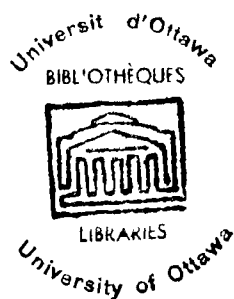


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PSYCHOLOGICAL DIFFERENTIATION AND STRATEGY CHOICE
IN BRUNER'S CONCEPT ATTAINMENT TASKS

by Robert C. Lyle

Thesis presented to the School of
Graduate Studies as partial fulfillment
of the requirements for the degree
of Ph.D. in Education



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CURRICULUM STUDIORUM

Robert C. Lyle was born May 30, 1938 in Lindsay, Ontario. He received the Bachelor Arts in Chemistry from University College, University of Western Ontario, London, Ontario in 1959, and a Master of Education from the University of Ottawa, Ottawa, Ontario in 1968. The title of his upgrading paper was The Validity of Strategy Determining Procedures in Bruner's Concept Attainment Tasks.

TABLE OF CONTENTS

Chapter	page
INTRODUCTION	vii
I.- REVIEW OF THE LITERATURE	1
1. Bruner's Notion of Concept Learning	2
2. Witkin's Concept of Psychological Differentiation	22
II.- EXPERIMENTAL DESIGN	42
1. The Subjects	42
2. Bruner's Stimulus Display	43
3. Instruments Used for the Collection of Data	44
4. The Procedure Used to Collect the Data	53
5. Selection, Training and Performance of Raters	59
6. Plan of the Statistical Analysis	62
III.- PRESENTATION AND DISCUSSION OF RESULTS	63
1. The Hypotheses to be Tested	63
2. The Reliability of the Measuring Instruments	64
3. The Determination of the Strategy being Employed by the Subject	67
4. The Results of the Statistical Analysis	73
5. Suggestions for Further Research	78
SUMMARY AND CONCLUSIONS	82
BIBLIOGRAPHY	87
Appendix	
1. SUMMARY OF APPROACHES AND RESULTANT STRATEGIES .	90
2. BRUNER'S STIMULUS ARRAY FOR THE PRESENTATION OF CONCEPT ATTAINMENT PROBLEMS FOLLOWING THE REQUIREMENTS OF THE SELECTION PARADIGM	92
3. THE QUESTIONNAIRE PRESENTED TO SUBJECTS AFTER COMPLETION OF THE CONCEPT ATTAINMENT PROBLEMS .	94
4. SAMPLE ITEM AND INSTRUCTIONS FOR ADMINISTRATION OF THE HFTV	97
5. INSTRUCTIONS TO SUBJECTS FOR ADMINISTRATION OF THE HENMON-NELSON TEST OF INTELLIGENCE	99

TABLE OF CONTENTS

v

Appendix	page
6. PROCEDURE FOR ADMINISTRATION OF THE PORTABLE RFT FOR ADULTS (ORFT)	102
7. INSTRUCTIONS TO SUBJECTS REGARDING PROCEDURE TO BE FOLLOWED DURING PERFORMANCE OF THE CONCEPT ATTAINMENT TASK	106
8. FOCUS CARDS AND RELEVANT ATTRIBUTES FOR EACH PROBLEM FOR EACH SUBJECT	109
9. INSTRUCTIONS TO RATERS	121
10. THE STRATEGY ASSIGNED TO EACH SUBJECT BY EACH RATER	124
11. AGE OF SUBJECTS AND SCORES ON HFTV, ORFT, AND HENMON-NELSON TEST OF INTELLIGENCE FOR INITIAL ADMINISTRATION AND RETEST	129
12. ABSTRACT OF <u>Psychological Differentiation and Strategy Choice in Bruner's Concept Attainment Tasks</u>	133

LIST OF TABLES

Table	page
I.- Summary of Rule Types for a Given Focus Card . .	58
II.- Typical Derivation of Rules from a Given Focus Card	60
III.- Intercorrelations among HFTV, ORFT, H-N(V) and H-N(Q) Scores	66
IV.- Age, HFTV, and ORFT Score Distributions for the Respective Strategy Types	72
V.- Results of Post Hoc Procedures following Multi- variate Analysis of Variance on the Dependent Measures	75

INTRODUCTION

The contention that a student's Cognitive Style is a significant factor in the learning process is the subject of increasing attention in educational research. One of the earliest notions of cognitive style may be traced to the works of Witkin. He has examined individual differences in the characteristic ways which people perceive both the world and themselves. In order to quantify these variations, he has developed the Field Independent-Dependent (FI-FD) dimension. Witkin has used the Differentiation Hypothesis to explain what he believes to be a more highly developed and complex intellectual function at the FI pole of the dimension.

A particularly interesting research problem is centred around the relationship between the cognitive style of the student and the strategies used by him in solving concept attainment problems.

Bruner has developed stimulus materials for the study of concept attainment which follow from his definition of a concept. These materials consist of eighty-one cards which contain various values of several perceptual attributes. The object of Bruner's experimental procedure is for the subject to discover a specific rule used to classify the cards. Bruner has suggested that two different strategies,

each having different degrees of effectiveness are used by subjects during concept attainment. An analysis of the approach which a subject might employ in the solution of concept attainment problems suggests that there may be a third strategy which Bruner has apparently not considered. A preliminary investigation has indicated the existence of such a strategy.

The report consists of three chapters. Chapter one, considers Bruner's notion of a concept and Witkin's concept of psychological differentiation. In addition, a theoretical rationale is established for the prediction that strategy choice in Bruner's concept attainment tasks using the selection paradigm is a function of the subject's degree of psychological differentiation.

Chapter two is concerned with the Experimental Design used in the present study. Particular attention is given to a description of the sample, Bruner's stimulus display and procedures, the instruments used to measure degree of psychological differentiation, the means used to determine a subject's strategy and the plan of the statistical analysis of the data.

Chapter three presents and discusses the results of the data analysis. The chapter begins with a recapitulation of the two hypotheses. The reliability of the measuring instruments used with the present population is next

established. That is followed by the presentation and discussion of the results of testing the previously mentioned hypotheses. The chapter concludes with suggestions for further research.

The final portion of the text summarizes the particulars of the present study and the major conclusions which have been drawn.

CHAPTER I

REVIEW OF THE LITERATURE

The present research was designed to examine the relationship between psychological differentiation, as defined by Witkin, and strategy choice in Brunerian concept attainment tasks. Bruner's research has indicated that subjects demonstrate a consistent approach to the solution of concept attainment problems. In addition, Witkin has shown that the individual's characteristic mode of perceiving the environment can be identified. A specific link between the two has yet to be established.

The following steps are followed in the establishment of the theoretical rationale for the present study. Bruner's notion of a Concept will be defined and illustrated. Further, his procedures and the strategies which he has identified will be explained. On the basis of an examination of the relevant literature, the existence of an additional strategy apparently not considered by Bruner is postulated. Support for that postulate is found in the results of a pilot study which is reported.

The next section considers Witkin's theoretical basis of the differentiation hypothesis. Following this, the final section establishes a theoretical basis for predicting that strategy choice is a function of the subject's cognitive style.

1. Bruner's Notion of Concept Learning.

"A Study of Thinking", by Bruner, Goodnow and Austin¹ stimulated interest in concept learning by both educators and psychologists. Following this work, many experiments have appeared in the last decade.

Although the word "Concept" is now widely used, there is considerable disagreement among philosophers, psychologists and educators regarding its nature. In the present research, a concept will be defined according to Bruner. He reflects the viewpoints of cognitive psychologists and information theorists when he refers to a concept as:

A network of sign-significant inferences by which one goes beyond a set of observed criterial properties exhibited by an object or event to the class identity of the object or event in question and thence to additional inferences about other unobserved properties of the object or event.²

As an illustration of this definition, consider the concept 'apple'. It is noted that an object is red, shiny, roundish and has a stem. From these observed criterion properties, it may be inferred that the object is an apple. Once it has been concluded that the object is in fact an apple, additional inferences can be made about unobserved

¹ J. S. Bruner, J. J. Goodnow, and G. A. Austin, A Study of Thinking, New York, Wiley, 1956, xi-330 p.

² Ibid., p. 244.

properties. For example, if one concludes that the object is an apple one might infer that it is also good to eat, has brown seeds in the centre and will bruise if dropped on a hard surface.

The methods used by Bruner, provide both stimulus materials and methodology for the study of concept attainment within the framework of the aforementioned definition. In a number of researches, several different types of concept attainment tasks, stimulus materials and rule structures have been used. In the present study, Bruner's methodology and stimulus cards will be employed.

Bruner's stimulus materials present the subject with cards containing several perceptual attributes (i.e. colour, shape, number of shapes, number of borders). Either the subject is presented with a predetermined series of cards upon which the attributes can be observed (Reception Paradigm) or he is shown the total stimulus array (Selection Paradigm) with a focus card.

The concept attainment task requires the subject to analyze these attribute complexes into their component features. The subject must determine relevant attributes and must respond to each card in terms of its position along each of the attribute dimensions. For example, a card containing three green squares and a border must be classified by the subject in terms of its "Greenness", "Threeness" and

its "Single Borderedness", as well as the type of shape. The perception of a card as a unitary whole must be replaced by a perception of its attribute values as separate and independent features. The subject must adopt this procedure to determine the relevant attributes which together constitute the concept. An example of a concept to be attained might be "All cards containing three green objects".

When the selection paradigm³ is used, the subject is first shown a given card (referred to as the focus card) which is a "Positive Instance" of the concept. In the example previously given it will be recalled that the focus card shown would contain three green objects with one border. That card would be part of the entire universe of exemplars and non-exemplars displayed to the subject who must then select a card which he believes to be another instance of the concept. That is, an example of the rule to be attained. The only information given the subject is the experimenter's statement that the selection is a positive or negative instance of the concept. After such a cue, the subject may, if he wishes, attempt to state the correct concept which is being used to classify the attributes. If he fails to correctly verbalize the concept or does not wish to attempt a verbalization (hypothesis), another card selection is allowed.

3 Bruner, Goodnow, and Austin, Op. Cit., p. 83.

The process continues in this fashion until the concept is correctly verbalized. The experimenter is able to gain information necessary to determine which strategy is being used from responses given by the subject.

Bruner⁴ postulated the existence of and experimentally identified two general strategies, namely "Scanning", an approach in which the subject makes and tests hypotheses, and "Focussing", a strategy in which the subject tests the relevance of various attributes given a conjunctive rule structure; in which the attributes are joined by the logical connector "and".

He suggested that Scanning may be of two types, "Simultaneous Scanning", and "Successive Scanning". These variations involve the question of whether the subject chooses to work with all the possible rules for each focus card or a single rule at a time. It should be noted that if an eighty-one card display consists of four attributes per card, each with three values, then any given focus card can represent a total of fifteen possible rule types. A general method for the derivation of each of the rules for a given focus card will be discussed in Chapter Two. A summary of possible approaches and their Resultant Strategies is included in Appendix 1.

4 Bruner, Goodnow, and Austin, Op. Cit., p. 83-90.

When a subject uses a "Simultaneous Scanning" strategy, all of the fifteen possible rules for a focus card are kept in mind. Cards are chosen to systematically eliminate irrelevant rules. Simultaneous scanning will be defined as Strategy Type One. As will be pointed out later, it is a highly exacting strategy, seldom employed by subjects.

"Successive Scanning", the second variation of the "Entire Rule" approach to concept attainment is much less demanding of the subject than the first variation. This strategy, which will be termed "Strategy Type Two", involves the testing of a single rule which the subject chooses. Here, the subject makes a guess as to the correct rule then selects instances to modify his original rule choice until the correct rule is evolved. Since the use of this strategy involves the selection and modification of hypotheses, Bruner expected that the subject would state many hypotheses and would attain the concept with much variance in the time to solution, number of card selections and number of card selections plus hypotheses.

Whereas the subject using the "Entire Rule" approach deals with complete rules, one using the "Attribute Approach" attempts to build the correct rule from attributes which have been found to be relevant. Bruner's notion of "Conservative Focussing" and "Focus Gambling" are examples of the latter approach. He has described Conservative Focussing as follows:

According to this strategy, the subject uses the focus card to make a sequence of choices, each of which alters but one attribute value of the first focus card and tests to see whether the change yields a positive or a negative instance. Those attribute values of the focus card that yield negative instances when changes are features of the concept.⁵

This strategy which will be defined as Strategy Type Four involves an extremely systematic and highly logical means of card selection and interpretation. When it is used, the subject selects cards which vary in only one attribute from the focus card. If a change in the attribute results in the selection of a card which is a positive instance, then that particular attribute is irrelevant. If the subject varies only one attribute and the card selected is a negative instance of the concept, then the attribute which has been varied is relevant. Once all the attributes have been checked for relevance, the subject synthesizes the rule from its component relevant attributes. Thus, the subject should make very few hypotheses. Since the testing of each attribute requires only one card selection, it is reasonable to expect the subject to attain the concept with little variability in the number of cards selected, the time to solution and the number of cards selected, plus hypotheses made. In fact, the number of card selections should be equal to or

5 Bruner, Goodnow, and Austin, Op. Cit., p. 87.

slightly greater than the number of attributes contained in the stimulus display.

The second variation of the Focussing Strategy is termed "Focus Gambling" by Bruner. The principal feature of this strategy is that the subject refers to the focus card as a positive instance, then deliberately changes more than one attribute value at a time. In speaking of such an approach, Bruner has stated:

It does not guarantee that redundant choices will be avoided. For in so far as the person using this procedure does not use the information contained in negative instances he is likely to, and frequently does, choose instances in the course of solution that contain the same information that might have been assimilated from such prior negative instances.⁶

Focus Gambling will be labelled Strategy Type Four-A.

The "Gambling" nature of this strategy is as follows. If as the result of varying two attributes the subject selects a card which is a positive instance then information on two of the attributes will have been obtained with a single choice. If the instance selected is negative however, it is impossible to tell which of the two attributes is relevant and the subject must retrace his steps. It is likely that the subject using this strategy will attain the concept with fewer trials on the average than a subject using "Strategy Type Four". The subject using this strategy will

6 Bruner, Goodnow, and Austin, Op. Cit., p. 90.

state very few hypotheses and reach solution with slightly more variability in the number of cards selected, number of cards selected plus hypotheses and time to solution than a "Strategy Type Four" subject.

An apparent and intentional gap is found in the numbering of Bruner's strategy types by the omission of Strategy Type Three. Having examined Bruner's ideal strategies, the existence of a strategy like Focussing where the subject attempts to attain the concept by determining the status of individual attributes which form the rule can be postulated. Unlike Focussing, however, the subject tries to choose cards which are positive instances to discover the relevance of specific attributes by considering the attributes which positive instances have in common. That is, if two positive instances contain the element of "Greenness", then it is likely that "Greenness" is part of the concept. This strategy will be known as "Strategy Type Three". Using such an approach, the selection of cards may be made on a random basis initially. The subject may find however, that the probability of receiving a positive instance is increased by the selection of cards in some systematic manner such as by row or by column or by the selection of cards adjacent to the focus card. Since the rule is developed attribute by attribute, it is expected that the subject will make few hypotheses. Because the subject does not employ a technique which will

guarantee the selection of a positive instance with each card choice, some across problem variation in such measures as time to solution, the number of cards selected and number of cards selected plus number of hypotheses generated can be anticipated.

Bruner did not discount the existence of such a strategy although it was apparently not explored by him. Examination of the literature suggests that Strategy Type Three would be subsumed under the Scanning Strategy. This follows from Bruner's operational definition of Scanning previously cited. Moreover, Bruner's strategy research has been unable to find that subjects use the Simultaneous Scanning Strategy in practice. He therefore distinguished only between Successive Scanning and a category which includes both Conservative Focussing and Focus Gambling.

A pilot study to be elaborated upon later in the text, yielded information about the existence of Strategy Type Three. Analysis of the pilot study data led to the conclusion that sixteen of the 29 subjects tested did in fact employ this strategy.

Accordingly, it seems not unfounded to suggest that there could be five distinct and separate strategies which subjects adopt in the solution of concept attainment tasks given a conjunctive rule structure and presented by the selection paradigm. Moreover, it is suggested that the

strategy being used may be detected in the subject's responses to the following questions:

- 1) Did the subject entertain an initial hypothesis following the presentation of the focus card?
- 2) What factors contributed to the choice of a particular card?
- 3) In what way was the status of a particular card choice used to gain information regarding the concept to be attained?
- 4) Was the focus card used as a reference point or were the instances pooled in order to find common attributes?

Having considered the various strategy alternatives which are available to subjects and one general method of determining strategy, more specific methods employed by researchers will now be considered.

A review of the literature on the problem of strategy determination during concept attainment reveals that little work has been done since Bruner's original research. A

number of studies, Laughlin,^{7,8} Laughlin and Jordan,⁹ Giambra¹⁰ and Johnson,¹¹ have attempted to identify selection strategies for a number of conceptual rules and to explore some of the conditions which may influence strategy use or choice. These studies have assumed the validity of existent strategy determinant procedures. Only two researches, Laughlin¹² and Johnson,¹³ have attempted to extend the work of Bruner relating to the identification of strategy during a concept attainment task using the selection paradigm. Essentially, methods employed by these

7 P. R. Laughlin, "Focussing Strategy for Eight Concept Rules", in Journal of Experimental Psychology, Vol. 77, No. 4, 1968, p. 661-669.

8 P. R. Laughlin, "Selection Versus Reception Concept Attainment Paradigms as a Function of Memory, Concept Rule, and Concept Universe", in Journal of Educational Psychology, Vol. 60, No. 4, 1969, p. 267-273.

9 P. R. Laughlin and R. M. Jordan, "Selection Strategies in Conjunctive, Disjunctive, and Biconditional Concept Attainment", in Journal of Experimental Psychology, Vol. 75, No. 2, 1967, p. 188-193.

10 L. M. Giambra, "Selection Strategies for Eight Concept Rules with Nonexemplar Start Cards", in Journal of Experimental Psychology, Vol. 87, No. 1, 1971, p. 78-92.

11 E. S. Johnson, "Objective Identification of Strategy on a Selection Concept Learning Task", in Journal of Experimental Psychology Monograph, Vol. 90, No. 1, p. 167-196.

12 P. R. Laughlin, "Selection Strategies in Concept Attainment as a Function of Number of Persons and Stimulus Display", in Journal of Experimental Psychology, Vol. 70, No. 3, 1965, p. 323-327.

13 Johnson, Op. Cit., p. 169.

researchers to identify the subject's strategy are of two types. Both of these make use of an aspect of the subject's performance related to his selection of cards and statement of possible rules or hypotheses. In the paragraphs which follow, both of these methods will be discussed and their usage critically evaluated.

The first approach to strategy determination may be termed the "Method of Direct Classification" (DC) whereas the second approach may be termed the "Strategy Dependent Measure Approach" (SDM). The two approaches differ mainly in that the DC method makes a qualitative assessment of the subject's card selections and statement of hypotheses across several problems.

Although developed in its present form by Laughlin,¹⁴ the DC procedure can be traced to Bruner's¹⁵ notion that individuals classified as "Focussers" choose cards containing attributes which are more like the focus card than cards chosen by "Scanners". This approach requires the formulation of a number of rules which follow from the specific nature of the possible strategies. Those rules are used to classify the subject's performance on each concept attainment

14 Laughlin, "Selection Versus Reception Concept Attainment Paradigms as a Function of Memory, Concept Rule, and Concept Universe", p. 269.

15 Bruner, Goodnow, and Austin, Op. Cit., p. 100.

problem. The following rules to determine instances of focussing were developed by Laughlin and applied to each card choice and hypothesis statement in a given problem. Laughlin was thus able to calculate a Focussing Index which he defined as the ratio of the total number of focussing instances to total card choices for a given problem. The rules which he formulated are as follows:¹⁶

Rule 1: Each card choice must obtain information on one new attribute. New information is obtained if the card choice altered only one attribute not previously proven irrelevant or if more than one attribute was altered, the instance was either positive or the ambiguous information correctly resolved on the next card by altering only one attribute.

Rule 2: If a hypothesis is made, it has to be tenable considering the information available. Untenable hypotheses are of two types (a) a hypothesis for a value of an attribute when the other value of the attribute had previously occurred on a positive instance, e.g. the hypothesis "red square" when a green instance had been positive; (b) a hypothesis for a value which had previously occurred on a positive instance, e.g. the hypothesis "red square", when an instance with a red square had been negative.

Rule 3: The hypothesis must not be a repetition of a previous hypothesis.

After the rules have been applied, each card choice with or without a relevant hypothesis that satisfies the three rules is counted as a Focussing trial. The total number of Focussing trials can be divided by the total number of

¹⁶ Laughlin, "Selection Versus Reception Concept Attainment Paradigms as a Function of Memory, Concept Rule, and Concept Universe", p. 270.

card choices to give a continuous Focussing Index with values from 0.00 to 1.00. Accordingly, values nearing 1.00 are suggestive of a Focussing strategy.

The DC approach is thus sensitive to the way cards are selected and should reliably discriminate between a category composed of Strategy Types Four and Four-A on the one hand and a category composed of Strategy Types Two and Three on the other hand. This discrimination is possible because Strategy Types Four and Four-A systematically select cards which vary in one or two respects from the focus card whereas subjects using Strategy Types Two or Three do not employ this practice. As noted previously, subjects using Strategy Types Three, Four and Four-A do not entertain an initial hypothesis concerning the rule which the experimenter has in mind. The DC method does not make provision for the detection of whether or not a subject has entertained an initial hypothesis. It is important to note that it is not possible for the DC method to distinguish between individuals using a Type Two strategy and Subjects using a Type Three strategy because card selection is random in both cases.

A serious shortcoming of the DC method is that there is no assurance that it has tapped the intended strategy being used by the subject. In fact, it is possible that even though the subject has not purposely varied one attribute, some card choices will vary only in one respect from the

focus card. Using the rules previously cited, such a choice would be erroneously interpreted as part of a Focussing strategy. This misinterpretation will be particularly serious when subjects using the Successive Scanning (Type Two Strategy) attain the concept in a few card choices. It will be recalled that by using this strategy, a subject can attain the concept in a highly variable number of trials. With Strategy Type Two, it is to be expected that some subjects will reach criterion in as few as two trials. If both of these card selections are interpreted as Focussing trials, then the subject will be given a Focussing Index of 1.00. Such an occurrence was noted in a pilot study.¹⁷ When the aforementioned focussing rules were applied to the card choices made during several short solutions by subjects employing the Type Two Strategy, determined by other strategy determination methods to be discussed later, the Focussing Index suggested a Type Four Strategy. Therefore it seems questionable that the DC method can guarantee valid strategy classification.

Whereas the DC approach considers the qualitative nature of the cards chosen by the subject and assesses this by use of the Focussing Index, the SDM approach is based

¹⁷ R. Lyle, The Validity of Strategy Determining Procedures in Bruner's Concept Attainment Tasks, unpublished upgrading paper presented to the Faculty of Education, University of Ottawa, Ontario, 1973, ii-63 p.

entirely on strategy dependent measures. This approach requires that dependent measures be created which reflect the characteristics of strategy types. For example, the mean number of hypotheses has been used successfully by both Bruner¹⁸ and Johnson¹⁹ to distinguish Focussers from Scanners. The number of hypotheses refers to the number of rules stated by the subject before the rule is correctly stated. Since the Scanning Strategy (Strategy Type Two) involves an extension or verification of a rule which the subject entertains when the focus card is given, it is assumed that the Scanner will make more hypotheses than the Focusser, i.e. Strategy Type Two will involve the verbalization of more hypotheses than Strategy Type Three or either variation of Strategy Type Four.

There is also reason to believe that different amounts of across-problem variance in the number of cards selected, hypotheses made and time to solution will occur when different strategies are employed. One explanation of this phenomenon is as follows.

The fundamental nature of the Scanning Strategy suggests that "Scanners" (Strategy Types One and Two) choose a tenable hypothesis suggested by the focus card and proceed

18 Bruner, Goodnow, and Austin, Op. Cit., p. 101.

19 Johnson, Op. Cit., p. 170.

to test this hypothesis. Using Bruner's eighty-one card display, each focus card can be associated with fifteen tenable hypotheses. If the subject were aware of all the possible relevant hypotheses, then the strategy known as "Simultaneous Scanning", discussed previously, would be possible. The review of the literature suggests that such a situation is highly unlikely, since the use of Simultaneous Scanning (Strategy Type One) has not been identified except in research by Johnson.²⁰ The use of Simultaneous Scanning appears to be related to the complexity of the stimulus array. An analysis of Johnson's display suggests that its lack of complexity made it possible for the subject to detect and keep track of the entire set of tenable hypotheses and is a possible explanation of his finding. In general, although a subject is not able to formulate the complete set of hypotheses required for the employment of Simultaneous Scanning, he will be able to formulate some tenable hypotheses. It is from these hypotheses that he selects one to test when the Successive Scanning (Type Two) Strategy is used. There is a degree of probability that the subject will immediately choose the correct rule by chance and thus quickly attain the concept with few card choices and hypotheses. The probability of consistent rapid concept

20 Johnson, Op. Cit., p. 178.

attainment by chance hypothesis selection is small.

On the other hand, strategy types Three, Four and Four-A ensure a stable amount of information gain on each selection. It would therefore be expected that subjects using these strategies would attain the concept with less variability than Strategy Type Two subjects with respect to the following: 1) the number of cards selected, 2) the number of hypotheses made, plus the number of cards selected, and 3) time to solution.

The information gathering process has been shown to be less efficient for Strategy Type Three than for either form of Strategy Type Four. Therefore Strategy Type Three subjects should exhibit more variance in strategy dependent measures than the Type Four Strategists.

A vital question which has not been answered in previous research concerns the validity of these strategy determining procedures. Since valid and reliable classification of a subject's strategy on each problem is central to this research, a pilot study was designed and conducted to both cross validate and extend existent strategy determination methodologies. In that study,²¹ each subject was given one practice and three experimental concept attainment problems, using Bruner's stimulus array, instructions and

21 Lyle, Op. Cit., p. 27.

the selection paradigm. The time to solution, number of hypotheses, number of card choices and the nature of each card choice were recorded for each subject and problem.

Subsequently, each subject answered a questionnaire and made tape-recorded comments to provide information to directly determine the strategy being used. Three judges then examined this information and classified the strategy being used by each subject into one of three strategy types, Two, Three or Four. The mean Focussing Index, mean number of card choices to solution, and the mean number of hypotheses were calculated for each strategy type group. The variance in time to solution, number of card choices and number of card choices plus hypotheses stated was also determined.

As predicted, the strategy groups did exhibit differences in each of the aforementioned measures. These differences were in the predicted direction but were not statistically significant.

It was found that the subject's description of the method used to solve the problems yielded much information. It is suggested that this information is essential to the proper determination of strategy usage. This is because subjects often make card choices on a purely random basis which the experimenter could falsely interpret as an indication of a particular strategy. It was concluded that until

further research has been done to validate strategy determination methods, emphasis should be placed on evidence obtained directly from the subject together with that provided by statistically based strategy determinant procedures. The present research will therefore extend previously employed strategy determination procedures by considering evidence given directly by the subject together with that suggested by those statistically based indicators previously described.

To this point, this chapter has been concerned with the nature of concept attainment tasks and related research. Since the present study proposed to investigate the relationship between mode of stimulus perception and strategy choice, the discussion will now be directed to Witkin's Concept of Psychological Differentiation.

2. Witkin's Concept of Psychological Differentiation.

Witkin's^{22,23,24,25} earliest reported works were concerned with establishing the locus of spatial orientation. Those experiments were developed to determine whether environmental cues in the surrounding perceptual field or postural factors were responsible for a subject's ability to perceive the upright in space. The results indicated that there were consistent and stable differences in a subject's ability to orient himself in space. It was also shown that perceptual orientation is related to social and personal traits. Witkin expressed this notion as follows:

22 S. E. Asch and H. A. Witkin, "Studies in Space Orientation: I. Perception of the Upright with Displaced Visual Fields", in Journal of Experimental Psychology, Vol. 33, No. 3, 1948, p. 324-337.

23 S. E. Asch and H. A. Witkin, "Studies in Space Orientation: II. Perception of the Upright with Displaced Visual Fields and with Body Tilted", in Journal of Experimental Psychology, Vol. 38, No. 4, 1948, p. 455-477.

24 H. A. Witkin and S. E. Asch, "Studies in Space Orientation: III. Perception of the Upright in the Absence of a Visual Field", in Journal of Experimental Psychology, Vol. 38, No. 5, 1948, p. 603-614.

25 H. A. Witkin and S. E. Asch, "Studies in Space Orientation: IV. Further Experiments in Perception of the Upright with Displaced Visual Fields", in Journal of Experimental Psychology, Vol. 38, No. 5, 1948, p. 762-783.

The way in which a person orients himself in space is an expression of a more general preferred mode of perceiving which, in turn, is linked to a broad and varied array of personal characteristics involving a great many areas of psychological functioning.²⁶

A number of ingenious tests were developed to detect an individual's spatial orientation skills. These included the Rod and Frame Test (RFT)²⁷ and the Tilting Room-Tilting Test (TRTT).²⁸ The latter test is administered in two parts: (i) the Room Adjustment Test (RAT); and (ii) Body Adjustment Test (BAT). Another test called the Embedded Figures Test (EFT),²⁹ with both individual and group versions was developed later. A children's Embedded Figures Test (CEFT)³⁰ was designed as well.

Each of the tests mentioned above require the subject to perceptually differentiate an item from the influence of the surrounding field, whether it be a rod, a figure, or a body in space. Witkin considered the subject's degree of proficiency in the various tasks to be the reflection of a

26 H. A. Witkin, R. B. Dyk, H. F. Faterson, D. R. Goodenough, and S. A. Karp, Psychological Differentiation, New York, Wiley, 1962, xii-418 p.

27 Ibid., p. 36-37.

28 Ibid., p. 37-39.

29 Ibid., p. 39-40.

30 S. A. Karp and Norma L. Konstadt, Manual for the Children's Embedded Figures Test, New York, Cognitive Tests, 1963.

field approach mode which he called the field dependent-independent dimension. The consistent performances of subjects on these measures were considered to support the contention that field dependence-independence is a reflection of a stable aspect of an individual's perceptual process. Thus a field dependent person who experiences difficulty on the RFT would be expected to encounter difficulty in locating an embedded figure as well as overcoming the influence of a tilted room. Conversely, a field independent subject with the ability to overcome the influence of the frame in the RFT would be expected quickly to locate the embedded figure in the EFT and more closely estimate the vertical position of his body in space.

Witkin therefore contends that the field dependent-independent dimension reflects an individual's mode of field approach; and that this field approach is reliably linked to a varied array of personality characteristics.

In order to test the consistency of that linkage, Witkin and his co-workers have correlated information from clinical interviews as well as psychodiagnostic and perceptual tests. They have identified several correlates of the field dependence-independence dimension, some of which are noted below.

Personality characteristics of the field dependent extreme are:

1. A less well developed notion of self esteem and body image.
2. Great sensitivity and/or attentiveness to social contacts.
3. Maintenance of popular attitudes.
4. A tendency to change attitudes to coincide with attitudes held by authority figures.

By contrast, the field independent extreme of the dimension is usually associated with characteristics which are in direct contrast to the aforementioned attributes. A more elaborate treatment of these field dependent-independent personality characteristics is presented in Witkin's text.³¹

Witkin, et al. carried out many investigations to consider the developmental aspects of the field dependent-independent dimension. It was found that young children tended to function in a field dependent manner. Cross sectional studies revealed that as the age of the subjects studied was increased, there was a noticeable tendency for the group to yield scores which indicated increasing field independence, but individual subjects maintained the same relative position within the group with respect to the dimension.

31 Witkin, et al., Op. Cit., 1962, p. 229-269.

It is understandable that personality characteristics are related to the developmental path. As Witkin suggests, a child's self concept is initially undifferentiated and lacking in decisiveness in nearly all areas of functioning. As the child matures, it is increasingly easier for him to distinguish himself from others, objects from other objects and times from other times.

To this point, Witkin's research consisted of a series of varied and interesting observations that were lacking a theoretical basis. Then he evolved the differentiation hypothesis which is based on Werner's orthogenic principle to provide the necessary theoretical underpinning. According to the orthogenic principle,

... an increasing differentiation and refinement of mental phenomena and functions and a progressive hierarchization may be accepted as a basic principle.³²

Werner contends that the development of differentiation proceeds from a relatively diffuse or global or undifferentiated state toward more differentiation and hierarchic integration. Furthermore, he considers both an external and internal aspect of differentiation. For example, the primitive or "yet to develop" personality structure is more homogeneous, more globally determined, similar to Lewin's concept

³² H. Werner, Comparative Psychology of Mental Development, New York, Science Editions, 1948, p. 51.

of the inner-personal region of an undifferentiated person. The external aspects have to do with extent of differentiation between self and other. That is reflected in the global and undifferentiated perceptual process. In other words, the undifferentiated individual is diffuse and global in both his inner psychological structure and in his total functioning.

An appropriate extension of Werner's principle might be that an individual who is poorly differentiated would be expected to experience difficulty in perceiving an object or stimulus out of context of its surroundings or to have a clearly articulated concept of himself. In fact such a claim was made and demonstrated by Witkin, et al. who formulated an elaboration and precise extension of the definition of differentiation which states that differentiation is

... the complexity of a System's Structure. A less differentiated system is in a relatively homogeneous structural state; a more differentiated system in a relatively heterogeneous state.³³

The following quotations offer at once a summary and elaboration of the view Witkin, et al. have on differentiation and the functioning of a highly differentiated system, its application to a psychological system and the relation with the surrounding field.

33 Witkin, et al., Op. Cit., 1962, p. 9.

Among the major characteristics of the functioning of a highly differentiated system is specialization. The sub-systems which are present within the general system are capable of mediating specific functions which, in a relatively undifferentiated state, are not possible or are performed in a more rudimentary way by the system as a whole.

When used to describe an individual's psychological system specialization means a degree of separation of psychological areas, as feeling from perceiving, thinking from acting. It means as well specificity in manner of functioning within an area. Specific reactions are apt to occur in response to specific stimuli as opposed to diffuse reaction to any variety of stimuli. Parts of a perceptual field are experienced as discrete, rather than fused with their background. Impulses are channelized, contrasting with the easy 'spilling over' characteristic of the relatively undifferentiated state. More or less discrete feelings and needs are likely to be present.

[...] With respect to relation with the surrounding field, a high level of differentiation implies clear separation of what is identified as belonging to the self and what is identified as external to the self. The self is experienced as having definite limits or boundaries. Segregation of the self helps make possible greater determination of functioning from within, as opposed to a more or less enforced reliance on external nurturance and support for maintenance, typical of the relatively undifferentiated state.³⁴

Thus, Witkin's perceptual measures in effect operationally define the extent to which a person's systems are differentiated. That is, a relatively undifferentiated person tends to be field dependent in his perceptual performance and would experience difficulty in overcoming the influence of the surrounding form in the RFT, the tilt of the room in

34 Witkin, et al., Op. Cit., 1962, p. 9-10.

the BAT, or distracting lines in the EFT. A more differentiated person would be expected to perform in a field independent manner and despite distracting stimuli be able to accurately orient himself to the vertical in space, adjust the rod to the true vertical or locate a hidden figure. Because the self is segregated from that which is external to the self, the field independent individual can function more independently of the thoughts and actions of others than one who is field dependent. This conclusion has, in fact, been borne out by empirical research.

Witkin's contention that the dimension of field dependence-independence is a unique factor in psychological functioning is not universally accepted. Zeigler^{35,36} expresses concern that many of the empirical relationships found between Witkin's perceptual measures and certain other tests could be due to the common relationship between all the scores on these measures and "general intelligence" as determined by standard intelligence tests.

With respect to this point, the literature which has examined the relationship between scores on measures of

35 E. Zeigler, "A Measure in Search of a Theory", in Contemporary Psychology, Vol. 8, No. 4, September 1963, p. 134.

36 E. Zeigler, "Zeigler Stands Firm", in Contemporary Psychology, Vol. 8, No. 4, 1963, p. 459-461.

psychological differentiation and intelligence has revealed that:

1. Correlations between total intelligence scores and measures of psychological differentiation ranged from 0.20 to 0.57.^{37,38,39}
2. Correlations between scores on verbal measures of intelligence and measures of psychological differentiation ranged from 0.06 to 0.47.^{40,41,42}
3. Correlations between scores on quantitative measures of intelligence and measures of psychological differentiation

37 T. E. Dubois and W. Cohen, "Relationship between Measures of Psychological Differentiation and Intellectual Ability", in Perceptual and Motor Skills, Vol. 31, 1970, p. 411-416.

38 James V. Spotts and Bernard Mackler, "Relationship of Field-Dependent and Field-Independent Cognitive Styles to Creative Test Performance", in Perceptual and Motor Skills, Vol. 24, 1967, p. 349-268.

39 M. McCarrey, Laurent Dayhaw and Gilles P. Chagnon, "Attitude Shift, Approval Need, and Extent of Psychological Differentiation", in Journal of Social Psychology, Vol. 84, 1971, p. 141-149.

40 Roger Elliott, "Interrelationships Among Measures of Field Dependence, Ability, and Personality Traits", in Journal of Abnormal and Social Psychology, Vol. 63, No. 1, 1961, p. 27-36.

41 J. Bieri, W. Bradburn and Galinski, "Sex Differences in Perceptual Behaviour", in Journal of Personality, Vol. 26, 1958, p. 1-12.

42 Spotts and Mackler, Op. Cit., 1967, p. 240.

ranged from 0.09 to 0.51.^{43,44,45,46}

4. Correlations between the RFT and total intelligence scores are generally smaller than those obtained with the EFT.^{47,48,49}
5. Correlations between scores on tests of Quantitative ability and the EFT are greater than for those obtained on measures of verbal ability.^{50,51,52}
6. Correlations between total intelligence and measures of psychological differentiation are generally lower for females than for males.^{53,54}

43 Elliott, Op. Cit., 1961, p. 30.

44 Bieri, et al., Op. Cit., 1958, p. 11.

45 Spotts and Mackler, Op. Cit., 1967, p. 245.

46 Dubois and Cohen, Op. Cit., 1967, p. 414.

47 F. Haronian and A. Sugerman, "Field Independence and Resistance to Reversal of Perspective", in Perceptual and Motor Skills, Vol. 22, 1966, p. 543-546.

48 Elliott, Op. Cit., 1961, p. 30.

49 Dubois and Cohen, Op. Cit., 1970, p. 415.

50 Bieri, et al., Op. Cit., 1958, p. 11.

51 Dubois and Cohen, Op. Cit., 1970, p. 415.

52 Spotts and Mackler, Op. Cit., 1967, p. 245.

53 Norman L. Corah, "Differentiation in Children and Parents", in Journal of Personality, Vol. 33, 1965, p. 300-309.

54 Douglas N. Jackson, "Intellectual Ability and Mode of Perception", in Journal of Consulting Psychology, Vol. 21, No. 6, 1957, p. 458.

In order to explain findings such as these, Witkin has replied:

The significant relation frequently reported between measures of field dependence and total intelligence test scores is "carried" largely by those portions of intelligence tests which require analytical functioning.⁵⁵

Notwithstanding Witkin's view, in light of the existing empirical evidence, it is suggested that a measure of intelligence should be included in experiments which use measures of psychological differentiation, to provide a basis for statistical control.

Other authors have defended Witkin from his critics, for example, McCarrey points out that:

Despite the possible earlier methodological weakness and possible over extension of the breadth of the psychological differentiation construct, its value as a heuristic model is paid tribute by the sheer abundance of data it articulates and synthesizes.⁵⁶

Yamada⁵⁷ too, makes a pertinent observation when he notes that a strong critique is a reflection of viable theory building. In this study then, the dimension of field dependence-independence is assumed to provide an index of the

55 Witkin et al., Op. Cit., 1962, p. 80.

56 M. McCarrey, Attitude Shift Approval Need and Extent of Psychological Differentiation, unpublished doctoral thesis presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1969, p. 32.

57 K. Yamada, Extent of Psychological Differentiation as Related to Intelligence, unpublished doctoral thesis presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1968, viii-100 p.

extent of psychological differentiation.

It has been shown previously that there are characteristic modes of attack which are employed when subjects perform concept attainment tasks. On the other hand, an examination of Witkin's notion of cognitive style revealed several pervasive dimensions of psychological functioning, each of which appears to be consistent with the requirements for the utilization of a specific strategy during concept attainment. Although no research was found which predicted that the use of a particular strategy is a function of the subject's cognitive style, two recent studies have shown that there is a relationship between certain measures of psychological differentiation and performance on concept attainment tasks. Dickstein⁵⁸ compared the performance of female FI and FD groups using Bruner's stimulus array and selection paradigm. (N=20 for each group). Three dependent measures were used. These were: number of choices to solution, number of redundant choices and number of incorrect verbalizations of hypotheses. Each subject was given three problems in the same order, as well as the Otis Self Administered Test of Mental Ability Higher Examination Form A, to provide data with which to determine if intelligence was a

⁵⁸ L. Dickstein, "Field Independence in Concept Attainment", in Perceptual and Motor Skills, Vol. 27, 1968, p. 635-642.

significant variable in performance.

Analysis of the data indicated that no significant difference existed between the mean intelligence scores of the subjects in the two groups. As hypothesized, the FI group of subjects was more efficient in the performance of the concept attainment task as measured by a) the mean number of card choices, b) the total number of incorrect verbalizations, c) the thoroughness with which attributes were tested. Thoroughness was determined by comparing the attributes tested by subjects to the total number of attributes which could have been tested. The FI subjects left fewer attributes unvaried throughout a problem than the FD subjects.

The study suffered from several shortcomings. First, the study only used one measure of psychological differentiation, the HFT. The use of a proprioceptive measure, such as the RFT, in addition to the perceptive measure would have greatly increased the generalizability of the results. Secondly, since all problems were identical and given in the same order, it was possible for experimental bias to take place because of communication between subjects. Thirdly, qualitative differences, that is the specific nature of the cards selected and hypotheses made, in the subject's solution, were not considered. Although a relationship was found between degree of psychological differentiation as measured by the HFT and quantitative measures of performance (number

of cards selected, etc.), no specific explanation can be deduced from the data. This is because no information was gathered with which to determine either a subject's rationale for the selection of particular cards, or the use of feedback from the experimenter or the role of the subject's interpretation of the role which her hypothesis played in problem solution.

Another study by Klausmeier⁵⁹ attempted to examine the extent to which an individual's cognitive style influences performance on concept attainment problems of varying complexity levels. Complexity was defined in terms of the number of bits of irrelevant information, that is the attributes not included in the rule contained within the problem. His stimulus material had several dimensions. These dimensions and corresponding values were (1) letter H or L, (2) number of letters 1 or 2, (3) size of letters, large or small, (4) colour of letters, red or green, (5) position of letters, upright or tilted, (6) normal position of letters, left or right, (7) vertical position, that is upper or lower case.

A slide projector was used to present stimuli according to the requirements of the reception paradigm previously described. It will be recalled that the reception paradigm

59 J. Klausmeier and J. Davis, "Cognitive Style and Concept Identification as a Function of Complexity and Training Procedures", in Journal of Educational Psychology, Vol. 61, No. 6, 1970, p. 428.

procedure differs from the selection paradigm procedure. In the former a predetermined sequence of cards are presented one at a time. In the latter the subject is allowed to see the entire universe of cards and subsequently to make his own selections.

Klausmeier's subjects were fully instructed as to the nature of their task and the complexity of the particular problem to be solved. A field dependence measure was obtained by use of a HFT administered to 310 high school males. Three groups of 30 subjects were selected. One group which scored plus one or more standard deviations from the mean was defined as the FI group. The second group which scored plus or minus one or more standard deviations from the mean was described as the FD group. A third group was selected at random from subjects with scores between plus and minus one standard deviations from the mean. Three response measures were employed. These were trials to criterion, total errors to criterion and total time to criterion.

As hypothesized, the FI group identified the concepts easily and the FD group experienced considerable difficulty while individuals falling in the middle of the hidden figures test score distribution performed at an intermediate level. A hypothesized interaction of cognitive style and complexity was not supported.

The major criticisms of that study are: a) failure to control for intelligence; b) since the reception paradigm was used there was no opportunity to compare the performance of subjects in qualitative ways; and c) psychological differentiation was defined only by means of the HFT, as in the Dickstein experiment.

Thus, a review of the literature has revealed that a subject's performance on concept attainment tasks is related to his score on some measures of psychological differentiation. Klausmeier stated:

Based upon the cognitive style literature, it may be suggested that subjects who experience difficulty in separating a simple geometric pattern from an embedded context also experience difficulty in separating relevant from irrelevant dimensions in concept identification.⁶⁰

In order to explain this relationship Klausmeier has hypothesized:

It may be that Low Analytic Subjects (FD) are unable to utilize feedback to process information or to test hypotheses as effectively as High Analytic Subjects (FI).⁶¹

A more complete explanation of the relationship was touched upon earlier in this chapter. It was stated that a number of strategies are available for use during concept attainment problem solution. Moreover, the use of those

60 Klausmeier and Davis, Op. Cit., 1970, p. 428.

61 Ibid.

strategies requires varying degrees of skills and feedback utilization. It can be deduced that certain aspects of psychological functioning known to be characteristic of the FI-FD dimension are pre-requisite to the application of these strategies. For example, in order to use Strategy Type Four, the subject must perform a perceptually complex routine. First, there must be an awareness of all the attributes which have been included in the stimulus display. Secondly, cards must be selected in order to vary one or two attributes with respect to the focus card. Thirdly, the feedback concerning the significance of selecting either a positive or a negative instance must be correctly interpreted. Finally, the rule must be synthesized from the attributes which have been found to be relevant.

The use of Strategy Type Four appears to require the skills and aptitudes which are characteristic of Field Independent individuals. That is, a subject must demonstrate an ability to experience each of the individual attributes on the cards of the stimulus display as discrete components in order to make selections which vary only in one respect from the focus card.

Perhaps the most striking requirement is the necessity to interpret both positive and negative responses as useful information in concept attainment. It may well be that Field Dependent individuals possess a tendency to

interpret such information as being an indication of the personal approval or disapproval on the part of the experimenter. This would seem to suggest that these subjects would be less likely to employ a Strategy Type Four which carries the danger of apparent social rejection by the experimenter.

In direct contrast, subjects who use Strategy Type Two are more likely to score at the Field Dependent end of the FI-FD continuum, since hypotheses can be tested directly without need for perceptual awareness of all the attributes in the display. That is, the subject can develop a tenable hypothesis by considering the focus card as a whole. This hypothesis can be tested directly, and can be altered without the application of a complex card selection system.

Although the use of Strategy Type Three involves testing of attributes as did Strategy Type Four, the method for selecting positive instances is not too exacting. That is, information is obtained by directly assessing the significance of positive instances which makes Strategy Type Three much less demanding than Strategy Type Four in terms of perceptual requirements placed on the subject.

Since the use of Strategy Type Three requires an intermediate level of skill when compared to Strategy Type Four and Strategy Type Two, this Strategy would most likely be employed by the subject in the middle of the FI-FD

continuum. In practice, it is possible that not all subjects perceptually capable of using Type Four will in fact use it. Many have been taught to reserve judgement until sufficient evidence has been accumulated with which to make a decision. Accordingly, it would be expected that such subjects would experience difficulty in determining the attributes which positive instances have in common and hence attain the concept with considerable difficulty.

Based upon the preceding observations, the present study will consider the following question: Is the choice of strategy during the performance of Bruner's concept attainment tasks related to the subject's degree of psychological differentiation?

In order to examine that question, it was postulated that the choice of a given strategy during the performance of Bruner's concept attainment tasks is related to differences in the subjects with respect to degree of psychological differentiation. Specific approaches to testing that postulate are found in the following hypotheses:

- a) The mean psychological differentiation score of individuals who use Strategy Type Two differs from that of those who use Strategy Type Four. Type Two individuals score toward the Field Dependent end of the Field Independent-Dependent continuum while Type Four individuals score toward the Field Independent end.

- b) The mean psychological differentiation score of individuals who use Strategy Type Three lies between the means of Strategy Type Two and Strategy Type Four individuals.

CHAPTER II

EXPERIMENTAL DESIGN

The purpose of the present study was to examine the relationship between psychological differentiation as defined by Witkin and Strategy choice in Bruner's Concept Attainment tasks. The theoretical rationale underlying the current research was presented in Chapter One while this Chapter details the selection of the measuring instruments and the experimental procedure. A description of the sample is followed by a description of Bruner's Stimulus display for use with the selection paradigm. Justification for the selection of the measuring instruments to measure psychological differentiation are given. Specific aspects of the method used to determine a subject's strategy selection are explained. Procedures used for the administration of the testing instruments are elaborated upon. The selection and training of raters who determined each subject's strategy is described. The final portion deals with the plan for the statistical analysis of the data.

1. The Subjects.

The ninety-five volunteer subjects who participated in the experiment were female first year nursing students enrolled at the Algonquin College School of Nursing during

the 1973/74 academic year. The mean age of the group was nineteen point seven four years with a standard deviation of 2.17. All subjects were Ontario Grade 12 graduates enrolled in the school for the first time. Of the ninety-five subjects who completed the First Session of the experiment, five chose not to continue. In addition, the data obtained from one subject was not included in the analysis since she had taken part in a similar type of experiment.

2. Bruner's Stimulus Display.

The stimulus array used to present Bruner's concept attainment tasks to subjects, following the requirements of the selection paradigm, consists of eighty-one cards 2.5 by 4.0 inches in size. These are arranged in a specific order to form a nine by nine matrix. For ease of administration, in the study they were mounted on a piece of plywood forty inches long and twenty-nine inches wide. Each card was numbered in sequence commencing with the extreme left of the uppermost row. This was done to facilitate the identification of individual cards during the experiment.

The cards in the stimulus display showed combinations of four attributes. These were: colour of shape (red, black or green), shape (square, cross or circle), number of shapes (one, two or three) and number of borders (one, two or three). It must be noted that all borders were black in colour. The

first three rows of the matrix contained twenty-seven cards with single borders. The second three rows showed twenty-seven cards with double borders while the third three rows had twenty-seven cards with three borders. Rows one, four and seven contained cards with one shape. Rows two, five and eight had cards with two shapes while rows three, six and nine contained cards with three shapes. Columns one, four and seven contained cards with crosses. Columns two, five and eight had circles on the cards while Columns three, six and nine had cards with squares. The first three Columns contained black figures, the second three Columns contained green figures while the third three Columns had red figures. An illustration of the entire stimulus array is to be found in Appendix 2. Administration of the Concept Attainment Task is described later in this chapter.

3. Instruments Used for the Collection of Data.

The independent variable was the strategy used by individual subjects during a series of concept attainment problems. The dependent variable was the degree of a subject's psychological differentiation. A standard measure of intelligence was included for reasons which have been discussed previously.

a) The measurement of psychological differentiation.-

A number of perceptual and cognitive tasks were available with

which to operationally define this variable. The two instruments selected were versions of Witkin's measures. These were: Hidden Figures Test Form V (HFTV) and the Oltman Rod and Frame Test (ORFT). In the following paragraphs, the selection of these particular tests will be justified on the strength of levels of reliability and validity reported in the literature.

Witkin's¹ first Hidden Figures Test was designed for individual administration. Subsequently, group versions have been developed for use with large samples. Recent research by Jackson, Messick and Myers² and Spotts and Mackler³ have shown significant correlations between Witkin's original individual form of the HFT and several group forms of the Embedded Figures Tests. The Hidden Figures Test Form V, which is one such test, was used in the present research. Jackson et al.⁴ have found a correlation of 0.84 ($p < 0.01$) between it

1 H. A. Witkin, "Individual Differences in Ease of Perception of Embedded Figures", in Journal of Personality, Vol. 19, No. 1, 1950, p. 1-15.

2 Douglas N. Jackson, Samuel Messick and Charles T. Myers, "Evaluation of Group and Individual Forms of Embedded Figures Measures of Field-Independence", in Education and Psychological Measurement, Vol. 24, No. 2, 1964, p. 177-192.

3 James V. Spotts and Bernard Mackler, "Relationships of Field-Dependent and Field-Independent Cognitive Styles to Creative Test Performance", in Perceptual and Motor Skills, Vol. 24, No. 1, 1967, p. 239-268.

4 Jackson, et al., Op. Cit., p. 187.

and Witkin's original test. In addition, Stelmack⁵ reports a test-retest reliability coefficient of 0.67 ($p < 0.01$) for that same instrument.

It has been shown repeatedly that the standard Rod and Frame Test displays much consistency and stability over time as indicated by both high split-half coefficients^{6,7} and test-retest estimates of reliability.⁸ This apparatus is designed to be used in a darkened room and requires elaborate facilities. Oltman⁹ has developed a portable apparatus for use in fully illuminated surroundings which appears to demonstrate comparable stability and validity. He reports a Spearman-Brown split-half estimate of 0.96 for a

5 Robert Stelmack, A Signal Detection and Information Theory Analysis of the Effect of Hue on Apparent Size for Groups of High and Low Analytic Ability, unpublished doctoral thesis presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1970, p. 47.

6 Kerry Yamada, Extent of Psychological Differentiation as Related to Intelligence, unpublished doctoral thesis presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1968, p. 65.

7 D. Hellkamp, Extent of Psychological Differentiation Among Male Hospitalized Schizophrenics Classified Along the Process-Reaction and Delusional-Halucinatory Dimensions, unpublished doctoral thesis presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1967, p. 67.

8 Witkin, Op. Cit., p. 15.

9 Oltman, P. K., "A Portable Rod and Frame Apparatus", in Perceptual and Motor Skills, Vol. 26, 1968, p. 506.

sample of eighty male and eighty-three female college undergraduate students and a correlation of 0.90 and 0.89 between this instrument and Witkin's RFT. McCarrey¹⁰ found a split-half coefficient of reliability of 0.90 ($p < 0.01$) for a sample of eighty graduate education and psychology students and he reports a test-retest reliability coefficient of 0.85 ($p < 0.01$).

In light of the aforementioned factors, both the Hidden Figures Test Form V and the Oltman Rod and Frame Test were considered to have demonstrated sufficient reliability and validity for use as research tools in the present study.

b) The choice of an Intelligence Measuring Instrument.-

A standard measure of intelligence was included in the present study for possible use as a co-variate because of the previously mentioned controversy concerning the relationship of general intelligence to mode of field approach. The Henmon-Nelson College Level Revised Edition (HN) was selected because of its widespread use and acceptability. This test consists of two scales; they are referred to as the Verbal Subtest, H-N(V) and the Quantitative Subtest, H-N(Q). The standard 40 minute time limit was employed in the present

¹⁰ Michael McCarrey, Attitude Shift, Approval Need and Extent of Psychological Differentiation, unpublished doctoral thesis presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1969, p. 76.

study. That this test manifests sufficient reliability for research purposes has been demonstrated by the high coefficients of odd-even reliability ranging from 0.92 to 0.95.¹¹ Its validity is reflected by correlations of 0.54 and 0.78 when the criterion was school achievement and the Nelson Denny Reading Test respectively.¹² It would therefore appear that the Henmon-Nelson test has demonstrated sufficient validity for the purpose of this experiment.

c) Means used to gather information to detect the subject's intended strategy.- The methods which have been developed to determine the strategy which a subject is using have been discussed in Chapter One. It will be recalled that the factors which allowed the detection of a specific strategy centred around the subject's use of hypotheses, her method of card selection and her interpretation of feedback from the experimenter concerning the status of the cards which were chosen by her. Reference was made to the development of an extension to existent strategy determination methods for use in the present study. This approach uses information obtained directly from the subjects during a taped interview and their responses to a questionnaire

¹¹ M. J. Nelson et al., Examiner's Manual, the Henmon-Nelson Tests of Mental Ability, College Level Revised Edition, Boston, Houghton Mifflin, 1961, p. 14.

¹² Ibid., p. 14.

administered after the completion of the Concept Attainment problems. The questionnaire was developed to cross-validate information concerning strategy utilization gathered by traditional modes. It also provides cross-validation for comments made by the subjects and taped by the experimenter. In addition, the questionnaire provides a check on the adequacy of the stimulus array and the procedure used during the concept attainment task. Since the explanation of the taped interview protocol sheds considerable light on the reasons for its inclusion in the experiment, it was decided to cite it here rather than in the appendix.

The first question asked by the experimenter during the taped interview was "Did you try to build the rule which was used from its components i.e. colour, number of shapes, etc. or did you consider a complete rule such as all cards containing 3 red circles, then modify it as you went along?"

Based on the theory which has been previously discussed, if a subject indicated that she used a complete rule and then subsequently modified it, this was taken as an indication of the use of Strategy Type Two. Similarly, subjects who responded that they built the rule from its component parts were judged to be using either Strategy Type Three or Four. Subjects using the complete rule were not required to answer question two since that question was designed to separate Strategy Type Three subjects from those

using Strategy Type Four.

The second question was "Using your method, would you be able to determine if a particular feature of the card such as number of shapes would be included as part of the rule on the basis of one card selection or did you have to choose a number of cards in order to gain that information?" If a subject indicated that only one card was required to determine the relevance of an attribute this was judged to be indicative of a Type Four Strategy.

Question three was "Describe how you selected particular cards during the solution of the problems?" It was assumed that subjects using Strategy Type Two would indicate that they selected particular cards to verify or correct the initial hypothesis. Strategy Type Three subjects apparently selected cards more or less at random, and Strategy Type Four subjects characteristically selected cards which varied in one or two aspects from the focus card.

The fourth question was "When you made a card selection, what were you able to conclude when the experimenter informed you that your card selection was an example of the rule?" Strategy Type Two subjects were expected to use a positive instance to confirm the rule which they had in mind. Strategy Type Three subjects were considered to have compared the characteristics of this card with those on the focus card in order to isolate the elements which these

cards had in common. To a Type Four strategist, a positive instance indicated that the particular attribute which was varied in that particular card selection was not part of the rule.

The fifth question was "When you made a card selection, what were you able to conclude when the experimenter informed you that the card was not an example of this rule?" Strategy Type Two subjects were obliged to conclude that the rule which they had in mind was not correct. A Strategy Type Three subject was expected to gain little information from such a choice. Subjects using Strategy Type Four concluded that the particular attribute which they had varied was indeed a part of the rule.

The final question was "At what point did you decide to state the rule?" Subjects using Strategy Type Two stated the rule after the selection of one or two positive instances. Strategy Type Three subjects stated the rule after a series of positive instances. Subjects employing Strategy Type Four stated the rule only after testing all attributes.

While the taped interview was designed to provide direct evidence concerning the particular strategy being used by the subject, the questionnaire, the complete text of which appears in Appendix 3, was used to cross validate the information obtained during the interview and to check the effectiveness of the procedures and stimulus display used during the

concept attainment task.

Question one of the questionnaire, completed in writing by the subject, was designed to determine if the procedure was fully understood before the three problems were performed. The subject was also given an opportunity to suggest information which might be included to improve the quality of the instructions for future experiments.

Question two was designed to determine if a given subject used the same strategy in each of the three problems. If the response was negative, the subject was asked to explain the nature of the change in attack. Thus it was seen as providing a check on the consistency of strategy usage as well as gaining information concerning the specific change in strategy if such took place.

Question three was intended to provide further evidence of strategy usage. It was expected that subjects using a Type Four Strategy would suggest that their performance would not improve if an additional three or four problems were given since this strategy involves the systematic testing of each attribute. A Strategy Type Three subject may feel that improvement in performance could be made by more efficient selection of cards and less redundancy in positive instances designed to test a specific attribute. A Type Two strategist should feel that he would become more adept at hypothesis generation and testing with practice and

thus improve his performance.

Question four was included to test whether any aspect of the stimulus display such as the size of the cards or the clarity of the features appearing on the cards, affected performance. In this way it was hoped to determine if the quality of the stimulus material was acceptable for this and future experiments.

Questions five and six taken in concert were designed to provide a cross-check on the strategy used by a subject. The assumption was made that there is a relationship between the strategy which a person would suggest to another individual and the strategy she herself uses. A discrepancy between the responses to these questions would suggest that the subject realized that there was more than one strategy available. This information served to alert the raters that a particular subject might change strategy during the performance of the three problems.

Question seven was designed to give the subject a chance to express her feelings concerning the experiment. This question served as a final check on the adequacy of the experimental procedure.

4. The Procedure used to Collect the Data.

To this point, a description of the characteristics of the subjects and Bruner's Concept Attainment Stimulus

Array have been provided. In addition the choice of instruments to determine extent of psychological differentiation and the method used to gather data with which to determine a given subject's strategy choice have been discussed. The report will now consider how each of those elements were combined in the procedure which was employed to collect the data.

The data were collected in four sessions. During the first session, subjects were introduced to the Experimenter and given the HFTV and the HN. Appendix 4 provides a sample item and the complete instructions of the HFTV while Appendix 5 contains the directions for the administration of the HN. In the second session, each subject a) was tested on the ORFT, b) performed the one practice and three experimental concept attainment problems, c) responded to the questionnaire, d) completed the taped interview. Appendix 6 contains Oltman's directions for the administration of the ORFT. Appendix 7 presents the instructions to subjects regarding the procedure to be followed during the performance of the concept attainment task.

The school administration requested potential subjects for the experiment to report to a large classroom for the first session. The Nursing Director encouraged the students to take part in the experiment, then introduced the experimenter who explained the time requirements and the general

nature of the experiment. Students were given the opportunity to leave if they did not wish to participate in the study; none left. The HFTV and the HN were then administered. The experimenter then indicated that each subject would be contacted individually concerning the time and place of the next session of the experiment.

For the second session each subject was asked to report to a room in the Nursing Building according to a pre-arranged schedule. The times ranged from eight o'clock in the morning to six o'clock in the evening. The room contained the Oltman Apparatus, and a table on which the stimulus display board had been placed and concealed with a cloth. A tape recorder was located on another small table.

Upon arrival at the laboratory, each subject was registered by the experimenter and asked to sit on a chair in front of the Oltman Apparatus and given the test.

When the subject completed the RFT she was then seated in front of the table on which the stimulus display had been placed. She was given the instructions concerning the procedure to be used in the Concept Attainment Task and told to study them for as long as desired. (Appendix 7).

The subject was told that her score would be determined by the number of card choices made before she was able to state the rule correctly. It was indicated that the first problem would be a practice problem and would not be scored.

After having completed the practice problem and the three experimental problems, each subject was given the questionnaire discussed previously. These questions were designed to give information concerning the particular strategy used for problem solution and to determine the adequacy of the instructions as well as the stimulus material. During the final portion of the second session, the subject was asked to make a taped interview to help the raters determine her strategy. When the session was completed, the subject was asked to refrain from talking to others about the experiment and assured that a complete explanation concerning its purpose would be provided after completion of the experiment.

The purpose of the third session was to obtain retest data on the HFTV and the Henmon-Nelson test of intelligence. These data were gathered using the same procedures employed in the first session. Similarly, the fourth session was a retest for the ORFT, again using Oltman's recommended procedure.

The method of gathering the information used to detect the particular strategy being employed by a subject has been explained earlier. A following section of the report will show how the aforementioned information was interpreted in order to arrive at a final strategy classification for each subject. Prior to that it is necessary to explain in

some detail how the concept attainment problems, given to each subject, were selected. That step is required because the literature does not report any systematic derivation procedures to be followed in establishing the fifteen rules, which can be derived from any given focus card used in the selection paradigm of Bruner's concept attainment stimulus materials.

Because the subjects were required to perform three experimental problems following the practice problem, it was necessary to select four specific conjunctive rules for each subject. It will be recalled that the rule comprises the substance of the problem. Subjects were each given a different set of rules to avoid the possibility of collusion.

Two steps were involved in the selection of a set of problems for each subject. These were: a) The random selection of a focus card from the eighty-one cards in the display and b) the random selection of four conjunctive rules from the fifteen rules which can be associated with a particular focus card. Table I shows fifteen rules which can be derived from any given focus card.

The focus cards were selected at random to decrease the possibility that any aspect of a given card or series of cards for example position on the display or colour would differentially affect a subject's performance. The random selection of particular rules which can be represented by a

Table I.-
Summary of Rule Types for a Given Focus Card

Number of Irrelevant Attributes	Characteristics of Possible Rules
0	Rn Rc Rb Rs
1	In Rc Rs Rb Rn Ic Rs Rb Rn Rc Is Rb Rn Rc Rs Ib
2	In Ic Rs Rb Rn Ic Is Rb Rn Rc Is Ib In Rc Rs Ib In Rc Is Rb Rn Ic Rs Ib
3	Rn Ic Is Ib In Rc Is Ib In Ic Rs Ib In Ic Is Rb

Rn - number of shapes relevant
Rc-colour of shapes relevant
Rs - shape relevant
Rb - number of borders relevant

In - number of shapes irrelevant
Ic - colour of shapes irrelevant
Is - shape irrelevant
Ib - number of borders irrelevant

given focus card was done to assure that subjects would not systematically be given rules with any particular number of irrelevant attributes. Since some evidence exists which suggests that concept attainment task difficulty is related to the number of irrelevant attributes in the rule, this precaution was felt to be necessary.

Table II shows a typical set of rules which could have been derived for and given to a subject for solution. Card 29 was randomly selected from the eighty-one cards in the display. Card 29 shows two black crosses and three borders. The relevant attributes comprising the characteristics of the rules are shown on the right hand side of Table II. These were selected at random from the fifteen possible rules shown in Table I. Appendix 8 contains the focus cards and the rules selected for each subject who served in the current study.

5. Selection, Training and Performance of Raters.

One female and four male raters were selected from the 1973-74 graduate students in the University of Ottawa Faculty of Education. It was ascertained that all were familiar with Bruner's work in concept attainment tasks.

The raters met collectively with the experimenter for an orientation session prior to the independent rating of each subject's strategies. At that time, each of the

Table II.-
 Typical Derivation of Rules from a Given Focus Card
 (Focus Card Number 29)

Problem	Rule	Characteristics of Rule
Practice Problem	2 Black Shapes	Rn Rc Is Ib
Problem 1	2 Black Shapes, 3 Borders	Rn Rc Is Rb
Problem 2	Black Shapes	In Rc Is Ib
Problem 3	2 Crosses	Rn Ic Rs Ib

strategies mentioned in Chapter One were reviewed in detail. In order to demonstrate a thorough understanding of these strategies, each rater was required to perform concept attainment problems using each strategy with the exception of simultaneous scanning. During that performance each rater was required to indicate why particular cards were chosen and why particular hypotheses were made. The raters were then provided with the instructions which appear in Appendix 9, and given access to the subject's taped interview, responses to the questionnaire and protocols for each of the three experimental concept attainment problems. The responses to the questionnaire and the protocols were placed in six loose leaf binders in the order which the subjects appeared on cassette recordings of their interviews. Six 60-minute cassettes were required for these purposes. The raters were thus able to work independently of each other in classifying the concept attainment strategy being used by each subject.

Approximately three weeks after all raters had completed the strategy determination process, they were asked to repeat their ratings of twenty-five subjects selected at random from the sample. This was done to provide a measure of rater reliability.

6. Plan of the Statistical Analysis.

The following consists of an overview of the statistical procedures used in the data analysis. Test-retest correlations were calculated for the HFTV, ORFT and HN tests to determine their stability during this experiment. Inter-correlations of the scores obtained by subjects on these instruments were also computed to determine if intelligence should be considered as a co-variate during subsequent analysis. The reliability of the raters was evaluated. Finally, a multivariate analysis of variance without a co-variate was carried out to test the hypotheses stated in Chapter One which predicted that type two subjects would differ from type four subjects on measures of psychological differentiation. Specifically Strategy Type Two subjects were expected to score toward the field dependent end of the continuum and Type Four subjects toward the field independent end. Furthermore, the mean psychological differentiation scores of subjects using Strategy Type Three were expected to fall between the means of the scores of Type Two and Type Four subjects.

This chapter has outlined the particulars of the experiment including such features as the rationale for the selection of the measuring instruments, the procedure for the collection of data and the plan for the data analysis. The next chapter will consider the results of the statistical procedures which were applied.

CHAPTER III

PRESENTATION AND DISCUSSION OF RESULTS

This chapter, which presents and discusses the results of the data analysis, begins with a recapitulation of the hypotheses to be tested. Specific attention is then given to reporting the test-retest reliability for the instruments to measure degree of psychological differentiation and intelligence from data gathered during the experiment. The intercorrelations among the subject's scores on the ORFT, HFTV, HN verbal and quantitative sub-tests were calculated to ascertain whether intelligence scores should be used as a co-variate. An analysis and discussion of the subjects' responses to the questionnaire is followed by an analysis and discussion of the results of the raters' independent ratings of each subject's intended strategy. The results of the multivariate analysis of variance and associated post hoc procedures to test the hypotheses are considered next. The chapter concludes with a discussion of the results of testing the two hypotheses considered in this study and suggestions for further research.

1. The Hypotheses to be tested.

As indicated in chapter one, the purpose of the current study was to determine if the choice of strategy during

the performance of Bruner's concept attainment tasks is related to the subject's degree of psychological differentiation. It was also postulated that a strategy apparently not considered by Bruner is identifiable. The two hypotheses to be tested were:

- a) Subjects who use Strategy Type Two will differ from subjects who use Strategy Type Four on the ORFT and the HFTV. Specifically, Type Two subjects will score toward the field dependent end of the continuum while Type Four subjects will score toward the field independent end.
- b) The mean psychological differentiation score of subjects who use Strategy Type Three lies between the means of Strategy Type Two and Strategy Type Four subjects.

2. The Reliability of the Measuring Instruments.

Prior to the analysis of the data to test the hypotheses, it was held to be prudent to establish the test-retest reliabilities of the instruments which measured degree of psychological differentiation and intelligence respectively. Provision was made during the experiment to collect the necessary retest data for these tests three weeks after the initial administration. The calculations yielded the following test-retest coefficients of reliability: 1) for the

ORFT, 0.76 (N=77, $p<0.01$); 2) for the HFTV, 0.74 (N=87, $p<0.01$); 3) for the Henmon-Nelson Verbal Scores, 0.85 (N=65, $p<0.01$); and 4) for the Henmon-Nelson Quantitative Scores, 0.89 (N=65, $p<0.01$). Those values are consistent with those reported in the literature.

Table III shows that the correlations between the H-N(V) scores and both the HFTV scores and the ORFT scores are not statistically significant. Neither is the correlation between the H-N(Q) and scores on the ORFT significant. A low but significant correlation was found between the H-N(Q) scores and the HFTV scores. In light of those results, it was concluded that the intelligence measures were not sufficiently correlated with either the HFTV scores or the ORFT scores to warrant their inclusion as co-variates in the present study. The findings are consistent with those of Dickstein¹ who reported a low correlation between measures of intelligence and the HFTV.

The correlation between the portable ORFT scores and HFTV scores was statistically significant yet lower than expected. The pilot study which preceded this research, obtained a correlation of -0.72 (N=29).

¹ L. Dickstein, "Field Independence in Concept Attainment", in Perceptual and Motor Skills, Vol. 27, 1968, p. 635-642.

Table III.-

Intercorrelations among HFTV, ORFT,
H-N(V) and H-N(Q) Scores, (N=90).

	ORFT*	Henmon-Nelson Verbal Subtest	Henmon-Nelson Quantitative Subtest
HFTV	-0.37**	0.20	0.30**
ORFT		-0.11	0.09
Henmon-Nelson Verbal Subtest			0.27**

* The negative correlation is due to the fact that
the scales are opposite in direction.

** $p < 0.01$

3. The Determination of the Strategy being Employed by the Subjects.

The stability of the measuring instruments as well as the relationship between measures of intelligence and psychological differentiation having been demonstrated, the concept attainment strategy being used by each subject was determined.

In chapter two, it was indicated that after performing the four concept attainment problems, the subjects completed a seven-item questionnaire. As mentioned previously, the items were designed not only to provide information regarding the strategy employed by a particular subject but also to determine the adequacy of the instructions and the clarity of the stimulus display. The responses to each of the items of the questionnaire are reported, followed by a presentation of the strategy classifications.

The purpose of question one was to determine if, in the opinion of the subjects, sufficient instruction had been given concerning the procedure to be followed during the concept attainment problems. Examination of the responses revealed that eighty-three of the subjects answered in the affirmative while only 7 answered in the negative. In each of these latter cases, the subject indicated that the practice problem clarified the procedure. It was therefore concluded that the subjects understood the procedure and the

required outcome of the concept attainment task before beginning the experimental problems.

Question two was designed to determine if a subject used the same strategy in each of the three experimental problems. Seventy-eight subjects responded in the affirmative and 12 in the negative. The explanations given by the twelve subjects were analyzed. The findings were consistent with those of the pilot study in that a true change in strategy occurred in only one case (type Two to type Four). In five instances, subjects merely added features to improve the basic strategy. In the remaining six cases, it was reported that only the order in which the attributes were tested was altered from problem to problem. This change in testing order was not held to constitute an application of a different strategy. Based on the data, it is therefore suggested that in most cases, subjects establish a basic strategy in the practice problem and attempt to refine it in subsequent problems.

In response to question three, seventy-seven subjects indicated that performance would improve if three or four more problems were given while twelve indicated that no improvement could be expected. While the problem of performance improvement over an increased number of problems was not specifically tested in this study, the data obtained revealed only a slight improvement by the group as a whole

over the three problems in terms of time to solution, number of cards selected and number of hypotheses made.

The purpose of question four was to ascertain if the stimulus display was of sufficient technical quality for this and future experiments. Sixty-six subjects responded in the affirmative. The qualifications which accompanied the remaining twenty-four negative responses were analyzed. In every case but one, the explanation centred around the subject's difficulty in breaking down the stimulus into its component parts rather than on the technical quality of the display.

Questions five and six taken together were designed to provide a comparison of the subject's written description of his strategy with his verbal description of that same event. It was found that eighty-five of the subjects would advise others to adopt their strategy in attempting to solve the task.

The final question gave the subject a chance to state any questions she would have liked to ask during the experiment. The majority of subjects declined to comment. However, those who did characteristically requested to be told the purpose of the experiment rather than to be given additional information related to the procedure.

There were differences in the clarity and completeness with which the subjects were able to describe their

strategies. On the whole, subjects gave more complete information during the taped interview. It is contended that the taped description was usually more valuable for strategy assignment than the written material.

It is of interest to note that the subjects who used Strategy Type Four are able to provide the most precise description of their strategy. For example, in the pilot study, one Type Four Strategist was able to draw a generalized flow chart which indicated how cards should be selected as well as the information gained when either positive or negative instances were encountered. Instructions on how to synthesize the rule after attributes had been tested were also included.

In summary, the analysis of the questionnaire supported the notion that subjects use the same strategy over a number of problems. It was also concluded that the instructions and stimulus display were adequate for use with this population.

The five raters, who had been trained according to the procedure discussed in chapter two, independently classified the subject's concept attainment strategy after 1) listening to the taped interview, 2) considering the responses to the questionnaire and 3) examining the protocols. The latter were examined to determine if the reason for the subjects' choice of cards and statement of hypotheses were

consistent with the pattern indicated by the other two information sources.

A subject was assigned to a particular strategy when three or more of the raters designated her to a given strategy. During the analysis of the questionnaire, it was discovered that one subject claimed to have had prior training on specific tasks which were similar to Bruner's Concept Attainment tasks. It was decided not to use the data obtained from this subject on the grounds that its inclusion might bias the results. The distribution of subjects by strategy group is shown in Table IV. The data generated by the raters for each of the subjects is shown in Appendix 10. Table IV also shows that of the eighty-nine subjects in the final portion of the experiment, 26 were assigned to Strategy Type Two, 44 to Strategy Type Three, and 19 to Strategy Type Four.

When the raters' assignments of strategy for each subject were compared, it was found that there was rater unanimity on thirty cases. That is, all raters assigned those subjects to the same strategy. In thirty-three instances, there was agreement among four of the raters while in twenty-six cases there was agreement between three of the raters. It was observed that rarely did disagreement occur between raters involving assignment of Strategy Type Four and Two. For the most part disagreements centred around whether or not a particular subject's strategy should

Table IV.
Age, HFTV and ORFT Score Distributions
for the Respective Strategy Types.

	Mean Age (years)	HFTV		ORFT	
		Mean	S.D.	Mean	S.D.
Strategy Type 2 (N=26)	19.67	4.81	3.47	6.35	6.33
Strategy Type 3 (N=44)	19.77	7.61	4.26	3.59	2.32
Strategy Type 4 (N=19)	19.83	9.00	3.69	2.53	1.72

be adjudged to be an example of Strategy Type Three. The ages of the subjects and their respective scores on the HFTV, ORFT and Henmon-Nelson Test of Intelligence for the initial administration and retest are shown in Appendix 11.

4. The Results of the Statistical Analysis.

The results of the raters' analyses indicate that a finite number of strategies exist which can be identified on the basis of verbal and written comments made by subjects after the solution of concept attainment problems. A significantly new finding is that Strategy Type Three exists. In that strategy the subject first arrives at the relevant attributes which constitute the rule through selection of a series of instances which have features in common with the focus card. She then combines those relevant attributes to give the final rule.

An analysis of variance was carried out with dependent variables being the subjects' scores on the HFTV and the ORFT. The computer program NYBMUL was developed by Finn² at the University of New York at Buffalo. The F-ratio for the multivariate test of equality of mean vectors was 4.99 there being 4,170 degrees of freedom ($p < 0.0008$). Since the pre-determined level for rejecting the null hypothesis

2 J. Finn, A General Model for Multivariate Analysis, New York, Holt, Rinehart and Winston, in progress.

was set at $p < 0.05$, it was concluded that significant differences between the mean scores on measures of psychological differentiation for the various strategies did in fact exist.

The null hypothesis having been rejected, the confidence interval procedure recommended by Finn was applied to determine whether differences between the means of the scores in the strategy groups in the HFTV and/or the ORFT contributed to the rejection. The intervals for each of the three contrasts for each dependent measure are shown in Table V.

Hypothesis one predicted that subjects who use Strategy Type Two will differ from subjects who use Strategy Type Four on measures of field independence. Type two subjects will score toward the field independent end. As hypothesized, the mean score for Strategy Group Two on both the HFTV and the ORFT was located toward the Field Dependent end of the FI-FD continuum while the mean score for Strategy Group Four was located toward the field independent end. These results were previously shown in Table IV.

Contrasts $Y_{11} - Y_{13}$ and $Y_{21} - Y_{23}$, that is mean scores of Strategy Type Two and Strategy Type Four subjects on both dependent measures served as the statistical test for hypothesis one. Both of these contrasts were significant at the $p < 0.05$ level of confidence. Hypothesis one was therefore supported.

Table V.-

Results of Post Hoc Procedures following Multivariate
Analysis of Variance on the Dependent Measures.

Dependent Measure	Contrast**	Confidence Interval
HFTV	$Y_{11} - Y_{13}$	$-7.20 \leq (Y_{11} - Y_{13}) \leq -1.18^*$
HFTV	$Y_{11} - Y_{12}$	$-5.23 \leq (Y_{12} - Y_{13}) \leq -0.39^*$
HFTV	$Y_{12} - Y_{13}$	$-4.36 \leq (Y_{12} - Y_{13}) \leq 1.58$
ORFT	$Y_{21} - Y_{23}$	$0.85 \leq (Y_{21} - Y_{23}) \leq 6.79^*$
ORFT	$Y_{21} - Y_{22}$	$0.37 \leq (Y_{21} - Y_{22}) \leq 5.15^*$
ORFT	$Y_{22} - Y_{23}$	$-1.87 \leq (Y_{22} - Y_{23}) \leq 3.99$

* $p < 0.05$.

** For each contrast Y_{ij} is used where i denotes a dependent variable and j denotes a strategy.

Hypothesis two predicted that the mean of the scores for subjects using Strategy Type Three should fall between the means of the scores of type two and type four subjects. Examination of Table IV reveals that the mean of scores for subjects using Strategy Type Three fell between the mean of the scores for the other two strategy types. Contrasts $Y_{11}-Y_{12}$ and $Y_{21}-Y_{22}$ were examined to determine if statistically significant differences existed between the mean scores of subjects using Strategy Type Two and those using Strategy Type Three. Both of these contrasts were significant at the 0.05 level of confidence. Similarly, contrasts $Y_{12}-Y_{13}$ and $Y_{22}-Y_{23}$ were examined to determine if statistically significant differences existed between the mean scores of subjects using Strategy Type Three and those using Strategy Type Four. Neither of these contrasts previously reported were significant at the 0.05 level of confidence. However, the relationship between Strategies Two and Three warrants the cautious claim that hypothesis two was partially supported.

It was thus found that significant differences existed between the mean scores of subjects using Strategy Type Three and Strategy Type Two on measures of psychological differentiation while no significant differences on these measures were found between subjects using Strategy Type Three and those using Strategy Type Four. It would thus seem that the perceptual requirements for the performance of

Strategy Type Three are more similar to those for Strategy Type Four than those for Strategy Type Two. This observation has some theoretical basis. It will be recalled that the performance of Strategy Type Three requires that each attribute of the display be tested individually. This is also the case for Strategy Type Four but not for Strategy Type Two. Thus both Type Three and Type Four Strategists must remember the relevance of each attribute and combine this information to form the rule after all attributes are tested. While the selection of cards is not as exacting for Strategy Type Three as it is for Strategy Type Four, when using the former strategy, subjects must nonetheless remember the status of several positive instances in order to determine the relevance of a particular attribute, whereas with Strategy Type Two, the subject need only remember the hypothesis which he has made. That is, Card choices can be made without any prior rationale and choices have no other purpose than as a verification of the particular hypothesis being tested. Thus it may be seen that the perceptual requirements for Strategy Type Three are more like those required for Strategy Type Four than those required for Strategy Type Two.

It is interesting to note however, that Bruner limited himself to classifying subject strategies into two types. Because his classification criteria for Strategy

Type Four is based on the selection of cards which vary only in one or two aspects from the focus card, it is highly probable that the majority of subjects which would be classified as using Strategy Type Three in the present research would be considered to be using Strategy Type Two according to Bruner's classification system.

As indicated in chapter one, the purpose of this research was to investigate a link between an individual's mode of perceiving the environment and the consistent approach which subjects demonstrate during the performance of concept attainment problems. Such a link appears to have been established. As the result of the specific findings in the present research, a number of suggestions for further research emerge. These will be discussed in the next section of this chapter.

5. Suggestions for Further Research.

A number of studies which follow from the current research will now be suggested. Before considering the specifics of such studies, a synthesis and possible extension of Bruner's theory concerning factors which he thought to be associated with strategy usage will be considered.

Bruner has suggested that in a given concept attainment problem, a number of factors are present which cause cognitive strain on the subject. The cognitive strain is

considered to result from the perceptual, informational, memory and inferential requirements of the concept attainment solution. He considered one source of cognitive strain to be the complexity of the stimulus display itself. The greater the number of attributes and dimensions of these attributes, the greater the cognitive strain imposed on the subject. He also considered that the various strategies which can be used by a subject are the source of varying degrees of strain. Thus according to his views, the cognitive strain in a given concept attainment problem might be considered as follows:

$$\text{cognitive strain} = f(\text{strategy, stimulus display})$$

Bruner suggests that as the strain imposed by the stimulus display increases, subjects tend to choose a strategy which in itself imposes less strain. By implication, it appears that the total strain capacity is peculiar to a given individual and is probably constant for that individual. It may well be that the strain imposed by a given stimulus display for a field independent individual is less than that for a field dependent subject. In the present study, field independent individuals were able to use a perceptually more complex strategy (Strategy Type Four) than the field dependent subjects. An extension of Bruner's notion might be that the individual's ability to withstand cognitive strain is a function of that individual's degree of psychological differentiation.

It is also possible that the type of rule structure being considered is also a contributor to the strain imposed by the concept attainment problem. Giambra³ for example has shown that certain rule structures are more difficult than others.

Thus total strain (ST) may be considered as a function of Strategy (S), stimulus display (SD), and rule structure (R). This may be expressed symbolically as follows:

$$ST = f(S, SD, R)$$

Given this model, a number of suggestions for further research emerge.

First, the present experiment should be repeated with other rule structures. For example, disjunctive rule structures could be introduced to see how strategy choice is related to degree of psychological differentiation.

Secondly, the relationship between degree of psychological differentiation and strategy choice with different complexity levels of the stimulus array should be examined. When stimulus complexity is increased, there should be fewer subjects who use a focussing strategy. It may be logically suggested that these subjects would be more field independent than those who used Strategy Types Two or Three.

³ L. Giambra, "Selection Strategies for Eight Concept Rules with Non-Exemplar Start Cards", in Journal of Experimental Psychology, Vol. 87, No. 1, 1971, p. 78-92.

The findings of the present study indicate that field independent subjects when performing a concept attainment task, given only information concerning the procedure to be followed, will develop and use a more perceptually complex and efficient strategy than field dependent subjects.

Since FD subjects apparently tend to employ a relatively direct yet inefficient strategy, the findings lead to a question which has direct implication for educational practice. That is, can field dependent subjects be trained to use a superior strategy to "compensate" for their lack of perceptual awareness? One possible way to explore such a question might be to train field independent subjects to employ Strategy Type Four with one stimulus array then determine the extent to which they were able to transfer the use of this strategy to another stimulus array. Showing that such training is beneficial would suggest possible approaches for use with FD students. For example, when teaching field dependent students subject matter such as mathematics or science, emphasis should be placed initially on the development of learning strategies rather than on subject matter as such.

This chapter has presented and discussed the results obtained in the current study. The report will now conclude with the summary and conclusions of the present study.

SUMMARY AND CONCLUSIONS

The methods used by Bruner, provide both stimulus materials and methodology for the study of concept attainment within his definition of a concept. A review of the literature revealed that subjects demonstrate a consistent approach to the solution of concept attainment problems and that these strategies which have been labelled Focussing and Scanning can be identified. An analysis of the processes involved in the aforementioned tasks suggest the existence of a third strategy apparently not considered by him.

Witkin et al. on the other hand, have demonstrated that a person's characteristic mode of perceiving can be identified. He has developed a number of measuring instruments such as the HFT and RFT with which to determine a subject's position on what he has called Field dependence-independence continuum. Many personality characteristics appear to be correlated with an individual's score on the aforementioned tests. Witkin and his colleagues developed the Differentiation Hypothesis, based on Werner's Orthogenic principle to provide a theoretical basis to account for the particular personality correlates which had been demonstrated.

Bruner's research has shown that subjects use a consistent approach to the solution of concept attainment problems while Witkin et al. have found that the individual's

characteristic mode of perceiving the environment can be identified. The purpose of this research was to explore an as yet unestablished link between the two.

Specifically, the purpose of the current study was to

- a) determine if groups of subjects who use different strategies differ with respect to scores on measures of psychological differentiation (the HFTV and ORFT);
- b) ascertain if a logically possible strategy which has been termed "Strategy Type Three" exists and can be identified.

A total of eighty-nine first year nursing students, ranging in age from 17.75 to 35.25 years served as the volunteer subjects for this experiment. The group had a mean age of 19.74 years with a standard deviation of 2.17 years.

Their degrees of psychological differentiation were determined by their scores on the Oltman Portable Rod and Frame Test apparatus and the CF-V group version of the Hidden Figures Test. Both instruments were administered according to the standard procedure. The Henmon-Nelson Test of Intelligence was included for possible use as a co-variate. Each of these instruments was re-administered after approximately three weeks to provide a measure of test-retest reliability.

The subjects were given one practice and three experimental conjunctive rule concept attainment problems using Bruner's eighty-one card, four attribute stimulus display board and selection paradigm procedure. The problems were

selected at random from a universe of possible problems. Each subject received a different set of problems to avoid experimental bias due to inter-subject communication.

The stimulus cards were numbered for easy reference. Thus it was possible for the experimenter quickly to record each subject's card selections and the status of that selection. Each subject completed a questionnaire and answered questions the responses to which were recorded on tape. These steps were performed to provide the researcher with information concerning the strategy which the subjects used to solve the Concept Attainment problems. Five raters then determined the strategy being used by each subject after having considered the information contained in the questionnaire, tape and protocols. Once the strategy for each subject had been established, a multivariate analysis of variance followed by appropriate post hoc procedures was carried out to test the following hypotheses.

- a) Subjects who use Strategy Type Two will differ from subjects who use Strategy Type Four on measures of Field Independence. Type Two subjects will score toward the Field Dependent End of the Field Independent-Dependent continuum while Type Four subjects will score toward the Field Independent End.
- b) The mean psychological differentiation score of subjects who use Strategy Type Three lies between the

means of Strategy Type Two and Strategy Type Four subjects.

The results of applying the multivariate analysis of variance to the dependent measures showed significant differences. Hypothesis one was supported ($p < 0.05$) for both dependent measures. That is, subjects using Strategy Type Four scored toward the Field Dependent end while subjects using Strategy Type Two scored toward the Field Independent end of the Field Independent-Dependent Continuum.

With respect to hypothesis two, the means of Strategy Type Three subjects' scores on both measures of psychological differentiation fell between the means of subjects using Strategy Types Two and Four. When the dependent measure means for subjects using Strategy Type Three were contrasted with those using Strategy Type Two, significant differences were noted ($p < 0.05$). Similar contrasts between Strategy Types Three and Four failed to reach significance.

It was shown that Strategy Type Three does exist and can be identified. As might be expected from the theory, this strategy is employed by subjects who are more highly differentiated than those who use Strategy Type Two.

In the final analysis, it appears that there are some important differences in the strategy choice of individuals at the extremes of the Field Independence-Dependence continuum. This is clearly reflected in Concept Attainment Tasks. It

is therefore suggested that a student's degree of psychological differentiation is an important dimension to be considered when designing methods of instruction for subject matter heavily loaded with conceptual content. In conclusion, it is suggested that educators who are concerned with the individualization of the learning process might profitably explore the practical applications of the current findings.

BIBLIOGRAPHY

Asch, S. E., and H. A. Witkin, "Studies in Space Orientation: I. Perception of the Upright with Displaced Visual Fields", in Journal of Experimental Psychology, Vol. 33, No. 3, 1948, p. 324-337.

In this, the first of several early studies, on space orientation by the same authors, an effort was made to determine the relative importance of visual and postural factors in the perception of the upright.

-----, "Studies in Space Orientation: II. Perception of the Upright with Displaced Visual Fields and with Body Tilted", in Journal of Experimental Psychology, Vol. 38, No. 4, 1948, p. 455-477.

The second study in the aforementioned series. A new procedure was developed to overcome certain disadvantages of the tilting mirror apparatus in the separation of visual and postural determinants of the perceived upright.

Bruner, J. S., J. Goodnow, and G. Austin, A Study of Thinking, New York, Wiley, 1956, xi-330 p.

A definitive work in the area of Concept Learning. The notion of a concept is explored and the development of stimulus materials and experimental methods for the study of concepts is described. The Strategies used by subjects during the process of concept attainment are discussed. Many of the experiments conducted by the authors in support of theory relating to concept learning are considered.

Dickstein, L., "Field Independence in Concept Attainment", in Perceptual and Motor Skills, Vol. 27, 1968, p. 635-642.

This study considers the relationship between one measure of field dependence-independence and performance on a concept attainment task. This study served as the point of departure for the present research.

Giambra, L., "Selection Strategies for Eight Concept Rules with Non-Exemplar Start Cards", in Journal of Experimental Psychology, Vol. 87, No. 1, 1971, p. 78-92.

This study attempted to determine the extent which the ideal strategies of Focussing and Scanning were used with eight concept rules. Strategy indicants such as the ratio of the standard deviation to mean trials per problem and the Laughlin Focusing Index were used to determine strategy usage. The results of this experiment are questionable since no attempt was made to show that the strategy determinant procedures were valid.

Johnson, E., "Objective Identification of Strategy on a Selection Concept Learning Task", in Journal of Experimental Psychology Monograph, Vol. 90, No. 1, p. 167-196.

Several methods to objectify the identification of concept learning strategy were explored. This work presents an excellent review of the limited work which has been done since Bruner's original work. A number of potentially useful statistical methods for the detection of strategy usage are explored.

Laughlin, P. R., "Selection Strategies in Concept Attainment as a Function of Number of Persons and Stimulus Display", in Journal of Experimental Psychology, Vol. 70, No. 3, 1965, p. 323-327.

Rules are formulated for the detection of Focussing and Scanning strategies in concept attainment tasks when the subject must determine a particular conjunctive rule structure. The validity of Laughlin's procedure is questioned in the present study.

Werner, H., Comparative Psychology of Mental Development, New York, Science Editions, 1948, xii-564 p.

In this work, the author presents, discusses and illustrates his thesis that Monakow's law of anatomical hierarchization may logically be applied to mental functions per se. This principle later provided a theoretical basis for the differentiation hypothesis. Required reading for those wishing to fully comprehend Witkin's work.

Witkin, H. A., and S. E. Asch, "Studies in Space Orientation: III. Perception of the Upright in the Absence of a Visual Field", in Journal of Experimental Psychology, Vol. 38, No. 5, 1948, p. 603-614.

The third study on spacial orientation. The purpose of the experiment was to determine how the upright is established in the absence of an upright visual field. The visual framework was eliminated by utilizing a completely darkened room with a luminous rod as the only visual data.

-----, "Studies in Space Orientation: IV. Further Experiments in Perception of the Upright with Displaced Visual Fields", in Journal of Experimental Psychology, Vol. 38, No. 5, 1948, p. 762-783.

This the fourth study in the series, describes a new technique to permit easy changes in the field. The apparatus was essentially the same as that used for the Rod and Frame test employed in many later experiments.

Witkin, H. A., et al., Psychological Differentiation, New York, Wiley, 1962, xii-418 p.

The author and his colleagues report numerous personality correlates of the field dependence-independence continuum. The differentiation hypothesis is developed as the theoretical link between individual differences in perception and diverse aspects of psychological functioning.

APPENDIX 1

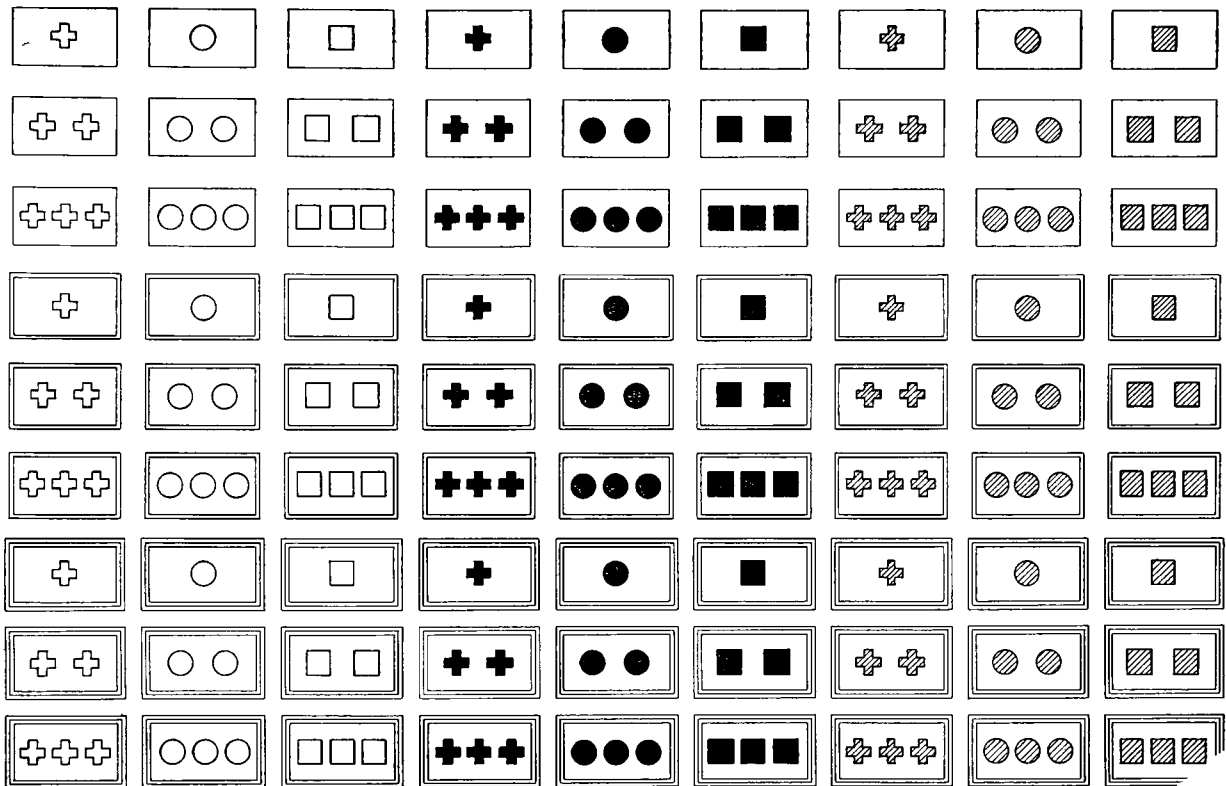
SUMMARY OF APPROACHES AND RESULTANT STRATEGIES

Summary of Approaches and Resultant Strategies

Approaches	
1	2
Subject attempts to attain concept by considering an <u>entire rule which is consistent with information on the focus card.</u>	Subject attempts to attain concept by <u>determining the status of individual attributes which form the rule.</u>
Rationale for the selection of cards	Rationale for the selection of cards
a) Subject considers all possible rules and chooses cards to eliminate entire rules. (Strategy Type One)	a) Subject chooses cards with intention of obtaining enough positive instances to discover the rule by considering the elements which positive instances have in common. (Strategy Type Three)
b) Subject believes a certain rule is the correct one. Subject chooses cards to verify or correct initial rule. (Strategy Type Two)	b) Subject chooses cards to test the relevance of each attribute individually (Strategy Type Four) or in pairs (Strategy Type Four-A). Subject varies one or two attributes from the focus card on each card selection.

APPENDIX 2

BRUNER'S STIMULUS ARRAY FOR THE PRESENTATION OF
CONCEPT ATTAINMENT PROBLEMS FOLLOWING THE
REQUIREMENTS OF THE SELECTION PARADIGM



Bruner's Stimulus Display comprising combinations of four attributes, each exhibiting three values. Plain figures are in green, striped figures in red, solid figures in black.

APPENDIX 3

THE QUESTIONNAIRE PRESENTED TO SUBJECTS AFTER
COMPLETION OF THE CONCEPT ATTAINMENT PROBLEMS

Name _____

Subject Number _____

Questionnaire

1. Did you understand the procedure which would be followed after having read the instructions and having performed the practice problem?

Yes _____ No _____

If your response is no, please explain

2. Did you attack each of the problems in the same way?

Yes _____ No _____

If your answer is no, please explain how your problem solving technique differed from problem to problem.

3. Do you think that your performance would improve if you were given an opportunity to do 3 or more problems?

Yes _____ No _____

Why?

4. Did any aspect of the stimulus display adversely affect your performance?

Yes _____ No _____

If yes, please explain.

5. Describe briefly how you would teach a person to do this task.

6. Did you use the method which you just described to solve any of the problems?

7. What questions would you have liked to ask the experimenter during the session?

APPENDIX 4

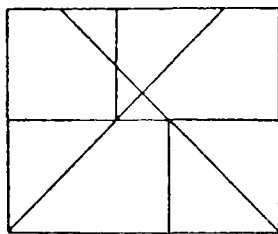
SAMPLE ITEM AND INSTRUCTIONS FOR ADMINISTRATION OF THE HFTV

INSTRUCTIONS TO SUBJECTS

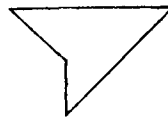
HIDDEN FIGURES TEST—V

Each problem in this test is made up of two designs, a complicated figure on the first page and a simple figure on the next. In each problem the simple design is contained in the complicated design. You are to find where the simple design is contained in the larger design and sketch it in over the lines of the figure.

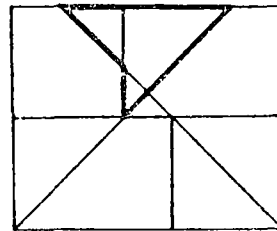
Here is an example of a complicated figure, a simple figure, and the complicated figure shown again with the simple figure sketched in.



Complicated figure



Simple figure



Simple figure sketched in

The smaller figure is always present in the larger figure and always in the upright position. Be sure the figure you find is exactly the same as the simple figure, both in size and proportions. Work carefully and as systematically as you can. If you feel that you cannot solve one of the figures, you may skip it and come back to it later if you have time, but you will waste time if you keep skipping from figure to figure. Do not worry about erasing completely if you have one or two incorrect lines, but be sure that you have all the correct ones clearly indicated.

The subjects were allowed ten minutes to complete the test after which time the booklets were collected.

APPENDIX 5

INSTRUCTIONS TO SUBJECTS FOR ADMINISTRATION OF THE HENMON-NELSON TEST OF INTELLIGENCE

Instructions in bold print are to be read aloud to the students. The remainder are for the examiner's use only.

Say: Today we are going to take a test of academic aptitude. Your test scores will become a part of your permanent record here. I shall distribute a test booklet and answer sheet to each of you. Write nothing on your answer sheet until I tell you to do so. Keep the test booklet closed with the front cover up. Distribute the answer sheets and tests with cover facing up.

When distribution has been completed, say: We shall now fill in the blanks on the answer sheet. Please print your name and all other information requested. Where it says Form, write either A or B according to the form designated on your test booklet. Students who are using the self-marking answer sheet will find either Form A or Form B already printed on it. Nevertheless, these students should fill in the form designated on their test booklet as a check to assure that the correct answer sheet is being used. Students using the self-marking answer sheet should be instructed to turn their answer sheets over after they have filled in all of the required information.

After the required information has been recorded, say: Now open the test booklet and fold the cover back. The page headed Directions to Students should be before you. I will read the directions with you. Read the directions aloud,

pausing to allow the students to work on the practice exercises. The directions are reproduced on page 5 of this manual for the convenience of the examiner.

After reading the directions, say: Are there any questions? No questions will be answered during the testing period. Answer any question of procedure. If questions are asked about guessing, simply repeat that part of the directions dealing with this matter. Next say: The test has 100 items; you will have 40 minutes of working time. When I say begin -- not yet -- turn the page and start work. The test should be timed within five seconds of 40 minutes. You will need a watch or clock with a second hand. Wait until the second hand reaches 15, 30, 45, or 60; then say: Begin. Write down the time. Add 40 minutes to it; the result is the time when you must say "Stop".

After 40 minutes, say: Stop. Close your test booklets. Look over your answer sheets to make sure your marks are heavy and black and that there are not stray marks. After allowing sufficient time for students to scan their papers, collect the answer sheets; then collect the test booklets and any special pencils. Count the test booklets and answer sheets as received to make sure that everyone has turned in his booklet and answer sheet.

APPENDIX 6

PROCEDURE FOR ADMINISTRATION OF THE PORTABLE RFT FOR ADULTS (ORFT)

PROCEDURE FOR PORTABLE RFT - ADULTS

Philip K. Oltman
Psychology Laboratory, Department of Psychiatry
State University of New York Downstate Medical Centre
450 Clarkson Avenue
Brooklyn, New York 11203

Note: Apparatus must be on sturdy table and be level.

Before seating S in front of apparatus:

"In this test we want to find out how well you can determine the upright - the vertical - under various conditions."

"In this box (PRFT) you will see a square frame and within the frame you will see a rod."

"It is possible for me to tilt the frame to the left or the right. I can also tilt the rod to the left or right. I can tilt the frame alone or the rod alone; or I can tilt them both at the same time, either to the same side or to opposite sides."

"When I lower the curtain at the beginning of each trial, I want you to tell me whether the rod and frame are straight up and down - i.e. vertical - or whether they are tilted. In other words, tell me whether they are tilted."

"Are there any questions?"

Seat S in front of apparatus and adjust headrest. S's hands must be in his lap, not touching table. Tell S to keep his head in the rest at all times. Feet together.

Trial 1: Adjust the frame to 28L and the rod to 28L. Lower curtain. Say to S: "What is the position of the rod and the frame?" (Record S's response).

If S says the rod is not vertical, say to him:

"I will now turn the rod slowly until you think it is straight with the walls of this room. As I said, I will turn it slowly, and after each turn, tell me whether it has been turned enough or whether you want it turned some more. Just say 'more' or 'enough' after each turn. Please make your decisions quickly and don't be too finicky. Which way shall I move the rod to make it vertical - clockwise or counterclockwise?"

Now move the rod about 3' at a time opposite to the direction in which S says it is tilted, until he reports "enough". Ask the S after he reports the rod vertical: "Is the rod now vertical - that is, is it straight with the walls of this room? In other words, is it straight up the way the flagpole outside is?"

If the subject should now say that he wants the rod moved some more in either direction, do so. Raise the curtain and record the position of the rod.

If on this first trial, the S reports the rod to be straight at the outset, ask him the question: "Is the rod now vertical, that is, is it straight with the walls of this room?"

In such instances, give the S the instructions concerning the straightening of the rod, as above, on the next trial. If on the next trial, the S again states that the rod is straight at the outset, give him these instructions on the first trial on which he says the rod is tilted.

Trial 2: Leave the frame at 28L and adjust the rod to 28R. Lower the curtain and say to the S:

"Would you tell me now and at the beginning of all subsequent trials whether the rod and frame are straight with the walls of this room, or tilted; and if the rod is tilted, whether the rod should be moved clockwise or counter-clockwise to be made straight?"

If the S asks you to turn the rod, do so until he says "enough".

Ask him again: "Is the rod now vertical - that is, is it straight with the walls of this room?"

Do not ask this question of subsequent trials. Raise curtain. Record adjustment. Proceed to next trials.

Trial 3: Frame 28R Rod 28R

Trial 4: Frame 28R Rod 28L

Trial 5: Frame 28L Rod 28L

Trial 6: Frame 28L Rod 28R

Trial 7: Frame 28R Rod 28R

Trial 8: Frame 28R Rod 28L

Before S enters the room, be sure frame is straight and curtain up.

If at any time after the rod has been adjusted on a given trial the S should say that he wants it moved some more in either direction, do so.

If the S should take more than 5 seconds on any trial before saying "more" or "enough", tell him: "Please make your decisions quickly".

If the S should repeatedly say "more" or "enough" before the turn of the rod is completed, say to him: "Please wait until I have completed the turn".

Check from time to time to determine whether the S's head is in the proper position in the headrest. Attaching the elastic cord around the back of S's head is recommended.

APPENDIX 7

INSTRUCTIONS TO SUBJECTS REGARDING PROCEDURE
TO BE FOLLOWED DURING PERFORMANCE OF THE
CONCEPT ATTAINMENT TASK

INSTRUCTIONS TO SUBJECTS

Each of the cards in front of you contain 1, 2, or 3 Circles, Squares, or Crosses. The circles, squares or crosses are surrounded by 1, 2 or 3 black borders. The Circles, Squares or Crosses are displayed in Red, Green, or Black. The borders are displayed in Black only.

The cards in the display can be grouped and/or classified into several categories.

An example of one category is:

"All cards which contain 3 circles"

Another example of a category is:

"All cards containing 2 squares and 1 border"

Your task will be to find the category which the experimenter has in mind.

In order to find the solution, the following procedure will be followed:

- Step 1 You will be shown a card which is an example of the category which the experimenter has in mind.
- Step 2 You will then be asked to select a card which you think will belong in the same category as the one I have shown you to help solve the problem.
- Step 3 You will be told if your card selection is or is not an example of the category which the experimenter has in mind.
- Step 4 If at this time you think that you know the rule used to establish the category, you may if you wish, try to state that rule.

Step 5 If you have not stated the rule which the experimenter had in mind when he established the category, you will be asked to select another card in a further attempt to solve the problem.

Please indicate when you are ready to proceed.

APPENDIX 8

FOCUS CARDS AND RELEVANT ATTRIBUTES
FOR EACH PROBLEM FOR EACH SUBJECT

<u>Subject</u>	<u>Focus Card</u>	<u>Relevant Attributes of the Rules</u>
1	11	2 objects 1 border 2 green circles 1 border green objects 1 border
2	41	2 black objects with 2 borders circles with 2 borders 2 objects 2 borders 2 circles
3	27	red objects with 1 border red squares with 1 border red objects 1 border
4	57	1 green object with 3 borders squares green squares with 3 borders 1 square with 3 borders
5	8	1 red object red circles with 1 border 1 circle circles
6	81	3 objects squares red objects with 3 borders red squares
7	71	red objects with 3 borders 2 circles with 3 borders 2 objects with 3 borders 2 red circles
8	66	2 squares with 3 borders 2 green objects green squares 2 squares
9	67	2 black shapes 2 black shapes 3 borders black shapes 2 crosses

<u>Subject</u>	<u>Focus Card</u>	<u>Relevant Attributes of the Rules</u>
10	32	circle 1 circle with 2 borders black circles 1 black object
11	28	crosses 1 green object green crosses 1 green object with 2 borders
12	6	squares 1 black square 1 black object black squares with 1 border
13	24	3 black objects black squares squares 1 border 3 black squares
14	45	2 squares red objects 2 borders squares red squares
15	65	2 objects with 3 borders 2 green circles circles with 3 borders 2 circles with 3 borders
16	41	black circles 2 circles 2 borders black circles 2 borders 2 objects
17	52	3 crosses 3 objects 2 borders red crosses crosses 2 borders
18	14	circles black objects 2 objects 1 border 2 black objects 1 border

<u>Subject</u>	<u>Focus Card</u>	<u>Relevant Attributes of the Rules</u>
19	68	2 black objects circles with 3 borders circles black circles with 3 borders
20	16	crosses 2 objects 1 border red objects red crosses
21	36	1 square 1 red square red objects 2 borders
22	18	2 objects 2 squares 1 border red objects squares 1 border
23	40	2 black objects black objects 2 borders 2 objects 2 crosses 2 borders
24	79	red crosses 3 red objects 3 red objects 3 borders red objects
25	51	2 borders black objects 2 borders 3 black squares squares 2 borders
26	62	1 red circle circles 3 borders 1 object 1 red object
27	69	2 objects 3 borders squares 3 borders 2 squares

<u>Subject</u>	<u>Focus Card</u>	<u>Relevant Attributes of the Rules</u>
28	02	green circles green objects 1 border 1 green object green circles 1 border
29	14	2 circles 2 black objects circles 1 border 1 border
30	69	2 black objects 3 borders 2 objects squares 2 black objects
31	5	black objects 1 circle 1 border 1 object circles
32	63	1 square 3 borders 1 object 3 borders 1 square red squares 3 borders
33	05	1 black circle 1 circle 1 border black circles 1 border black objects
34	45	2 red objects 2 borders red objects 2 borders 2 red squares
35	34	1 object 2 borders 1 red object 2 borders 1 cross 2 borders red objects
36	11	1 border circles 1 border circles 2 green objects 1 border

<u>Subject</u>	<u>Focus Card</u>	<u>Relevant Attributes of the Rules</u>
37	67	2 crosses 3 borders 2 black crosses 2 objects 3 borders 2 crosses
38	16	crosses 2 red objects red crosses 1 border 2 red objects 1 border
39	40	2 crosses 2 black objects 2 borders 2 borders 2 objects 2 borders
40	06	1 object 1 border 1 object 1 black object 1 black square
41	51	3 squares 2 borders black squares black objects 2 borders 3 black objects 2 borders
42	68	2 objects 3 borders black objects black circles 2 black objects 3 borders
43	39	2 squares squares 2 borders 2 green squares 2 objects
44	70	2 red objects 3 borders red crosses crosses red crosses 3 borders
45	22	3 crosses crosses 1 border black crosses 1 border 3 black objects 1 border

<u>Subject</u>	<u>Focus Card</u>	<u>Relevant Attributes of the Rules</u>
46	01	1 cross 1 border green shapes 1 border green shapes 1 shape 1 border
47	20	red crosses 2 objects red objects 3 borders 3 borders
48	51	3 squares 2 borders squares black squares 2 borders 3 objects 2 borders
49	30	1 object 1 square 2 borders green squares green objects
50	42	2 objects 2 borders black objects 2 borders 2 objects 2 black squares
51	06	1 square black objects 1 black object 1 border 1 black object
52	71	3 borders 2 circles 2 objects 3 borders 2 red objects
53	48	green squares 2 borders squares green objects 2 borders 3 objects
54	10	green objects 2 objects 2 green objects 1 border

<u>Subject</u>	<u>Focus Card</u>	<u>Relevant Attributes of the Rules</u>
55	05	1 border 1 object 1 border circles black circles
56	06	black objects 1 border black squares 1 border 1 object 1 border 1 black object 1 border
57	43	red objects 2 red objects 2 borders crosses 2 borders 2 crosses
58	47	circles 2 borders 2 borders 3 circles 3 green objects 2 borders
59	62	1 red object red circles circles 1 object
60	42	black objects 2 borders 2 black objects 2 squares 2 borders
61	66	2 squares 2 objects 3 borders 3 borders 2 green objects 3 borders
62	45	2 red objects 2 borders 2 squares 2 borders 2 objects 2 borders red squares 2 borders
63	17	circles 1 border 2 objects red objects 2 circles 1 border

<u>Subject</u>	<u>Focus Card</u>	<u>Relevant Attributes of the Rules</u>
64	34	crosses 1 cross 2 borders 1 object 2 borders 1 red object
65	68	2 circles 3 borders 3 borders 2 black circles 2 objects
66	47	2 borders 3 circles 2 borders green objects green circles
67	35	red objects, 2 borders 1 object circles 1 circle 2 borders
68	16	2 red shapes 2 red objects 1 border red objects 1 border red objects
69	81	3 objects 3 borders squares 3 borders 3 squares 3 objects
70	44	2 red objects red circles 2 borders 2 objects 2 red circles
71	67	3 borders 2 objects 3 borders 2 black objects black objects
72	20	green objects green objects 1 border circles 3 circles

<u>Subject</u>	<u>Focus Card</u>	<u>Relevant Attributes of the Rules</u>
73	04	1 black object 1 cross 1 object 1 border 1 object
74	51	black objects 3 black objects 2 borders black objects 2 borders 3 black objects
75	16	2 crosses 1 border 2 objects 2 crosses red objects 1 border
76	72	red squares 3 borders 2 red squares 2 squares
77	17	circles 1 border 2 circles 2 objects 1 border
78	32	black circles 2 borders 1 black circle black objects 2 borders
79	28	green objects 1 green object 1 green object 2 borders green objects 2 borders
80	14	1 border black circles 1 border black objects 2 objects 1 border
81	11	green objects 1 border circles 2 objects green circles

<u>Subject</u>	<u>Focus Card</u>	<u>Relevant Attributes of the Rules</u>
82	23	3 objects black objects 1 border black objects 1 border
83	78	3 objects 3 black objects black objects 3 borders 3 squares
84	09	1 object 1 border squares red objects red objects 1 border
85	18	1 border 2 red objects 1 border red objects 1 border red squares 1 border
86	19	1 border crosses 3 green objects 1 border 3 objects
87	10	1 border green corsses crosses green objects
88	12	1 border 2 objects green squares 1 border 2 squares 1 border
89	51	black squares 2 borders squares squares 2 borders 3 black squares
90	05	black objects 1 black object 1 border black objects 1 border 1 circle

<u>Subject</u>	<u>Focus Card</u>	<u>Relevant Attributes of the Rules</u>
91	11	2 green objects 1 border green objects 2 green circles
92	74	3 green objects 3 borders circles green objects 3 borders green objects
93	27	squares 1 border 3 objects 3 objects 1 border red object 1 border
94	3	1 square green squares 1 border 1 border 1 green object
95	28	green objects 2 borders 1 green cross green crosses 2 borders green objects

APPENDIX 9

INSTRUCTIONS TO RATERS

INSTRUCTIONS TO RATERS

In this exercise, you will be asked to classify the strategy used by an individual on a concept attainment task. The subjects were given a practice problem followed by three experimental problems. After the experimental problems had been given, the subjects completed a questionnaire and then gave a taped description of the "Approach", which they used to solve the problems. Use the information on the tape and in the questionnaire. After you have made your classification using that information, check the protocols to see if you agree with the classification you made using the tape and the questionnaire. Please classify the approach used by an individual subject into one of the following categories:

Category 2 The subject quickly entertained a hypothesis concerning the rule. Subject selected instances to verify or correct the initial hypothesis. Subjects tended to modify the initial hypothesis. Subjects may have expected harder rules than the experimenter required.

Category 3 The subject did not entertain an initial hypothesis but tested attributes one at a time (not necessarily in the same order from question to question). Subject selected instances at random or used some strategy such as selecting instances from the immediate area of the focus card or from some row or column of the display. Subjects tended

to look for common elements in a series of positive instances. Subjects may have lost track of the focus card completely and may also have expected rules which were harder than the experimenter required.

Category 4 The subject did not entertain an initial hypothesis but tested attributes one at a time by systematically selecting cards which varied in one or two respects from the focus card. The selection of instances was performed purposively with as much information to be gained from a negative instance as from a positive instance.

Category 5 The subject did not employ any of the previous categories.

APPENDIX 10

THE STRATEGY ASSIGNED TO EACH SUBJECT BY EACH RATER

Strategy Assigned to Each Subject

Subject	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5
1	4	4	4	3	4
2	2	3	2	3	2
3	4	4	4	4	3
4	2	2	3	2	3
5	3	3	2	2	2
6	2	2	3	2	2
7	3	3	2	2	3
9	3	2	3	2	2
10	2	2	2	2	2
12	2	2	2	2	2
13	2	2	3	3	2
14	3	3	2	2	2
15	3	3	3	3	3
16	2	4	3	4	4
17	3	3	4	3	3
18	2	2	3	3	2
19	2	2	3	2	2
20	2	3	3	3	3
21	2	4	4	3	4
23	4	3	3	4	4
24	3	2	2	3	2
25	3	3	3	3	3
26	3	2	2	2	2

Subject	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5
27	4	3	3	4	4
28	3	3	3	3	3
29	3	4	4	4	4
30	3	3	3	3	3
31	2	3	2	2	3
32	3	3	3	3	3
33	3	3	3	4	3
34	2	2	3	3	2
35	3	3	3	3	4
36	3	4	3	4	4
37	3	3	4	3	3
38	3	2	2	3	2
39	3	2	2	2	3
40	3	3	3	3	3
41	2	3	2	2	3
42	3	3	3	3	3
44	4	4	4	4	4
45	3	3	3	3	3
46	3	2	2	2	3
48	3	3	3	3	3
49	3	3	4	4	4
50	4	3	2	3	3
51	3	3	3	2	3
52	4	3	3	4	4

Subject	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5
53	2	2	2	2	2
54	3	2	3	3	3
55	3	3	3	3	3
56	3	3	3	3	2
57	3	3	3	3	3
58	3	3	3	3	3
59	3	3	3	3	3
60	3	3	3	3	3
61	4	4	3	4	4
62	2	3	3	3	2
63	4	3	4	4	3
64	2	3	3	3	3
65	3	3	3	3	3
66	4	4	4	4	4
67	3	3	3	3	3
68	2	2	2	2	2
69	3	3	3	3	3
70	4	4	2	4	4
71	4	4	3	4	3
72	2	2	2	3	2
73	4	4	4	4	4
74	2	4	4	4	4
75	3	3	3	3	3

Subject	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5
76	3	2	2	2	2
77	2	3	3	3	3
78	3	3	4	3	3
79	3	3	3	3	3
80	3	3	2	3	3
81	2	3	3	3	3
82	3	3	3	3	3
83	3	3	3	3	3
84	3	3	3	3	3
85	3	2	2	2	2
86	3	3	3	3	3
87	3	3	3	3	3
88	4	3	4	4	4
89	3	3	3	3	3
90	3	3	3	3	3
91	3	3	3	2	3
92	4	4	3	4	4
93	4	3	3	3	3
94	3	3	3	3	3
95	2	2	3	2	3

APPENDIX 11

AGE OF SUBJECTS AND SCORES ON HFTV, ORFT,
AND HENMON-NELSON TEST OF INTELLIGENCE FOR
INITIAL ADMINISTRATION AND RETEST

Subject #	Subject Age (Yrs)	ORFT		HFTV		HN					
		Test	Retest	Test	Retest	Test			Retest		
						V	Q	T	V	Q	T
1	18.58	2.43	1.87	12	14	35	28	63	41	34	75
2	20.83	28.0	9.06	0	0	36	5	41			
3	19.41	6.25	4.19	4	12	35	21	56	39	17	56
4	18.50	3.25	0.56	4	3	17	12	29	30	15	45
5	18.58	3.87	2.81	3	7	18	19	27	20	24	44
6	18.67	8.75	3.93	8	15	34	30	64	32	31	63
7	18.75	1.50	1.25	8	7	49	26	75	47	29	76
8	*20.50			7		24	6	30			
9	24	6.12	2.80	7	8	44	10	54	53	13	66
10	20.00	2.87	2.68	9	11	25	12	37	34	11	45
11	*18.61			6		33	22	55			
12	20.16	0.87	1.06	12	16	25	22	41			
13	19.34	4.0	2.37	1	13	50	32	82	41	31	72
14	18.00	5.81	2.06	3	8	31	14	45	31	22	53
15	18.34	1.25	3.00	8	10	46	25	71			
16	19.16	1.31	1.62	10	10	34	20	54	38	22	60
17	18.75	3.25	1.81	11	16	41	36	77	42	34	76
18	19.00	1.0	2.12	2	3	24	16	40	17	14	31
19	19.75	3.75	1.31	3	5	26	5	31	30	5	35
20	19.00	2.81	1.62	2	7	36	14	50	37	9	46
21	18.08	7.93	3.62	14	13	27	25	52			
22	*18.16			3		26	16	42			
23	20.00	2.87		2	9	41	11	52	45	13	58
24	20.34	22.25	14.75	1	0	35	20	55	43	13	56
25	18.34	9.18	3.37	0	6	21	26	47	25	32	57
26	19.00	2.25	1.87	3	9	36	7	43			
27	18.00	1.81	1.63	12	16	41	32	73	37	30	67
28	20.00	6.56		8	10	14	9	23	23	14	37
29	21.58	2.56	5.63	0	5	42	9	51	46	13	59
30	18.67	4.06	1.00	6	10	34	29	63	39	32	71
31	19.08	10.62	2.60	2	4	28	15	43	30	19	49
32	19.83	1.87	1.81	4	9	31	13	43	39	16	55
33	20.25	1.56	1.00	4	5	42	9	51	47	8	55
34	19.75	9.56	3.37	1	2	29	13	42			
35	19.41	3.75	1.62	4	4	36	19	55	37	26	63
36	24.00	1.62	1.44	11	16	39	17	46	38	25	63
37	19.50	2.56	2.13	3	3	18	13	31	22	13	37
38	19.00	8.18		5	8	30	12	42			
39	19.00	3.81	2.25	1	2	36	12	48			
40	20.00	2.18		6	5	31	16	47			
41	18.25	5.25	4.25	3	9	27	19	46	33	19	52
42	19.08	7.6	1.62	13	16	42	36	78	46	37	83
43	*18.00			11		29	6	35			
44	23.67	1.31	0.88	10	4	58	32	90	56	26	82

* indicates that subject discontinued participation in the experiment.

Subject #	Subject Age (Yrs)	ORFT		HFTV		HN					
		Test	Retest	Test	Petest	Test			Petest		
						V	Q	T	V	Q	T
45	20.58	6.06	4.63	6	14	33	20	53	30	28	58
46	19.41	11.75	12.69	5		25	22	47			
47	*20.25			6		32	12	44			
48	19.50	1.31		14	14	36	31	67	45	34	89
49	18.41	2.87	1.37	10	12	45	25	70	45	28	73
50	19.00	2.31	0.87	7	9	29	21	50	36	20	56
51	23.75	1.37	1.06	2	2	43	22	65			
52	19.41	2.37		14	15	44	7	70			
53	18.58	3.75	2.70	6	2	29	30	59			
54	20.83	2.06		11		33	24	57			
55	20.34	5.62	2.75	3	2	19	38	57	45	16	61
56	19.41	2.63		5	13	27	15	42	32	20	52
57	18.91	5.75	2.0	7	6	24	20	44	41	17	58
58	19.00	1.31	1.12	11	7	21	15	36			
59	20.08	4.81		5	6	30	20	50			
60	35.25	2.68	1.87	16	16	56	28	84	57	33	90
61	18.67	1.37	1.25	9	9	33	22	55	36	24	60
62	19.75	7.6	3.75	9	11	30	15	45	47	27	74
63	19.58	1.43	1.94	10	16	15	8	23			
64	20.67	1.68	3.00	7	15	41	24	65			
65	18.34	1.93	1.25	14	16	37	19	56	45	24	69
66	19.34	2.06	1.56	10	12	23	27	50	27	27	54
67	17.67	5.0	2.56	11	15	30	24	54	42	25	67
68	17.75	1.87		10	15	53	18	71			
69	19.25	0.75	1.0	15	15	44	21	65	46	21	67
70	19.34	1.37		7	13	34	18	52	31	25	56
71	18.75	1.81	3.12	10	16	30	19	49	34	20	54
72	19.67	0.75		5	10	30	13	43	31	19	50
73	19.16	11.6	3.93	6	13	36	22	58	36	28	64
74	22.34	2.68	2.25	8	1	44	22	66			
75	18.75	6.56	4.06	10	7	27	8	35			
76	19.16	3.06	2.2	9	14	30	8	38	35	6	41
77	19.91	6.93	6.05	2	8	29	17	46	36	17	53
78	18.75	2.18	3.0	15	16	55	21	76	53	23	76
79	19.25	0.75	1.06	13	16	32	13	45	36	14	50
80	19.25	2.31	0.93	5	6	35	16	51	40	15	55
81	19.08	2.31	1.06	6	11	37	22	59	25	65	2
82	18.67	2.62	0.56	11	11	34	19	53	35	20	55
83	19.75	4.75	4.63	4	3	39	18	57	46	18	64
84	19.25	3.37	0.93	7	9	42	20	62	41	21	62
85	26.91	3.06	2.38	3	1	53	11	64	55	17	72
86	18.83	1.75	1.25	8	14	11	17	28	19	18	37
87	19.00	8.25	3.56	6	4	42	20	62	45	23	68
88	19.08	2.68	3.69	11	15	38	31	69	43	36	79
89	19.00	9.0		3	11	24	17	41	20	23	43

Subject #	Subject Age (Yrs)	ORFT		HFTV		HN					
		Test	Retest	Test	Retest	V	Q	T	V	Q	T
90	19.91	5.0	6.68	8	10	48	15	63	55	16	71
91	19.50	2.87	1.75	12	12	35	21	56	40	25	65
92	19.41	1.43	1.69	7	15	48	30	78			
93	18.67	5.06	2.81	6	8	53	25	78	54	30	84
94	20.00	1.18	1.81	2	2	25	8	33			
95	19.16	3.25	2.56	10	16	19	16	35	23	20	43

APPENDIX 12

ABSTRACT OF

Psychological Differentiation and Strategy Choice
in Bruner's Concept Attainment Tasks

ABSTRACT OF

Psychological Differentiation and Strategy Choice
in Bruner's Concept Attainment Tasks¹

Bruner's research has indicated that subjects demonstrate a consistent approach to the solution of Concept Attainment problems. Witkin has shown that an individual's characteristic mode of perceiving the environment, that is his degree of psychological differentiation can be reliably identified. A specific link between those two theoretical positions has yet to be established. Bruner has experimentally identified two main strategies, focussing and scanning which subjects employ during the performance of his concept attainment tasks presented by the selection paradigm. Witkin and others have developed measuring instruments to determine a subject's degree of psychological differentiation.

The purpose of the present study was to test the hitherto unexplored connection between a subject's strategy choice in Bruner's Concept Attainment Tasks and his degree of psychological differentiation. In addition, the study sought to determine the existence of an additional strategy, apparently not considered by Bruner, which was named Strategy Type Three.

¹ Robert C. Lyle, doctoral thesis presented to the Faculty of Education of the University of Ottawa, Ottawa, Ontario, 1974, ix-136 p.

In the current research, scores on the degree of psychological differentiation were measured by Jackson's version of Witkin's Hidden Figures Test (HFTV) and the Oltman portable Rod and Frame Test (ORFT). Subjects were ninety-five first year female nursing students who were given one practice and three experimental conjunctive rule concept attainment problems using Bruner's eighty-one card stimulus display board and selection paradigm. Each subject was required to make a taped interview and complete a questionnaire to reveal the characteristics of the strategy which she had used to solve the experimental problems. Five raters independently reviewed the information contained on the tape, in the questionnaire and the protocols to classify the subject's strategy.

The hypothesis that there would be significantly different scores on the HFTV and the ORFT between subjects who had used the Focussing strategy and those who had used the Successive Scanning strategy was supported. In addition, the prediction that subjects who used the Focussing Strategy would score toward the Field Independent end of the continuum whereas those who employed the Successive Scanning would score toward the Field Dependent end was upheld. The predicted existence of Strategy Type Three was verified in that forty-four subjects were found to be employing it. It was also shown that the mean psychological differentiation scores for subjects using Strategy Type Three fell between the means of the

psychological differentiation scores of subjects who used
Strategy Type Two and Strategy Type Four.