Figures Test (HFT) was used to measure subject's level of field independence. Test results were then used to group individuals into homogeneous groups which differed significantly in terms of the independent variable.

The major differences between psychometric and experimental research procedure have been summarized by Good (1966) in a study of the essentials of educational research. Good quoted Bindra and Scheier who had presented an example of the functioning of the two research designs as follows:

> In an investigation of the relation between, let us say, reaction time and alcoholic content of blood, variations in alcoholic content of blood are likely to be produced experimentally by feeding comparable groups of subjects different amounts of alcohol. The groups are treated in different ways, subjected to different conditions. On the other hand, in studying the relation between memory and intelligence, for example, variations in intelligence are obtained psychometrically by selecting individuals who vary with respect to scores on an intelligence test. In both cases we vary each of at least two variables in order to determine the relation between them, but the method of producing variation is different. In experimental investigations the investigator produces variation by changing the external environment, or internal state, or both, of his subjects. In psychometric research no attempt is made to produce any change in the individual subject. Rather, the subject is assumed to stay put with respect to the property (e.g., intelligence) in which the investigator is interested, and variation in that property is obtained by selecting individuals who differ with respect to it. The experimentalist obtains variation by subjecting a given group of subjects to different experimental conditions, the psychometric researcher

> achieves it by moving from individual to individual (Binder and Scheier, 1954, p. 69).

N. L. Gage (1963, pp. 412-413) has also commented on the nature of psychometric research. Gage characterized psychometric studies as "nomothetic-ahistorical" in strategy and noted that such studies "deal with the analysis of relationships under field conditions for the purpose of arriving at general laws." The psychologist Thurstone was quoted by Gage (1963, pp. 412-143) as the originator of the psychometric research tradition:

> I suggest that we dethrone the stimulus. He is only nominally the ruler of psychology. The real ruler of the domain which psychology studies is the individual and his motives, desires, wants, ambitions, cravings, aspirations. The stimulus is merely the more or less accidental fact... (Thurstone, 1923, p. 364).

The psychometric approach, therefore, was ideally suited to studies in which it was not possible to manipulate experimentally the independent variable since it is a functional characteristic of the research subject, as in the present study. Gage notes (1963, p. 413) that in psychometric research the individual is viewed as "the point of intersection of a number of quantitative variables," and points out that such an approach is significant only insofar as the research can show that the behavior of the test subject is related to some other dimension of behavior as, for example, in the case where an aptitude test score can be used as an indicator of potential for academic or vocational success (Gage, 1963, p. 413).

Pilot Study

A pilot study (Study A) was conducted in the spring semester of 1974, one year prior to the principal study (Study B). The pilot and principal studies were similar in format. However, in the pilot study an experimental design was employed and an attempt was made to vary the instructional stimulus, while no such attempt was made in the principal study. Rather, in the principal study two related but different forms of criteria (verbal and visual) were employed and all subjects received an identical learning stimulus. The purpose of the pilot study was to develop familiarity with data collection and research procedures, and to test the hypotheses listed below.

Null Hypotheses Tested in Study A

The null hypotheses tested in Study A are as follows:

1. For the subjects of Study A, there will be no significant difference in mean adjusted RCT[1] score between field dependent and field independent subjects.

2. For the subjects of Study A, there will be no significant difference in mean adjusted RCT score between subjects who receive the inductively organized geography lecture and subjects who receive the deductively organized geography lecture.

3. For the subjects of Study A, there will be no significant interaction in mean adjusted RCT score between cognitive style and sex.

4. For the subjects of Study A, there will be no significant interaction in mean adjusted RCT score, between lecture method and sex.

5. For the subjects of Study A, there will be no significant interaction in adjusted mean RCT score between cognitive style and lecture method.

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[1]Regional Concept Test

6. For the subjects of Study A, there will be no significant interaction, in adjusted mean RCT score, between cognitive style, lecture method and sex.

Null Hypotheses Tested in Study B

(Principal Study)

1. For the subjects of Study B, there will be no significant difference in mean GVR[2] test score between male and female subjects.

2. For the subjects of Study B, there will be no significant difference in mean GVR test score between field dependent and field independent subjects.

3. For the subjects of Study B, there will be no significant interaction in adjusted mean GVR test score between cognitive style and sex.

4. For the subjects of Study B, there will be no significant difference in adjusted mean VMR[3] test score between male and female subjects.

5. For the subjects of Study B, there will be no significant difference in mean adjusted VMR test score between field dependent and field independent subjects.

6. For the subjects of Study B, there will be no significant interaction between sex and cognitive style with regard to mean VMR test scores.

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[2] Geographic Verbal Recognition

[3] Visual Map Recognition

7. For the subjects of Study B, there will be no significant difference in mean HFT score between subjects who score above the median on the GVR test and subjects who score below the median on the GVR test.

8. For the subjects of Study B, there will be no significant difference in mean HFT score between subjects who score above the median on the VMR test and subjects who score below the median on the VMR test.

9. For the subjects of Study B, there will be no significant interaction in terms of adjusted mean HFT score between high vs. low GVR test groups, and high vs. low VMR test groups.

Design of Study A

Eighty-six students in an introductory geography course (Geography 1113, Introduction in Geographic Behavior) at Oklahoma State University were randomly assigned to one of two lecture sections by university enrollment procedures.[4] Such randomization, it was assumed, helped to control for bias in intelligence, geographic knowledge, test taking sophistication, age, and other individual difference not otherwise taken into account directly by the research design.

Two tests were given in connection with Study A. The HFT was administered near the beginning of the semester in accordance with instructions printed on the front of the test (Appendix A). Subjects were given five (5) minutes in which to read over test taking instructions, and study the sample test items. Questions with regard to test procedure were answered verbally. Subjects were reminded that all hidden figures were "right-side up" (i.e., not rotated) and were the

[4]University enrollment procedures have been documented as valid a randomization technique by West (1969, p. 264).

exact size and shape of one of the five response items. Subjects were asked not to mark on the test booklets and to record all answers on the answer sheets provided. In addition, subjects were told the test would be timed and that they would have ten minutes to work on the first half of the test (16 items) and ten minutes to work on the second half (16 items). The test was timed with the aid of a stopwatch. At the conclusion of the test, all test papers were collected and later hand scored.

When the Geography 1113 course syllabus called for introduction of the concept of the geographic region, two 30-minute illustrated lectures were prepared with the objective of communicating to the students knowledge regarding the regional concept (Appendices B and C).[5] In terms of factual content, the two lectures were made as identical as possible. Both lectures employed the same set of map transparencies projected on a screen with the aid of an overhead projector to illustrate the regional concept. However, one lecture was designed as an "inductively" organized lecture and the other as a "deductively" organized lecture. The inductively organized regional concept lecture (Appendix B) was defined as a lecture presentation in which verbalization of the generalization(s) being taught was delayed until the end of the 30-minute lecture period. The deductively organized regional concept lecture (Appendix C) was defined as a lecture presentation in which verbalization of the generalization(s) being taught was the initial step taken at the beginning of the 30-minute period. Thus, the essential difference between the two

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[5]Ripple (1969) has shown the mean attention span of college age students to be approximately 50 minutes with a standard deviation of 15 minutes. A 30-minute lecture was therefore assumed to be within the attention span of most students.

lecture methods was the placement of a verbal statement of the geographic concepts supported by the instructional materials.

Both lectures were delivered in the same lecture hall under similar lighting and accoustical conditions, and read in as similar a tone of voice as possible by the same lecture instructor. The two lectures were judged to be very similar in content by three professional geographers, and an independent observer present at the time both lectures were read was of the opinion that the lectures were delivered in a similar manner under similar conditions.

Two days prior to the regional concept lecture, the Regional Concept Test (RCT) designed by the researcher was administered to both lecture groups as a pretest to determine individual differences in knowledge of the regional concept (Appendix D). Immediately following each lecture, the RCT was administered as a posttest. The RCT was designed to measure gain in knowledge of the concepts and generalizations contained in the regional concept lecture. Both pretest and posttest consisted of thirty multiple-choice test items and subjects were allowed thirty minutes to complete each test. Immediately following the pretest and posttest, all test papers were collected and later hand socred.

Design of Study B

One hundred fifty-six students enrolled in Geography 1113 at Oklahoma State University in the spring semester of 1975 were used as subjects in Study B. Seventy-eight of the subjects were male and seventy-eight were female. Average age of the subjects was 19 years 10 months. Forty-nine of the students participating in Study B were enrolled in the College of Arts and Sciences, thirty-six in the School of Business Administration, fifty-two in the College of Education, and four in the College of Engineering. Ten students did not indicate the college or school of the university in which they were enrolled. Thirty-nine students indicated they had previously taken at least one college geography course, while one hundred twenty-two reported never having previously studied geography.

The Hidden Figures Test (HFT) was administered to all subjects at the beginning of the 1974 spring semester and procedures identical to those used in Study A were employed in administering the test. At a later date in the semester all subjects were administered a 20-minute, 50-item pretest consisting of the GVR and VMR subtest of the Map of Africa Learning Module (Appendices E and F).

In connection with the map exercise, all subjects were told they would be working on an exercise intended to teach them basic knowledge of the political geography of Africa as part of the regular Geography 1113 course of study. All students were then given the first portion of the exercise consisting of the 25-item GVR multiple-choice test. After reading test instructions, subjects were told they would have six minutes to complete the test and that there would be no penalty for guessing.[6] A stopwatch was used to time the test. No reference map of Africa was provided.

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[6]This is in accordance with suggestions in the literature on test taking regarding the use of a "penalty for guessing." E. B. Little, (1966, p. 47), for example, in an article on "Overcorrection and Under-correction in Multiple-Choice Test Scoring" notes that "rights-only scores give a much better indication of the student's knowledge and his ability to cope within the limits set by the examination." Similarly, M. Y. Quereshi (1974, p. 175) in an article concerning "Performance on Multiple-Choice Tests and Penalty of Guessing" concluded that "the penalty for guessing resulted in highly ($p<.001$) significant a) decrease in rights, b) increase in wrongs, and c) increase in omissions."

After six minutes had elapsed, the GVR test was collected, and the VMR test of the Map of Africa Learning Module distributed. Subjects were again read test instructions and told they would have six minutes in which to complete the test. Upon expiration of six minutes all test materials were collected and the learning stimulus distributed.

The learning stimulus, consisting of a map location exercise designed to give all subjects an equal opportunity to become familiar with the geographic arrangement of twenty-five of the larger political states of Africa, was given in two parts (Appendix G). Part one of the exercise consisted of a map of the continent of Africa with stippled ocean areas, and international boundaries indicated by a dashed line symbol. Twenty-five of the larger political states were given numbers on the map corresponding to a list giving the name of each numbered state. Subjects were instructed to begin the exercise by writing the correct name of each numbered country on the map in the appropriate area.

Part two of the learning stimulus, consisting of a 25x25 matrix with the names of the twenty-five countries numbered across the top and down the left margin, was also distributed. Students were instructed to place an "x" in each cell of the matrix if the political state named at the head of a column bordered any part of the political state named at the left of that row. The first political state listed (Egypt) was completed as an example. Subjects were informed they would have fifteen minutes to finish the exercise.

At the completion of the time allotted for the learning stimulus, the map and all materials were collected and the posttest administered (Appendices E and F). The posttest was administered in a manner similar to the pretest. Subjects were not informed beforehand they would be given both a pre and a post test. However, in order to provide test motivation, subjects were told they would be given a learning exercise and quiz which would count as part of their regular classwork.

Instrumentation

Four test instruments were employed in gathering data for Study B: (1) the Hidden Figures Test (HFT), (2) the Regional Concept Test (RCT), (3) the Geographic Verbal Recognition (GVR) test, and (4) the Visual Map Recognition (VMR) test. The nature, validity, and reliability of each instrument will be reviewed in brief.

(1) Hidden Figures Test. The HFT (Appendix A), designed by French, Ekstrom, and Price (1963) to supersede in group usage Witkin's Embedded Figures Test (EFT) is very similar to the EFT and other "embedded-figures" type tests of field independence. Like the EFT, the HFT is an adaptation of the Gottschaldt Figures Test designed in 1926 (Gottschaldt, 1926). The subject's task on the HFT is to decide which of five geometrical figures is located or "embedded" in a matrix comprising the simulus configuration. The test consists of two 16-item segments and is scored according to the percent of correct responses. Subjects are given ten minutes to complete each segment of the test. The HFT was originally developed to be used in the study of field dependence-independence cognitive style with subjects 12 years of age and over. Jackson, Messick, and Meyers (1964, p. 190) compared group and individual forms of embedded figures tests, and found that group and individually-administered embedded figures tests are sufficiently correlated to warrant substitution of group for individual tests. According to Boersma (1968, p. 555) who checked the test-retest reliability of the

HFT, "it is a very difficult test" in that subjects are generally unable to guess correct responses, and determination of the correct response requires a very significant level of field independence and/or spatial ability ('k').

In addition, Boersma (1968) gave one hundred five college freshmen the HFT on two different occasions twenty weeks apart, resulting in a test-retest reliability coefficient of .63 for total mean scores between administrations. Sex differences were reported to be negligible on the HFT (Boersma, 1968, p. 559).

(2) Regional Concept Test (RCT). The RCT was developed by the researcher for use in Study A. The test consisted of twenty multiple-choice test items with a stem and four possible responses, only one of which was considered the correct response. All test items related to the content of the regional concept lectures delivered by the researcher to students in Geography 1113 late in the spring semester of 1974. The test was scored according to the percent of correct responses (Appendix D). In developing the multiple-choice type criterion tests used in Study A and Study B, the following procedure was followed. First, the objectives and content of instructional materials were carefully reviewed by the researcher and a list of test items devised. Following this, the list of proposed test items was submitted to a review panel consisting of three professional geographers with considerable teaching experience. Each referee individually reviewed the test items. Any test item which could not be modified to meet the unanimous approval of the panel was discarded. Remaining items were then used in the criterion test. This procedure was assumed to provide additional curricular validity for the test instruments.

(3) Map of Africa Learning Module (Appendix G). The Map of Africa Learning Module (MALM) was designed by the researcher with the objective in mind of creating an instrument to measure subjects ability to learn a specified quantity of simple geographic information, presented in map form, in a short time. Two subtest and a map learning exercise were included in the MALM. Subtest 1, designated the Geographic Verbal Recognition (GVR) subtest, was designed to measure a subject's ability to recognize the correct nominal designation of a geographical place when presented with a verbal description of the relative geographic location of that place. Twenty-five multiple-choice questions, each consisting of a stem and four possible responses, only one of which was considered the correct response, were employed in the test. No maps or other visual or graphic materials were part of the test or present while Ss were taking the test. All test items referred to the relative geographic location of one of the twenty-five largest political states of Africa. Africa was selected for the test because it was assumed American students would be at least as ignorant of the relative location of African political states as of other non-Western world regions, and, in addition, the relatively large number of African political states provided ample opportunity to design test items without undue repetition.

Subtest two of the MALM, designated the Visual Map Recognition (VMR) test, was designed to measure a subject's ability to recognize the correct nominal designation of a geographical place when presented with a visual symbolic image (map) showing the shape and relative geographic location of that place. No verbal questions were included in the VMR subtest. Rather, the subject was presented with a series of ten relatively large scale (approximately 1:10 million) maps of various portions of the continent of Africa on which international boundaries were indicated by heavy dashed lines, coastlines by heavy solid lines, and oceanic areas by stippling. On each map, the complete international boundary of one or more of the political states of Africa was shown. Twenty-five countries were indicated by letters of the alphabet. The subject's task was to examine each map in an attempt to recognize, from visual cues only, the political states indicated by choosing the correct name of the state from among those given on an accompanying list. No complete map of the entire African continent was provided for reference. Subjects were required by the nature of the test to rely on the strength of their mental image of the internal arrangement and organization of the political states of Africa in order to respond correctly to the test items.

Both subtests were designed to measure Ss ability to retain in mind an "array" of geographic information. It was theorized that subjects high in verbal ability would create a verbal file of information on the location of African political states and use that information to advantage in responding to test items presented in a verbal (multiple-choice) form, or that subjects exhibiting a field dependent cognitive style would achieve significantly higher scores on the verbal (GVR) subtest than on the visual (VMR) subtest. On the other hand, subjects exhibiting a field independent cognitive style, (and thus greater spatial than verbal ability) should achieve a significantly higher score on the visual subtest than on the verbal subtest.

Because no accepted criterion was available with which to compare these instruments, statements about validity cannot be projected above the level of content (curricular) validity. All test items and correct responses were subject to review by two professional geographers prior to testing. Test items about which there was controversy or uncertainty as to correct response were eliminated. The tests were adjudged to have covered adequately both the content and objectives of the instructional material. Griffith has defended curricular validity as follows:

> It (curricular validity) is a special case of logical relevance. An ordinary subject matter test has usually been considered to possess curricular relevance to the extent that it tests the student's knowledge and effective grasp of those facts, principles, relations, patterns, and generalizations which are the de facto immediate objectives of instruction. It is perfectly reasonable for the test user to purpose to use a test to measure what it actually does measure (Griffith, 1967, p. 68).

The claim may be made, therefore, that the criterion tests have validity since there was a high degree of concurrence among experts in geography with regard to test responses deemed correct. Reliability was calculated on the posttest using a split-half technique and the Pearson product-moment method of correlation. Results of the reliability test are presented in the finding of the study.

Dependent and Independent Variables in Study A

The following dependent and independent variables were employed in Study A:

1. FDI Cognitive Style. This independent variable was measured with the aid of the HFT. Following the example of Grieve and Davis (1971, p. 138) a median split (M = 28.13%) of HFT scores was used to distinguish field dependent from field independent subjects. Those students who scored above the median were assumed to represent the field independent end of the FDI cognitive style continuum, while students who scored below the median were assumed to represent the

field dependent end of the continuum.

2. Knowledge of the Regional Concept. This dependent variable was measured with the aid of the Regional Concept Test (RCT). It was considered a surrogate measure of a more general capacity to learn information of a geographic nature.

3. Sex. Subject's sex was employed as an organismic variable in the statistical analysis. Previous studies have shown that FDI cognitive style is sex related, i.e., female subjects exhibit a consistent tendency to score lower on spatial tests than do male subjects. Therefore, sex was included in the statistical analysis in order to detect significant sex related differences in field independence. Where such differences were found, sex was included in subsequent analysis as a covariate.

Dependent and Independent Variables in Study B

The following dependent and independent variables were used in Study B:

1. FDI Cognitive Syle. FDI cognitive style was employed as the major independent variable in the principal study as it was in the pilot study. However, results of the HFT were also employed as a dependent variable in the principal study in testing for significant differences between subjects who scored above and below the median on GVR and VMR tests.

2. Geographic Verbal Recognition Ability. This dependent variable was measured using the GVR subtest of the Map of Africa Learning Module. It is referred to as "geographic verbal recognition ability" because, in taking the GVR subtest, subjects were required to interpret verbal questions relating to geographic knowledge before recognition of the

correct test response was possible. No maps are employed in this test.

3. Visual Map Recognition Ability. Visual Map Recognition (VMR) ability was employed as a dependent variable in Study B and was measured with the aid of the VMR subtest of the Map of Africa Learning Module. Visual Map Recognition ability refers to a demonstrated capacity on the part of an individual to recognize by name the visual cartographic image of a delimited area of earthspace when such an image has previously been studied at a smaller map scale. Visual recognition of cartographic shape is emphasized in this test. No verbal questions are employed, and no reference map provided.

It is felt by the researcher that VMR ability is vital in the study of geography because it is frequently necessary for the geography student to examine and refer by name to areas of the earth surface at a variety of map scales. Ability to identify the relative nominal location of a cartographic image previously examined at another map scale allows the individual to mentally analyze spatial relationships despite shifting map scales.

4. Sex. This organismic variable was included in Study B for the same reason it was included in Study A, i.e., to control for sex bias in spatial ability.

Design of the Statistical Analysis

Multivariate analysis of covariance (MANCOVA) was the principal statistical tool used in analysis of the data for both Study A and Study B. Analysis of covariance has been recommended by educational researchers as an ideal tool for use in investigations where it is difficult or impossible to control for all individual differences between groups at the start of the research. Analysis of covariance represents an extension of analysis of variance to allow for correlation between initial and final scores, a situation which often obtains under field research conditions in psychometric studies, as in the present instance.

Through the use of covariance, one is able to allow for individual differences in some initial variable. Griffith (1967, p. 81) for example, noted that a typical application of analysis of covariance is to allow a covariate or initial score to be represented by a pretest score. Therefore, in both Study A and Study B, criterion pretest score is used as a covariate in order to control for individual differences in prior knowledge of the learning stimulus material employed.

Mitzel and Gross (1956) have also recommended use of analysis of covariance in psychometric studies. After reviewing three methods of dealing with achievement gains (raw scores, achievement quotient gains, and regression methods) Mitzel and Gross argued for the use of analysis of covariance as the best available technique for matching groups of students with potentially different initial ability levels.

In Study A, a 2x2 factorial design was used to combine two levels of cognitive style with two levels of lecture method. Covariates were sex and pretest score on the RCT. Posttest score on the RCT served as the criterion or dependent variable. All null hypotheses and interactions were tested at the 0.05 level of confidence. Where significant interaction was found, the new Duncan Multiple Range Test (DMRT) for multiple means was employed to test for significance of difference between group means.

In the statistical analysis of the data for Study B, two factorial designs were employed. A 2x2 (sex by cognitive style) design was used to test hypotheses one through six relating to dependent variables derived from the GVR and VMR subtests of the Map of Africa Learning Module. In addition, two levels of sex were combined with two levels of demonstrated ability on the GVR subtest and two levels of ability on the VMR subtest to produce a 2x2x2 factorial design for testing hypotheses seven through ten of Study B.

Analysis of variance (ANOVA) and Pearson's product-moment correlation were also employed in the statistical analysis in testing the reliability of the criterion test instruments, and in establishing the equivalence of groups.

All data analysis was accomplished with the aid of the computer programs of the Statistical Analysis System (SAS) designed by A. J. Barr and J. H. Goodnight (1972). SAS programs were implemented on the IBM 360/65 computer system at Oklahoma State University.

The following two chapters will present the findings of the statistical analysis, and the summary and conclusions of the study.

CHAPTER IV

RESULTS OF THE STATISTICAL ANALYSIS

Introduction

The results of the statistical analysis are presented in four parts. Part one is a report on the analysis of the criterion tests for reliability. In parts two and three, the findings of Study A and Study B are presented. Part four is devoted to additional findings and considerations not included in parts two and three.

Instrument Analysis

Three criterion tests were employed in Study A and Study B. For each instrument, the split-half reliability coefficient of internal test consistency was determined based on posttest results. In each case, test scores for all numbered test items were correlated with scores on even numbered test items.

The Pearson product moment correlation coefficient for the Regional Concept Test employed in Study A was found to be .76 corrected by the Spearman-Brown formula to .81 (Ebel, 1965, pp. 314-315). For the Geographic Verbal Recognition (GVR) subtest employed in Study B the same procedure yielded a correlation coefficient of .84 corrected to .89. For the Visual Map Recognition (VMR) subtest, a split-half correlation of .82 corrected to .87 was found. These correlation coefficients indicate that the criterion tests employed were effective in discriminating between high and low ability subjects.

Findings of Study A

As an initial step in the analysis of the pilot study data, Pearson product moment correlation coefficients were calculated between Hidden Figures Test scores and Regional Concept pretest and posttest scores for both male and female subjects. Results are presented in Table I. As indicated, there was no significant correlation between results of the HFT and the Regional Concept pretest for any group. However, there was a low, but statistically significant, correlation ($r = .21$, $p < 0.05$) between scores on the Regional Concept posttest and the HFT for the group as a whole. This significant correlation seemed to be largely the result of the significant correlation found between RCT scores of field dependent subjects taken alone and the HFT ($r = .34$, $p < .05$) since no significant correlation was found between RCT scores and HFT scores for field independent subjects considered separately. No significant correlation was found between RCT scores of male or female Ss and HFT scores.

In an attempt to determine the degree to which cognitive style, lecture section, and sex groups were equivalent in knowledge of the regional concept at the outset of the study, all subjects in Study A were pretested using the Regional Concept Test (RCT) at the beginning of the data collection procedure. The data collected was analyzed using a 2x2x2 factorial design which combined two levels of cognitive style (FI and FD) with two levels of lecture section (section 1 and section 2) with two levels of sex. Results of the multivariate analysis of variance are presented in Table II.

TABLE I

TABLE OF r BETWEEN REGIONAL CONCEPT TEST
AND HIDDEN FIGURES TEST

Group	RCT Pretest	RCT Posttest
Overall N = 75	.12	.21*
Males N = 30	.04	.21
Females N = 45	.18	.18
Field Dependent N = 43	.15	.34*
Field Independent N = 43	.05	-.04

*$p < 0.05$

TABLE II

F TEST RESULTS FOR REGIONAL CONCEPT PRETEST

Source	SS	df	MS	F Ratio[1]
Sex	308.09	1	308.09	1.59
Section	0.96	1	0.96	0.01
Cognitive Style	138.34	1	138.34	0.71
Sex*Section	568.42	1	568.42	2.93
Sex*Cognitive Style	47.43	1	0.24	0.62
Cognitive Style*Section	4.28	1	4.28	0.02
Sex*Cognitive Style*Section	472.96	1	472.96	2.43
Error	13020.67	66	193.33	
Corrected Total	14560.74	74		

[1] F ratio for significance at 0.05 level of confidence with 1 and 66 degrees of freedome is 3.99.

As indicated in Table II, no F ratio for between group differences reached the .05 level of statistical significance. There was no significant difference in mean Regional Concept pretest score between male and female students, between field dependent and field independent students, or between students enrolled in lecture section one and students enrolled in lecture section two of Geography 1113. In addition, the analysis also indicated no significant interaction between these groups in terms of mean RCT pretest score. It can therefore be said that all groups employed in the study were roughly equivalent in knowledge of the concept of the geographic region prior to instructional treatment. Even though the analysis of variance indicated that groups employed in Study A were not significantly different in pretest knowledge of the lecture material, pretest score was retained as a covariate in the posttest analysis to control for initial differences among subjects in knowledge of the regional concept, academic ability, and test taking sophistication. Sex was also retained in the posttest analysis as a covariate (Fiebert, 1967, pp. 1277-1278) though no significant difference in HFT score was found between male and female subjects in the present study.

Testing the Hypotheses of Study A

Results of the analysis of covariance using Regional Concept posttest score as the criterion are presented in Table III. As indicated, use of the RCT pretest score as a covariate had a significant effect on the posttest scores, accounting for approximately three quarters of the total variance among posttest scores ($F = 35.0$, with df 1 and 66, $p < 0.001$). Sex related differences in knowledge of the regional

TABLE III

F TEST RESULTS FOR REGIONAL CONCEPT POSTTEST

Source	SS	df	MS	F Ratio
Pretest[1]	3111.67	1	3111.67	35.18
Sex	46.30	1	46.30	0.52
Cognitive Style	306.62	1	306.62	3.46*
Lecture Method	45.21	1	45.21	0.51
Cognitive Style*Sex	5.87	1	5.87	0.06
Lecture Method*Sex	0.22	1	0.22	0.002
Cognitive Style*Method	603.26	1	603.26	6.82**
Cognitive Style*Method*Sex	29.72	1	29.72	0.33
Error	5836.64	66	88.43	
Corrected Total	9985.54	74		

(1) Covariate was score on Regional Concept pretest

*$p < 0.10$

**$p < 0.01$

concept had much less impact on posttest scores. The F ratio for sex did not approach the level of statistical significance ($F = 0.52$ with df 1 and 66, $p < 0.47$). The 0.05 level of confidence was employed in testing the following null hypotheses of Study A:

Hypothesis 1

For the subjects of Study A, there will be no significant difference in mean adjusted RCT score between field dependent and field independent subjects.

As indicated in Table III, the F ratio for cognitive style differences on the RCT posttest was 3.46. Rejection of the null hypothesis at the 0.05 level of confidence with 1 and 66 degrees of freedom requires an F ratio of 3.99. Therefore, the null hypothesis was accepted. There was no significant difference in mean adjusted posttest score between field dependent and field independent subjects. However, the F ratio of 3.46 for cognitive style was significant at the .07 level of confidence. This close approach to the level of statistical significance, obtained in what is considered the pilot study, was considered encouraging and will be retained as marginal evidence that FDI cognitive style may influence geographic learning. Adjusted and unadjusted posttest means for the field dependent and field independent cognitive style groups are given in Table IV.

Hypothesis 2

For the subjects of Study A, there will be no significant difference in mean adjusted RCT score between those subjects who received the inductively organized geography lecture and those subjects who received the deductively organized geography lecture.

TABLE IV

FDI COGNITIVE STYLE GROUP MEANS FOR REGIONAL CONCEPT TEST

Group	N	Pretest Mean	Unadjusted Posttest Mean	Adjusted Posttest Mean*
Field Dependent	37	53.62	71.62	71.71
Field Independent	38	54.09	73.91	73.79

*Covariate was RCT pretest score.

As indicated in Table III, the F ratio for lecture method was 0.51. Rejection of the null hypothesis at the 0.05 level of confidence with 1 and 66 degrees of freedom requires an F ratio of 3.99. Therefore, the null hypothesis was accepted. There was no significant difference in mean adjusted posttest score between heterogeneously grouped students who received the inductively organized lecture and heterogeneously grouped students who received the deductively organized lecture.[1]

[1]It was necessary to modify this conclusion in light of the significant interaction found between cognitive style and lecture method. Indeed there is a significant difference in the effect of the lecture method insofar as it interacts with cognitive style as will be discussed under the hypotheses dealing with interaction between cognitive style and lecture method.

Hypothesis 3

For the subjects of Study A, there will be no significant interaction in mean adjusted RCT score between cognitive style and sex.

Table III indicates an F ratio for the interaction between cognitive style and sex of 0.06. Rejection of the null hypothesis with 1 and 66 degrees of freedom requires an F ratio of 3.99. The null hypothesis for the interaction of cognitive style and sex was therefore accepted. There was no significant interaction between sex and FDI cognitive style with regard to score on the Regional Concept Test. A graphic illustration of the nonsignificant interaction is shown by Figure 8.

Hypothesis 4

For the subjects of Study A, there will be no significant interaction in mean adjusted RCT score between lecture method and sex.

Table III gives an F ratio for the interaction between lecture method and sex of 0.002. Rejection of the null hypothesis at the 0.05 level of confidence with 1 and 66 degrees of freedom requires an F ratio of 3.99. Therefore, the null hypothesis was accepted. There was no significant interaction between lecture method and sex with regard to score on the Regional Concept Test. A graphic illustration of the interaction is shown in Figure 9.

Hypothesis 5

For the subjects of Study A, there will be no significant interaction in adjusted mean RCT score between cognitive style and lecture method.

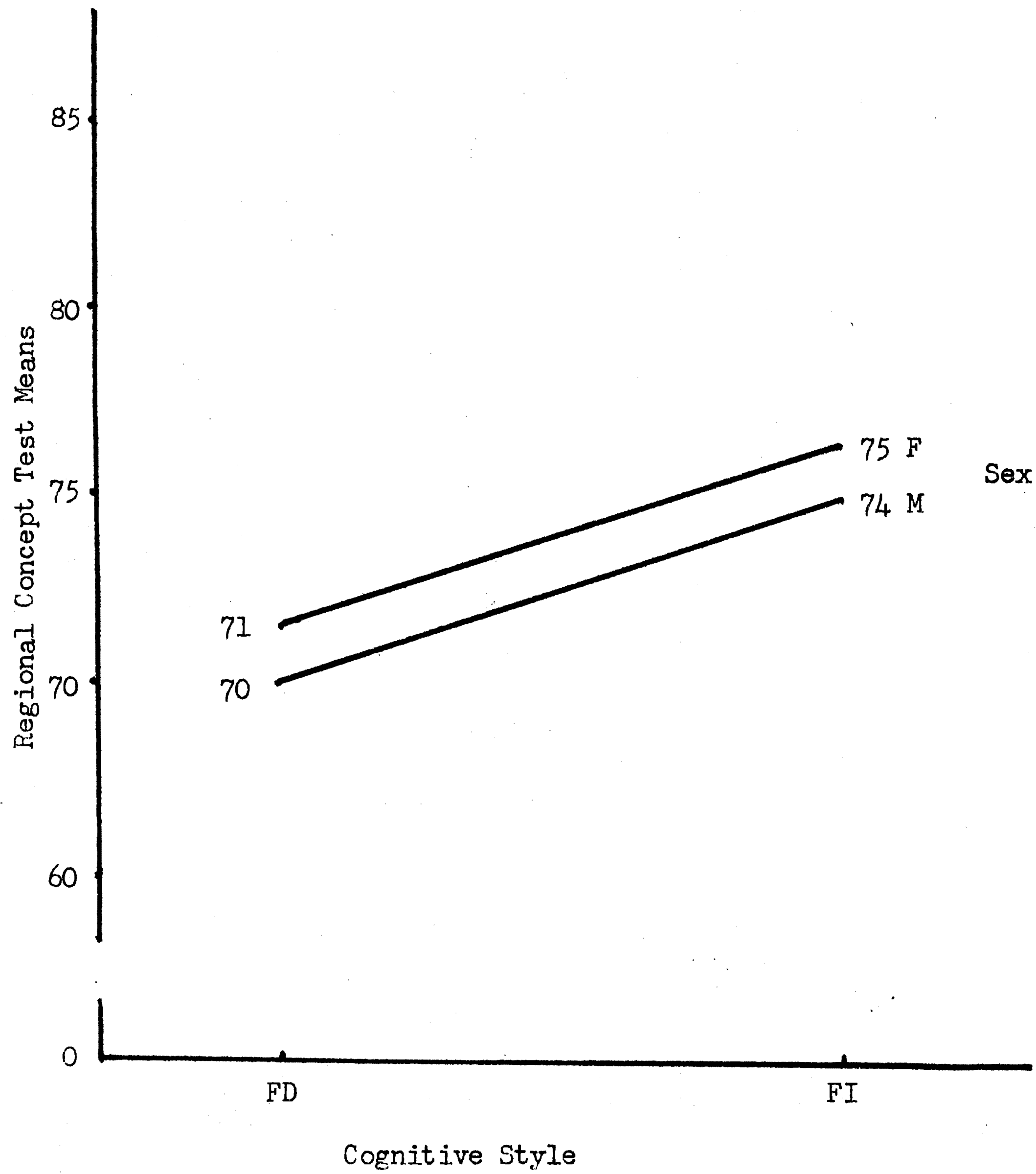

Figure 8. Illustration of Sex by Cognitive Style Interaction for Regional Concept Test Means.

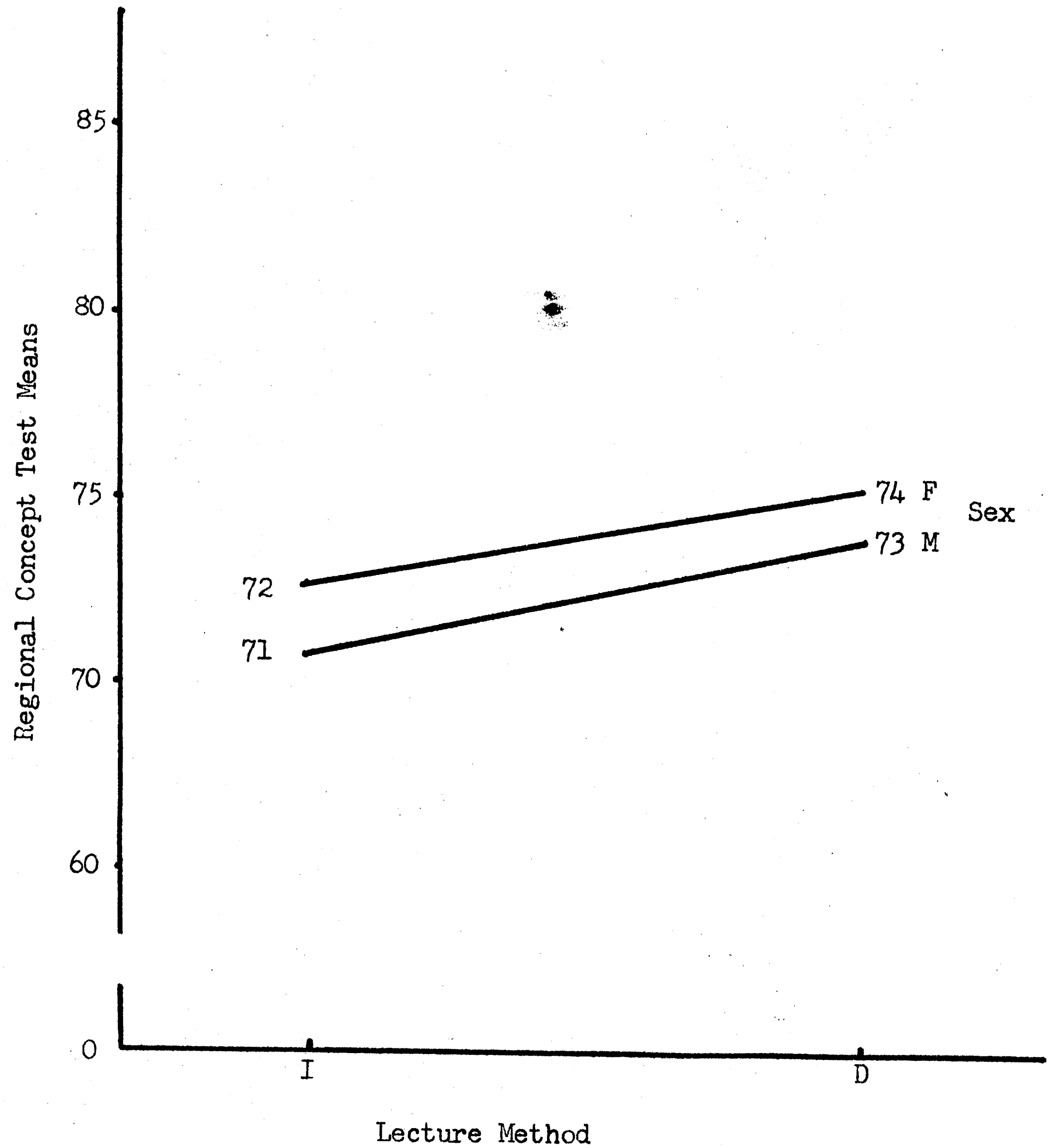

Figure 9. Illustration of Sex by Method Interaction for Regional Concept Test Means.

As indicated in Table III, the F ratio for interaction between cognitive style and lecture method was 6.82. Rejection of the null hypothesis with 1 and 66 degrees of freedom requires an F ratio of 3.99. Therefore the null hypothesis was rejected. There was a significant degree of interaction between FDI cognitive style and the lecture method employed in teaching the regional concept as measured by score on the Regional Concept Test. This finding necessitated post hoc analysis in order to examine differences among individual group means.

Adjusted posttest means for the cognitive style/lecture method interaction are given in Table V, and illustrated in Figure 10.

Hypothesis 6

For the subjects of Study A, there will be no significant interaction in adjusted mean RCT score, between cognitive style, lecture method, and sex.

Table III indicated an F ratio for the three-way interaction between cognitive style, lecture method, and sex of 0.33. Rejection of the null hypothesis at the 0.05 level of confidence with 1 and 66 degrees of freedom requires an F ratio of 3.99. Therefore the null hypothesis was accepted. There was no significant interaction between cognitive style, lecture method, and sex with regard to knowledge of the regional concept.

Post Hoc Analysis

The interaction between FDI cognitive style and lecture method (inductive vs. deductive) was found to be significant at the 0.05 level of confidence for subjects tested in Study A. A follow-up analysis

TABLE V

ADJUSTED REGIONAL CONCEPT POSTTEST MEANS
FOR COGNITIVE STYLE BY
LECTURE METHOD
INTERACTION

Cognitive Style	N	Lecture Method	Adjusted Posttest Mean*
Field Dependent	22	Inductive	67.51
Field Dependent	15	Deductive	74.78
Field Independent	16	Inductive	76.89
Field Independent	22	Deductive	73.17

*Covariate was Regional Concept Pretest Score.

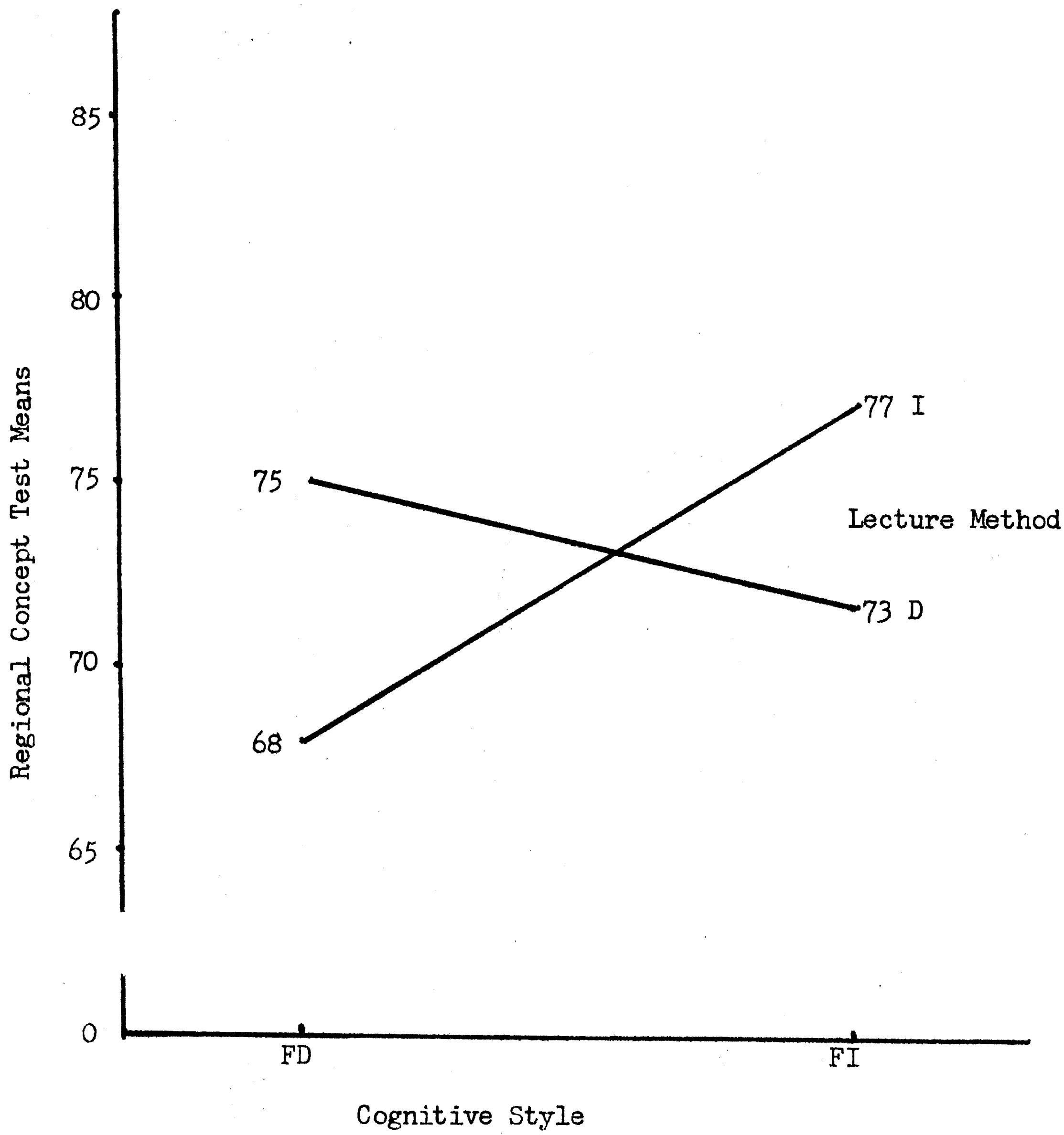

Figure 10. Illustration of Cognitive Style by Method Interaction for Regional Concept Test Means.

was therefore required to determine the pattern of interaction among the group means. The follow-up test selected was the new Duncan Multiple Range Test for Multiple Means. This test has been recommended for use in conjunction with multivariate analysis of covariance as one which offers "a moderate amount of protection against Type I error" (Williams, 1968, p. 90).

Results of the Duncan's Multiple Range Test are shown in Table VI. As indicated, only the group mean for the interaction between the inductively organized geography lecture and field dependence cognitive style was significant at the 0.05 level of confidence. The present study has produced evidence, therefore, that field dependent students of college age have greater difficulty learning geographic concepts and information when compared with field independent students of college age when both groups have been exposed to a geographic lecture which is inductively organized. Similarly, the present study has produced evidence that field dependent students of college age have a greater tendency to learn concepts and information related to the regional concept when such information is presented via a deductively organized lecture as opposed to an inductively organized lecture.

These findings are reinforced by interpretation of the graphic illustration of the cognitive style/lecture method interaction shown in Figure 10. As indicated, the inductively organized lecture appears to have had some slight, but not statistically significant, positive impact on the achievement of field independent students when compared with the achievement of field independent students exposed to the deductively organized regional concept lecture. For field dependent students,

TABLE VI

TABULAR REPORT OF INTERACTION INTERPRETATION
FOR REGIONAL CONCEPT TEST SCORES

		Cognitive Style	
		FD	FI
Lecture Method	I	67a	77b
	D	75b	73b

(Means with common subscripts are not significantly [p <.05] different from one another.)

however, a definite advantage is indicated for those students receiving the deductively organized regional concept lecture over those receiving the inductively organized regional concept lecture. Field dependent students exposed to inductively organized geographic lecture material appear to operate under a disadvantage when compared with similar field dependent students exposed to deductively organized geographic lecture material.

Summary of Study A

The purpose of Study A was to determine whether field dependent and field independent students of college age possess equal ability to learn geographic concepts and information, and whether ability to learn geographic concepts and information is affected by the type of logical sequence employed in lecture organization and presentation. Results of Study A were encouraging as indicated by a comparison of the means and variances for Study A presented in Table VII. Marginal evidence ($p<.07$) was found that students of college age who exhibit a field independent cognitive style are significantly more able to learn geographic concepts and information than similar students who exhibit a field dependent cognitive style. In addition, evidence was found that field dependent students of college age tend to achieve higher test scores when a deductive method of lecture organization is employed in geographic instruction. Such a relationship has been suggested in the literature on the basis of psychological theory (Kagan, 1966; Lesser, 1968; Maccoby, 1966; Van Voorhis, 1941), but never previously demonstrated in practice, to the best knowledge of the researcher. Because of the encouraging findings of the pilot study, it was decided to continue with

TABLE VII

SUMMARY OF MEANS AND VARIANCES FOR STUDY A

Subjects	HFT	RCT (Pretest)	RCT (Posttest)	Statistic
Female	35.08	53.68	73.69	Mean
	19.78	12.53	12.24	Variance
Male	29.92	59.16	72.83	Mean
	19.61	16.06	11.43	Variance
Field Dependent	17.75	53.52	71.57	Mean
	8.69	14.95	12.32	Variance
Field Independent	50.22	55.58	75.37	Mean
	13.67	12.49	11.27	Variance
FD Male	14.60	53.66	70.26	Mean
	8.49	16.52	12.34	Variance
FI Male	45.22	58.66	75.40	Mean
	14.93	15.75	10.21	Variance
FD Females	19.20	52.39	71.11	Mean
	9.30	13.47	12.41	Variance
FI Females	51.20	54.48	75.52	Mean
	14.40	11.89	11.98	Variance
Overall	33.52	54.50	73.21	Mean
	20.05	13.94	12.00	Variance
Section One FD	14.49	53.15	66.89	Mean
	8.67	15.56	11.40	Variance
Section One FI	42.74	55.00	76.26	Mean
	14.75	14.62	9.22	Variance
Section Two FD	17.21	51.57	74.29	Mean
	6.69	16.29	12.07	Variance
Section Two FI	49.32	54.78	73.34	Mean
	16.92	11.23	12.24	Variance

the research in the principal study (Study B). While related in some ways to Study A, Study B is in most respects a separate investigation whose purpose was to learn more about the nature of the relationship of FDI cognitive style to learning of geographic concepts and information. In particular, both Study A and Study B employed the HFT as a measure of the organismic variable FDI cognitive style, but in Study B, a different criterion test and learning stimulus were employed in an attempt to determine more specifically whether FDI cognitive style influences college students' ability to learn spatial information presented graphically, i.e., in map form.

Findings of Study B

As with Study A, the initial phase of Study B involved classification of subjects according to location on the FDI cognitive style continuum. This was accomplished with the aid of the Hidden Figures Test as previously described. Results of analysis of variance using HFT score as the dependent variable are presented in Table VIII. As indicated, the F ratio on the HFT was 14.97 for sex differences and 318.22 for cognitive style differences. Since the critical F ratio at the .05 level of significance with 1 and 154 degrees of freedom is 3.91, it was established that there was a statistically significant difference in mean score between male and female subjects, and between field dependent and field independent subjects. The mean HFT score of female subjects was significantly lower than the mean HFT score of male subjects. Sex was therefore retained in the analysis as a covariate to control for sex-related differences in cognitive style. This practice is in agreement with suggestions in the literature (Grieve and Davis, 1971,

TABLE VIII

F TEST RESULTS FOR HIDDEN FIGURES TEST SCORES

Source	SS	df	MS	F Ratio
Sex	1455	1	1455	14.97*
Cognitive Style	30932	1	30932	318.22*
Sex*Cognitive Style	282	1	282	2.90
Error	14969	154	97.21	
Corrected Total	47639			

*$p < 0.001$

pp. 137-141). In addition, it was established that the mean HFT score of the field dependent subjects (17.94) was considerably lower than that of the field independent subjects (46.32), and the two groups occupied significantly different positions on the FDI cognitive style continuum. There was no significant interaction between sex and cognitive style on the Hidden Figures Test.

Initial equivalence of field dependent and field independent subjects with regard to knowledge of the political geography of Africa was established by two-way analysis of variance using pretest scores for each of the Map of Africa Learning Module (MALM) subtests. As indicated in Table IX, the F ratio for sex-related differences on the Geographic Verbal Recognition (GVR) pretest was 2.78; for cognitive style, 0.81, and for interaction between sex and cognitive style, 2.04. The critical value for statistical significance at the 0.05 level of confidence with 1 and 154 degrees of freedom is 3.91. Therefore, there was no significant difference in mean GVR pretest score between male and female students, or between field dependent and field independent students; nor was there any statistically significant interaction between sex and cognitive style for the GVR pretest. Initially, therefore, subjects possessed to an approximately equal degree, knowledge of the political geography of Africa. As an additional control however, GVR pretest score was retained as a covariate in testing the hypotheses of Study A.

Table X provides F test results for the Visual Map Recognition (VMR) pretest. As indicated, there was no significant difference in mean Visual Map Recognition (VMR) pretest score between male and female subjects, or between field dependent and field independent subjects.

TABLE IX

F TEST RESULTS FOR GEOGRAPHIC VERBAL RECOGNITION PRETEST SCORES

Source	SS	df	MS	F Ratio*
Sex	2120	1	2120	2.78
Cognitive Style	623	1	623	0.81
Sex*Cognitive Style	1554	1	1554	2.04
Error	117268	154	761	
Corrected Total	121566	157		

*p < .05 for F = 3.91 with df 1 and 154

TABLE X

F TEST RESULTS FOR VISUAL MAP RECOGNITION
PRETEST SCORES

Source	SS	df	MS	F Ratio*
Sex	231.14	1	231.14	3.41
Cognitive Style	5.53	1	5.53	0.08
Sex*Cognitive Style	0.02	1	0.02	0.01
Error	10442.49	154	67.81	
Corrected Total	10679.19	157		

*$p < 0.05$ for $F = 3.91$ with df 1 and 154

Results were similar, therefore, to the results of the group equivalence test for the GVR pretest. Prior to treatment, sex and cognitive style groups did not differ significantly in map recognition ability as measured by the VMR pretest, nor was interaction between sex and cognitive style significant. As with GVR pretest score, however, VMR pretest score was retained in the posttest analysis as control for residual between group differences in academic ability, test taking sophistication and geographical knowledge.

Testing the Hypotheses of Study B

Two of the 160 subjects originally participating in Study A were lost to experimental mortality, leaving a total of 158 students for the analysis. Seventy-eight of the remaining Ss were male and seventy-eight were female. Distribution of raw scores on the GVR and VMR posttests were within the limits of the normality for both field dependent and field independent subjects (Appendix I). All null hypotheses for Study B were tested at the 0.05 level of confidence.

Hypothesis 1

For the subjects of Study B, there will be no significant difference in mean GVR posttest score between male and female subjects.

Table XI indicates an F ratio of 0.47 for sex differences in mean GVR posttest score. Rejection of the null hypothesis at the 0.05 level of confidence with 1 and 153 degrees of freedom would require an F ratio of 3.91. Therefore, the null hypothesis was accepted. Male and female students were not significantly different with respect to Geographic Verbal Recognition ability as measured by the GVR posttest.

TABLE XI

F TEST RESULTS FOR GEOGRAPHIC VERBAL RECOGNITION POSTTEST SCORES

Source	SS	df	MS	F Ratio
Pretest[(1)]	797	1	797	2.32
Sex	161	1	161	0.47
Cognitive Style	6190	1	6190	18.08**
Sex*Cognitive Style	40	1	40	0.11
Error	52372	153	342	
Corrected Total	59562	157		

**p < 0.0001

[(1)]Covariate: GVR pretest score

Hypothesis 2

For the subjects of Study B, there will be no significant difference in mean GVR posttest score between field dependent and field independent subjects.

Table XI indicated an F ratio of 18.08 for cognitive style group differences in mean score on the Geographic Verbal Recognition posttest. An F ratio of 3.91 would be sufficient for rejection of the null hypothesis at the 0.05 level of confidence with 1 and 153 degrees of freedom. Therefore the null hypothesis was rejected. There was a significant difference in GVR posttest score between FD and FI subjects. Table XII gives adjusted GVR posttest means for cognitive style groups. As indicated, the mean adjusted GVR posstest score of field independent subjects was significantly higher than that of field dependent subjects.

Hypothesis 3

For the subjects of Study B, there will be no significant interaction in adjusted mean GVR subtest score between cognitive style and sex.

Table XI indicates an F ratio of 0.11 for the interaction between sex and cognitive style. Rejection of the null hypothesis with 1 and 153 degrees of freedom requires an F ratio of 3.91. Therefore, the null hypothesis was accepted. The Geographic Verbal Recognition Test scores of undergraduate geography students were not significantly influenced by the interaction of sex and FDI cognitive style.

Hypothesis 4

For the subjects of Study B, there will be no significant difference in adjusted mean VMR posttest score between male and female subjects.

TABLE XII

FDI COGNITIVE STYLE GROUP MEANS
FOR THE GEOGRAPHIC VERBAL
RECOGNITION TEST

Group	N	Unadjusted GVR Mean Score	Adjusted GVR Mean Score
Field Dependent	79	42.91	43.15
Field Independent	79	55.56	55.51

As indicated in Table XIII, the F ratio for sex differences on the VMR posttest was 0.86. Rejection of the null hypothesis at the 0.05 level of confidence with 1 and 153 degrees of freedom requires an F ratio of 3.91. The null hypothesis was therefore accepted. Subject's sex did not significantly influence achievement on the VMR posttest.

TABLE XIII

F TEST RESULTS FOR VISUAL MAP RECOGNITION
POSTTEST SCORES

Source	SS	df	MS	F Ratio
Pretest[(1)]	10130	1	10130	29.08
Sex	300	1	300	0.86
FDI Cognitive Style	5697	1	5697	16.35***
Sex*Cognitive Style	323	1	323	0.93
Error	53292	153	53292	
Corrected Total	69744	157	69744	

***p < 0.0001

[(1)]Covariate: VMR pretest score.

Hypothesis 5

For the subjects of Study B, there will be no significant difference in mean adjusted VMR posttest score between field dependent and field independent subjects.

As indicated in Table XIII, the F ratio for cognitive style group differences on the VMR posttest was 16.35. Rejection of the null hypothesis at the 0.05 level of confidence with 1 and 153 degrees of freedom requires an F ratio of 3.91. Therefore the null hypothesis was rejected. There was a significant difference in VMR posttest score between FD and FI subjects. As indicated in Table XIV giving adjusted VMR posttest means, scores made by subjects exhibiting a field independent cognitive style were significantly higher than VMR posttest scores of subjects exhibiting a field dependent cognitive style.

TABLE XIV

FDI COGNITIVE STYLE GROUP MEANS
FOR VISUAL MAP RECOGNITION
TEST SCORES

Group	N	Unadjusted VMR Mean Score	Adjusted VMR Mean Score(1)
Field Dependent	79	30.49	30.88
Field Independent	79	43.06	42.65

(1)VMR posttest score adjusted by VMR pretest scores

Hypothesis 6

For the subjects of Study B, there will be no significant interaction between sex and cognitive style with regard to mean VMR posttest score.

As indicated in Table XIII, the F ratio for the interaction between sex and cognitive style was 0.93. Rejection of the null hypothesis at the 0.05 level of confidence with 1 and 153 degrees of freedom requires an F ratio of 3.91. The null hypothesis was therefore accepted. Visual Map test scores of undergraduate geography students were not significantly influenced by the interaction of sex and FDI cognitive style.

Hypothesis 7

For the subjects of Study B, there will be no significant difference in mean HFT score between subjects who score above the median on the GVR posttest and subjects who score below the median on the GVR posttest.

As indicated in Table XV, the F ratio for mean HFT score differences between GVR ability groups was 6.86. Rejection of the null hypothesis at the 0.05 level of confidence with 1 and 153 degrees of freedom requires an F ratio of 3.91. Therefore, the null hypothesis was rejected. There was a significant difference in mean HFT score between high and low GVR ability subjects. As indicated in Table XVI giving adjusted HFT means, subjects who scored above the median on the Geographic Verbal Recognitive posttest achieved significantly higher HFT scores than did subjects scoring below the median.

TABLE XV

F TEST RESULTS FOR GVR AND VMR ABILITY GROUPS
FOR HIDDEN FIGURES TEST SCORES

Source	SS	df	MS	F Ratio
Sex	1455.1	1	1455	5.37*
GVR Ability Groups	1885.2	1	1858	6.86**
VMR Ability Groups	3117.2	1	3117	11.51***
Sex*GVR Ability	295.15	1	296	1.09
Sex*VMR Ability	1.3019	1	1.3019	0.004
GVR*Ability*VMR Ability	9.3606	1	9.3606	0.034
Error	40902	151	271	
Corrected Total	47639	157		

*p< 0.05

**p < 0.01

***p < 0.001

TABLE XVI

SUMMARY OF MEANS AND VARIANCES FOR STUDY B

Subjects	HFT	GVR Pretest	GVR Posttest	VMR Pretest	VMR Posttest	Statistic
All (N = 158)	31.86	26.92	49.12	9.58	36.66	Mean
	17.37	27.75	19.60	8.24	21.05	Variance
Field Dependent (N = 79)	17.82	24.75	42.65	9.35	30.47	Mean
	6.73	12.85	17.25	8.46	18.16	Variance
Field Independent (N = 79)	46.08	29.12	55.67	9.82	42.92	Mean
	12.57	37.18	19.74	8.04	22.01	Variance
Male (N = 79)	34.98	30.58	48.62	10.77	36.57	Mean
	19.07	37.39	19.36	9.48	20.80	Variance
Female (N = 79)	28.86	23.41	49.60	8.44	36.74	Mean
	15.08	12.22	19.33	6.69	21.42	Variance

Hypothesis 8

For the subjects of Study B, there will be no significant difference in mean HFT score between subjects who score above the median on the VMR posttest and subjects who score below the median on the VMR posttest.

As indicated in Table XV, the F ratio for the VMR ability groups comparison on HFT scores was 11.51. Rejection of the null hypothesis at the 0.05 level of significance with 1 and 153 degrees of freedom requires an F ratio of 3.91. The null hypothesis was therefore rejected. There was a significant difference in mean HFT score between high and low VMR ability groups. Table XVI gives adjusted HFT means for VMR ability groups. As indicated, subjects scoring above the median on the VMR posttest showed a tendency to achieve significantly higher HFT scores compared to subjects scoring below the median.

Hypothesis 9

For the subjects of Study B, there will be no significant interaction in adjusted mean HFT score between GVR ability and VMR ability.

The F ratio for the interaction between Geographic Verbal, and Visual Map recognition ability was 0.034 (Table XV). Rejection of the hypothesis at the 0.05 level of confidence with 1 and 151 degrees of freedom requires an F ratio of 3.91. The null hypothesis for interaction was accepted. There was no significant degree of interaction between Geographic Verbal Recognition ability and Visual Map Recognition ability in terms of mean Hidden Figures Test score.

A graphic illustration of the above interaction is shown in

Figure 11. Consistently, subjects who scored above the median on either the GVR or VMR posttest achieved higher HFT scores than did subjects who scored below the median on these tests.

Summary of Study B

The purpose of Study B was to determine whether students of college age who exhibit a field dependent cognitive style on an embedded figures test differ significantly from field independent subjects in ability to learn geographical information presented in cartographic form. An attempt was also made to determine whether the format of a test of geographic learning (verbal, multiple-choice format vs. visual, map recognition format) interacts significantly with FDI cognitive style thereby influencing achievement on the criterion test.

As indicated in Table XVI showing a summary of the means and variances for Study B, FD students of college age consistently achieved significantly <u>higher</u> posttest scores on geographic tests containing cartographic information than did field dependent students. Conversely, college students who exhibited a field <u>dependent</u> cognitive style consistently achieved significantly <u>lower</u> test scores than did field independent students whether the geographic criterion test was verbal or visual in format.

Additional Considerations

The following points, though not formally included in the statistical analysis or hypotheses of Study A or Study B may be of interest to the reader. In an effort to determine the relationship between overall academic ability and FDI cognitive style, American College Test (ACT) scores were obtained from the Office of the Registrar at Oklahoma State

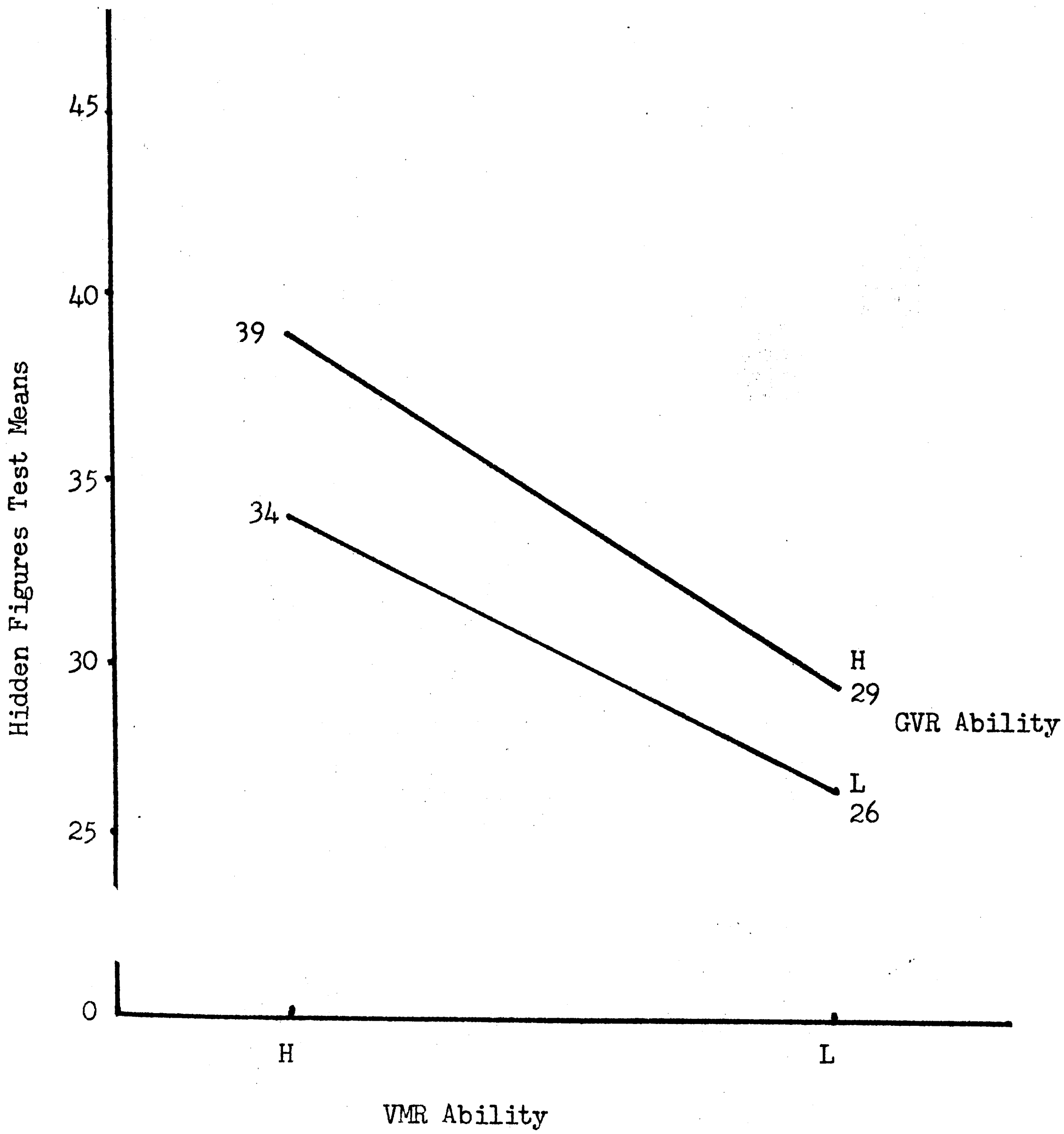

Figure II. Illustration of Interaction of GVR and VMR Ability Levels for Hidden Figures Test Means.

University for 56 of the 75 subjects employed in Study A.[2]

Analysis of these scores revealed the following: (1) for the subjects of Study A, there was no significant difference in composite ACT score between FD subjects enrolled in Section one and FD subjects enrolled in Section two of Geography 1113 (20.6 vs. 20.2); (2) similarly, there was no significant difference in composite ACT score between FI students enrolled in lecture section one and FI students enrolled in lecture section two (22.5 vs. 22.0) of Geography 1113. Therefore, differences in overall academic ability were not responsible for the significant interaction found between lecture method and cognitive style for Regional Concept Test scores.[3]

For the subjects in Study A, careful records were kept of scores received on tests given in the Geography 1113 lecture sections. A similar procedure was followed for the subjects employed in Study B,

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[2]Test scores were available only for students originally enrolling in college at Oklahoma State University. No ACT scores were available for transfer students, amounting to approximately one-third of the population of the study. Because of this fact, and the low correlation observed between ACT scores and HFT scores, ACT scores were not included in the design of Study B.

[3]ANOVA for the partial sample of 56 Ss, using composite ACT/pretest scores jointly to control for initial differences in academic ability and intelligence between FD and FI Ss, produced no change in previous findings; i.e., there was still no significant difference in mean RCT score between male and female, or FD and FI Ss, and no significant difference between the effects of the inductive vs. deductive lecture for heterogeneously grouped Ss. However, as before, the interaction between cognitive style and lecture method <u>was</u> significant ($p < .01$, $F = 9.38$, $df = 1/48$). Adjusted for ACT differences, the difference in mean RCT scores of FD Ss exposed to the deductive lecture showed a slight increase over the mean RCT scores of FD Ss exposed to the inductive lecture method when unadjusted for ACT score differences.

except that laboratory averages and final course letter grades were also recorded.[4] This information was gathered in an attempt to determine whether differences in FDI cognitive style are related to scores received on typical teacher-made tests generally used as the criterion for determining "success" in an introductory college level human geography course. Analysis of the data produced the following results.

1. For the subjects of both sexes in Study A there was no significant difference in average lecture test score (73.19 percent vs. 73.39 percent) between FD and FI subjects. Identical results were found for the subjects of Study B (i.e., there was no significant difference in average lecture test scores between field dependent and field independent students of either sex).

2. No significant difference was detected in laboratory average between FD and FI subjects taken as a group.

3. When the laboratory average of each sex was analyzed separately it was found there was a significant difference ($F = 4.13$ with df 1 and 78, $p < 0.05$) between female FD and female FI subjects. FDI cognitive style, therefore, did seem to influence achievement involving practical applications of geographic knowledge.

For the subjects of Study B, several organismic variables were collected in addition to those previously discussed. Information relating to subjects' age, academic major, and previous study of geography was obtained by questionnaire at the start of the semester. Analysis

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[4]The laboratory average consisted of scores achieved on teacher-made tests given in the "lab-discussion" sections of Geography 1113, plus scores achieved on lab assignments. Much of this material strongly emphasized practical application of the geographic concepts and information provided in Geography 1113 lectures.

of these data revealed *no* significant difference in any dependent variable used to measure achievement in geography between: (1) younger students [<19] and older students [19 and over]; (2) there was *no* significant difference in achievement on any geography test between students who had previously studied geography and those who reported no previous work in geography; (3) there *was* a significant difference in mean GVR and VMR posttest scores between students majoring in different academic areas. Post-hoc analysis revealed that students enrolled in the College of Education achieved significantly lower Geographic Verbal and Visual Map Recognition posttest scores than did students majoring in Business, Arts and Sciences, or Engineering. Students majoring in Education also achieved significantly lower scores on the HFT compared to students majoring in other academic areas. The great majority of the education students were relatively young, freshmen, and female, and were majoring in elementary education. These students, as a group, seem to experience difficulty assimilating geographic subject matter when geographic instruction emphasizes spatial thinking.

Analysis of variance was also used to test for significant differences in "gain scores" between FD and FI subjects in Study A and Study B. Gain score was calculated by subtracting pretest score from posttest score. There was no significant difference in RCT gain score between field dependent and field independent subjects in Study A. Analysis of variance for Study B cognitive style groups revealed a statistically significant difference ($F = 5.05$, with df 1 and 79, $p < 0.02$) in Geographic Verbal Recognition Test gain score between FD and FI Ss. Similarly, for the Visual Map Recognition test, a statistically significant difference in gain score was found between field dependent and field independent subjects (F = 11.79 with df 1 and 79, $p < 0.001$). In each case, the gain in geographic knowledge of the field dependent subjects was significantly less than that of the field independent subjects.

CHAPTER V

SUMMARY AND CONCLUSION

The Problem and Purpose of the Investigation

There have been repeated attempts by researchers in the field of educational psychology to discover the unique attributes of cognitive style and its relationship to the performance of learners. Interaction among instructional tasks, strategies, and learner characteristics appears to be significant in the determination of instructional effectiveness and studies of such interactions have become a major focus of educational research in recent years.

FDI cognitive style is a psychological characteristic known to be related to a number of significant differences in individual preferences and abilities. For example, persons of high spatial ability (field independent cognitive style) have been shown to favor an analytic as opposed to a global format in problem solving (Witkin, et al., 1962). Field independent individuals seem to prefer technical and practical fields of study and employment (Smith, 1964). In the classroom, Werdelin (1961) has established the importance of spatial perception ability for geometric problem solving. Smith (1964, p. 298-299) has gathered evidence that spatial and verbal ability are inversely correlated, bipolar intellectual characteristics. Far from being unimportant educationally, "spatial ability is necessary for the successful study of most practical and technical subjects and the more advanced study of mathematics, physics, and engineering. High spatial ability is essential in most scientific and technological occupations" (Smith, 1964, p. 299).

In relation to the field of geography, therefore, it would seem reasonable to ask whether FDI cognitive style has any significant impact on learning, since, by definition, geography is the science of spatial organization and relies heavily on graphic and cartographic devices containing embedded figures for purposes of illustration, analysis, and synthesis (Abler, Adams, and Gould, 1971). The question asked in the present study, therefore, was whether FDI cognitive style significantly influences learning of geographical concepts and information. A second question, hinging on the answer to the first, was whether the traditional lecture method of geographic instruction could be more closely adapted to the needs of students with differing cognitive styles so as to enhance learning of geographic material. Relatively little research involving psychological constructs relating to individual differences among learners appears to have been undertaken by geographers utilizing geographical instructional materials. Investigation of relationships between learner characteristics, instructional strategies, and the nature of geographic learning has for the most part been neglected at the college level.

The objective of this study, then, was to fill, in partial, the research void mentioned above by examination of the differential effectiveness of field dependent vs. field independent cognitive style in relation to learning of certain geographical concepts and information. In addition, a supporting objective of the study was to examine the differential effectiveness of two methods of organizing a geographical lecture, and to attempt to determine whether the format employed in tests of geographical knowledge interacts significantly with FDI cognitive style.

✓ The purpose of this chapter is to summarize and discuss the results of the study, draw conclusions based on the findings, discuss implications, and make recommendations regarding educational practice and the need for additional study of cognitive style in relation to geographic learning.

Summary of Research Procedures

In the present investigation, two similar but separate and independent studies were conducted: Study A and Study B. Study A was employed as a "pilot study" to familiarize the researcher with psychometric research procedures and test instruments. Study B, considered the "principal study," was similar to Study A in use of FDI cognitive style as the major organismic variable, but otherwise differed in research design and purpose.

The <u>Hidden Figures Test</u> (HFT) was employed in both Study A and Study B as an organismic variable to identify the FDI cognitive style of subjects. The HFT was administered near the beginning of the academic semester following instructions printed on the test. A median split of HFT scores was used to identify FDI cognitive style groups. Analysis of variance was then employed to ascertain that the groups of field dependent and field independent students so identified were significantly different in mean HFT score ($F = 318$, $p < 0.0001$) and thus, presumably, in cognitive style.

In Study A, an experiment was conducted to examine the differential effectiveness of two diverse instructional strategies in facilitating development of knowledge relating to the regional concept. Explanation of the regional concept was selected as instructional material for use in the pilot study experiment because the researcher felt this concept to be representative of ones that constitute the fundamental viewpoint of the geographer. In addition, knowledge of the regional concept is basic to understanding of many, if not most, geographical relationships and areal patterns.

The two instructional strategies selected were deductively vs. inductively organized lecture. Psychological theory has previously suggested the possibility of correspondence between use of deductive logic and field dependence and use of inductive logic with field independence. Two illustrated lectures involving explanation of the concept of the geographic region were presented. In one lecture section an inductively organized lecture proceeding from specific instance to generalization was prepared and delivered by the researcher. In the second lecture section of approximately equal size, age, and sex composition, a lecture using identical illustrative materials and information, but employing a deductive logical organization proceeding from generalization to specific instance was prepared and delivered. Prior to each lecture, a pretest was given to determine the comparability of field independent and field dependent students with regard to knowledge of the regional concept. The pretest score was subsequently employed as a covariate in the statistical analysis as a control for individual and group differences in prior knowledge of the regional concept. Immediately following each lecture a posttest was given to measure learning achievement.

Unlike Study A, no treatment differences were employed in Study B.

Instead, 158 Geography 1113 students were given an investigator designed "Map of Africa Learning Module" consisting of two subtests and an instructional stimulus designed to determine whether achievement on verbal vs. visual geographic criterion tests is related to individual differences in FDI cognitive style.

The learning stimulus employed was a political map of the continent of Africa. Subjects' task was to learn the relative spatial location of 25 of the largest political states of Africa. Subjects were provided with a numbered political base map on which 25 African countries were numbered and an identically numbered list of names corresponding to the map. Instructions were given to write the name of each country on the map in the appropriate location, and to note on a 25 x 25 matrix which countries bordered which other countries.

After fifteen minutes of study, all subjects were given a 12 minute posttest consisting of two subtests: (1) a 25-item multiple-choice test measuring subjects' ability to recognize a verbal description of the relative location of African countries, and (2) a 25-item map test measuring subjects' ability to visually recognize the outline shape of African countries when presented with a large scale map of the country. No reference map was provided for either test.

The principal tool employed in the statistical analysis was multivariate analysis of covariance, using pretest score as a covariate to control for prior knowledge of the regional concept. In Study A, a 2x2x2 factorial design was employed to test six main effects hypotheses and two interaction hypotheses. Duncan's Multiple Range Test was employed in post-hoc analysis to test for significant differences among group means.

In Study B, a 2x2 factorial analysis of covariance design was employed to test the hypotheses for relating to each of the two criterion tests employed. In addition, a 2x2x2 factorial design was employed to test for significant interaction between high and low ability on the verbal vs. the visual criterion tests. HFT score was employed as the dependent variable in this instance.

A split-half technique was used to test the reliability of the criterion test instruments used in both the pilot and principal studies. The criterion tests were found to be statistically reliable instruments, capable of successfully differentiating between high and low ability subjects. Test validity was not projected above the level of content (curricular) validity.

Discussion of the Findings of Study A

Subjects of Study A exhibiting a field independent cognitive style did not score significantly higher on the post Regional Concept Test than did subjects exhibiting a field dependent cognitive style ($p < .05$); therefore null hypothesis 1 of Study A was accepted. However, acceptance of the null hypothesis at the 0.05 level of significance was marginal. The scores of FD and FI Ss were significantly different at the 0.06 level of confidence. This close approach to the level of statistical significance was therefore considered marginal evidence of the possible existence of significant differences between field dependent and field independent subjects in ability to learn geographic knowledge presented via an illustrated lecture. There was no significant difference in Regional Concept posttest score between the lecture section exposed to the deductively organized lecture, and the lecture section exposed to the inductively organized lecture. Therefore, null hypothesis 2 of Study A was accepted.

Although results of the analysis of covariance for post Regional Concept Test scores failed to reveal any significant main effects differences for either cognitive style or method considered separately, the method by cognitive style interaction was significant ($p < 0.05$). Therefore, null hypothesis 3 of Study A was rejected. Subsequent analysis of the method by cognitive style interaction involved mean comparisons between cognitive style levels for each lecture method separately. A Duncan Multiple Range Test for group means revealed that under the inductive lecture method, field dependent subjects scored significantly lower than did field independent subjects; under the deductive lecture method there was no significant difference between the mean posttest scores of field dependent and field independent subjects. This finding suggests that field dependent students of college age are more likely to benefit from lecture type instruction which is deductively organized. This relationship lends support to Grieve and Davis (1971) who found that male field dependent subjects in a ninth grade geography class exhibited a tendency toward higher achievement after being exposed to a teacher-structured learning environment designed to develop knowledge of the geography of Japan by "intensifying and personalizing the concreteness of experience, and the operation of generalizing and abstracting from empirical data" (Grieve and Davis, 1971, pp. 139-140).

This finding may be considered evidence of the need to consider organismic characteristics of the student in assessing the differential effectiveness of instructional strategies. The often contradictory results obtained in studies comparing the differential effectiveness of various instructional strategies (see hypotheses 1 and 2 of Study A for example) can sometimes be explained by the indiscriminant grouping of subjects without due regard for individual differences among learners.

No significant interaction ($p < 0.05$) was found between cognitive style and sex, or between sex and lecture method in Study A. Therefore, hypotheses 4 and 5 were accepted. This would seem to indicate that sex is not an important factor in attempting to account for differences between FD and FI subjects on tests of ability to learn geographic concepts and information when such information is presented in normal classroom lecture format, and the criterion test does not emphasize or involve extensive use of cartographic material.

Discussion of the Findings of Study B

As a group, male subjects in Study B achieved significantly higher HFT scores than did female students ($p < 0.0001$).[1] Therefore, it was expected that male subjects would achieve significantly higher geography test scores than female subjects. Such was not the case. There was no significant difference in mean post Geographic Verbal Recognition posttest or Visual Map Recognition posttest scores between male and female students. Nor was interaction between sex and FDI cognitive style significant. Therefore, null hypotheses 1, 3, 4, and 6 of Study B were not rejected; sex was not a factor influencing performance on the Study B

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[1] The opposite was true of the subjects of Study A; i.e., female Ss achieved significantly higher HFT scores than male Ss ($p < .05$). There was no significant difference in mean HFT score between Ss employed in Study A and Ss employed in Study B, thus indicating the reliability of the Hidden Figures Test as a measure of field dependence-independence cognitive style.

criterion tests. This finding supports Sherman's (1967, p. 298) claim that relationships previously reported between spatial ability and sex "are mediated by sex-typed spatial learning, and would be greatly reduced by controlling for spatial ability, or, as Blade and Watson (1955) prefer to say, achievement in spatial perception." Use of pretest scores as a control apparently achieved the desired result.

However, subjects in Study B who exhibited field independence cognitive style on the Hidden Figures Test achieved significantly higher mean scores on both the post Geographic Verbal Recognition and Visual Map Recognition Tests than did subjects exhibiting field dependent cognitive style on the HFT ($p < 0.01$); therefore null hypotheses 2 and 5 of Study B were rejected. This rejection may be interpreted as evidence that students of college age who exhibit a field independent cognitive style are significantly more able to subsume geographic information presented in cartographic form than are subjects of college age who exhibit a field dependent cognitive style. This conclusion is reinforced by the fact that, while field independent subjects scored higher than field dependent subjects on both of the criterion tests employed in Study B, difference in mean score between the cognitive style groups was greatest on the Visual Map Recognition posttest, where perception and retention in mind of a visual configuration was more vital to task success than on the Geographic Verbal Recognition posttest.

Not surprisingly, subjects in Study B who scored above the median on both the post Geographic Verbal Recognition and Verbal Map Tests were found to exhibit significantly higher Hidden Figures Test scores than subjects who scored below the mean on the Study B criterion tests ($p < 0.01$); therefore null hypotheses 7 and 8 of Stuby B were rejected.

This rejection can be interpreted as evidence that college age students who achieve high scores on tasks requiring cartographic interpretation are more field independent in their cognitive style than similar students who achieve low scores on tasks requiring interpretation of geographic information presented in cartographic form.

No significant interaction between verbal recognition and visual recognition ability in terms of Hidden Figures Test scores was found; therefore null hypothesis 9 of Study B was not rejected. This finding was interpreted as evidence that field dependent students of college age who theoretically should exhibit greater verbal than spatial ability, are not better able than FI students to answer test questions involving interpretation of geographic information when those questions are presented in a verbal (multiple-choice) format as opposed to a visual (map) format. This finding is also supportive of the contention that students of college age who exhibit a field independent cognitive style are better able than FD students at learning geographic information when such information is presented using cartographic devices, no matter whether the criterion test involved verbal or visual description or relative geographic location.

Further Discussion of Results

Results of the statistical analysis for the present study are generally consistent and in agreement with the findings of other studies relating to the topic. Both Solomon (1968) and Feldman (1972), for example, reported finding a substantial correlation between ability to understand map codes and spatial ability. According to Solomon:

> It stands to reason that the ability to represent space and handle spatial relations is closely related to one's ability to manipulate covertly cartographic codes (Solomon, 1972, pp. 408-409).

The present finding of no significant difference between mean scores of field dependent and field independent subjects for the Study A Regional Concept posttest is in agreement with the findings of Taylor (1959, p. 270) with regard to the relationship between spatial ability and attainment in geography as measured by verbal format school geography tests. Taylor reported that attainment on typical grammar school geography tests was more dependent on verbal-educational ability than on spatial ability.

It would appear, therefore, that in a classroom learning environment involving geographic materials, field independence is most beneficial when: (1) the learning task involves study of spatial relations using graphic or cartographic instructional materials, or (2) when the learning task involves practical application of geographic information and concepts as in a geographic laboratory learning situation. When these conditions prevail, individuals low in field independence (i.e., field dependent) may be seriously hampered in their learning efforts. This conclusion is supported by the incidental finding of a significant difference in laboratory test averages between female field dependent and female field independent students in Study B, but no significant difference in lecture test averages between female cognitive style groups in Study A or Study B.

Satterly and Brimer (1971) have pointed out that contrasting FDI cognitive styles are correlated with preference and demonstrated abilities in the latter stages of secondary schooling and higher education. The present study supports this conclusion. Field independent subjects of college age showed a markedly higher level of ability in dealing with cartographic material when contrasted with similar subjects of field dependent cognitive style. The above mentioned authors have pointed out a number of possible consequences for educational guidance and curriculum planning:

> First, it could be argued that knowledge of the preference of the individual learner would ensure that he was not exposed only to the reinforcement of his preferred style but was encouraged to adopt a contrasting set. Secondly, the knowledge of preference might be utilized in fostering its discriminate exercise, by revelation of effective outcome in appropriate curriculum forms but noneffectiveness in others (Satterly and Brimer, 1971, p. 302).

Thus, it could be argued that field dependent students should be informed that their cognitive style does not match the task structure of certain fields of study (including geography to the extent that mapping and knowledge of spatial relationships in map form is emphasized over verbal assimilation of nonspatial information). Alternately, an attempt could be made to match geographic instructional procedures more closely to the needs of field dependent students so that such individuals might have a more equal opportunity to improve their understanding of geographic concepts and their ability to visualize geographic relationships.

Conclusions

Subject to the limitations previously stated, the data and statistical analyses employed in the present study appear to support the following conclusions:

1. Ability of college age students to understand and learn from geographical lectures is significantly affected by interaction between the students' field dependence-field independence cognitive style and

the instructional strategy employed in organizing and sequencing the lecture. Learning of geographical concepts by students who exhibit a field dependent cognitive style is significantly inhibited by exposure to inductively organized lecture material. However, the test performance of field independent students is not adversely affected by exposure to deductively organized lecture material.

2. Considered without the effects of the interaction described above, there is no differential effectiveness of inductively versus deductively organized geographical lecture material, and only marginal evidence ($p < .07$) that individual differences in FDI cognitive style directly affects learning of geographical concepts and information presented by means of an illustrated lecture.

3. Neither sex, or the interaction between sex and cognitive style, significantly affects learning of geographical concepts and information, whether the method of instruction employed involves deductively or inductively organized lecture.

4. Field dependence-independence cognitive style has a significant affect upon performance on geographic tests which involve the ability to recognize the correct relative location of geographic places after having briefly studied their location on a map.

5. Performance on a test involving the ability to recognize the correct relative location of geographic places is not significantly influenced by the use of a visual vs. a verbal format for the criterion test.

Implications

The enclosed educational environment from which the population for this investigation was drawn will not permit the results to be generalized beyond that environment. However, certain implications of the research may be suggested.

1. The findings of Study A imply that deductive organization of geographical lecture material will facilitate learning by students exhibiting a field dependent cognitive style. At the same time, adoption of such an instructional strategy will not significantly hamper learning by students exhibiting a field independent cognitive style.

2. The findings of Study A together with the findings of Study B suggest that field dependence-independence cognitive style is an important variable relative to geographic learning only when the material to be learned is cartographic in nature or contains specific reference to spatial patterns or spatial relationships, and requires the learner to envision relative location or other two-dimensional geographic configurations.

3. The findings of Study B imply that the format of the geographic test employed as a criterion of geographic learning does not interact with field dependence-independence cognitive style to any significant degree. No matter whether the test is verbal (multiple-choice) or visual (map recognition) in nature, subjects exhibiting field independent cognitive style are shown to be superior to subjects exhibiting a field dependent cognitive style when the learning stimulus is based on cartographic imagery.

4. In an overall sense, results of this investigation <u>strongly</u> suggest that consideration of individual differences in spatial perception and visualization ability is important in attempting to understand

the learning problems facing certain students who are attempting to learn geographical concepts and knowledge. Such individuals are more than likely field dependent in cognitive style and would benefit from exposure to a deductively structured, personalized learning environment.

Recommendations - for practice

Previous research has shown that field dependent and field independent students of college age differ significantly in their ability to perceive and retain in mind an impression of the shape or pattern of figure *as an organized whole* (Smith, 1964, pp. 98-99). The present study suggests that field dependence-field independence cognitive style interacts significantly with logical mode of lecture organization and is related to ability to learn geographic information when that information is presented in cartographic form. Therefore, the following recommendations are made in the interest of improving educational practice:

1. Whenever possible, instructional personnel in geography who employ lecture as an instructional tool should make a conscious effort to use deductive logic in organizing their materials, since it appears that subjects exhibiting a field dependent cognitive style have the most learning problems in relation to geography and benefit most from this type of lecture organization.

2. It should never be assumed that all subjects in a geography class have an equal ability to visualize and interpret spatial patterns. As Smith (1964, ppl 116-118) noted relative to instruction in mathematics and geometry, extensive use should be made of visual aids in all geographic instruction. Special effort should also be made to make

graphic and cartographic materials more comprehensible to students exhibiting an FD cognitive style. Whenever possible, for example, *concrete, socially relevant, humanistic* illustrations of geographic concepts should be employed. These efforts will *not* significantly inhibit learning by field independent students, while they have the potential of significantly improving comprehension of geographic materials by field dependent students.

Finally, due to the encouraging nature of results of the present study, it is recommended that a more extensive effort be made to investigate the nature of the relationship between individual differences in cognitive style and geographic learning. More specifically, it is recommended that this study be repeated, with a number of modifications:

A. An attempt should be made to replicate the findings of Study A. Future replications of the investigation might include a more diverse sample of geography courses, use of control groups, and perhaps additional controls for individual differences in prior knowledge and general intelligence.

B. Study A should also be repeated in a variety of academic settings and educational environments so that any significant findings could be generalized to a larger population of college classes.

C. A long term study of the relationship between cognitive style and geographic learning should be undertaken. For example, an entire semester course such as Geography 1113 might be structured deductively and inductively and a variety of test instruments employed to measure relative change in affective, cognitive, and skill areas in relation to cognitive style.

D. Studies should be conducted on populations of college geography students using a variety of geographic instructional materials and teaching strategies to further explore the nature of the interaction between FDI cognitive style and geographic learning. For example, there may exist a significant degree of interaction between instructor personality and FDI cognitive style.

E. The present study suggests the possibility that long term success in the study of geography may require a field independent cognitive style. Therefore, it is recommended that a study be done of the FDI cognitive style of professional geographic educators, and of the relationship between the instructional and research preferences of individual geographers, and the learning achievement of field dependent vs. field independent students at various levels of higher education.

F. The focus of the present study was upon the relationship of FDI cognitive style to learning of information and concepts relating specifically to the spatial tradition of geographic study. It is therefore recommended that studies be undertaken of the relationship of cognitive style to learning of the geographic concepts of other traditions of geographic study such as the earth science, man-environment or regional traditions of geographic study as defined by Pattison (1964).

G. The level of difficulty encountered in the present study with the generation of a criterion test of specifically geographic (i.e., spatial) content suggests the need for development and testing of standardized tests of geographic learning for higher education which incorporate higher cognitive levels and additional domains of behavior. Perhaps therein lies the recommendation for an entire realm of additional studies!

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APPENDIX A

HIDDEN FIGURES TEST

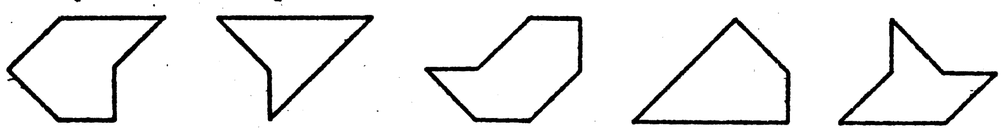
Name: ______________________________

HIDDEN FIGURES TEST — Cf-1

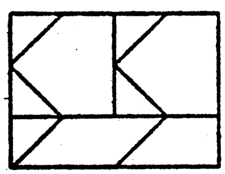
This is a test of your ability to tell which one of five simple figures can be found in a more complex pattern. At the top of each page in this test are five simple figures lettered A, B, C, D, and E. Beneath each row of figures is a page of patterns. Each pattern has a row of letters beneath it. Indicate your answer by putting an X through the letter of the figure which you find in the pattern.

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.

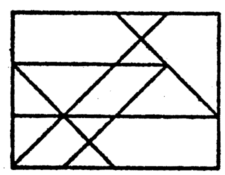
Now try these 2 examples.



A B C D E

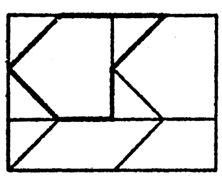
I 

A B C D E

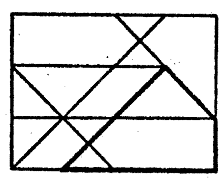
II 

A B C D E

The figures below show how the figures are included in the problems. Figure A is in the first problem and figure D in the second.

I 

X B C D E

II 

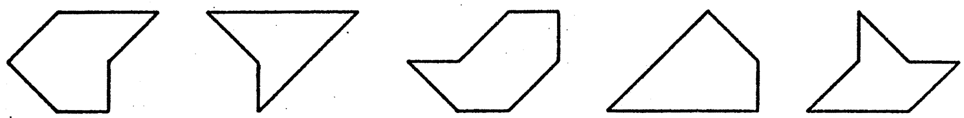
A B C X E

Your score on this test will be the number marked correctly minus a fraction of the number marked incorrectly. Therefore, it will not be to your advantage to guess unless you are able to eliminate one or more of the answer choices as wrong.

You will have 10 minutes for each of the two parts of this test. Each part has 2 pages. When you have finished Part 1, STOP. Please do not go on to Part 2 until you are asked to do so.

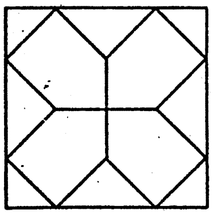
DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

Part 1 (10 minutes)



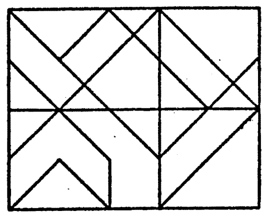
A B C D E

1.



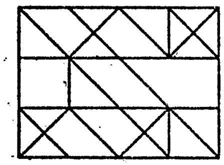
A B C D E

2.



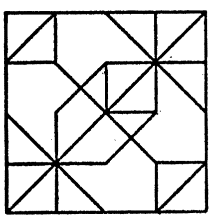
A B C D E

3.



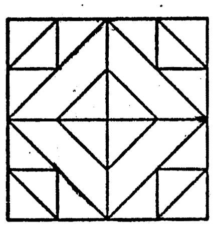
A B C D E

4.



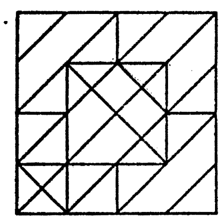
A B C D E

5.



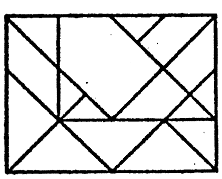
A B C D E

6.



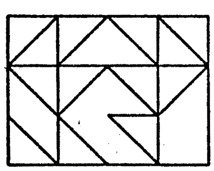
A B C D E

7.



A B C D E

8.



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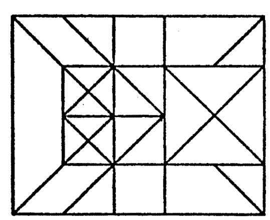

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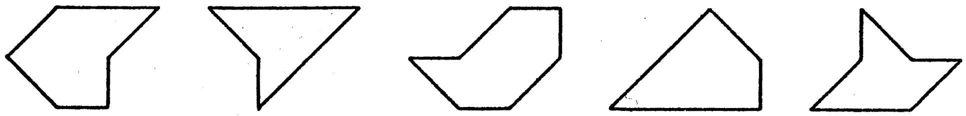

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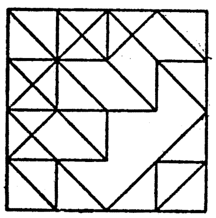
10. 

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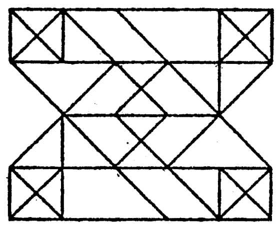
11. 

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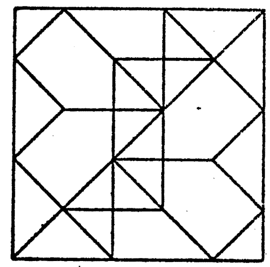
12. 

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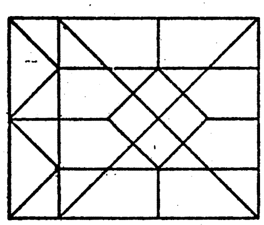
13. 

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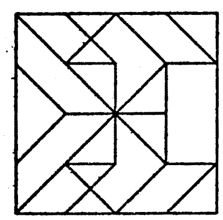
14. 

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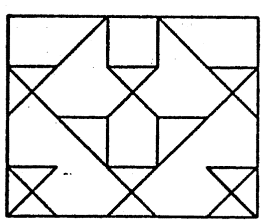
15. 

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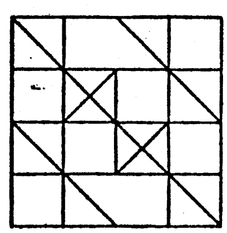
16. 

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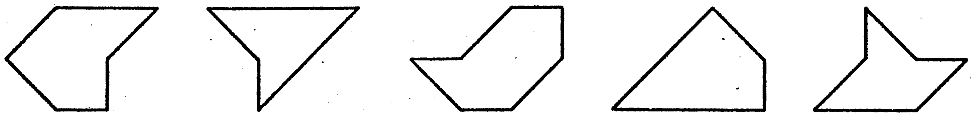

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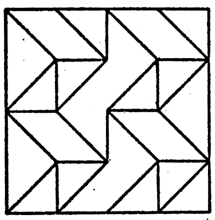

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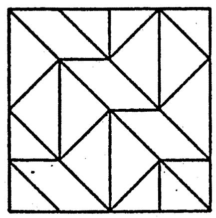

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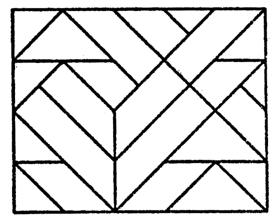

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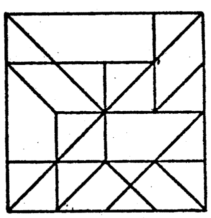

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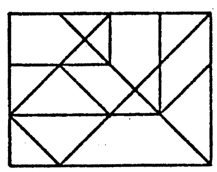

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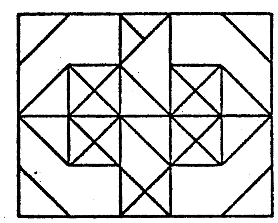

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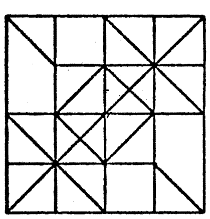

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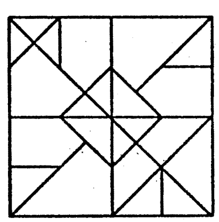

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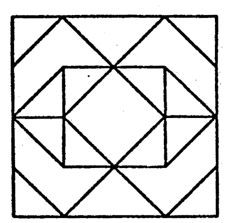

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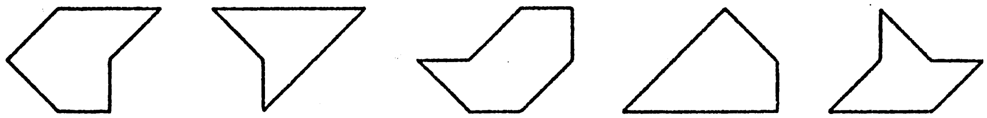

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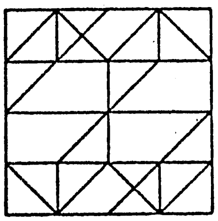
26. 

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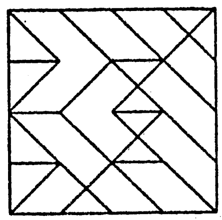
27. 

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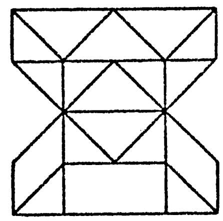
28. 

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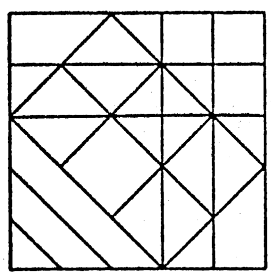
29. 

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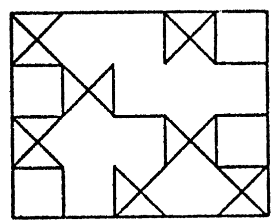
30. 

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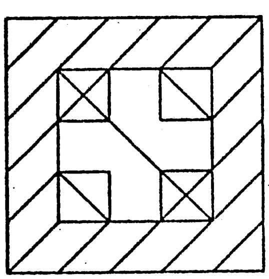
31. 

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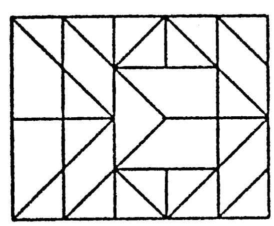
32. 

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DO NOT GO ON TO ANY OTHER TEST UNTIL ASKED TO DO SO.

APPENDIX B

INDUCTIVELY ORGANIZED REGIONAL CONCEPT LECTURE

INDUCTIVELY ORGANIZED REGIONAL CONCEPT LECTURE

With regard to the concept of the geographic region we need to ask ourselves two questions:

1. What _is_ a "geographic region?"

2. What different _kinds_ of regions are there?

Let us begin to examine these questions by pretending we are far above the earth. From such a distance the earth would look much like this globe. Looking at the earth from such a distance, you would immediately realize, if you stop to think about it, that the earth's surface is not homogeneous; i.e., it varies from place to place and from one area to another. For instance, you will notice that certain areas of the earth surface are mostly water covered, while certain other areas are mostly land. I say mostly because there are, of course, islands within the water covered area, and lakes, and rivers in the land areas. So when we identify these regions of the earth we are generalizing in defining them as water covered vs. land areas.

To large areas of the earch surface which are mostly covered with water we have given the term "ocean" or more precisely, "ocean region." Land areas we call "continents," or "continental regions."

Let us continue to pretend we are above the earth, but much closer now. For example, let us examine map 1 showing the distribution of major landform masses of the earth. What are plains, hill lands, plateaus, and mountains? Are not "plains" those areas of the earth surface which are mostly flat land? Are not hill lands and mountains on the other hand, mostly rough lands? Again we have generalized, i.e., we have overlooked the minor areas of flat land amongst the mountains, and small hilly areas on the plains. In so doing we have created physical regions called landform regions. Physical regions then, are those regions of the earth surface which are not man-made. One might think of physical regions of the earth as "natural regions" in that they are basically created through natural processes. Other physical regions of the earth include such phenomena as: a) time zones as illustrated in map 2, b) climatic regions, c) natural vegetation, and d) soil regions.

To continue our analogy, let us assume now that we are flying over the earth surface in a light plane at relatively low altitude. Low enough to observe place to place differences in what man is using the land for. For instance, we might notice, as we fly along, that the type of crops being grown varies from one area to another. We might even get it into our heads that we were going to try to identify which areas of the United States concentrates on wheat growing. The first thing we would have to do, in that case, would be to decide how we are going to measure "wheat growing." We might, for example, decide to collect data on the percentage of crop land in each county in the U.S. and to use that information to construct a choropleth map such as map 3. Upon examining the map, we decide to draw a boundary line around all those counties where more than thirty percent of the crop land is used to grow wheat. What would we have then identified but "wheat regions," or areas of the U.S. where more than thirty percent of the crop land is used to grow wheat.

Map 4 shows the major manufacturing districts of Europe. "District" is another work for region of course. Such regions as these are defined on the basis of concentration of industry. Crop and manufacturing regions are both examples of what are sometimes called "economic regions" because they refer to areas where some type of economic product is produced.

What do both physical and economic regions have in common? Notice that in all cases discussed so far, the criteria upon which the region is defined is the same or "uniform" throughout. For instance an ocean region is uniformly at least more than 99 percent water. Or a mountain region might be uniform in that 75 percent of the land is steeply sloping. The wheat regions we identified are uniform in that all counties within the region have more than 30 percent of their crop land in wheat.

Are all regions uniform regions? Look at map 5. The large circles represent towns and the dots represent the homes of people who attend church in those towns. One could draw a ring around all the area around any given town which would include 90 percent of the homes of people who attend church in that town. Would the number of churchgoers per unit area (per square mile, for instance) be uniform in any region so identified? No, of course not. Therefore this cannot be a uniform region. But notice that this region focuses on a point or "node" - the town. In this sense it is a "nodal region," or one which focuses on a point and all parts of the region are connected to the node. Map 6 displays two other regionalizations of the United States-Federal Reserve "districts" or Sear administrative "divisions." Are these uniform or "nodal" regions? Notice that both focus on certain cities. Therefore, they must be nodal regions.

Map 7 shows yet another possible regionalization of the U.S.-Metropolitan Regions. All the counties in the U.S. were assigned to the closest major wholesaling center. Would this procedure create uniform or nodal regions? Since they focus on wholesaling centers they must be nodal regions.

Map 9 shows a regionalization of the world based on many different phenomena - language, politics, and economic development. Such regions are sometimes called "culture regions" since they are broad areas of similar cultural characteristics. Notice that these major world regions are made up of countries, or political states. Anglo-American, for instance, consists of two countries - the United States and Canada - which have many cultural similarities.

What kind of region is a country? Since it is based on political control of a certain territory, countries are called "political regions." Any territory which is identified on the basis of political control is a political region. The states of the U.S. are political regions, as are the provinces of Canada. All political regions are nodal since they focus on a capital city and are governed from that city.

Getting back to our original question then, can we conclude from these several examples what a region is in general? Notice that all regions are areas of the earth surface of considerable extent. Notice also that all regions are identified on the basis of some common property. It is often said, for instance, that regions are areas of the earth surface which are homogeneous in terms of one or more stated category of phenomena. The regional concept is a tool for helping us to think and to mentally organize the many ways in which places on the earth are similar and different.

APPENDIX C

DEDUCTIVELY ORGANIZED REGIONAL CONCEPT LECTURE

DEDUCTIVELY ORGANIZED REGIONAL CONCEPT LECTURE

Today I would like to talk to you about the concept of the geographic region. A geographic region is an area of the earth surface of considerable size which is homogeneous in terms of one or more stated categories of phenomena. As such, the regional concept is a tool for helping us to think and to mentally organize the many ways in which places on the earth surface are similar and different.

There are several different kinds and categories of regions. One of the most common types of region you might encounter is the uniform physical region. One can see uniform physical regions when looking at the globe. Oceans and continents are uniform physical regions. Both are natural, i.e., they are not man-made; they are "physical" regions. They are uniform in that they are basically the same throughout, i.e., all water or all land, with the exception of islands in the ocean and lakes and rivers on land. We "generalize" or overlook such exceptions when we identify regions.

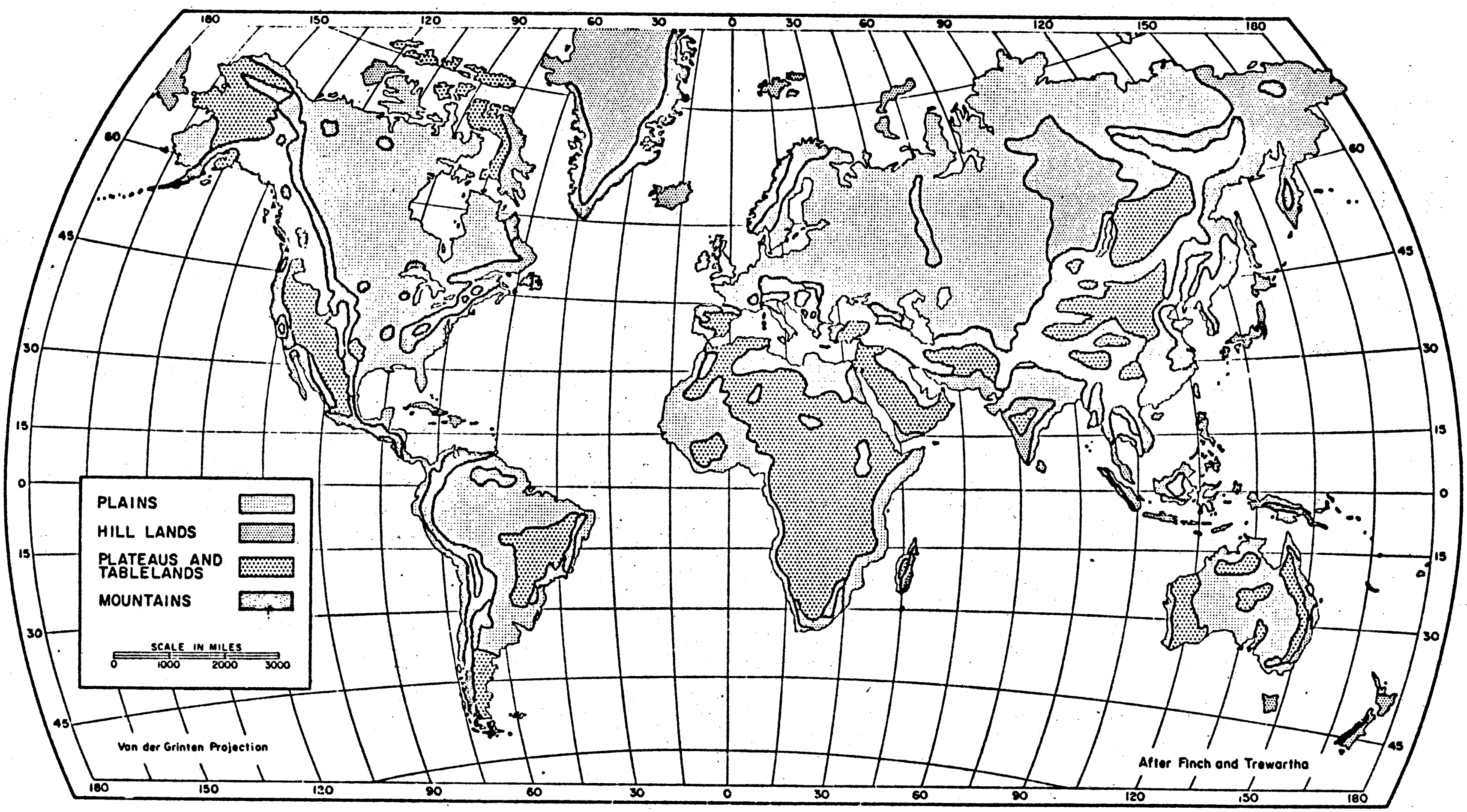
Map 1 shows another category of uniform physical region--the landform region. Mountains, plains, hill lands, and plateaus are landform regions. Such regions are relatively the same throughout in terms of the identifying criteria, i.e., flatness in the case of plains, for example. Other uniform physical regions include climatic regions, vegetation regions, and soil regions. Time zone regions, as shown in map 2 are also uniform physical regions.

In addition to uniform physical regions, there are also uniform economic regions. Economic agricultural crop regions are areas of the earth which produce some crop. Map 3 illustrates how one might identify uniform wheat growing regions of the U.S. First you would need to define how you were going to measure "wheat growing." You might, for instance, choose to measure it in terms of percent of crop land per county devoted to wheat. Then, in order to identify wheat growing regions, you would need to specify the criteria upon which your region was going to be based. You might decide, for example, to draw a border around all areas where more than thirty percent of the crop land is used for raising wheat. You would then have identified areas of the U. S. which are homogeneous in that all counties in those areas devote more than thirty percent of their land to wheat raising and could call these areas "wheat growing regions." Map 4 depicts another type of uniform economic region -- the manufacturing districts of Europe. The areas identified on this map are areas of concentrated industrial production.

Not all regions are uniform regions, however. Map 5 is an example of what are known as "nodal regions." Modal regions consist of a central point of focus for the region, i.e., the "node," and areas or places which are functionally linked or connected to the node. On map 5, notice that the circles represent towns where churches are located, and the lines with dots at the ends represent the homes of churchgoers who attend church in those towns. If you were to draw a ring aroung the area within which 90 percent of the homes of people who go to church in a given town are located you would have identified a nodal "churchmembership region."

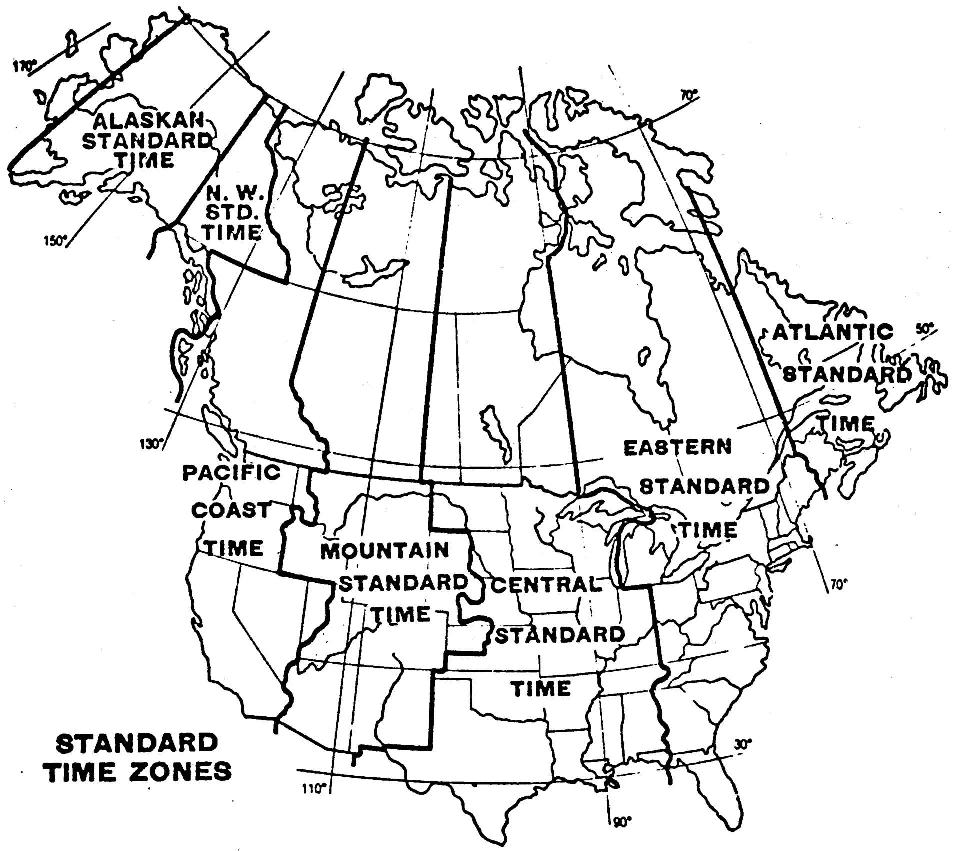
Maps 6 and 7 show three other types of nodal region, i.e., Federal Reserve Districts, Sears Administrative Divisions, and Metropolitan Regions of the U.S. In each of these regions the phenomena which identifies the region is focused upon certain key or nodal cities, and outlying places are connected to the nodal city by transportation and communication links.

Map 8 shows the arrangement of the earth's major world regions. These regions are defined on the basis of many phenomena, i.e., language, political system, economic system, etc., most of which are "cultural" in nature. They are sometimes called culture regions. Notice that they are made up of groups of countries, or, as geographers say, "political states." Countries are political regions and all political regions are nodal regions because they are governed from a certain nodal city called the capital. For example, Anglo-America is made up of the U.S. and Canada which are quite similar in many cultural items. Both Canada and the U.S. are political states with nodes at Washington, D. C., and Ottawa, Ontario, respectively. Other examples of political regions include the states of the U.S. and the provinces of Canada because these governmental subunits also focus on nodal capital cities. Both uniform and nodal geographic regions of many sorts are useful for helping us to organize our thinking about the spatial variation of the earth surface.



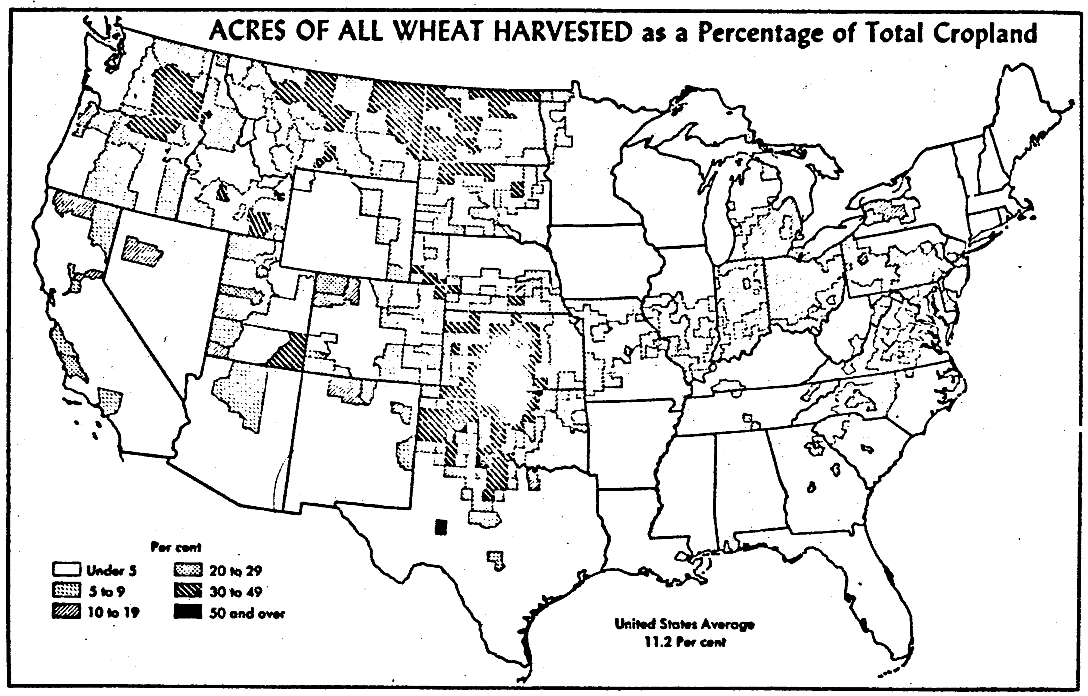
The world distribution of major landform masses.

Illustration employed in the regional- concept lecture.



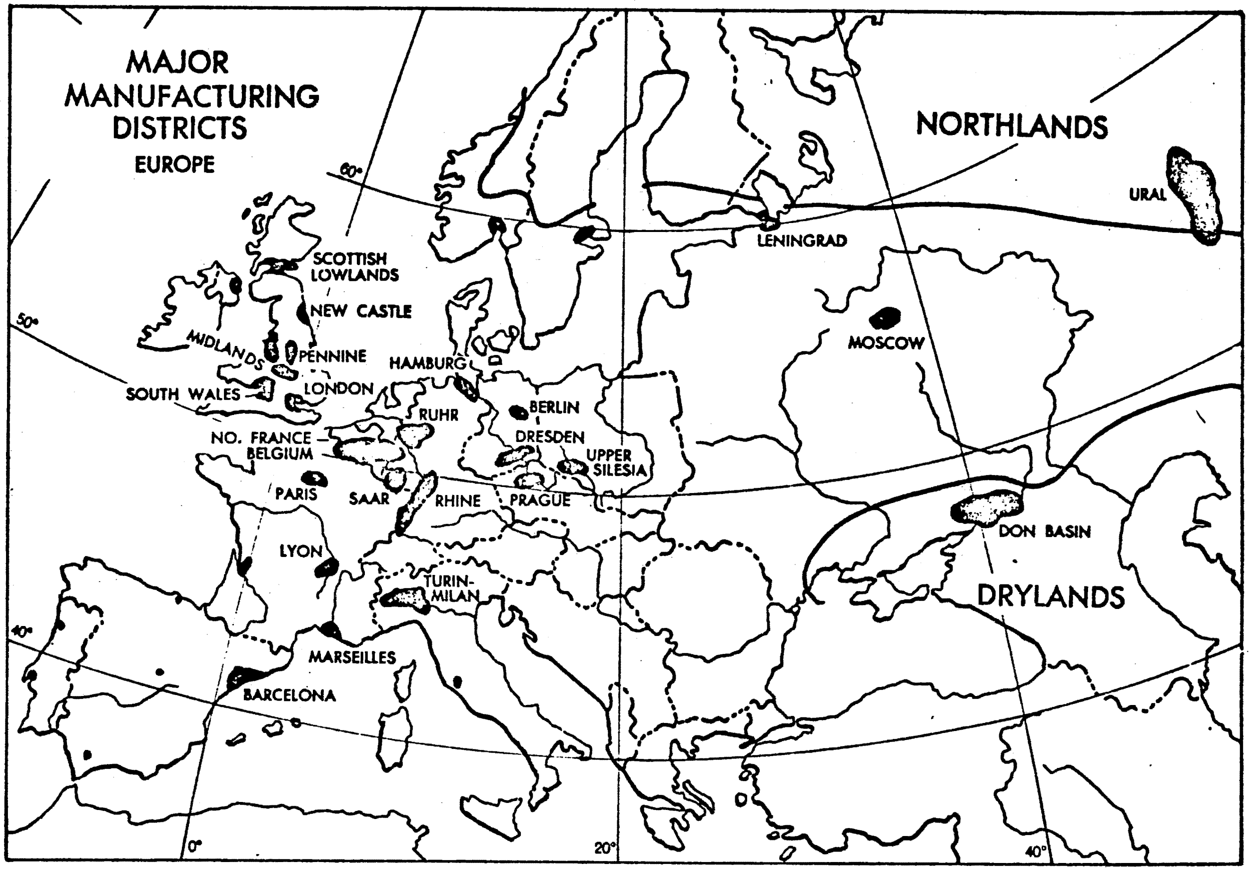
The divergences from meridian lines show up quite clearly here, as do the reasons for many of the divergences. In many areas, state borders are substituted for the meridian; in other places, trading centers. Spokane, Washington draws from northern Idaho, which thus keeps Pacific Coast Time rather than Mountain Time like the rest of Idaho.

Illustration employed in the regional concept lecture.



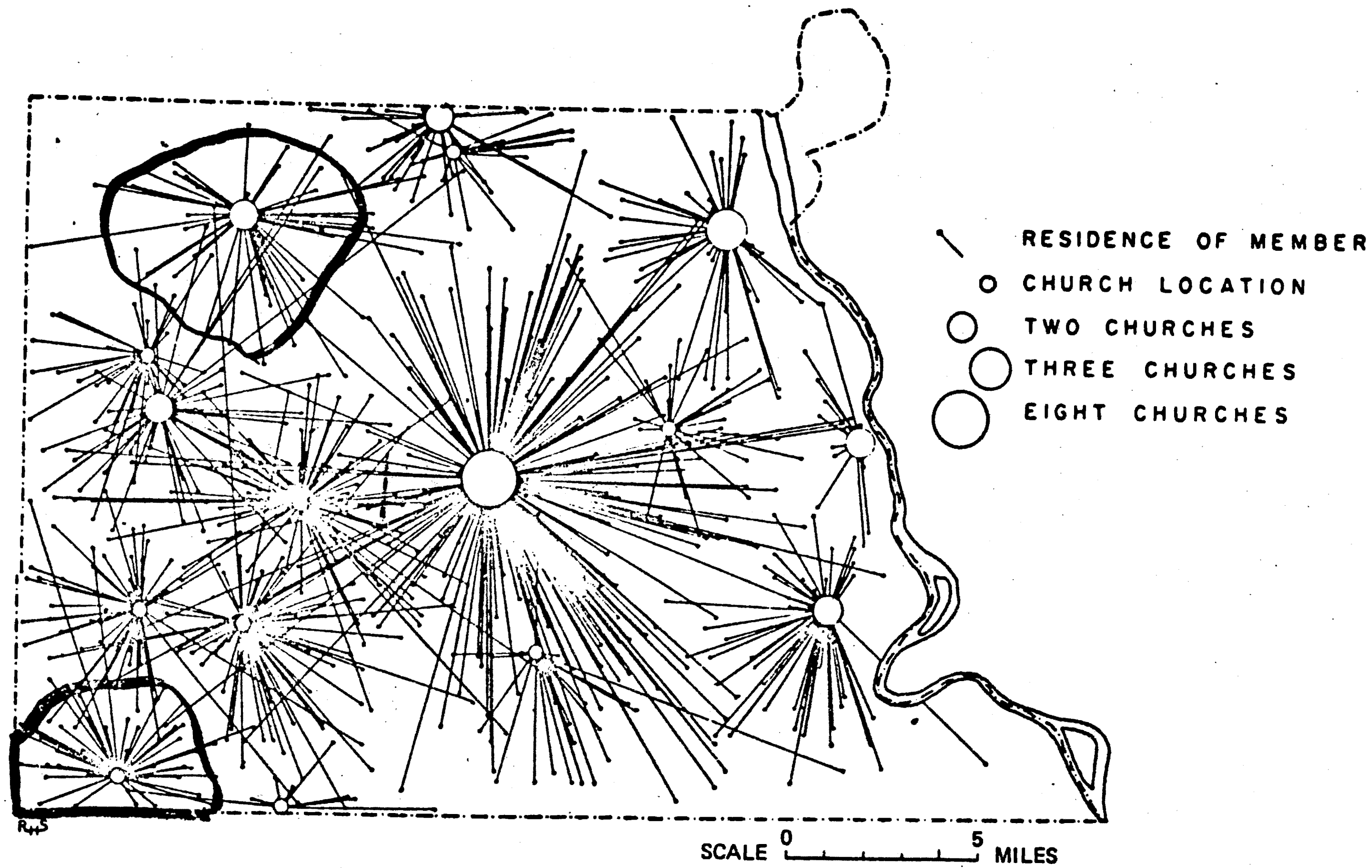
(From U. S. Bureau of the Census.)

Illustration employed in the regional concept lecture.



This map shows only the major manufacturing concentrations of Europe. In addition, there will be many large cities that depend upon this type of economy.

Illustration employed in the regional concept lecture.



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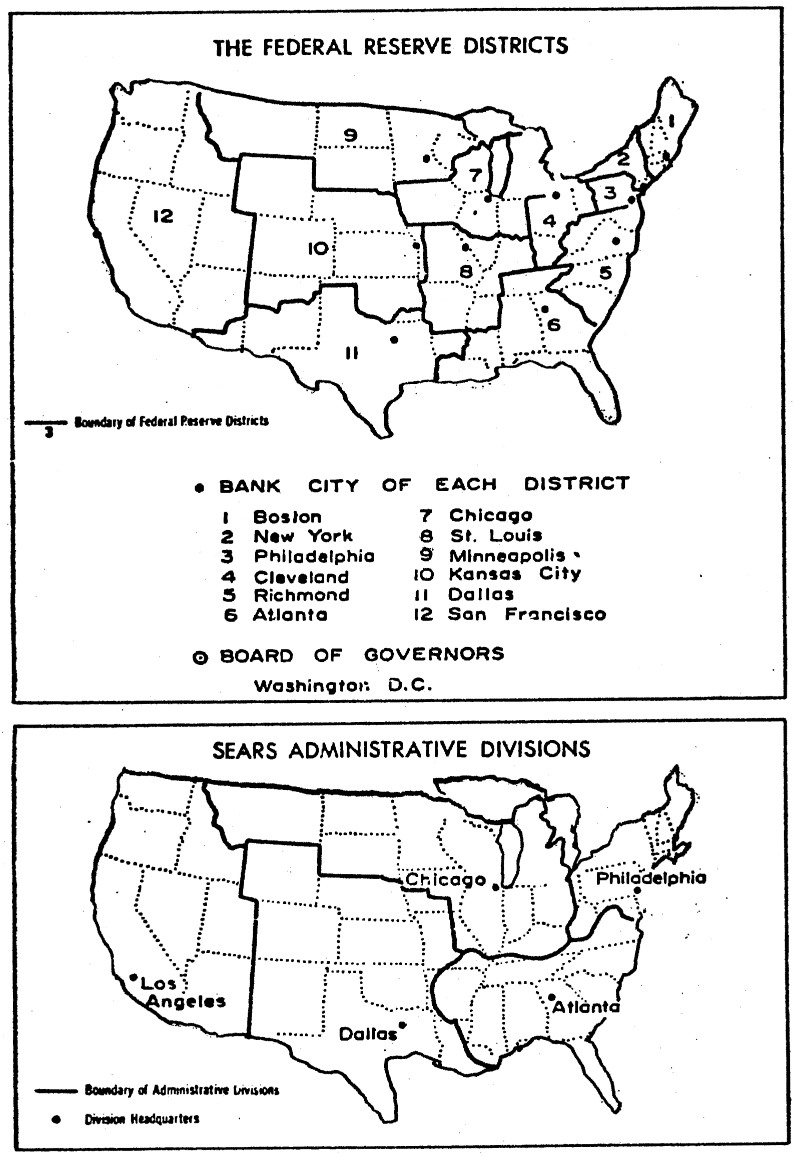
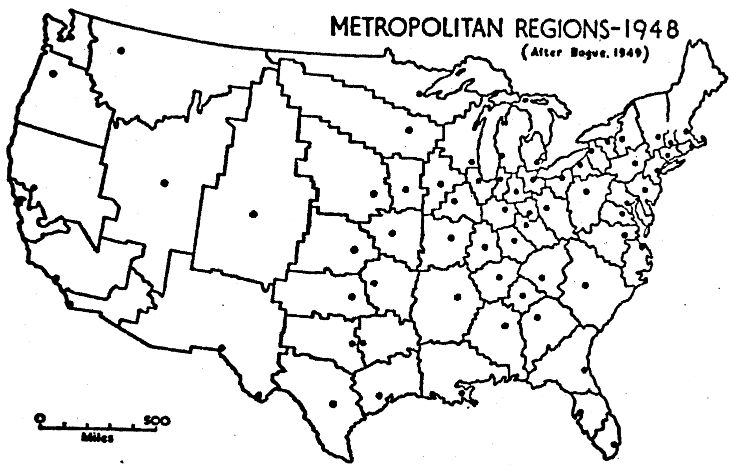


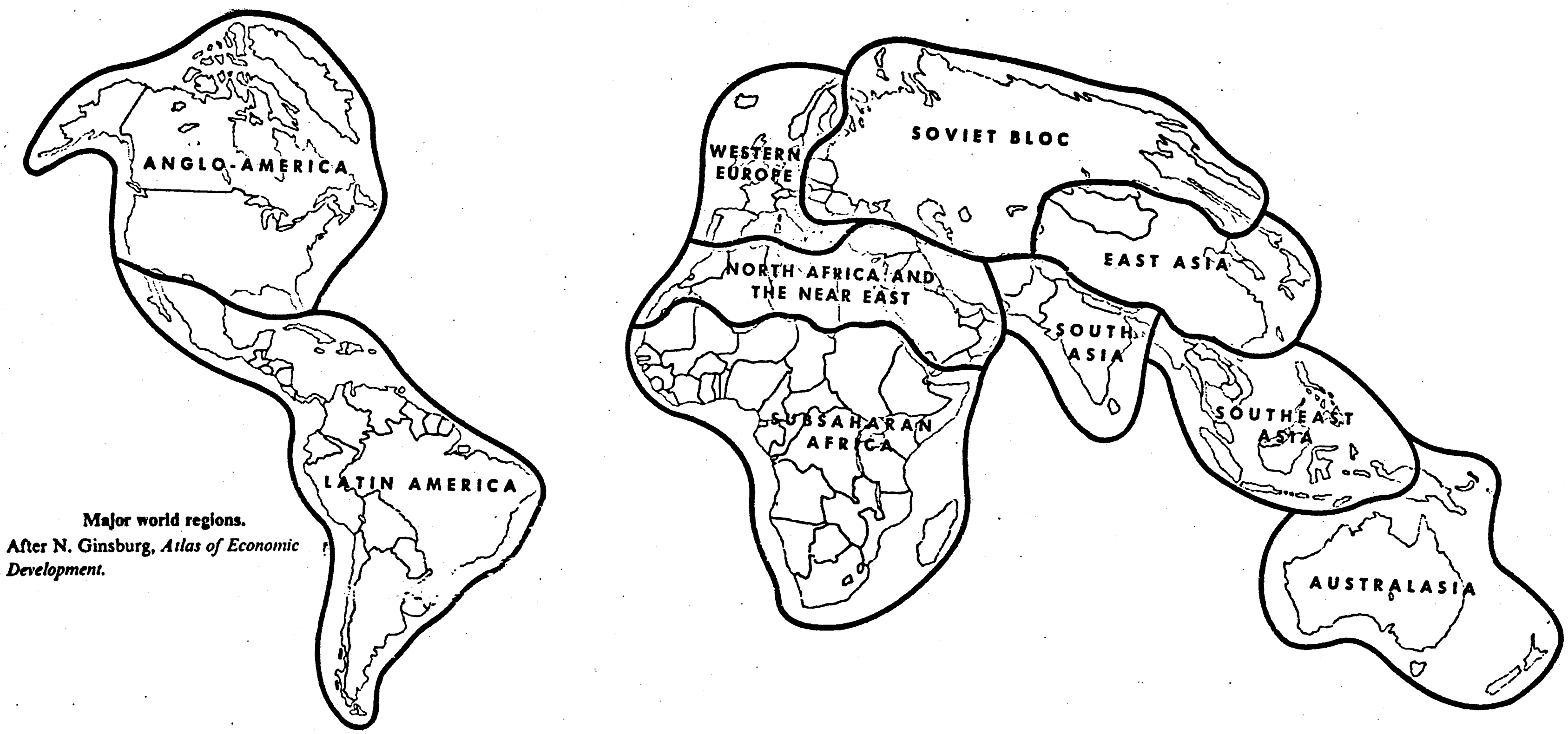
Sample Regionalizations of the United States.

Illustration employed in the regional concept lecture.



Regional structure of the United States. Here, all counties were assigned to the closest major wholesaling center, thus minimizing the distance of the population to such centers. (Reprinted by permission of The Johns Hopkins Press, from Otis Dudley Duncan et al., *Metropolis and Region.)*

Illustration employed in the regional concept lecture.



Major world regions.
After N. Ginsburg, ***Atlas of Economic Development.***

Illustration employed in the regional concept lecture.

APPENDIX D

REGIONAL CONCEPT TEST

REGIONAL CONCEPT TEST

Circle the best answer.

1. If one were to draw a red line around all the territory controlled from Tokyo one would have identified:
   A. the Greater East Asia Co-Prosperity Sphere
   B. the Kanto Plain
   C. the political region called Japan
   D. the node of the operational area of Japan Air Lines

2. The area served by "Air France" airline from Paris constitutes:
   A. a uniform region
   B. a political region
   C. a nodal region
   D. a region of physical and cultural homogeneity

3. The regional concept is most useful in attempting to generalize about:
   A. political matters
   B. economic conditions
   C. social processes
   D. spatial arrangements

4. If one wanted to identify the region of greatest bituminous coal production in the U.S. which of the following should be among your first steps:
   A. Identify the location of coal beds in the U.S.
   B. find out where coal is now being burned
   C. find some statistics on coal production by geographic areas
   D. look at a map of the U.S.

5. The Northeastern U.S. Industrial Core is:
   A. an economic region
   B. a political region
   C. not a region
   D. a physical region

6. Zip code areas of the U.S. are nodal regions. This means that:
   A. they focus on a central point
   B. they are uniform in speed of mail delivery
   C. they are run from a central office
   D. there is no focal point for zip code areas

7. Which of the following could be used to map geographical region?
   A. political organizations of the U.S.
   B. socioeconomic class groups of the population
   C. the U.S. government in Washington, D.C.
   D. the counties of the U.S.

8. Australia is:
   A. an economic region
   B. a political region
   C. a physical region
   D. both B and C

9. When one refers to the "Chicago Area" one is actually talking about:
   A. a uniform region
   B. a vaguely defined nodal region
   C. a physical and political region in northern Illinois
   D. a region of uniform population density

10. In what major world culture region is Oklahoma located?
   A. the U.S.A.
   B. the Great Plains
   C. the South
   D. Anglo-America

11. As a physical region, most of Europe is:
   A. densely populated
   B. heavily industrialized
   C. a peninsula of Eurasia
   D. inhabited by people of the Caucasian race

12. Which of the following regions has the least distinct borders:
   A. Areas of Eastern China with more than 3000 people per square mile
   B. the middle latitudes
   C. the Greenland Ice Cap
   D. the Middle West

13. All regions exhibit:
   A. areal homogeneity
   B. internal variation
   C. distinct borders
   D. a focal point

14. The U.S.S.R. is the largest of which of the following types of region:
   A. physical
   B. population
   C. agricultural
   D. political

15. Which of the following is not a region?
   A. the North Atlantic Treaty Organization
   B. the Common Market
   C. Eastern Europe
   D. New York City

16. Latin America, Sub-Saharan Africa, the Middle East, and South East Asia are all:
    A. political regions
    B. landform regions
    C. major world culture regions
    D. climatic regions

17. Which of the following is the most precisely defined region:
    A. the eastern Mediterranean
    B. the region of Cfa (humid subtropical climate)
    C. Siberia
    D. the developing countries

18. The map accompanying this quiz is:
    A. a world political base map
    B. a physical base map
    C. a map showing the location of countries in relation to population size
    D. a blank map

19. What do the Andes Mountains, the Amazon Basin, the Atlas Mountains, and the African Rift Valley all have in common?
    A. all are in the Western Hemisphere
    B. all are physical regions
    C. all are in the Northern Hemisphere
    D. they have nothing in common

20. The country of Argentina is:
    A. a political region
    B. a physical region
    C. a uniform region
    D. not a region

21. What type regions are indicated by number 1 on the attached map?
    A. Major world region
    B. Physical region
    C. Political region
    D. all of the above

22. What type region is indicated by number "2" on the attached map?
    A. Landform region
    B. Political region
    C. Climatic region
    D. Population region

23. What type of nodal region is indicated by the area labeled number "3" on the map?
    A. uniform North American
    B. nodal physical
    C. uniform nodal economic
    D. none of the above

24. The area indicated by number "4" on the map is:
    A. Major world culture region
    B. uniform political region
    C. uniform physical region
    D. nodal economic region

25. The area indicated by number "5" on the map is drained by the mighty Amazon River. It could be considered a:
    A. nodal physical region
    B. uniform political region
    C. major world culture region
    D. uniform South American region

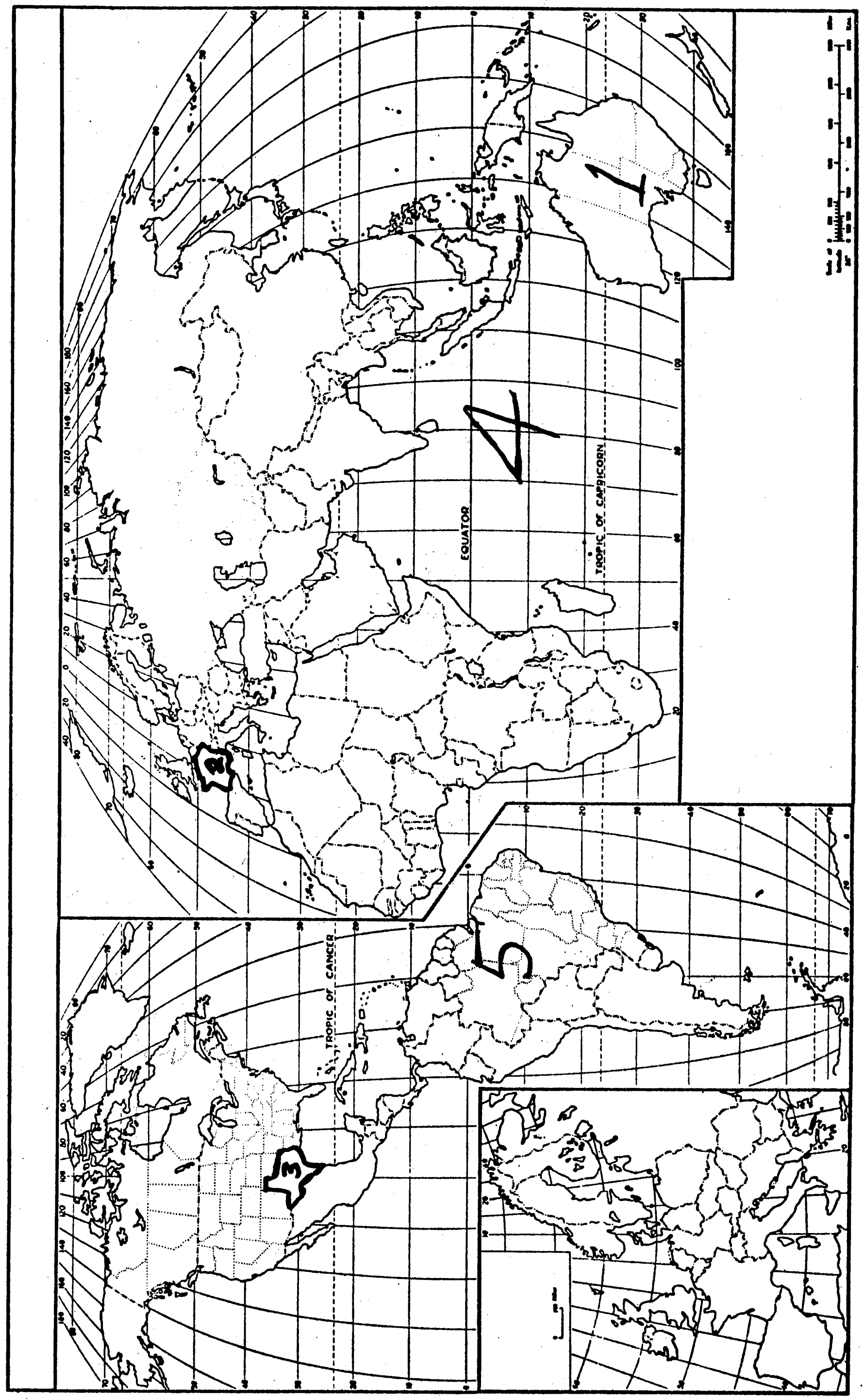
26. A city is:
    A. a uniform urban region
    B. a nodal region
    C. a region with no areal homogeneity
    D. not a region

27. Which of the following is <u>not</u> a region?
    A. Diffusion patterns of country music in the U.S.A.
    B. Provences of France
    C. Labor union districts in New York
    D. Time zones in the U.S.S.R.

28. What type region is Payne County, Oklahoma?
    A. physical region
    B. uniform region
    C. political region
    D. nodal economic region

29. All political regions are:
    A. uniform
    B. nodal
    C. physical
    D. economic

30. Not a geographic region:
    A. the Pacific Ocean
    B. the "Little Dixie" area of Oklahoma
    C. the Oklahoma Panhandle
    D. the atmosphere


EQUATOR
TROPIC OF CAPRICORN
TROPIC OF CANCER
1
2
3
4
5

APPENDIX E

MAP OF AFRICA LEARNING MODULE GEOGRAPHIC VERBAL RECOGNITION TEST

MAP OF AFRICA LEARNING MODULE GEOGRAPHIC

VERBAL RECOGNITION TEST

This is a test designed to measure your knowledge of the relative location of 25 of the largest countries of Africa. There are two parts to the test.

Instructions for Part I: Multiple Choice. Circle the one answer you think best for each of the following 25 multiple choice questions.

1. Egypt is bordered by:
   A. Somali and Ethiopia
   B. Sudan and Libya
   C. Angola and Zaire
   D. Malagasy and Morocco

2. Morocco is bordered by:
   A. Tunisia
   B. Mali
   C. Kenya
   D. Algeria

3. Libya is located to the north of:
   A. Tunisia
   B. Algeria
   C. Chad
   D. Egypt

4. Which of the following countries does not border the ocean or a sea?
   A. Morocco
   B. Mali
   C. Mauritania
   D. Mozambique

5. Tunisia is bordered by both:
   A. Libya and Algeria
   B. Sudan and Ethiopia
   C. Zaire and Zambia
   D. Angola and Niger

6. Somali borders both:
   A. Ethiopia and Kenya
   B. Sudan and Tanzania
   C. Central African Republic and Zaire

7. Mozambique is located to the south of:
   A. Tanzania
   B. Rhodesia
   C. Angola
   D. Malagasy

8. Tanzania is <u>not</u> bordered by:
   A. Angola
   B. Kenya
   C. Mozambique
   D. Zaire

9. Ethiopia is located <u>between</u>:
   A. Mozambique and Kenya
   B. Niger and Libya
   C. Mali and Chad
   D. Sudan and Somali

10. Kenya does <u>not</u> border:
   A. Malagasy
   B. Tanzania
   C. Ethiopia
   D. Somali

11. All the following countries border Zambia <u>except</u>:
   A. Rhodesia
   B. S. W. Africa
   C. Zaire
   D. Angola

12. The Republic of South Africa is <u>not</u> bordered by:
   A. Tanzania
   B. Botswana
   C. Rhodesia
   D. Mozambique

13. Botswana is located to the north of:
   A. S.W. Africa
   B. Angola
   C. S. Africa
   D. Zaire

14. Rhodesia is bordered by all the following <u>except</u>:
   A. S. Africa
   B. Mozambique
   C. Zaire
   D. Nigeria

15. Angola is located between:
   A. Zaire and Chad
   B. Chad and Niger
   C. S. W. Africa and Zaire
   D. Egypt and Algeria

16. The country of Zaire is located to the west of:
   A. Mali and Mauritania
   B. Niger and Nigeria
   C. Kenya and Tanzania
   D. Algeria and Morocco

17. Zaire is south of:
    A. Sudan
    B. Angola
    C. South Africa
    D. Zambia

18. Nigeria is located <u>furthest</u> from:
    A. Chad
    B. Mali
    C. Niger
    D. Somali

19. The Central African Republic is located directly <u>south</u> of:
    A. Nigeria
    B. Zaire
    C. Chad
    D. Egypt

20. The country directly <u>north</u> of Chad is:
    A. Libya
    B. Algeria
    C. Zambia
    D. Mali

21. Nigeria does not border any of the following <u>except</u>:
    A. Chad
    B. Zaire
    C. Algeria
    D. Tanzania

22. Mauritania is located directly to the <u>west</u> of:
    A. Morocco
    B. Mali
    C. Nigeria
    D. Tunisia

23. Niger is bordered by all of the following <u>except</u>:
    A. Kenya and Sudan
    B. Chad and Mali
    C. Nigeria and Algeria
    D. Libya and Chad

24. Chad is located <u>between</u> the countries of:
    A. Zaire and Rhodesia
    B. Niger and Mauritania
    C. Central African Republic and Kenya

25. The Central African Republic is <u>not</u> bordered by:
    A. Tunisia
    B. Sudan
    C. Chad
    D. Zaire

APPENDIX F

MAP OF AFRICA LEARNING MODULE

VISUAL MAP RECOGNITION TEST

MAP OF AFRICA LEARNING MODULE

VISUAL MAP RECOGNITION TEST

Instructions for Part II: Relative Location
On each of the following maps certain areas of Africa have been enlarged and certain countries identified by letters of the alphabet. You are to match the letter identifying a country with the number from the following list which corresponds to the correct name of that country. "A" has been done for you as an illustration.

1. Egypt
2. Libya
3. Tunisia
4. Algeria
5. Morocco
6. Mauritania
7. Mali
8. Niger
9. Nigeria
10. Chad
11. Central African Republic
12. Sudan
13. Ethiopia
14. Somali
15. Kenya
16. Tanzania
17. Zaire
18. Angola
19. Zambia
20. Mozambique
21. Malagasy
22. Rhodesia
23. Botswana
24. Southwest Africa
25. South Africa

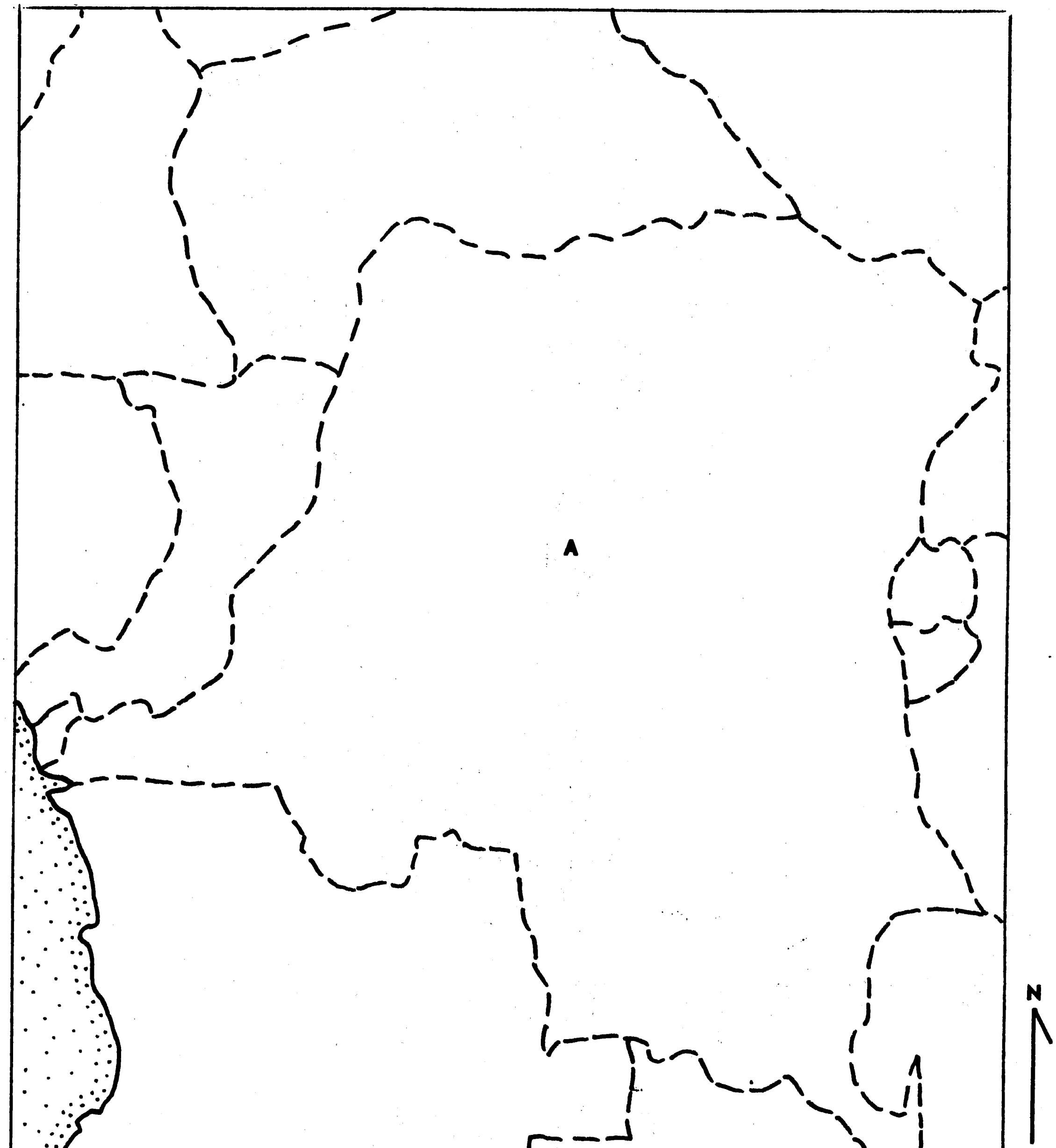
Record your answers in the spaces below.

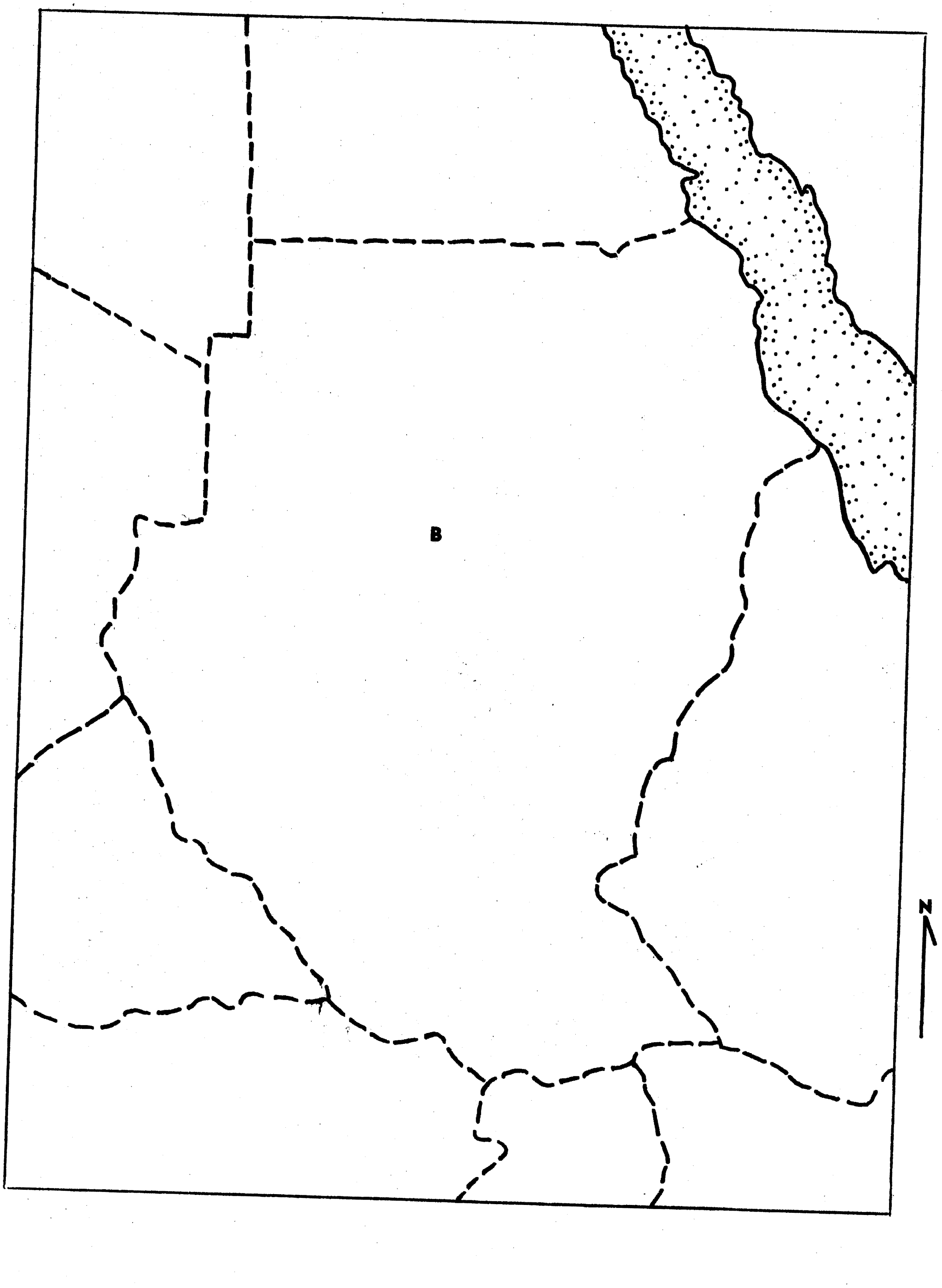
A. ______	F. ______	K. ______	P. ______	U. ______
B. ______	G. ______	L. ______	Q. ______	V. ______
C. ______	H. ______	M. ______	R. ______	W. ______
D. ______	I. ______	N. ______	S. ______	X. ______
E. ______	J. ______	O. ______	T. ______	Y. ______
				Z. ______

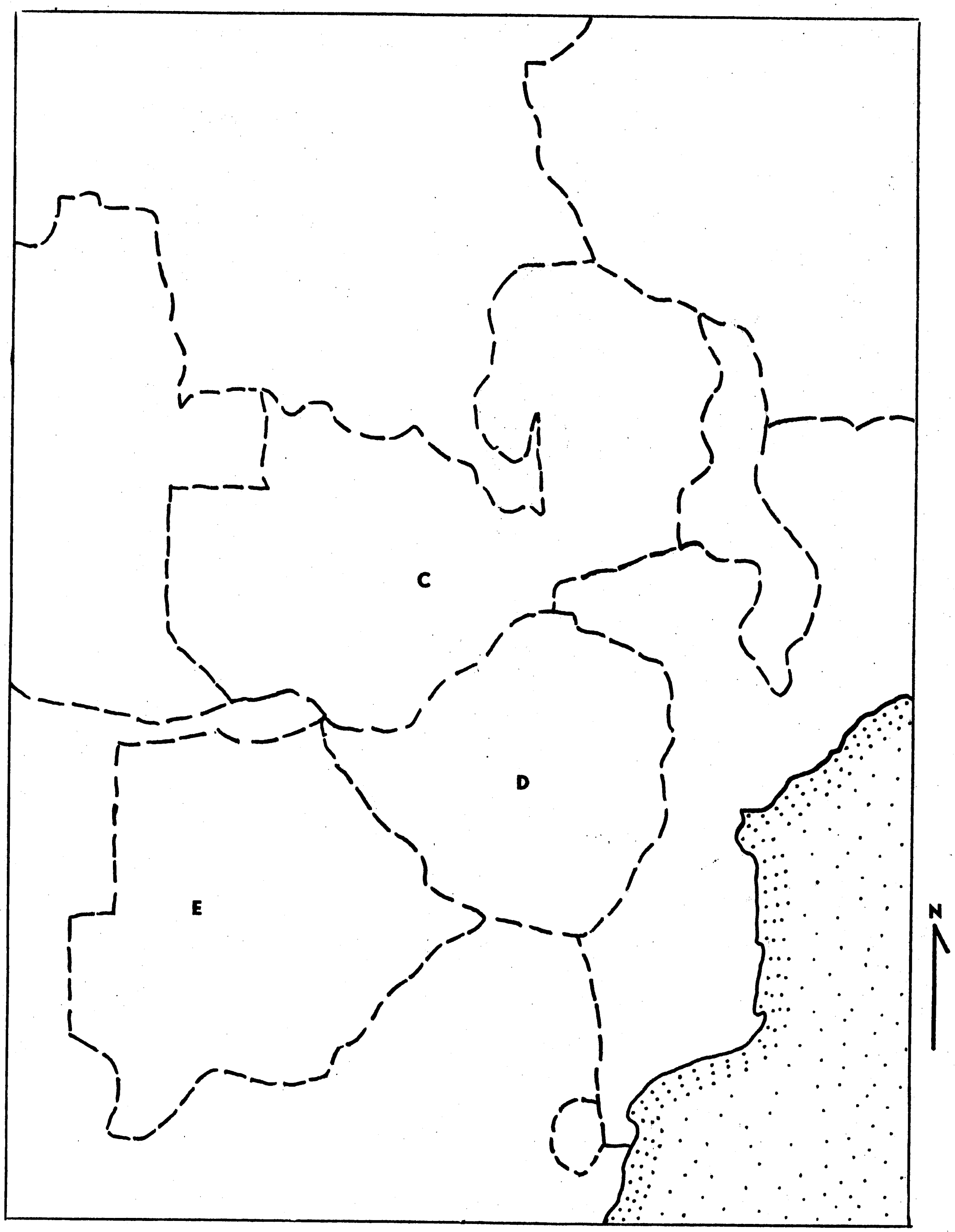
Note: 1) Solid Lines (⁀⁀) represent coastlines

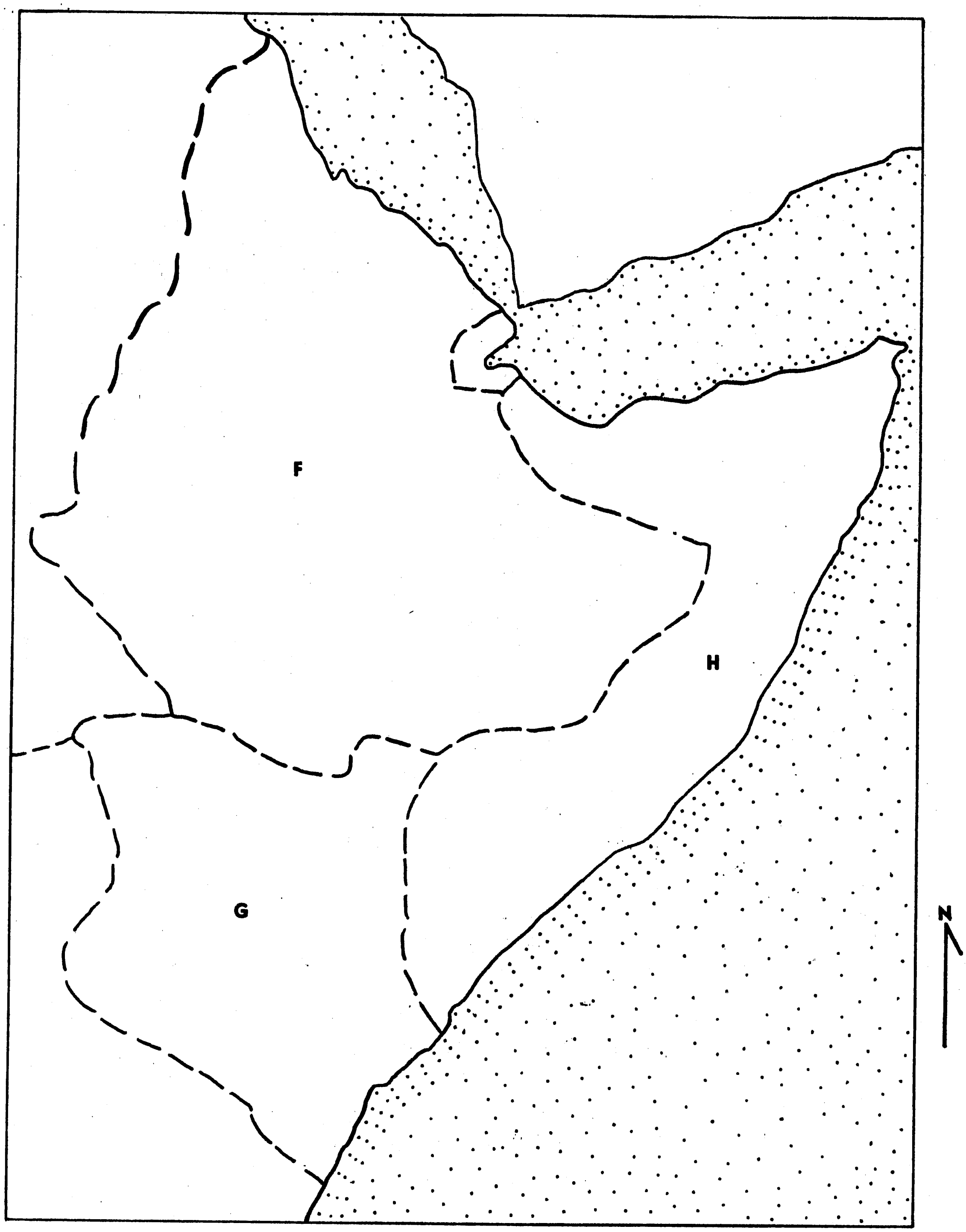
2) Dashed Lines (- - - -) represent political boundaries of countries

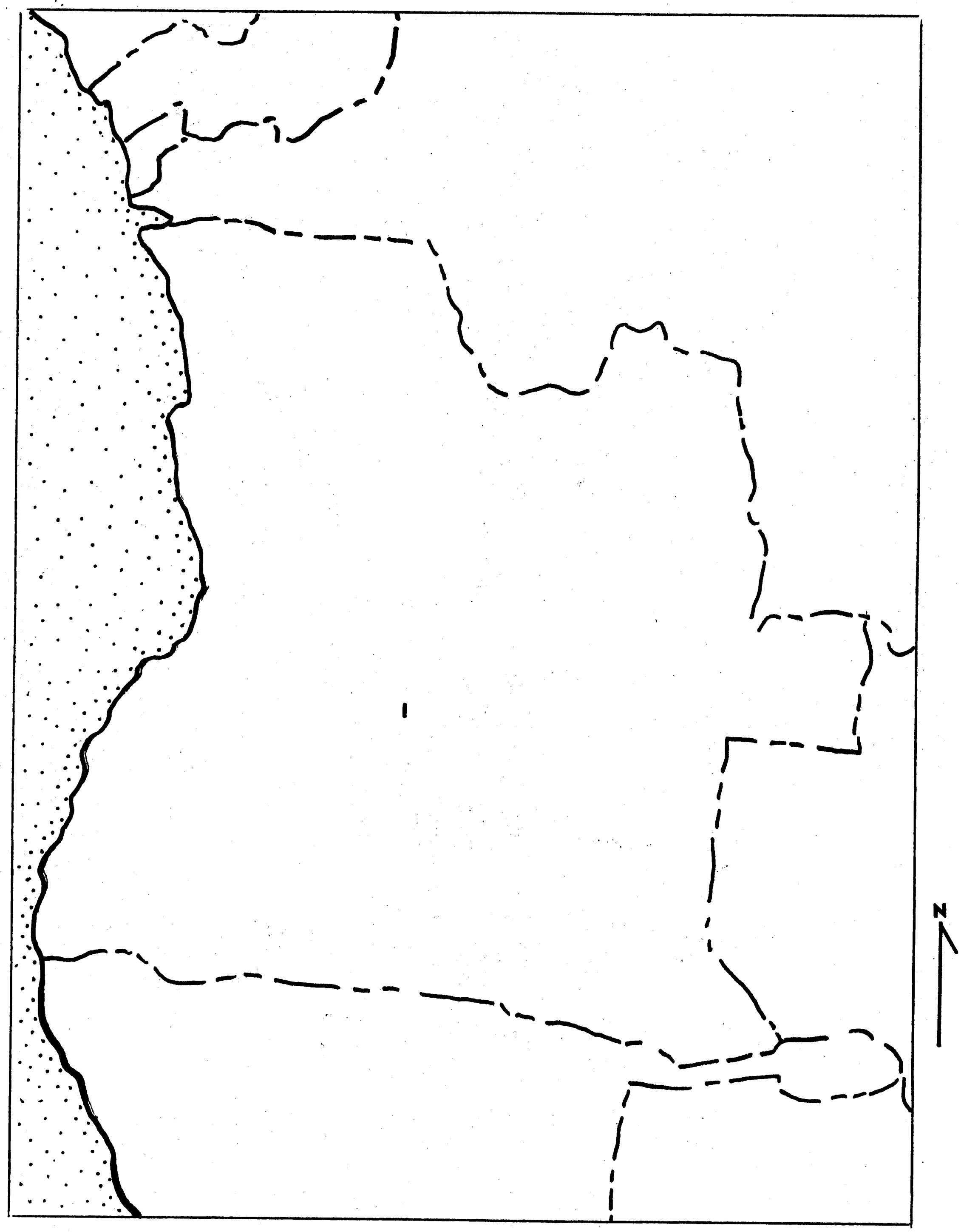
3) Stippled areas (∴∴) represent water covered area (seas and oceans).

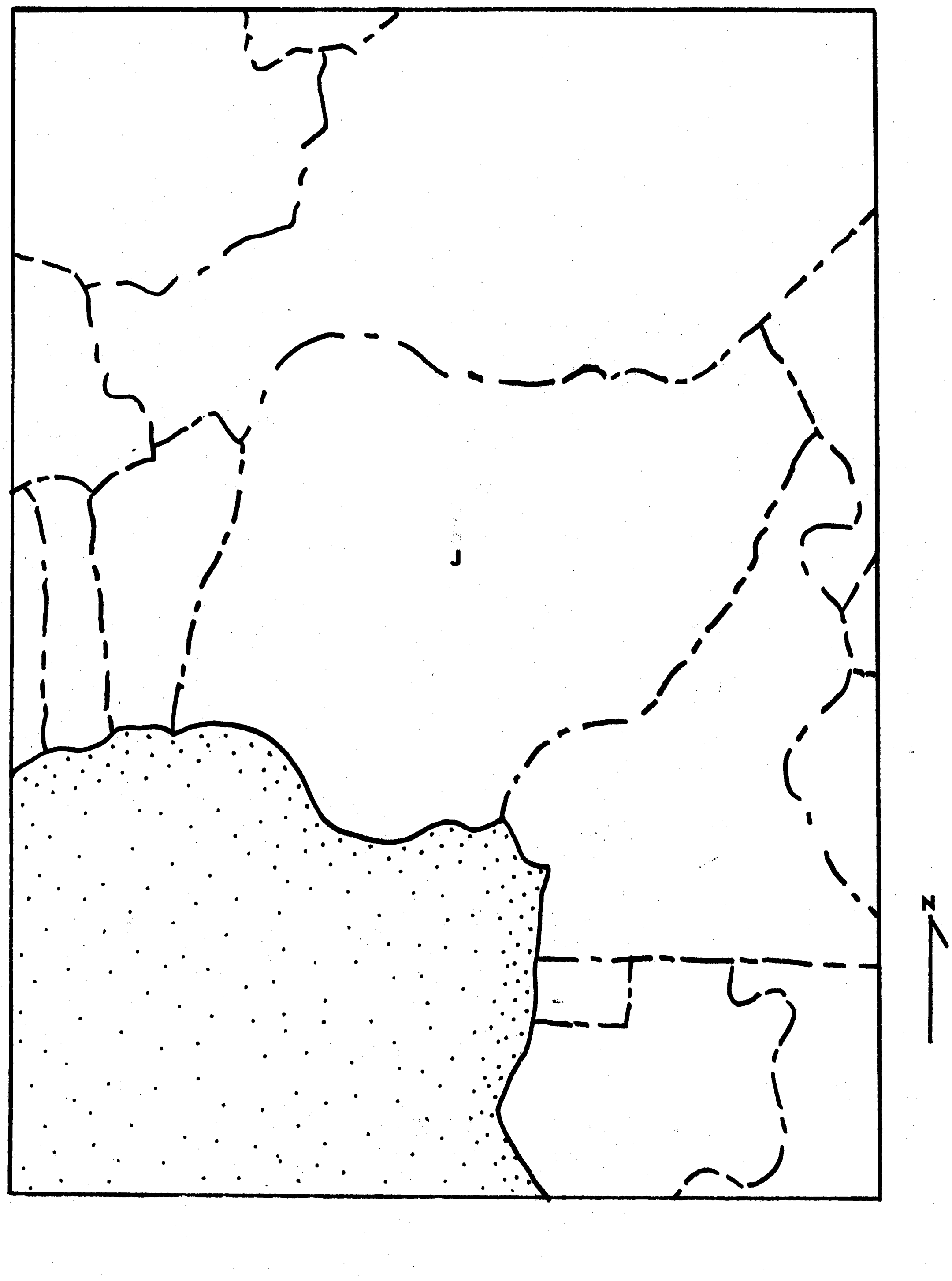

A
N

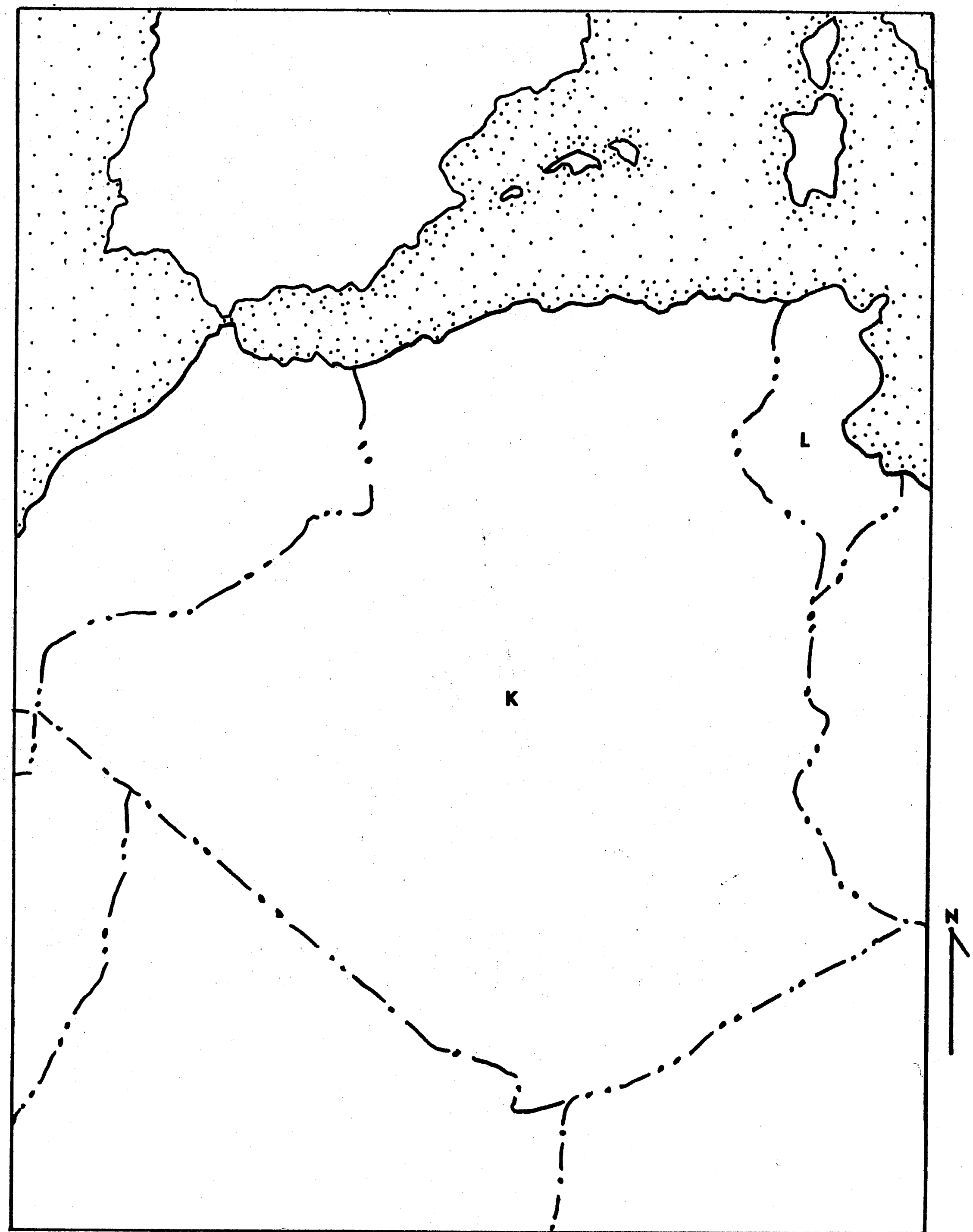

B
N

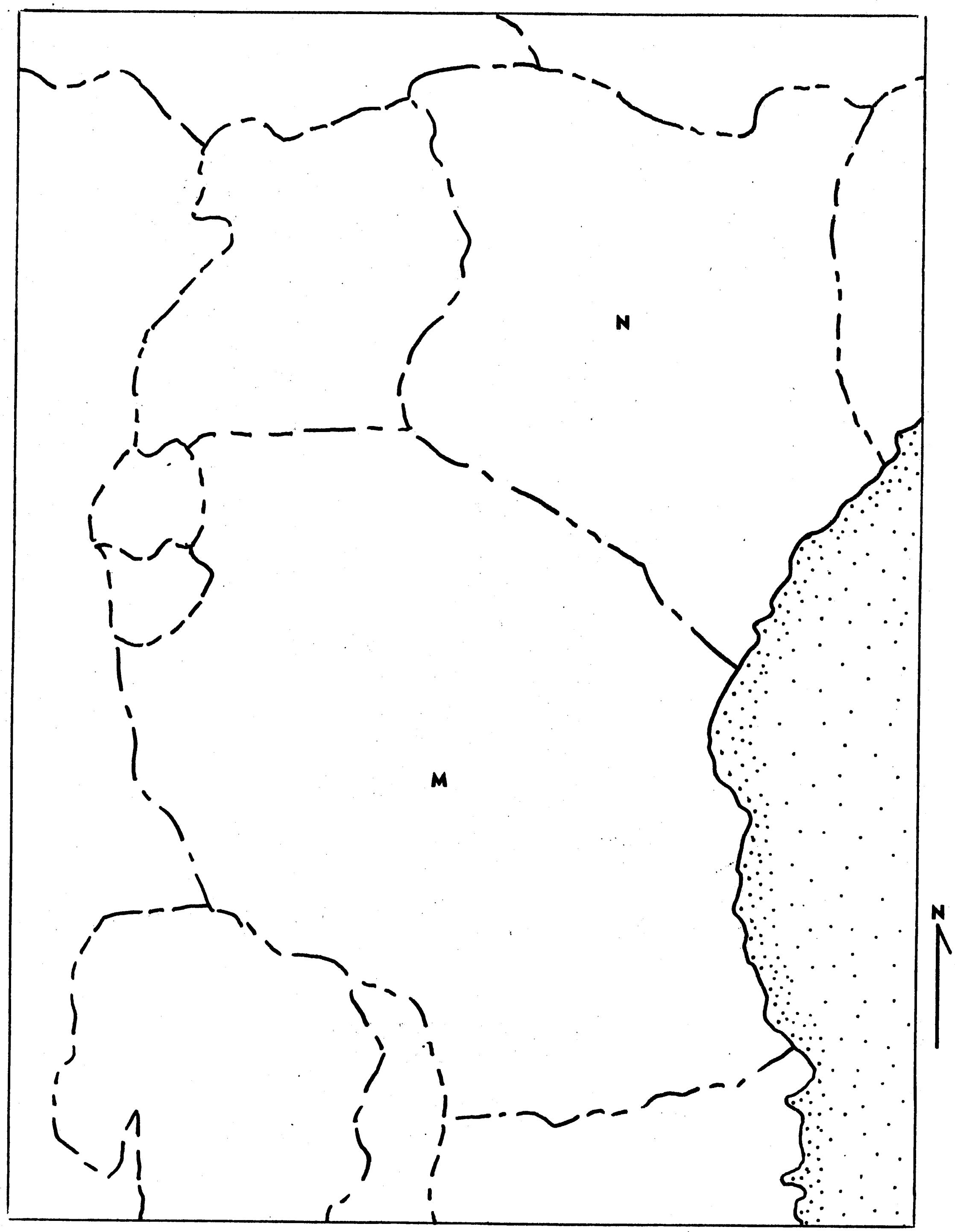

C
D
E
N

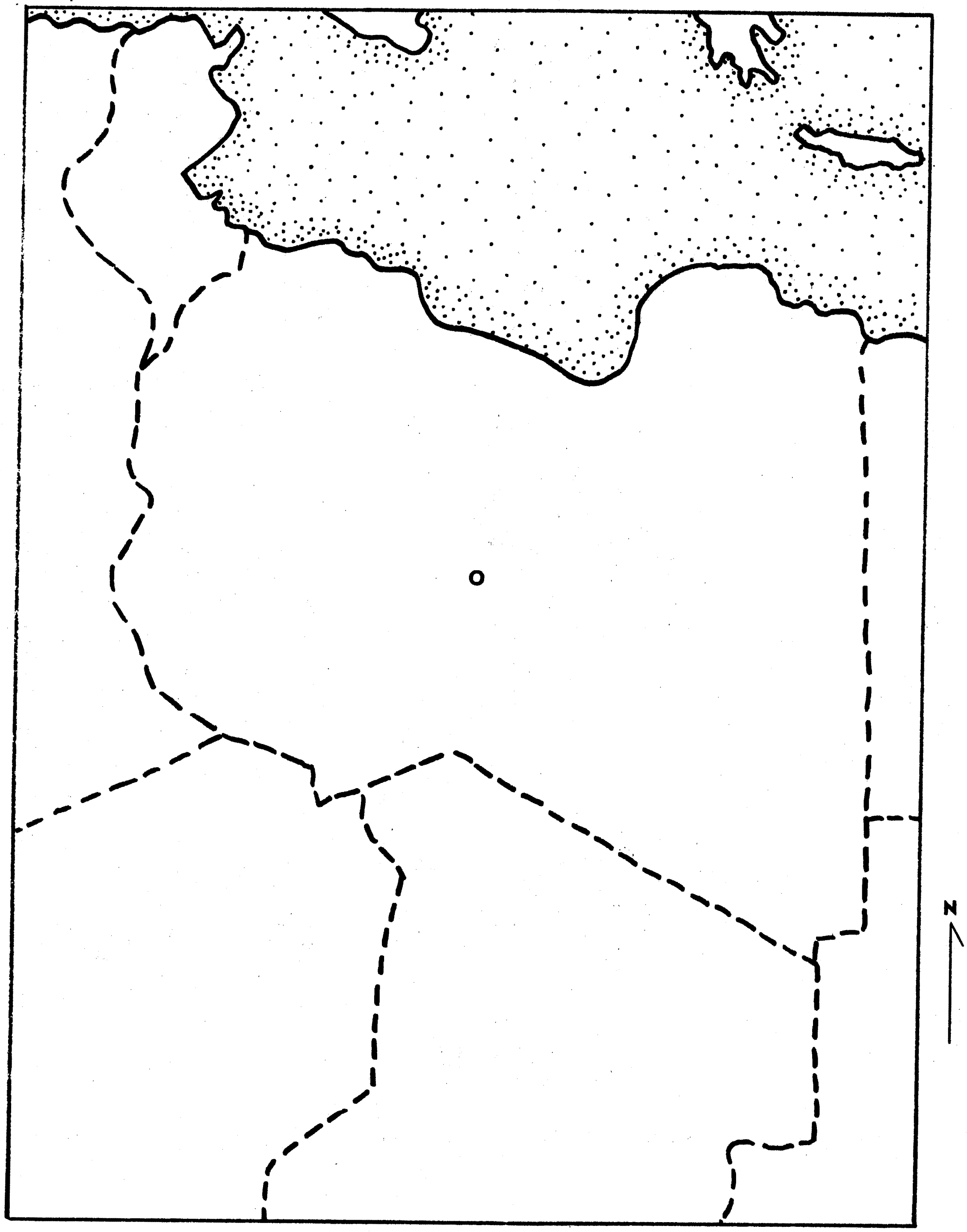

F
H
G
N

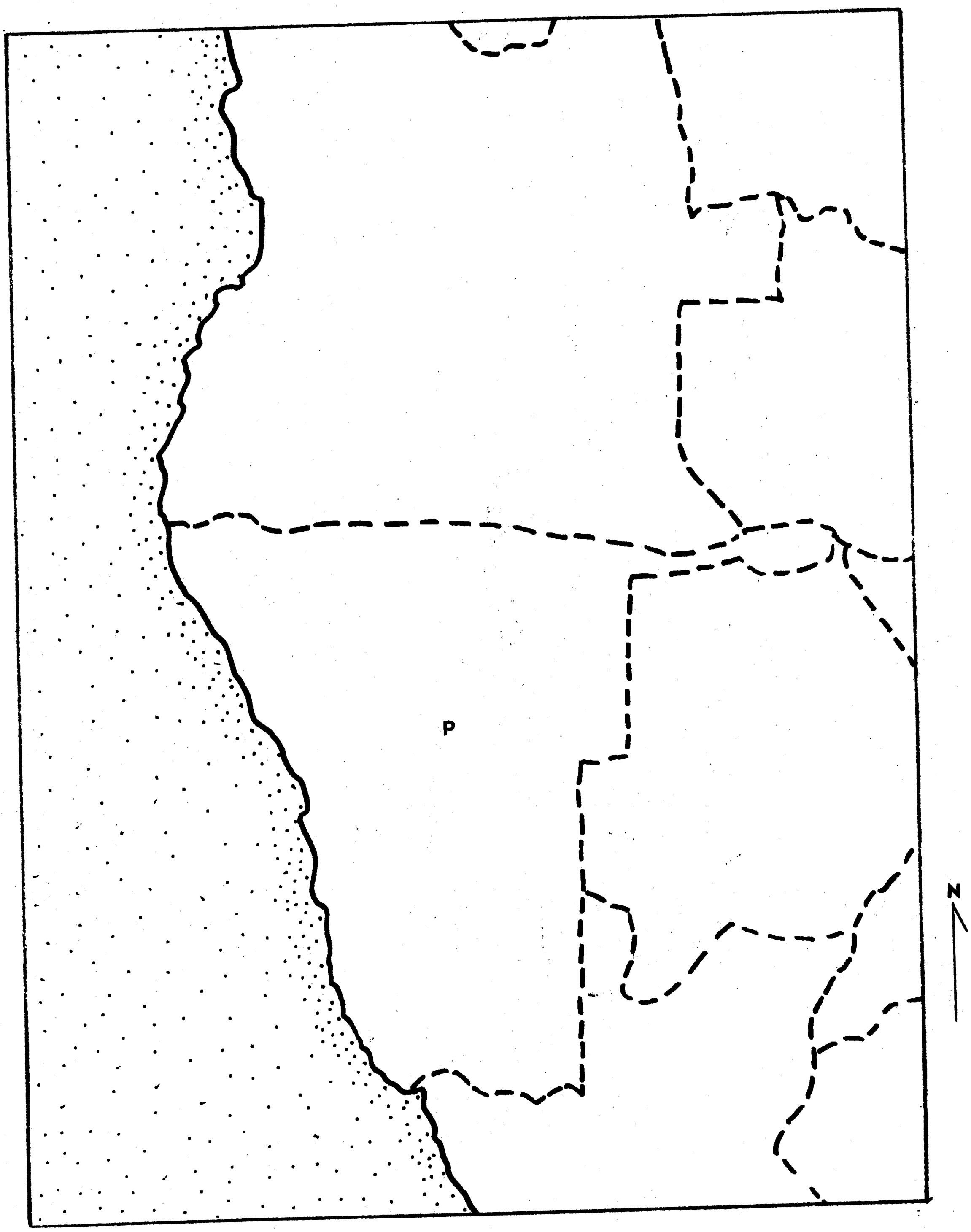

N

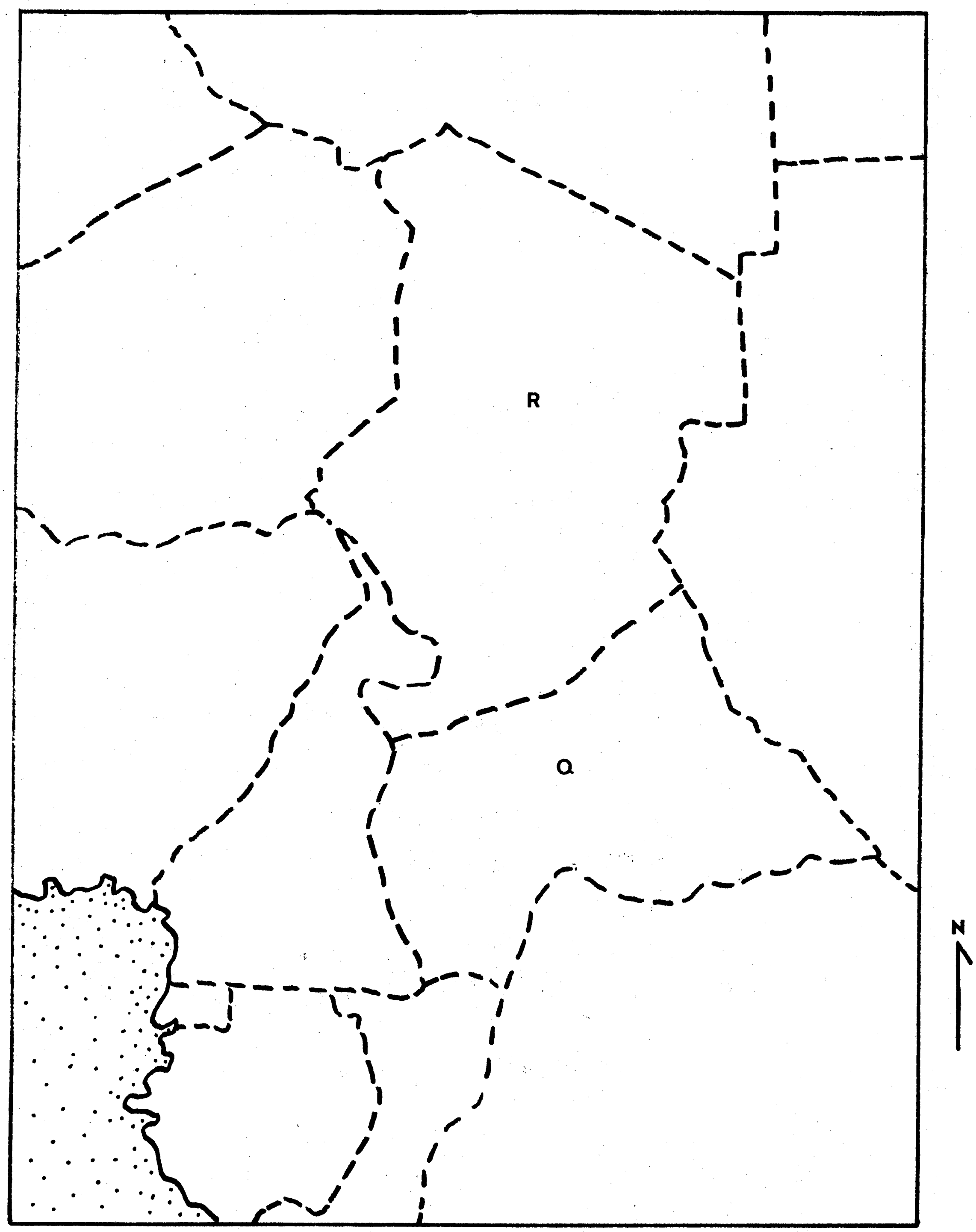

J
N

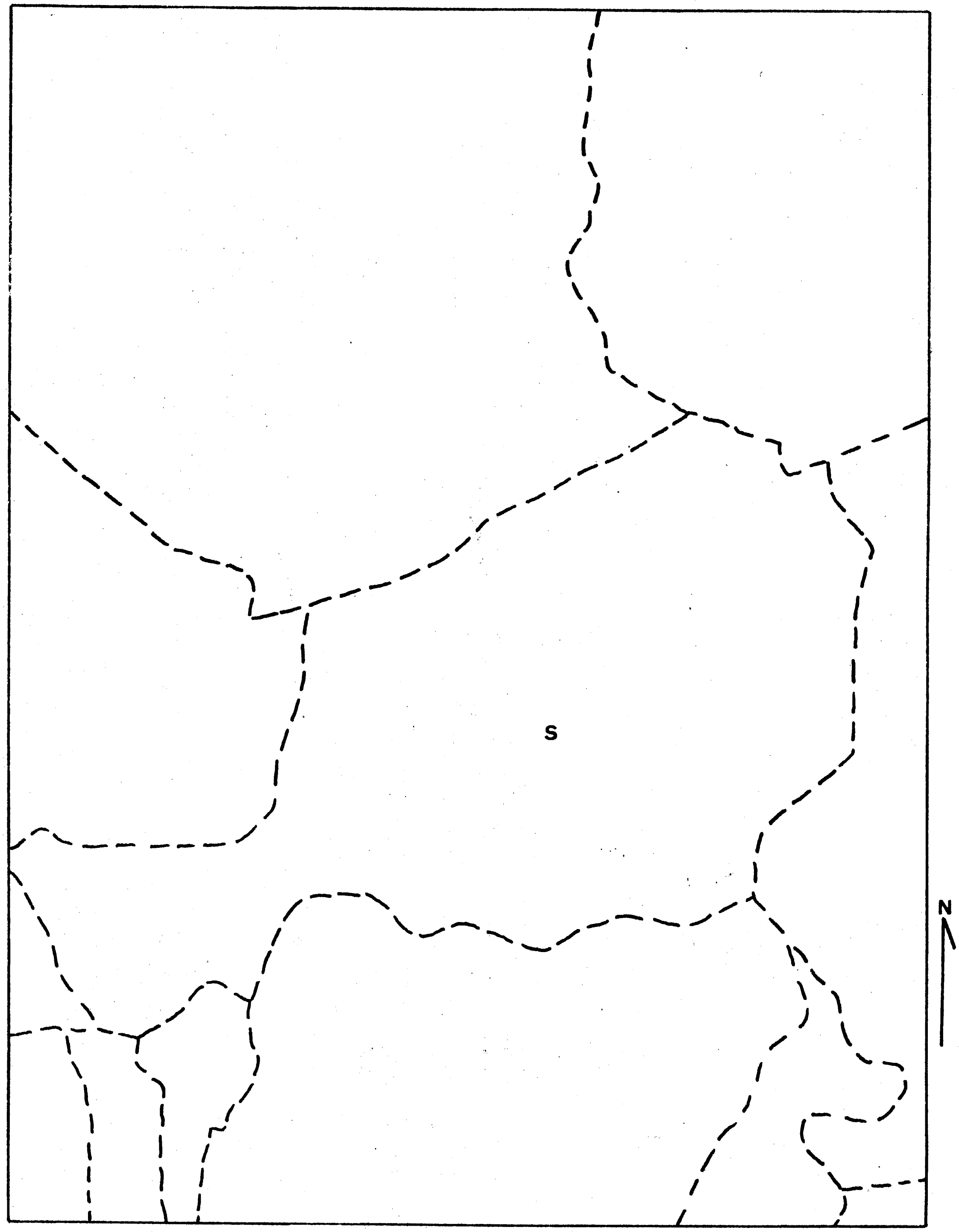

L
K
N

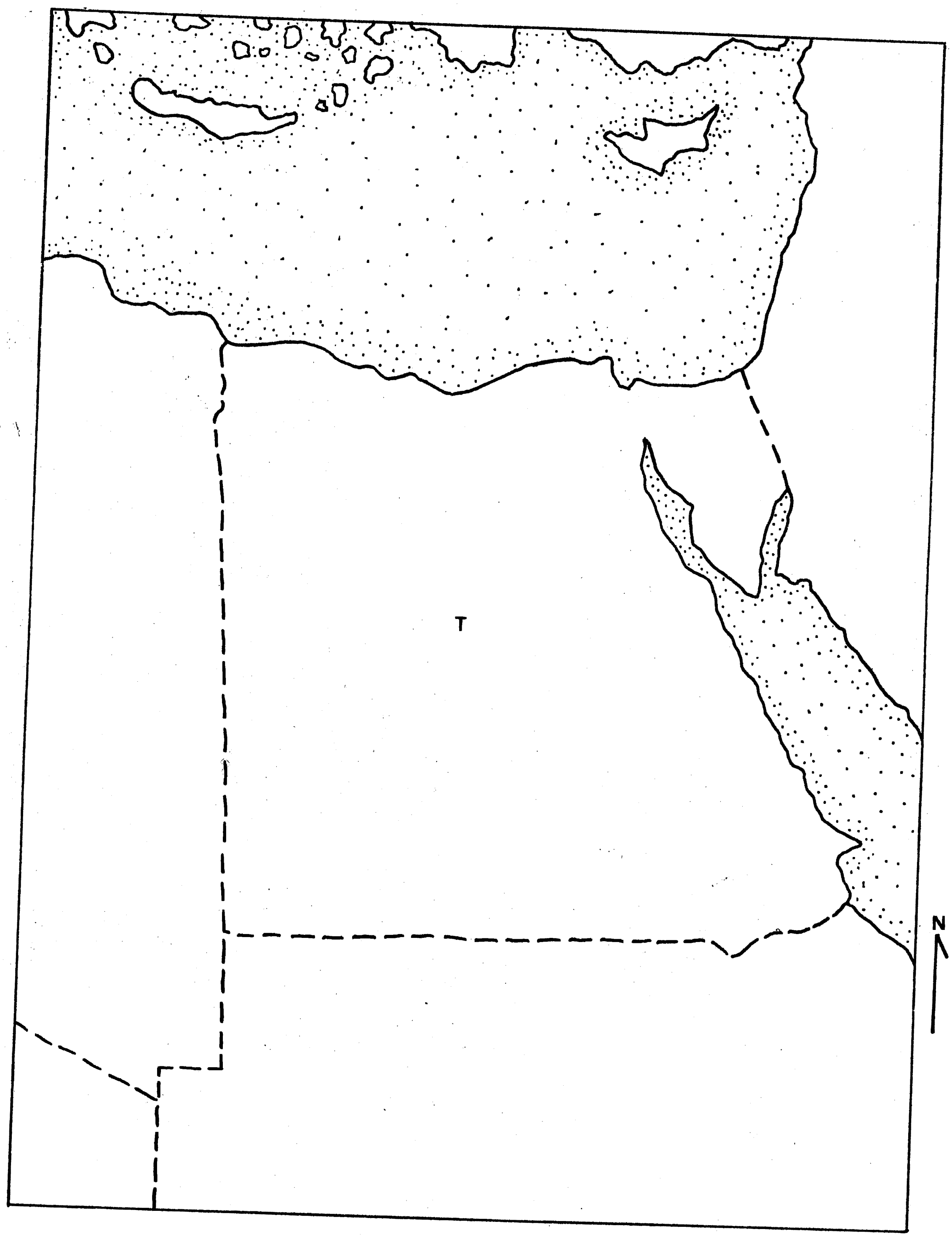

N
M
N

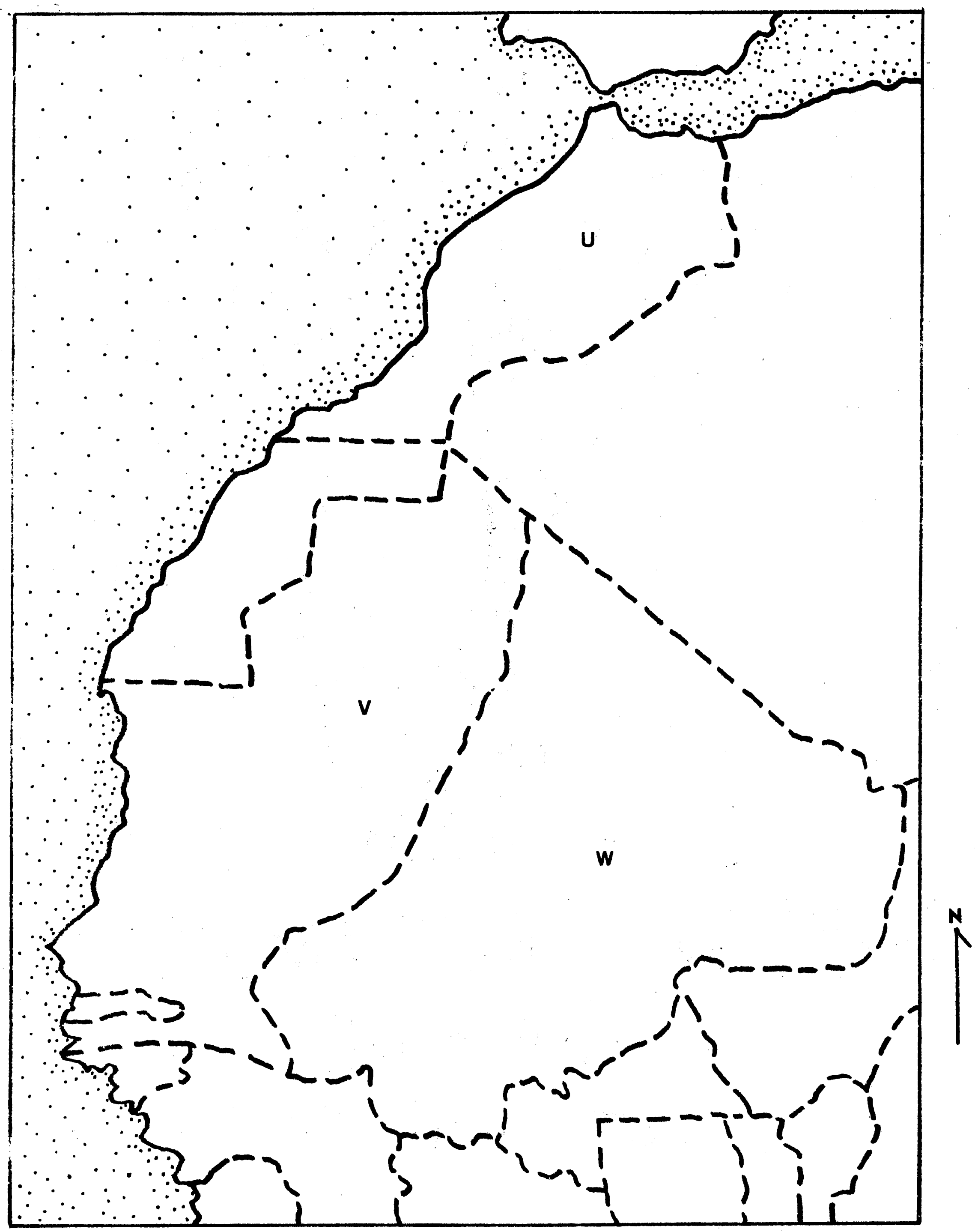

N

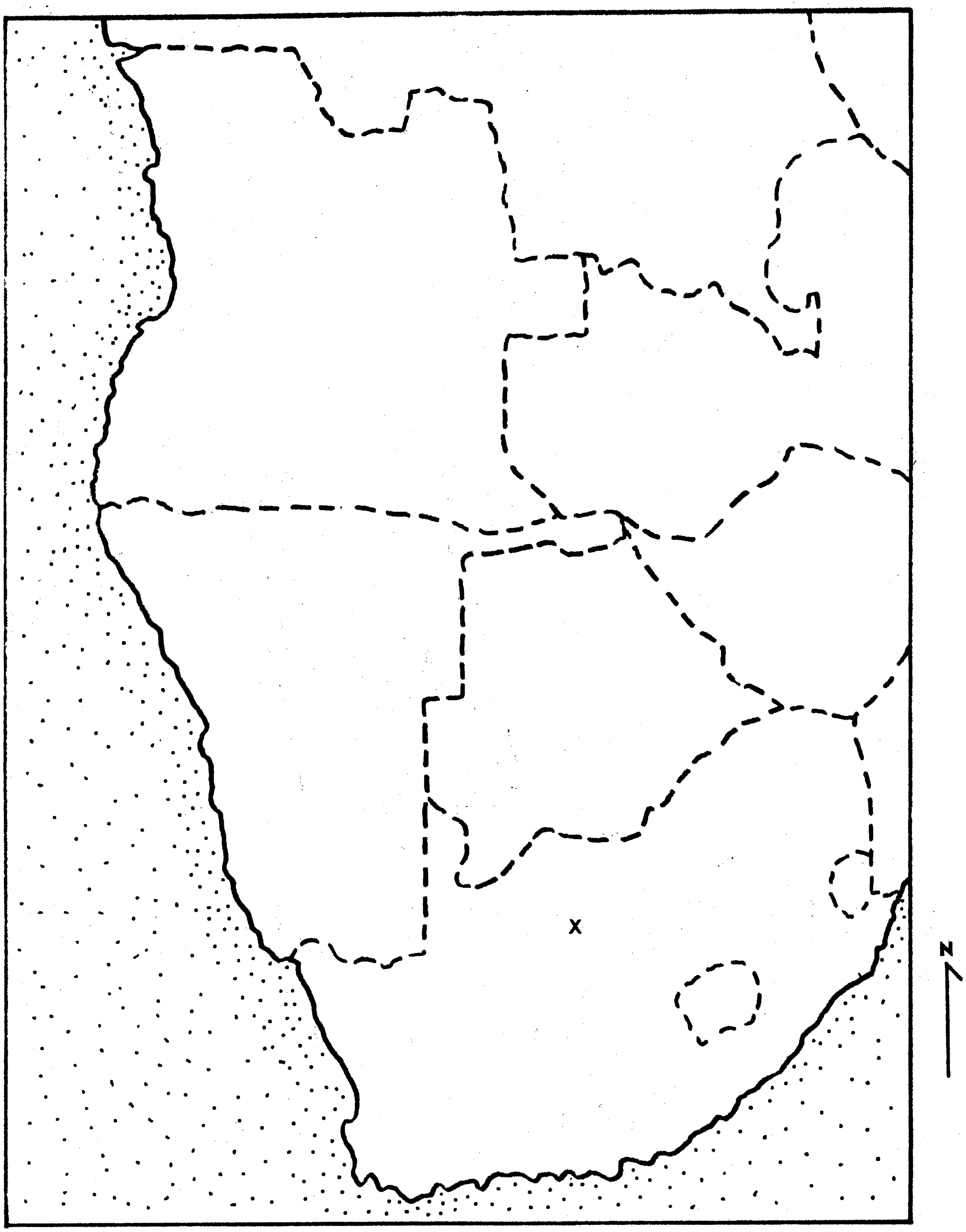

P
N

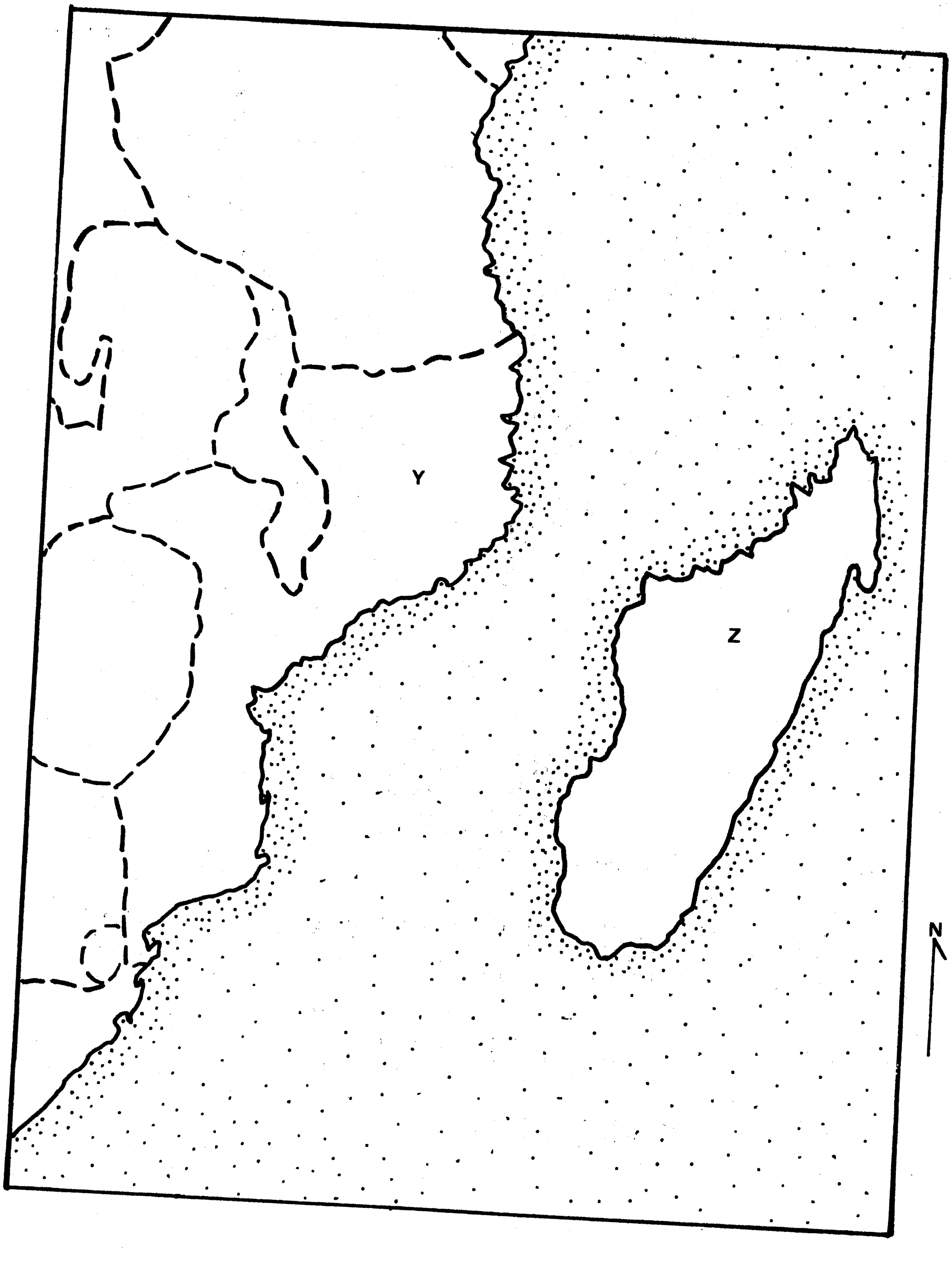

R
Q
N


S
N


T
N


U
V
W
N


X
N


Y
Z
N

APPENDIX G

MAP OF AFRICA LEARNING MODULE

GEOGRAPHY OF AFRICA - SELF-STUDY UNIT

This self-study unit is designed to help you learn the names and locations of 25 of the largest countries of Africa as quickly as possible. Work carefully and do as much as you can in the time allowed.

Step I: The attached map of Africa shows the correct location of the 25 countries listed below. The numbers on the map correspond to the numbers of the countries on the list. You are to write in the full name of each country on the map. As you do so try to memorize the location of the country, its size, shape, and name. When you are finished, go on to Step II.

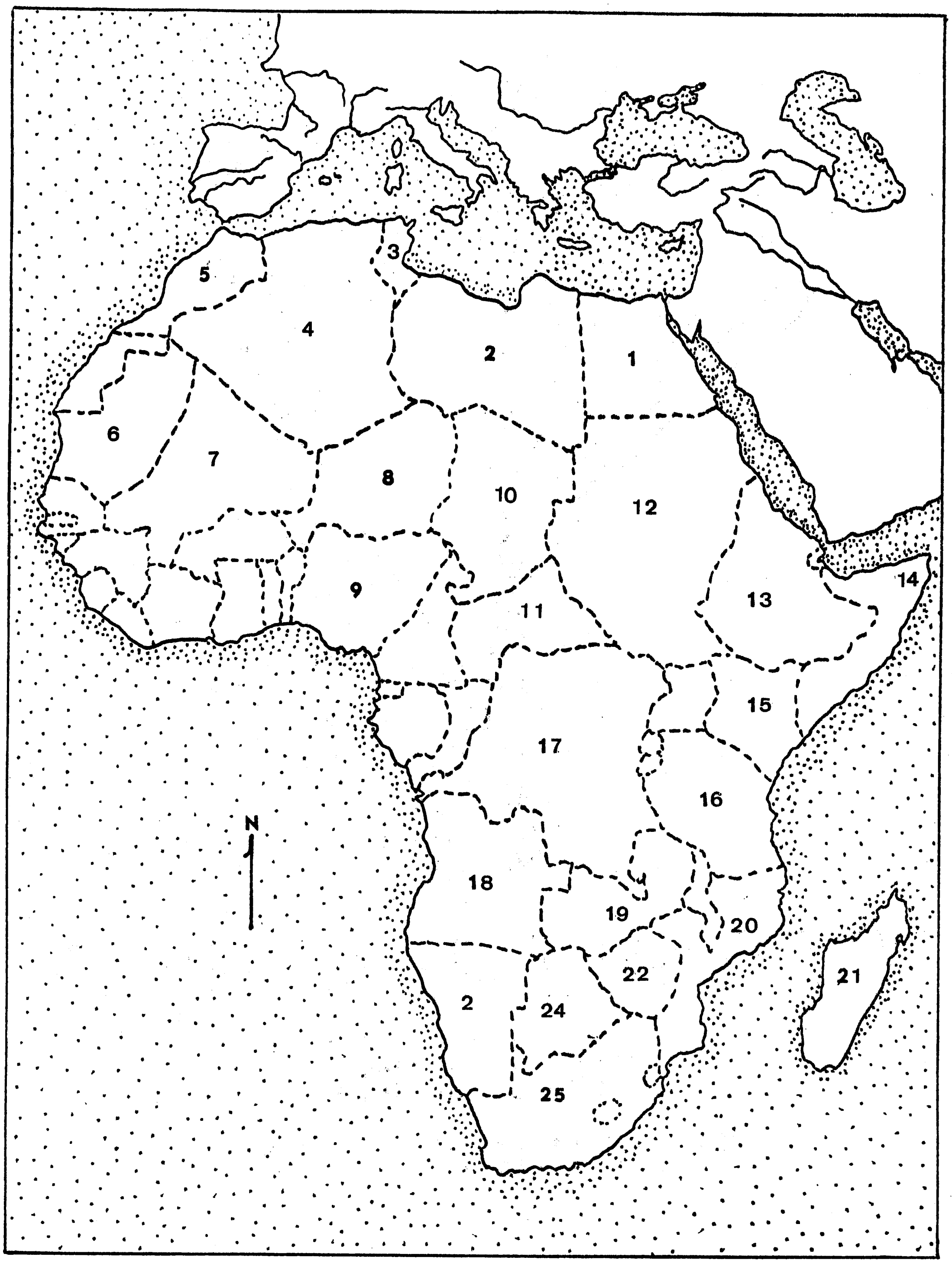
1. Egypt
2. Libya
3. Tunisia
4. Algeria
5. Morocco
6. Mauritania
7. Mali
8. Niger
9. Nigeria
10. Chad
11. Central African Republic
12. Sudan
13. Ethiopia
14. Somali
15. Kenya
16. Tanzania
17. Zaire
18. Angola
19. Zambia
20. Mozambique
21. Malagasy
22. Rhodesia
23. Botswana
24. Southwest Africa
25. South Africa

Step II: On the grid on the following page you are to indicate which countries of Africa border one another by placing X in the appropriate squares. Egypt has been done for you as an example; the X below Libya and Sudan indicates that both of these countries border Egypt. You are to complete the grid. Refer to you map as you do so.

Note: 1) Solid lines (⁓) represent coastlines

2) Dashed lines (------) represent political boundaries of countries

3) Stippled areas (:·:·:) represent water covered areas (seas and oceans).



AFRICA

	1. Egypt	2. Libya	3. Tunisia	4. Algeria	5. Morocco	6. Mauritania	7. Mali	8. Niger	9. Nigeria	10. Chad	11. Cen. African Rep.	12. Sudan	13. Ethiopia	14. Somali
South Africa														
S.W. Africa														
Botswana														
Rhodesia														
Malagasy														
Mozambique														
Zambia														
Angola														
Zaire														
Tanzania														
Kenya														
Somali														
Ethiopia														
Sudan	X													
Cen. African Rep.														
Chad														
Nigeria														
Niger														
Mali														
Mauritania														
Morocco														
Algeria														
Tunisia														
Libya	X													
Egypt														

	15. Kenya	16. Tanzania	17. Zaire	18. Angola	19. Zambia	20. Mozambique	21. Malagasy	22. Rhodesia	23. Botswana	24. S.W. Africa	25. South Africa			
South Africa														
S.W. Africa														
Botswana														
Rhodesia														
Malagasy														
Mozambique														
Zambia														
Angola														
Zaire														
Tanzania														
Kenya														
Somali														
Ethiopia														
Sudan														
Cen. African Rep.														
Chad														
Nigeria														
Niger														
Mali														
Mauritania														
Morocco														
Algeria														
Tunisia														
Libya														
Egypt														

APPENDIX H

RAW DATA FOR STUDY A (PILOT STUDY)

RAW DATA FOR STUDY A (PILOT STUDY)

Subjects	Sex	RCT Prt	RCT Pst	Sec	HFT
1	M	75	80	1	0.0
2	M	60	77	1	6.3
3	M	45	70	1	3.1
4	M	35	67	1	6.3
5	M	75	67	1	6.3
6	M	45	50	1	12.5
7	M	50	73	2	12.5
8	M	85	93	2	18.8
9	M	35	60	1	18.8
10	M	60	80	2	18.8
11	M	60	80	2	18.8
12	M	30	47	1	21.9
13	M	45	70	1	25.0
14	M	40	60	1	25.0
15	M	65	80	1	25.0
16	M	40	67	1	25.1
17	M	85	83	1	25.1
18	M	40	60	1	25.1
19	M	60	63	2	31.3
20	M	55	77	1	40.6
21	M	90	97	1	40.6
22	M	45	67	2	46.9
23	M	45	77	1	46.9
24	M	60	90	2	46.9
25	M	75	80	2	46.9
26	M	70	70	2	50.0
27	M	65	83	2	56.3
28	M	45	67	2	62.5
29	M	55	77	1	78.1
30	F	50	63	1	0.0
31	F	35	63	2	0.0
32	F	45	57	2	9.4
33	F	55	73	1	12.5
34	F	55	57	1	12.5
35	F	15	77	2	12.5
36	F	65	50	1	15.6
37	F	45	70	1	18.8
38	F	47	50	2	18.8
39	F	60	80	2	18.8
40	F	40	67	2	18.8
41	F	60	83	2	21.9
42	F	45	67	2	21.9
43	F	90	90	1	21.9
44	F	55	77	1	21.9
45	F	45	63	1	21.9
46	F	55	87	2	25.0
47	F	65	83	2	25.0
48	F	60	70	2	28.0
49	F	65	87	1	28.1
50	F	50	80	1	28.1

Subjects	Sex	RCT Prt	RCT Pst	Sec	HFT
51	F	55	87	2	28.1
52	F	65	83	2	28.1
53	F	60	80	2	28.1
54	F	40	67	1	31.3
55	F	65	80	2	34.4
56	F	45	90	2	37.5
57	F	55	63	1	40.6
58	F	35	77	2	40.6
59	F	45	53	2	40.6
60	F	65	83	1	43.8
61	F	55	87	1	43.8
62	F	45	67	1	43.8
63	F	65	77	1	43.8
64	F	40	73	1	46.9
65	F	45	67	2	50.0
66	F	45	77	1	50.0
67	F	45	53	2	53.1
68	F	55	77	2	59.4
69	F	65	80	1	62.5
70	F	40	73	2	62.5
71	F	45	57	2	65.6
72	F	55	80	2	68.8
73	F	45	70	1	68.8
74	F	50	50	2	81.3
75	F	75	90	2	87.5

APPENDIX I

RAW DATA FOR STUDY B (PRINCIPAL STUDY)

RAW DATA FOR STUDY B (PRINCIPAL STUDY)

Subjects	HFT	GVR Prt	GVR Pst	VMR Prt	VMR Pst	Sex
1	3.13	24	12	0	12	M
2	3.13	48	56	20	60	M
3	6.25	56	24	24	24	M
4	6.25	16	36	4	20	M
5	12.50	28	32	8	32	M
6	12.50	16	32	4	24	M
7	12.50	28	24	4	0	M
8	12.50	20	20	4	16	M
9	15.63	12	24	0	20	M
10	15.63	8	36	4	12	M
11	15.63	20	52	8	52	M
12	15.68	16	24	0	8	M
13	15.63	20	52	28	72	M
14	15.63	12	48	16	28	M
15	15.63	4	64	4	40	M
16	15.63	44	52	8	24	M
17	15.63	28	32	20	28	M
18	18.75	32	48	4	0	M
19	18.75	36	72	28	40	M
20	18.75	32	20	12	48	M
21	18.75	4	52	12	32	M
22	21.88	24	40	4	24	M
23	21.88	16	32	0	32	M
24	21.88	24	60	0	32	M
25	21.88	8	32	20	60	M
26	25.00	48	68	32	40	M
27	25.00	32	36	8	36	M
28	25.00	48	44	4	60	M
29	25.00	12	44	4	16	M
30	25.00	0	56	0	40	M
31	25.00	8	28	4	0	M
32	28.13	36	36	12	44	M
33	28.13	32	64	20	28	M
34	28.13	40	56	24	60	M
35	28.13	24	36	8	20	M
36	28.13	44	68	28	48	M
37	31.25	20	56	20	48	M
38	31.25	28	28	8	28	M
39	31.25	16	88	8	48	M
40	34.38	48	60	4	36	M
41	34.38	20	40	8	16	M
42	34.38	4	36	0	52	M
43	34.50	36	36	32	48	M
44	37.50	40	32	8	32	M
45	37.50	48	76	28	72	M
46	37.50	0	8	8	28	M
47	37.50	29	44	4	16	M
48	43.75	28	44	0	32	M
49	43.75	4	72	8	60	M

Subjects	HFT	GVR Prt	GVR Pst	VMR Prt	VMR Pst	Sex
50	43.75	44	44	8	12	M
51	40.63	24	48	4	16	M
52	40.63	32	24	16	28	M
53	40.63	20	52	8	24	M
54	40.63	32	40	8	52	M
55	40.63	24	56	8	16	M
56	43.75	12	56	8	16	M
57	46.88	40	40	32	12	M
58	46.88	24	56	12	32	M
59	46.88	56	72	28	42	M
60	50.00	8	40	0	40	M
61	46.88	0	28	4	48	M
62	46.88	36	56	16	48	M
63	46.88	16	52	4	36	M
64	50.00	36	48	12	20	M
65	50.00	28	64	4	64	M
66	59.37	32	48	0	44	M
67	59.37	48	88	20	76	M
68	62.50	20	32	0	12	M
69	62.50	48	68	12	36	M
70	65.63	36	96	20	99	M
71	59.37	56	88	12	48	M
72	56.37	16	44	8	36	M
73	68.75	28	76	0	60	M
74	71.88	12	76	12	80	M
75	71.88	32	96	32	96	M
76	75.00	4	60	12	56	M
77	78.13	44	72	24	36	M
78	81.25	56	40	0	20	M
79	3.13	28	8	0	14	F
80	6.25	36	24	16	44	F
81	6.25	16	72	4	40	F
82	9.38	32	48	4	16	F
83	9.38	56	56	16	12	F
84	9.38	32	12	0	0	F
85	9.38	16	44	4	40	F
86	9.38	20	16	8	4	F
87	9.38	28	44	12	20	F
88	12.50	24	48	12	52	F
89	12.50	12	60	12	72	F
90	12.50	8	44	8	12	F
91	12.50	28	40	0	8	F
92	12.50	12	44	4	32	F
93	15.63	8	32	8	20	F
94	15.63	16	36	4	28	F
95	15.63	20	32	0	8	F
96	15.63	24	60	8	32	F
97	18.75	32	52	12	28	F
98	18.75	40	64	24	20	F
99	18.75	24	40	16	44	F
100	18.75	36	60	12	36	F
101	18.75	40	56	8	4	F

Subjects	HFT	GVR Prt	GVR Pst	VMR Prt	VMR Pst	Sex
102	18.75	20	64	0	64	F
103	18.75	8	36	4	52	F
104	18.75	28	36	20	28	F
105	18.75	16	16	4	32	F
106	21.88	20	48	20	32	F
107	21.88	32	60	0	28	F
108	21.88	0	16	0	4	F
109	21.88	40	48	0	32	F
110	21.88	4	20	0	20	F
111	21.88	16	32	12	36	F
112	21.88	36	88	20	64	F
113	21.88	16	36	0	24	F
114	25.00	28	48	16	52	F
115	25.00	28	72	12	32	F
116	25.00	24	80	20	76	F
117	12.50	28	36	4	24	F
118	25.00	8	28	0	16	F
119	28.13	36	52	4	36	F
120	28.13	32	48	4	28	F
121	28.13	36	28	20	20	F
122	28.14	16	64	12	32	F
123	31.25	28	56	0	0	F
124	31.25	56	88	8	48	F
125	31.25	28	99	20	92	F
126	31.25	16	72	12	48	F
127	31.25	32	76	0	16	F
128	31.25	20	52	16	40	F
129	31.25	16	44	8	32	F
130	34.38	16	56	8	44	F
131	34.38	24	40	8	20	F
132	34.38	8	80	20	64	F
133	37.50	32	60	12	40	F
134	37.50	8	24	8	24	F
135	37.50	0	44	0	48	F
136	37.50	4	44	12	68	F
137	37.50	0	60	12	48	F
138	40.63	24	44	0	6	F
139	43.75	8	76	4	60	F
140	43.75	32	99	8	76	F
141	43.75	56	80	16	88	F
142	43.75	16	60	4	40	F
143	43.75	4	44	8	40	F
144	43.75	20	64	8	68	F
145	43.75	20	56	12	32	F
146	43.75	32	40	4	36	F
147	46.88	20	44	4	28	F
148	46.88	40	20	12	24	F
149	46.88	16	68	0	68	F
150	46.88	32	84	16	88	F
151	50.00	28	60	16	40	F

Subjects	HFT	GVR Prt	GVR Pst	VMR Prt	VMR Pst	Sex
152	50.00	12	36	0	68	F
153	53.25	28	52	8	48	F
154	56.25	32	60	0	60	F
155	59.37	24	36	20	48	F
156	59.37	16	44	8	40	F
157	68.75	28	40	8	24	F
158	62.50	24	52	4	24	F

VITA

John Garth Herning

Candidate for the Degree of

Doctor of Education

Thesis: A MULTIVARIATE ANALYSIS OF THE RELATIONSHIP OF FIELD DEPENDENCE-FIELD INDEPENDENCE COGNITIVE STYLE TO LEARNING OF GEOGRAPHICAL CONCEPTS AND INFORMATION AMONG COLLEGE STUDENTS

Major Field: Higher Education Minor: Geography

Biographical:

Personal Data: Born in Green Bay, Wisconsin, December 30, 1942, the son of Mr. and Mrs. Ralph L. Herning.

Education: Graduated from Appleton Senior High School, Appleton, Wisconsin, in June, 1961; received Bachelor of Science degree in American Institutions from the University of Wisonsin-Madison, Madison, Wisconsin, in 1965; received Master of Science degree in Geography and Education from the University of Wisconsin-Madison, Madison, Wisconsin, in January, 1968; enrolled in doctoral program at Oklahoma State University, August, 1971; completed requirements for the Doctor of Education degree at Oklahoma State University in May, 1976.

Professional Experience: Research Assistant, Department of Geography, University of Wisconsin-Madison, 1966-67; part-time instructor of physical geography at Marathon County Campus, University of Wisconsin Center System, 1967-68; Instructor of Geography, University of Wisconsin-Green Bay, 1968-71; graduate teaching assistant Department of Geography, Oklahoma State University, 1972-75.

Professional Organizations: Member, Association of American Geographers; Member, Gamma Theta Upsilon Professional Society; Member, Oklahoma Educational Association; Member, National Geographic Society; Member, Sierra Club of the United States of America; Member, Common Cause, Citizens Lobby Group.