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ABSTRACT

This study explores how an individual's cognitive style influences the development of a strategy in a concept identification task and how an individual tests his hypotheses in a concept learning set task. Subjects for the research were given the Hidden Figures Test as a means of identifying their cognitive styles. Half of the subjects were identified as being global, scoring one standard deviation below the mean, and half were analytic, scoring one standard deviation above the mean. A series of three experiments was conducted. In the first, subjects solved 80 conjunctive concept identification problems following a selection paradigm. In the second experiment the subjects were asked to solve a total of 24, your-trial learning set problems, while in the third they were given 24, 16-trial problems with intermittent reinforcement. All three experiments, in general, showed that analytic subjects solved more problems correctly and efficiently than did the global subjects; they clearly demonstrate that cognitive style is an important variable in concept learning. The results of these studies were discussed in relation to the body of knowledge concerning cognitive style and implications for future research and educational practice were identified. References are included. (Author/SES)

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STRATEGY DEVELOPMENT AND HYPOTNESIS TESTING AS A FUNCTION OF AN INDIVIDUAL'S COGNITIVE STYLE

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U.S. DEPARTMENT OF
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INTRODUCTION AND STATEMENT OF PROBLEM

Individual difference variables in concept identification have received relatively little attention compared to the consideration given task variables. Bruner, Goodnow, and Austin (1956), for example, observed that individuals differed in the strategies they utilized in identifying concepts but made no attempt to relate these differences to other variables. In extensive reviews of the concept learning literature both Hunt (1962) and Bourne (1966) indicated that the role of individual differences was largely unexplored.

An individual difference variable which seems likely to influence concept learning is that of cognitive style. The term cognitive style has been used to refer to individual consistencies in cognitive behavior resulting from the individual's perceptual and conceptual organization of the external environment (Kagan, Moss & Sigel, 1963). Although a number of different dimensions have been suggested within the rather general domain of cognitive style, there is one characteristic which appears to be common to a number of these dimensions. This characteristic is concerned primarily with the manner in which an individual perceives and analyzes a complex stimulus configuration. The two poles of this dimension are characterized by Ss who analyze and differentiate the components of the stimulus complex and by Ss who fail to analyze and differentiate the components and thus respond to the "stimulus-as-a-whole." Kagan et al., (1963) classified the former Ss as analytical and the latter as relational and believed that their classification system was similar to the field independent-dependent classification of Witkin, Lewis, Hertzman, Machover, Meissner, and Wapner (1954). Thus, there appears to be one dimension which involves an active analysis on the one hand and a more passive, global acceptance of the entire stimulus on the other hand.

Recent research has suggested that cognitive style is an influential variable in laboratory learning tasks. Long (1962), for example, reported that an analytic cognitive style was superior to a global cognitive style in serial learning and Guetzkow (1951) reported that successful performance in problem solving was correlated with an individual's cognitive style. Davis and Klausmeier (1970) reported that high school males with an analytic cognitive style performed better on a standard concept identification task than did males with a global cognitive style. Similarly, Ohnmacht (1966) found that analytic Ss were superior to global Ss in a reversal-nonreversal concept identification task. Although this dimension of cognitive style has received a good deal of experimental attention, its relationship to the development of strategies and the testing of hypotheses has yet to be determined.

Since concept learning tasks require selective attention to relevant aspects of complex stimulus configurations, it would seem that further research on the nature of cognitive style in concept identification is necessary. The present experiments were designed to examine further the extent to which an individual's cognitive style influences his performance on concept learning tasks.

Related Research--Concept Learning. The topic of strategies occupies a central position in many of the various approaches to learning, especially those concerned with conceptual behavior. This is clearly apparent from the steadily increasing number of research reports which have been concerned with strategies.

In an attempt to better understand the learning process, psychologists have focused upon strategies which Ss employ in various learning situations. Data concerning these strategies is then used as a basis for drawing inferences pertaining to cognitive processes. Although a wide variety of different tasks and methodologies are used, there is one assumption common to all of the approaches. This fundamental assumption is that a S begins a problem with a mediating process (implicit or explicit) which affects his overt behavior in specifiable ways. A number of different terms have been used to describe this mediating process: "strategies," "hypotheses," "sets," "expectancies," and "predictions."

Research on strategies used in concept learning proceeds, methodologically, in two ways. In one, the S attempts to verbally describe his process and can be referred to as the verbal report method. In the other, the S makes a series of responses from which the learning processes are demonstrated or inferred and can be referred to as the response sequence method. Several early concept identification studies utilized the verbal report method (Heidbreder, 1924, Smoke, 1932, Claparede, 1934; Duncker, 1945). In these studies the S was simply asked to talk while he worked through a problem and the investigators attempted to describe the strategies that a S used from his verbal report. Aside from the obvious difficulty of performing quantitative analysis on Ss' protocols when the verbal report method is used, the possibilities exist that instructions may produce a misleading type of behavior, the Ss' statements may be irrelevant to the learning processes, or Ss may lack the verbal ability to describe their processes.

More recently, the response sequence method has been used (Bruner, et al., 1956; Bourne, 1963; Byers, 1963; Rivka, 1965). A generalized procedure used in these experiments may be briefly described as follows. The S is presented an array of stimulus cards which vary along several dimensions. The S is told what the possible relevant dimensions are and that in the concept he is seeking any combination of them may be relevant. He is further told that he can determine the concept that the E has defined by testing stimulus cards and inferring from such tests which dimensions are relevant and which are irrelevant to the solution. The problem is initiated by presenting S a focus card which is a positive instance of the concept he is to identify. The S then begins to test any other stimulus card he wishes. Following the S's card choice, the E informs him whether the card selected is a positive or a negative instance of the concept that is to be identified. The S's card choice and the E's feedback is classified as a trial. A record is kept of all of the trials as they occur and the problem is terminated when the S states the correct concept.

A S's strategy is inferred from the characteristics of the cards that S selects. Using this procedure Bruner et al., (1956) developed the notion of ideal strategies and Byers (1961) developed the idea of strategies on a continuum ranging from conservative focusing to gambling. Although the response sequence method has been used to investigate strategies, it has not met with overwhelming success due to the great variability between Ss. There are three possible reasons for this relative lack of success which the proposed experiments attempt to eliminate. First, these studies usually give a S a small number of problems to solve. It is possible then, that in these complex problems a strategy must be learned and this learning does not occur in a situation which uses a few problems. Thus, if a S were given a large number of problems, as in Experiment I, it would seem that a definite strategy would develop and could more easily be identified. Second, the majority of these studies have used a large number of stimulus dimensions and consequently there are a large number of hypotheses which a S must eliminate in order to correctly identify the concept. Third, some investigators allow their Ss to select the instances about which they wanted information. This procedure results in a great deal of variance in terms of the specific instance which was selected by an individual S and further contributed to the problem of precisely specifying the strategy that a S was using.

Recently, Levine (1963, 1966) has introduced a technique which is of great potential in the study of strategies and avoids a number of the problems inherent in the other methods. First, he uses only four stimulus dimensions and consequently there are only five hypotheses which a S must deal with. Second, he uses a forced choice procedure in which S is presented two instances, a positive and a negative instance, and S must select one of the two stimuli. This procedure avoids the problem of variability which is present in the selection technique.

The essential features of Levine's technique are as follows. Groups of Ss are asked to solve a series of four-trial discrimination problems. Across all problems, there are four bivalued dimensions (color, form, size and position). Within each problem, each value of each dimension appears an equal number of times with every value of every other dimension. Levine defines problems which meet this condition as internally orthogonal and argues that these problems allow for the delineation of hypotheses in terms of response sequences. For example, in the four dimension problem there are only five different hypotheses. a color hypothesis, a form hypothesis, a size hypothesis, a position hypothesis, and a residual category into which Ss are placed when their response sequence does not conform to one of the other response sequences. Within a four-trial problem S is presented a pair of instances and asked to choose one. His hypothesis is inferred from the pattern of his responses across the four trials. For any problem two different feedback conditions can be employed. In one case the E says "right" or "wrong" following a response (outcome problems), and in the other the E says nothing following a response (nonoutcome problems). Levine estimates the frequencies of occurrence of certain experimentally defined strategies from his S's behavior on nonoutcome problems which are interpolated between blocks of outcome problems.

This method, which was employed in Experiments II and III, has provided some useful information concerning concept identification and the function of reinforcement in a concept learning experiment. Levine (1963) found that a S, having tried a hypothesis and having been told that it was wrong, does not replace his hypothesis and start over as Bourne and Restle (1959) suggest, but rather he eliminates the hypothesis and samples from the remaining set, i.e., he samples without replacement. Levine (1966) provided further empirical support for this notion and also demonstrated that the size of the hypothesis set from which S sampled was reduced with each successive outcome problem.

Related Research--Cognitive Style. It is well documented that there are large individual differences in the manner in which people perceive and analyze a complex stimulus configuration and that this particular manner or style carries over into other areas of cognitive functioning. Furthermore, there is a growing body of literature which suggests that individual differences in perceptual and conceptual organization are relatively stable and interact to produce consistencies in cognitive functioning.

Although previous interest in cognitive style has focused essentially on the relationships between cognitive style and personality structures and certain demographic relationships, it has been suggested that cognitive style has wide implications for a variety of areas including education (Witkin, 1965). The data from a number of studies concerned with cognitive style suggest that a person's cognitive style influences the quality of cognitive products involved in a variety of tasks such as paired-associate tasks (Kagan, et al., 1963), memory tasks (Gardner & Long, 1961), vigilance tasks (Kagan, et al., 1963), and problem solving tasks (Witkin, 1964). A study by Baggaley (1955) suggested that cognitive style was also a significant variable in concept identification. In this study, Ss were presented cards that varied along five bivalued dimensions, and were asked to identify two dimensions which were relevant to classifying the cards. Baggaley found that Ss who performed in an analytic manner on the Concealed Figures Test also performed significantly better on the concept identification task than did Ss who performed in a more global manner on the Concealed Figures Test.

Davis & Klausmeier (1970) found that individuals with an analytic cognitive style committed fewer errors in identifying concepts than did individuals with a global cognitive style. The exact reason for the poor performance of the global Ss, however, was not clear. It is possible that global Ss are unable to remember individual instances as well as analytic Ss or it may be that global Ss are unable to utilize feedback, to process information, or to test hypotheses as effectively as analytic Ss. In an unpublished study by Davis (1969) it was found that global Ss tested hypotheses from a relatively large hypothesis pool, many of which were irrelevant to the concept learning task, while analytic Ss sampled from a relatively small hypothesis pool, the majority of which were relevant to the learning task. Thus, the present experiments were designed to provide further information concerning the extent to which the poor performance of global Ss is attributable to deficiencies in hypothesis testing and strategy utilization.

The particular conceptualization of cognitive style followed in the proposed series of experiments is most closely related to that of Witkin, Dyk, Faterson, Goodenough & Karp (1962) and the operational index of the analytic-global dimension of cognitive style was performance on the Hidden Figures Test (HFT). The HFT is one of the reference tests for cognitive factors presented by French Ekstrom, and Price (1963) and has been found to be correlated (r = .62) with Witkin's Embedded Figures Test (Jackson, Messick & Meyers, 1964). The task is to identify one of five simple geometric figures which is embedded in a complex pattern. The HFT is divided into two parts, each part consisting of 16 complex patterns in which the simple geometric figure to be found is always right side up and of the same size as the simple figure example. It is assumed that Ss able to identify the hidden figures represent the analytic cognitive style, while Ss unable to identify the hidden figures represent the global cognitive style.

Problems to be Investigated. The purpose of the experiments outlined in this report is to provide further information concerning how an individual's cognitive style influences the development of a strategy in a concept identification task and how an individual tests his hypotheses in a concept learning set task. The specific questions to be answered by these experiments are

1. Can a S's strategy be more reliably identified through the use of a concept learning set procedure than has been possible in the past? (Experiment I)
2. Is there a difference between analytic and global Ss in terms of the efficiency with which these Ss identify concepts and is there a difference in the strategies they employ in identifying concepts using a selection paradigm? (Experiment I)
3. Is there a difference between analytic and global Ss in terms of the efficiency with which they test hypotheses in a concept learning situation which employs a fixed choice procedure? (Experiment II)
4. Is there a difference between analytic and global Ss in terms of the effects of intermittent reinforcement upon S's hypotheses? (Experiment III)

Organization of the Report. The remainder of the report will be organized according to the sequence in which each of the three experiments was conducted. Chapter II will describe the rationale, method, and results of the first experiment which was concerned with cognitive style and the development of strategies. Chapter III will describe the rationale, method, and results of the second experiment which was concerned with cognitive style and hypothesis testing. Chapter IV will describe the rationale, method, and results of the third experiment which was concerned with examining in greater detail the role of hypothesis testing as a function of an individual's cognitive style. Chapter V will discuss the results of the three experiments and the implications of these findings for future research as well as some implications for education.

CHAPTER TWO

EXPERIMENT I. COGNITIVE STYLE AND STRATEGY DEVELOPMENT

<u>Introduction</u>. Researchers interested in the study of concept learning have employed two general procedures for studying the learning process in concept learning--the reception paradigm and the selection paradigm. In the reception paradigm a <u>S</u> is presented a predetermined sequence of instances while in the selection paradigm the <u>S</u> is allowed to choose any of a variety of sequences of instances. Although the reception paradigm has been subjected to considerably more research and theorizing than the selection paradigm, the selection paradigm has been used most often to study strategies for solving concept learning problems.

Bruner, Goodnow, and Austin (1956) employed a selection paradigm in their research in which they described and identified several ideal strategies. They distinguished two basic selection strategies, focusing and scanning. When a <u>S</u> employs a focusing strategy he selects instances which vary from the focus or example instance on one (conservative focusing) or more (focus gambling) dimensions. When a <u>S</u> employs a scanning strategy he tests specific hypotheses, either one at a time (successive scanning), some intermediate number of hypotheses, or all possible hypotheses at one time (simultaneous scanning).

Early attempts at studying these strategies (Bruner, <u>et al.</u>, 1956; Byers, 1963), were not entirely successful in quantifying the specific type of strategies that <u>S</u>s employ in a concept learning situation. More recently, however, a series of studies by Laughlin (1965, 1966, 1968 and Laughlin and Jordan, 1967) and Johnson (1971) have been more successful in terms of developing procedures for identifying and quantifying selection strategies. Although these studies have demonstrated that the selection paradigm is greater in complexity than the reception paradigm, it has proven useful not only in terms of identifying selection strategies, but also in terms of providing information concerning the conditions that influence the use of selection strategies. In general, these studies have indicated that a focusing strategy is more often adopted than a scanning strategy. Furthermore, these studies have shown that many different variables and task procedures influence the strategies or plans Ss follow in solving this type of concept learning problem. Laughlin (1965), for example, found that a display of all possible instances in a concept learning problem resulted in more use of focusing strategies than did a sequence display of the same information. Furthermore, Laughlin and Jordan (1967) and Laughlin (1968) found that conjunctive problems were more likely to result in the use of focusing strategies than would problems with disjunctive or conditional rules. Therefore the present experiment employed a selection procedure which used a form display and required Ss to solve problems employing a conjunctive rule in order to maximize the possible occurrence of focusing strategies. One of the objectives of the present experiment was to select a task which was likely to evoke a focusing strategy and still be difficult enough to provide data concerning any differences in information processing by individuals manifesting different cognitive styles.

It was also decided to provide Ss with a large number of conjunctive problems (80 problems), since it was felt that Ss might learn or modify any pre-existing strategy in the course of learning several problems. Studies which are concerned with selection strategies typically provide Ss with a limited number of problems (1-5). This procedure may preclude the possibility that the selection strategies are in part learned within the actual testing situation. It is also possible that Ss initially adopt a simple strategy (e.g. conservative focusing) but with additional experience may adopt a more sophisticated strategy. In order to study the acquisition or modification of strategies a large number of problems are needed and therefore were included in the present experiment.

Using a reception paradigm, Davis and Klausmeier (1970) found that Ss with an analytic cognitive style were more efficient in solving conjunctive concept problems than were Ss with a global cognitive style. The specific reason for this finding, however, was not clear. Several possibilities were suggested. One possible explanation of the less efficient behavior of the global Ss is that they are not as efficient in recognizing, developing or utilizing a strategy which is appropriate to their task. Therefore one of the purposes of this experiment was to determine the extent to which analytic and global Ss differed in recognizing, developing or utilizing a selection type strategy.

Method

Subjects. The Hidden Figures Test (HFT) was administered to four sections of introductory educational psychology classes and involved testing 194 Ss. Seventy-eight of the Ss were males and 116 of the Ss were females. Scores on the HFT were corrected for guessing by subtracting the number wrong divided by four from the number right. Since previous research using the HFT has reported sex differences, separate distributions of the HFT scores were made for males and females. The mean score for the male Ss was 24.27 with a standard deviation equal to 7.88. Ten analytic male Ss were selected from the pool of Ss who scored +1 standard deviation above the mean (score = 32.00) and 10 global male Ss were selected from the pool of Ss who scored -1 standard deviations below the mean (score = 16.25). The mean score for the female Ss was 23.13 with a standard deviation equal to 7.62. Ten analytic female Ss were selected from the pool of Ss who scored +1 standard deviations above the mean (score = 30.75) and 10 global female Ss were selected from the pool of Ss who scored -1 standard deviation below the mean (score = 15.50). Each of the 40 Ss were tested individually on the concept learning problems and were paid an hourly rate for their eight testing sessions. Each testing session lasted approximately one hour.

Stimulus Materials. Stimulus cards were prepared by combining two levels of each of seven bi-valued dimensions on 3-in. by 3-in. cards. The dimensions and their corresponding values were: letter (A or E), number of letters (1 or 2), size of letters (large or small), color of letters (red or blue), orientation of letter (upright or tilted), horizontal position of letters (left or right), and vertical position of letters (top or bottom). The display of the stimulus cards was composed of 128 different 3-in. by 3-in. cards. These cards were mounted on a large stimulus-display board in an ordered array with 8 rows and 16 columns.

Procedures. Upon entering the laboratory, each S was told that he would be asked to solve several concept identification problems. A standard set of instructions similar to that used by Bruner et. al., (1956) was given to each S. In general, the instructions described the seven stimulus dimensions and illustrated how the cards could be classified in various ways, such as all cards which were red and E or all cards that were 2 and A. Each S was instructed that all of the problems he was to solve would be conjunctive problems with two relevant dimensions. Furthermore, each S was told that each problem would begin with a focus card which contained the two relevant dimensions he was searching for. He was further told that after the focus card was designated by its identification number, he could select any instance he wanted information about by calling out its identification number. The E would then respond by saying "yes" if the instance selected was a positive instance of the concept or respond by saying "no" if the instance was a negative instance of the concept. He was further instructed that after he had received feedback from the E he could offer a hypotheses concerning the solution to the problem. If the hypothesis was correct, the problem was terminated and if the hypothesis was incorrect, he was told no and continued by choosing another card. Thus only one hypothesis could be offered per card choice. The S was told that his task was to identify the concept as efficiently as possible, and that time would be recorded, but that they were to learn the concepts in as few card choices as possible.

Following the instructions, Ss were given a series of tasks to insure that they understood the instructions. First, all Ss were asked to name the seven values of certain stimulus cards. This task was conducted to insure that the Ss could remember the seven dimensions and their corresponding values. The E would simply call out an identification number and ask S to describe the card. If S forgot any of the values, E would supply it for the S. This procedure was continued until S was able to correctly describe six consecutive cards.

Following the stimulus naming task, Ss were given sample concepts and asked to give four cards which illustrated the concepts. Next, the Ss were asked to give feedback (respond by saying 'yes' or 'no') for certain cards which were positive or negative instances of two concepts. After Ss completed the three tasks, they were asked if they had any questions and if they did, E clarified any confusion that might have existed.

Each S solved 10 problems per day for eight days for a total of 80 problems. Within the confines of the stimulus population, there were 84 unique two-valued conjunctive concepts. From this pool of 84 concepts, 80 were randomly selected for each of the 40 Ss. Since the testing period lasted for eight days, it was necessary to provide a two-day period during which the testing was not conducted due to the problem of scheduling over the week-end. Therefore, each S began his testing sequence on Monday, Tuesday or Wednesday. Thus, each S had a minimum of three days testing experience before the two day delay. Informal observations suggested that the two day delay period did not in any way interfer with the performance of the Ss.

Results. A 2 x 2 x 8 analysis of variance was performed with the variables of sex (male or female), cognitive style (analytic or global) and blocks (eight blocks of 10 problems each). The unit of analysis was an individual's mean score over 10 problems. An analysis of variance was performed on each of five major dependent variables: mean number of trials to solution, mean time to solution, focusing strategy scores, mean percentage of problems in which a perfect conservative focusing strategy was followed, and mean number of trials in excess of sufficient information. Results of analyses on these dependent variables are presented in Table 1.

Since the necessary assumptions (Winer, 1971) for the analysis of variance model with repeated measures could not be met, the conservative test (Box, 1953) was employed. This procedure was used to test all factors involving repeated measures and involved reducing the degrees of freedom to $(a-1)\lambda$ and $(a-1)(n-1)\lambda$, where a is the number of levels of the repeated measure (8) and λ was set at 1/a-1.

TABLE 1

ANALYSIS OF VARIANCE FOR TRIALS TO SOLUTION, TIME TO SOLUTION, FOCUSING STRATEGY, MEAN NUMBER OF TRIALS IN EXCESS OF SUFFICIENT INFORMATION, AND MEAN PERCENT IN WHICH A PERFECT CONSERVATIVE FOCUSING STRATEGY WAS USED

SOURCE	df	TRIALS		TIME		FOCUSING STRATEGY		MEAN % OF PROBLEMS WITH A FOCUSING STRATEGY		EXCESS INFORMATION	
		MS	F	MS	F	MS	F	MS	F	MS	F
Sex (S)	1	59.43	1.55	1161.67	<1	.14	1.35	2880.00	<1	26.11	1.26
Cognitive Style (CS)	1	429.90	11.20**	76814.91	19.36**	1.39	12.44**	62161.25	15.48**	256.33	12.38**
S x CS	1	28.98	<1	1372.41	<1	.02	<1	1201.25	<1	18.43	<1
SS/SCS	36	38.38		3967.65		.022		4014.79		20.71	
Blocks(B)	7	86.47	212.04**	77456.09	77.07**	.43	37.64**	10631.42	46.21**	53.75	21.07**
B x S	7	1.47	3.59**	1202.41	1.20	.006	<1	323.57	1.41	.90	<1
B x CS	7	11.14	27.32**	7970.30	7.93**	.015	1.33	589.11	2.56*	9.11	3.57**
B x S x CS	7	90.40	221.68**	2201.58	2.19*	.007	<1	617.68	2.68*	13.89	5.45**
B x SS/ SCS	252	.41		1004.99		.01		230.07		2.55	

*$p < .05$
**$p < .01$

Mean Number of Trials to Solution. The dependent variable of mean number of trials to solution consisted to treating each card choice and hypothesis associated with the card choice (if offered) as a trial. The effect of cognitive style was significant at the .01 level, F (1,36) = 11.20. Analytic Ss solved the concept learning problems in fewer trials than the global Ss. Analytic Ss required an average of 5.71 trials to solution while the global Ss required an average of 8.03.

Analysis of the effect of blocks of 10 problems was found to be significant at the .01 level using the conservative test, F (1,40) = 212.04. In general, this finding merely reflected an improvement in performance across the eight blocks. The interaction of blocks by sex was not found to be significant ($p > .05$) using the conservative test.

The interaction involving blocks by cognitive style was found to be significant at the .01 level using the conservative test, F (1,20) = 27.32. Also, the three-way interaction involving blocks, sex and cognitive style was found to be significant F (1,12) = 221.68; $p < .01$). The means involved in this interaction are presented in Figure 1.

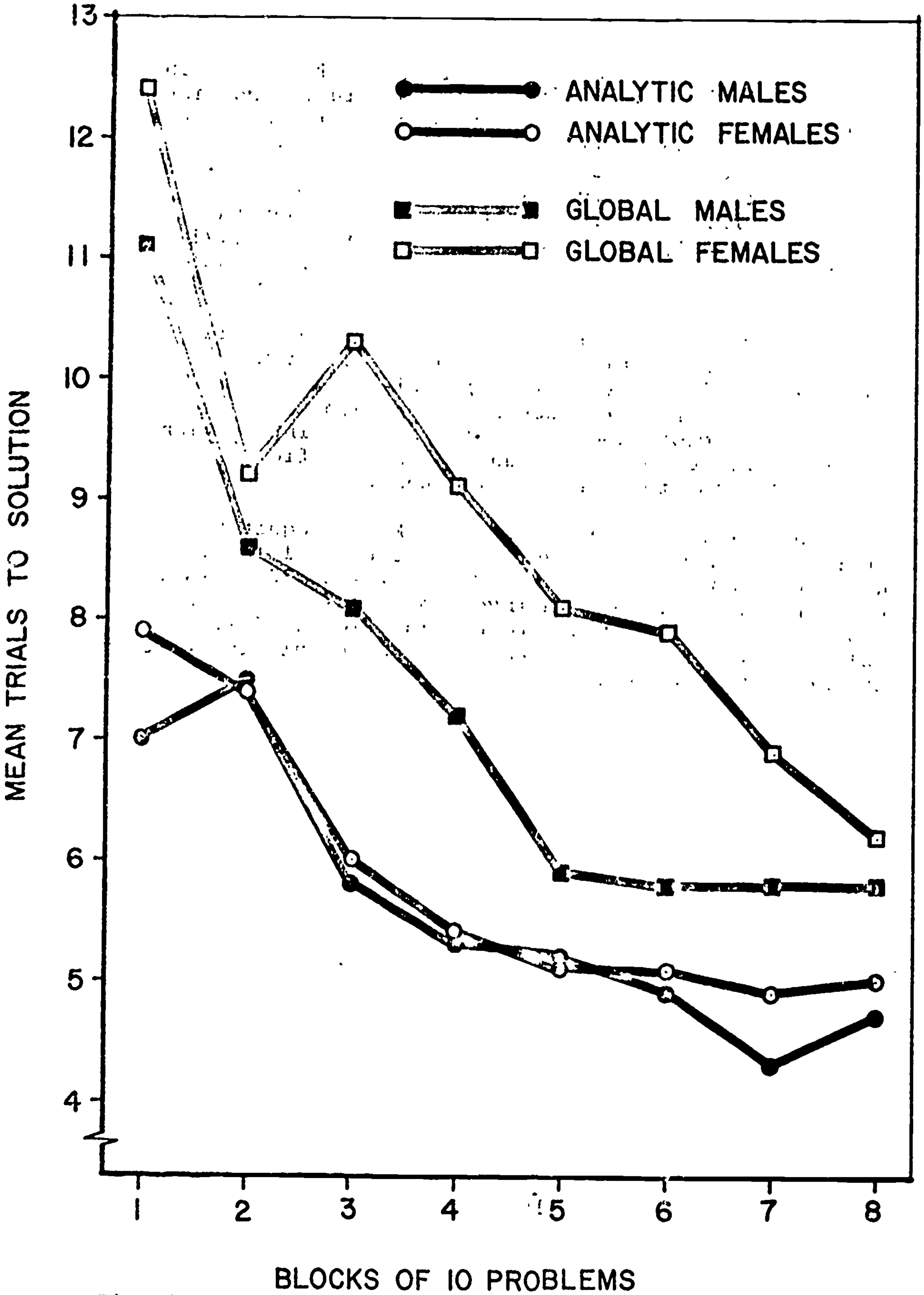

Fig. 1. Mean trials to solution as a function of cognitive style and sex.

Subsequent analysis of the means involved in the interaction of blocks by sex by cognitive style involved comparing each of the four means at each of the eight levels of blocks by the Newman-Keuls procedure (Winer, 1971). At block 1, each mean differed significantly ($p < .01$) from everyother mean, with the exception of the male analytic and female analytic contrast. At block 2, neither the analytic male and analytic female contrast, nor the global male and female contrast was reliable, but all other contrasts were reliable ($p < .01$). Thus, both the analytic males and females differed significantly from the global males and females. At blocks three and four, each mean differed significantly ($p < .01$) from everyother mean, with the exception of the analytic male and analytic female contrast. Mean comparisons at blocks five and six indicated that analytic males, analytic females and global males differed significantly ($p < .01$) from global females, but did not differ significantly from each other. At block seven, analytic males and analytic females did not differe, but all other comparisons were reliable ($p < .01$). At block eight, analytic males differed significantly ($p < .01$) from global males and global females, and analytic females differed from the global females. No other contrasts were significant.

Mean Time to Solution. Time in seconds was recorded for each S for each problem and then averaged across each block of 10 problems. Analysis of variance on this measure yielded a significant ($p < .01$) effect of cognitive style, $F(1,36) = 19.36$. Analytic Ss required an average of 59.83 seconds to solve the problems, while global Ss required an average of 90.82 seconds. The main effect of blocks was also found to be significant using the conservative test, $F(1,40) = 77.07$. This finding indicated that there was a general reduction in the amount of time to reach solution across blocks of problems.

A significant ($p < .05$) interaction of blocks by cognitive style was also found using the conservative test $F(1,20) = 7.3$). The means involved in this interaction are presented in Figure 2. Subsequent analysis of the interaction involved t-tests between the means of the analytic Ss and global Ss at each of the eight blocks. The t values for the first five blocks were 13.64, 2.95, 5.67, 4.28, 2.49, respectively and were significant at the .05 level with df = 20. The t values for the remaining three blocks were not significant. Thus the difference in time to solution was significant across the first five blocks of 10 problems, but performance was not significantly different for the last three blocks.

When the interaction of blocks by sex by cognitive style was reevaluated using the conservative test it did not reach an acceptable level of significance ($F(1,20) = 2.19$, $p > .05$).

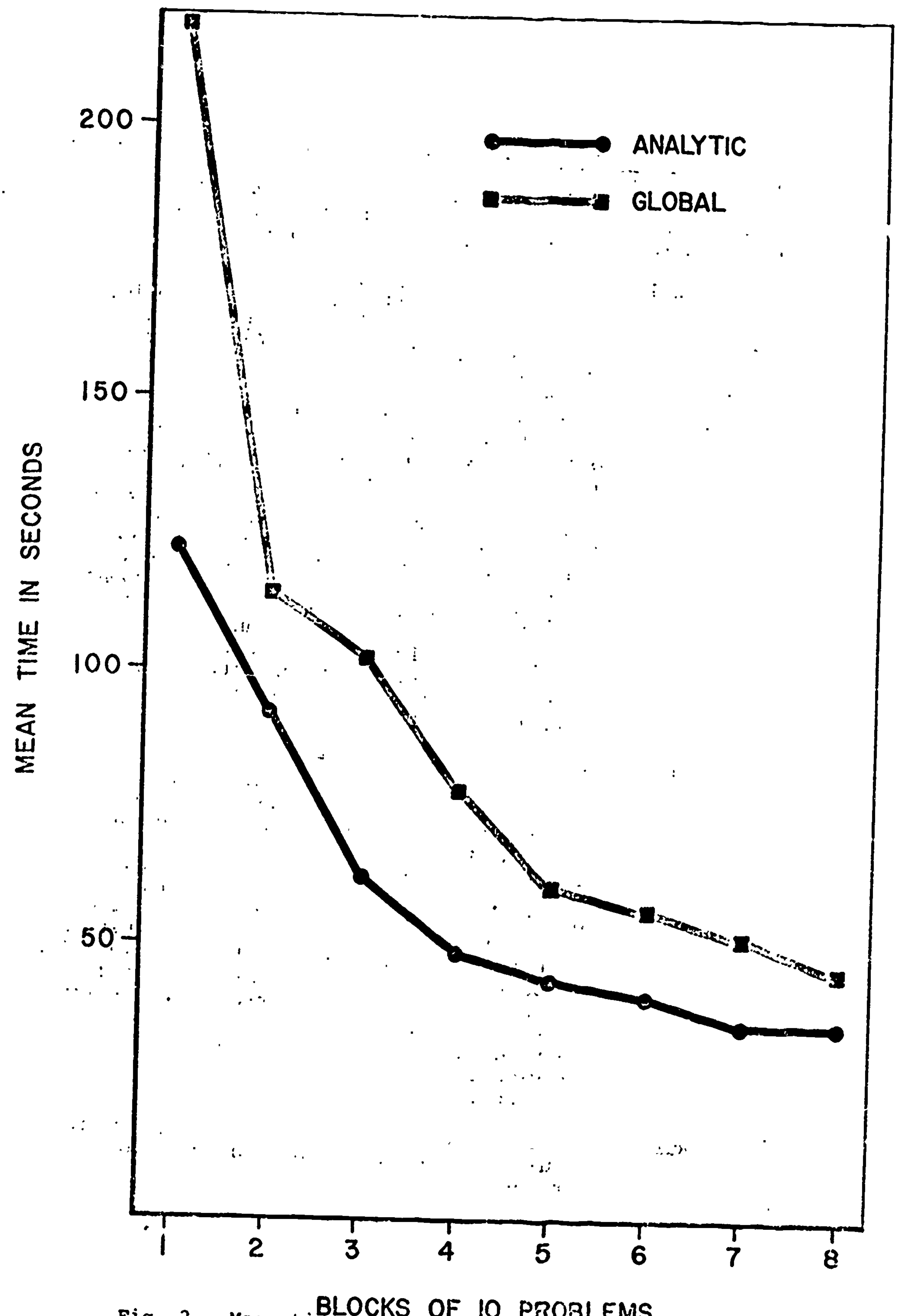

Fig. 2. Mean time to solution as a function of cognitive style and blocks.

Focusing Strategy. In order to arrive at a quantified measure of strategies, a procedure developed by Laughlin (1965, 1966, 1967) was employed. This procedure analyzed each trial of each of the 80 problems. Three rules were followed in implementing this scoring procedure:

Rule 1: Information had to be obtained on a new dimension following each card choice. This rule was met if a S followed either a conservative focusing or focus gambling strategy. In the case of a conservative focusing strategy, the S would select an instance which varied only one dimension from the focus card (trial 1) or varied only one dimension which had not previously been varied (trial 2...trial n). In the case of a focus gambling strategy, the S could vary more than one dimension on a trial. If the instance which varied on more than one dimension was classified as either a positive instance ("yes" response from E) or the ambiguous information (in the case of a negative instance) was correctly resolved on the next card choice by altering only one attribute, then the conditions of rule 1 were considered as being met.

Rule 2: If a hypothesis was offered it had to be consistent and tenable considering all previous information available to the S. Two types of inconsistent hypotheses were identified: (a) a hypothesis involving a value of a dimension when the opposite value of that dimension had previously occurred on a positive instance, e.g., the hypothesis "1-A" when an instance containing "2" had previously been classified as positive; (b) a hypothesis for a value which had previously occurred on a negative instance, e.g., the hypothesis "large A" when an instance with large A or both had previously been classified as a negative instance.

Rule 3: Neither the hypothesis nor the card choice could be a duplicate of a previous hypothesis or card choice.

If a given card choice and accompanying hypothesis (if offered) satisfied Rule 1 and did not violate the conditions of Rules 2 or 3, then the trial on which that card choice occurred was counted as an instance of focusing, and given a score of one. The total number of card choices which meet these conditions was divided by the total number of card choices. This ratio provided a continuous focusing score which ranged in value from .00 to 1.00. A score of .00 would indicate an absence of focusing, while a score of 1.00 would indicate a perfect focusing score.

For each S the focusing score was obtained for each problem and then an average focusing score for each block of 10 problems was calculated and analyzed in the analysis of variance. As can be seen in Table 1, the effect of cognitive style was significant at the .01 level, $F(1,36) = 12.44$. Analytic Ss had a mean focusing score of .86 and the global Ss had a mean focusing score of .73. Thus there was a greater tendency for the analytic Ss to use a focusing strategy.

A significant ($p < .01$) effect of blocks was also obtained, using the conservative test, $F(1,40) = 37.64$. Over-all this finding reflected a progressive improvement in the focusing score. The means for blocks are through eight were: .58, .72, .77, .81, .86, .84, .89, and .90, respectively. Subsequent analysis of the blocks effect by means of the Newman-Keuls procedure indicated that the mean for block one differed significantly ($p < .01$) from the means of blocks four through eight. The block three mean differed significantly ($p < .01$) from the means of blocks six through eight and the mean of block four differed significantly ($p < .01$) from the means of blocks seven and eight.

Mean Percentage of Problems in Which a Perfect Conservative Focusing Strategy was Used. Within each block of 10 problems, the percent of problems on which a S employed a perfect conservative focusing strategy was calculated and then averaged across all Ss. An analysis of variance on this data indicated that there was a significant ($p < .01$) effect of cognitive style, $F(1,36) = 15.84$. Analytic Ss had a mean of 42.9 percent and the global Ss had a mean of 38.1 percent.

Using the conservative test, a significant ($p < .01$) block effect was also found, with $F(1,40) = 46.21$. Subsequent analysis of the block effect involved the Newman-Keuls procedure. The mean of block one was found to differ significantly ($p < .01$) from the means for blocks two through eight. The mean of block two differed significantly ($p < .01$) from the means of blocks three through eight. The means for blocks three and four each differed significantly from the means of blocks five through eight. The means of blocks five through eight did not differ significantly. Thus, there was a general increase in the percent of problems per block which were solved using a perfect conservative focusing strategy. This general increase, however, begins to stablize after approximately 50 problems. None of the interactions involving blocks was significant.

Mean Number of Trials in Excess of Sufficient Information. Within a selection procedure such as the one employed in the present experiment, there are several optimal ways an individual can process information within the general domain of a conservative focusing strategy. Given that a Ss knows that the solution is a conjunctive rule involving only two relevant dimensions, and given that a S is employing a conservative focusing strategy in which only one dimension is varied per card choice, then a particular problem can be solved either at the point where he encounters his second negative instance or at the point where he gets five consecutive positive instances. If, for example, a S chose two cards which were negative instances for his first two card choices, then he would have sufficient information to solve the problem. By inference, he could conclude that the remaining five dimensions were irrelevant and thus the last five card choices could be considered as redundant and unnecessary. Like-wise, a S could receive a "yes" response for each of his first five card choices, and still have sufficient information to solve the problem. By inference, he could conclude that the remaining two dimensions are relevant and derive the solution without choosing any additional cards. If a subject is optimally processing information and can draw the proper inferences, for many of the problems he should be able to solve the problem without varying each of the seven dimensions. Therefore within each S's protocal the trial at which information was sufficient was determined and then the number of trials beyond this point was treated as a dependent variable. Thus, each problem was analyzed in terms of the number of trials beyond the point at which information was sufficient and was analyzed by means of the analysis of variance.

The summary of the analyses of this data is presented in Table 1. As can be seen there was a significant main effect of cognitive style $F = (1,36) = 12.38$; $p < .01$. Analytic Ss required an average of .91 trials beyond the point of sufficient information while the global Ss required an average of 2.7 trials beyond the point of sufficient information.

When the conservative test was employed a significant ($p < .01$) effect of blocks was obtained ($F(1,40) = 21.07$), and a significant ($p < .05$) blocks by cognitive style interaction ($F(1,20) = 5.45$). The means involved in this interaction are presented in Figure 3. Subsequent analysis by means of the Newman-Keuls procedure indicated that for blocks one and three the analytic males and females differed significantly from the global males and females, but did not differ from one another. For blocks four and five, analytic males, analytic females and global males differed significantly ($p < .05$) from global females, but did not differ significantly from one another. No significant differences were found at blocks two, six, seven and eight.

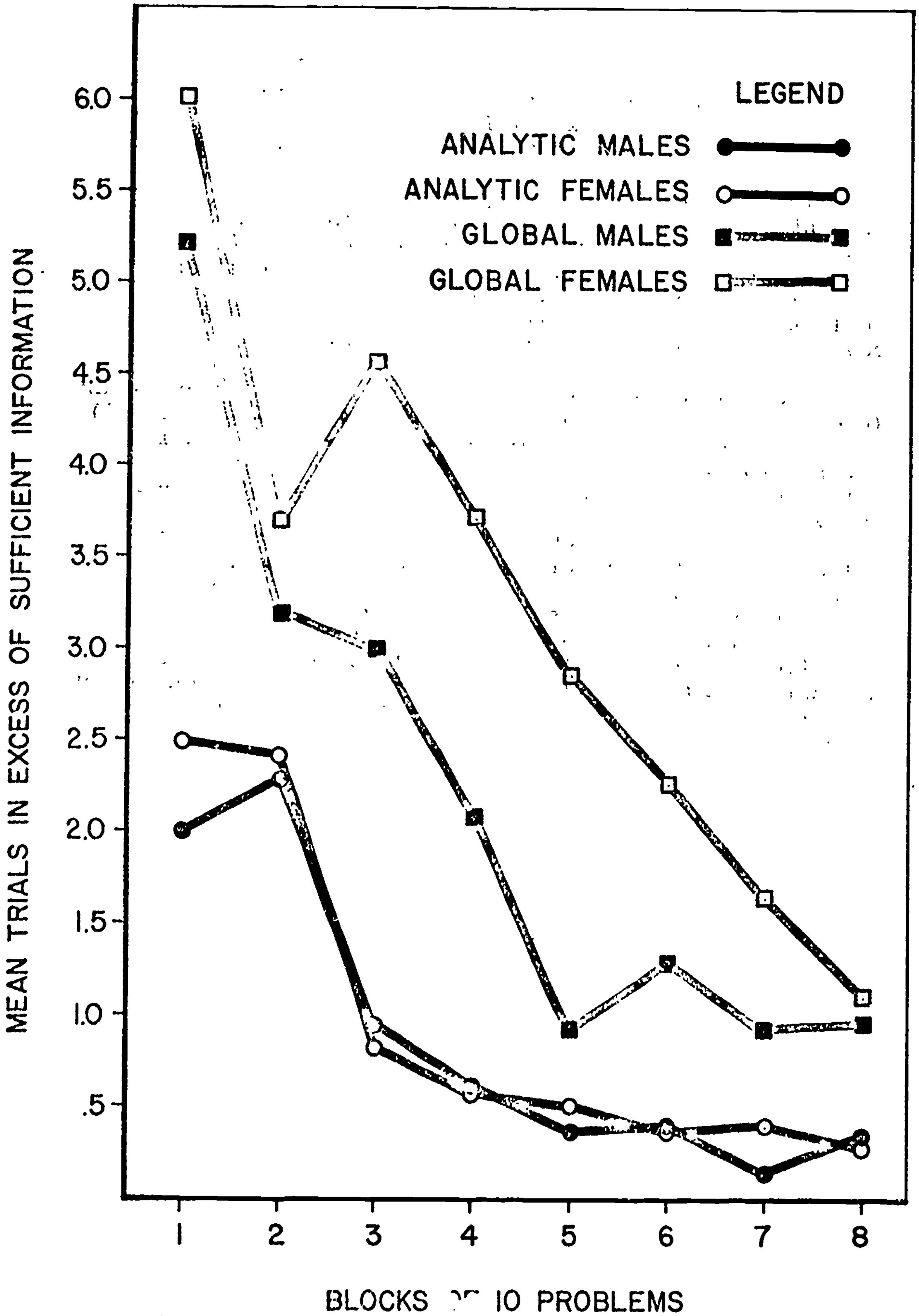

Fig. 3. Mean trials in excess of sufficient information as a function of cognitive style, sex and blocks.

Hypotheses. Analyses of variance were performed on data involving hypotheses and a summary of these analyses is presented in Table 2. Four dependent measures were obtained: mean number of hypotheses offered, mean number of tenable hypotheses, mean number of untenable hypotheses, and mean number of duplicate hypotheses.

Only one of the analyses reflected a significant effect of cognitive style. With respect to the mean number of duplicate hypotheses, cognitive style was significant ($p < .01$) with $F(1,36) = 16.88$. Analytic Ss had a mean of .10 duplicate hypotheses and global Ss had a mean of .19.

When the conservative test was applied to those factors involving repeated measures only the block effect in three of the analyses was significant. The means involved in the significant effect of blocks are presented in Table 3. For mean number of hypotheses offered, the F ratio was 27.20 and was significant at the .01 level. Subsequent analysis by means of the Newman-Keuls procedure indicated that the mean of the first block was significantly ($p < .01$) different from the means of blocks two through eight. Also, the mean of block two differed significantly from the means of blocks four through eight. None of the other comparisons was significant.

The analysis of mean number of untenable hypotheses reflected results identical to the results of mean number of hypotheses offered.

The subsequent analysis of mean number of duplicate hypotheses by the Newman-Keuls procedure indicated that the mean of block one differed significantly from the means of blocks three through eight.

None of the factors involved in the analysis of tenable hypotheses reached an acceptable level of significance.

TABLE 2

ANALYSIS OF VARIANCE FOR MEAN NUMBER OF HYPOTHESES OFFERED, MEAN NUMBER OF TENABLE HYPOTHESES, MEAN NUMBER OF UNTENABLE HYPOTHESES AND MEAN NUMBER OF DUPLICATE HYPOTHESES

SOURCE	df	HYPOTHESES OFFERED		TENABLE HYPOTHESES		UNTENABLE HYPOTHESES		DUPLICATE HYPOTHESES	
		MS	F	MS	F	MS	F	MS	F
Sex (s)	1	.34	< 1	.89	< 1	.20	< 1	.64	1.39
Cog. Styl. (CS)	1	8.75	< 1	.44	< 1	12.88	3.48	7.75	16.88**
S x CS	1	.85	< 1	.34	< 1	2.52	< 1	.08	< 1
SS/SCS	36	11.34		3.31		3.69		.46	
Blocks (B)	7	21.89	27.20**	.30	2.82	17.24	25.83**	1.11	8.09**
B x S	7	.57	< 1	.22	2.01	.28	< 1	.07	< 1
B x CS	7	1.43	1.78	.06	< 1	1.08	1.62	.11	< 1
B x S x CS	7	1.50	1.86	.05	< 1	1.03	1.55	.07	< 1
B x SS/SCS	252	.80		.1079		.6677		.1369	

*p .01

**p .01 for conservative test with 1/40 df

TABLE 3

MEAN NUMBER OF HYPOTHESES AS A FUNCTION OF BLOCKS

Hypotheses	BLOCKS OF 10 PROBLEMS							
	1	2	3	4	5	6	7	8
Hypotheses Offered	3.73	2.65	2.29	1.79	1.70	1.73	1.69	1.59
Untenable Hypotheses	2.05	1.08	.73	.40	.22	.25	.21	.13
Duplicate Hypotheses	.48	.28	.20	.06	.03	.05	.04	.02

Discussion.

Interproblem Transfer Effects. A particular feature of this experiment was that Ss were asked to solve 80 relatively simple conjunctive problems. A large number of problems was included in this experiment since it was assumed that Ss, in part, learn a particular strategy within the context of the experiences of the actual learning situation, and therefore do not begin the learning task with a fully developed strategy. Instead a strategy gradually evolved as Ss acquired more and more experience with each successive problem. This assumption was strongly supported in the present experiment and is illustrated by the significant effects of blocks for each of the dependent variables.

Table 4 presents the means of the block effect for each of the major analyses. Each of these dependent variables reflects an improvement in performance with an increase in the number of problems solved. For time to solution the mean number of trials to solution was 9.6 for the first block of 10 problems and was reduced to a mean of 5.4 for the last block of 10 problems. Thus, there was a significant reduction in the number of trials to solution across the 80 problems. The results of the analysis of time to solution showed an even more dramatic improvement. The mean time to solution for the first 10 problems was 170.54 seconds and by the last block of 10 problems was reduced to a mean of 40.32 seconds. Similar results were also found for the dependent variables of focusing strategy scores, percent of problems in which a perfect focusing strategy was employed, and mean trials in excess of sufficient information.

TABLE 4

MEANS FOR BLOCKS OF 10 PROBLEMS

DEPENDENT VARIABLES	BLOCKS							
	1	2	3	4	5	6	7	8
TRIALS	9.6	8.2	7.5	6.8	6.1	5.9	5.5	5.4
TIME	170.54	103.02	82.01	63.39	51.72	46.29	43.33	40.32
FOCUSING SCORE	.58	.72	.77	.81	.86	.84	.89	.90
% PROBLEMS WITH CONSERV-ATIVE FOCUSING	22.0%	34.0%	44.3%	50.0%	59.5%	61.8%	66.0%	67.5%
EXCESS INFORM-ATION	3.9	2.9	2.3	1.7	1.1	1.1	.75	.64

These results suggest that there was interproblem transfer for each of the dependent variables. Studies which employ a reception paradigm also report that interproblem transfer takes place (e.g., Haygood & Bourne, 1965; Neisser & Weene, 1962; Wells, 1962; Wells & Watson, 1965). Several studies employing a selection paradigm, however, fail to obtain an interproblem transfer effect (e.g., Bruner et. al., 1956; Conant & Trabasso, 1964; Laughlin, 1966; Laughlin & Jordan, 1967). These studies involved having Ss solve a limited number of problems and therefore probably did not provide Ss with enough interproblem experiences to allow for the refinement of the various strategies. The results of the present experiment do provide evidence that Ss do demonstrate strong interproblem transfer. Performance on the last block of 10 problems was nearly perfect for two-valued conjunctive concepts. Examination of individual Ss protocals also reveals that Ss became very consistent in terms of the sequences in which they would vary specific dimensions. For the last 10 problems, for example, a S would follow the sequence of first varying the horizontal position of letters, then the dimension of vertical position of the letters, next the orientation of the letters, followed by number, size, color, and finally letter. Although there was some variance between Ss in terms of the sequence in which specific dimensions were varied, each of the 40 Ss was quite consistent within their last 10 problems.

Cognitive Style. One of the purposes of this experiment was to determine the extent to which analytic and global Ss differed in recognizing, developing or utilizing a selection type strategy. In general, the performance of analytic Ss was found to be more efficient than the performance of global Ss. Overall, analytic Ss solved the concept learning problems in fewer trials, less time, and in fewer fewer trials beyond sufficient information; solved a greater percent of problems with a perfect conservative focusing strategy; and had a higher mean focusing score than did global Ss.

The processes or factors contributing to the general inefficiency of global Ss is not entirely clear. There is some evidence, however, which suggests that the relatively poor performance of the global Ss is in part due to a less efficient memory. This evidence was found in terms of a significant effect of cognitive style for duplicate hypotheses and a significant effect of duplicate card choices.[1] This finding suggests that global Ss were less able to remember the previous cards they had chosen and also less able to remember previous hypotheses they had offered. An alternative interpretation of these findings is also possible. It might be that the higher incidence of duplicate card choices and hypotheses reflects a tendency on the part of global Ss to reject the feedback of the E once they have erroneously arrived at a solution. Given that a global S has arrived at a solution which he feels is warranted by the information he has, he may still cling to that solution and simply go through the same sequence of card choices or hypotheses to verify to himself that his solution is consistent with the information he has processed. Additional research is needed to clarify which interpretation best accounts for the data.

The analyses of trials and excess information both had a significant interaction of blocks by cognitive style by sex. In general, both of these interactions revealed that there was little difference in performance between analytic males and females and that their performance in general improved across blocks of problems. Furthermore, the performance of global males and females was poorer than analytic Ss for the initial two blocks of 10 problems. At block three, however, the performance of global females deteriorated while that of the global males continued to improve and in general there was a sex difference between global males and females from blocks three through eight. The reason for this split in performance between global males and global females is not entirely clear. One possible explanation of this effect is that the sample of global males is less global than the sample of global females. Sex differences in cognitive style are frequently reported (e.g., Witkin et al., 1962). Since the sample of males was smaller

[1] An analysis of variance was performed on mean number of duplicate card choices and reflected a significant effect of cognitive style, $F(1,36) = 4.81$, $p < .05$. (Analytic $\bar{X} = .26$, Global $\bar{X} = .58$).

than the sample of females it is possible that some of the males classified as global were considerably more analytic than their female counter parts. It is also possible that motivational effects while taking the HFT are more likely to result in a greater percentage of false classification of global males than global females. Further research is needed to clarify the difference in performance between global males and females.

It was assumed that analytic Ss' performance would initially be more efficient than global Ss' and that with repeated experience with additional problems, analytic Ss would develop a more efficient strategy. Thus it was also assumed that analytic Ss would initially perfect a conservative focusing strategy and then improve on this strategy by perhaps developing a gambling strategy or by adopting a strategy in which information was also obtained from systematically varying hypotheses. This assumption was only partially supported. Analytic Ss' performance was initially better than the global Ss' and improved more rapidly. Also, both analytic and global Ss adopted and perfected the conservative focusing strategy, but neither analytic or global Ss adopted a strategy other than conservative focusing. Neither analytic nor global Ss seemed to make much use of hypotheses as a means of obtaining information. The failure to obtain any change in strategies or to utilize hypotheses as a means of obtaining information may have been a function of the procedures. At the outset of the experiment each Ss was informed that he would be asked to solve 80 conjunctive problems at a rate of 10 per day. Subjects were not explicitly instructed to develop or identify the most efficient strategy and therefore may have simply been content in staying with the conservative focusing strategy once it was perfected rather than risk the deterioration in performance by developing or trying different approaches.

CHAPTER THREE:

EXPERIMENT II: COGNITIVE STYLE AND HYPOTHESIS TESTING I

Introduction. The topic of information processing occupies a central position in many of the various approaches to learning, especially those concerned with cognitive behavior. This relatively recent emphasis on cognitive behavior is clearly apparent from the steadily increasing number of research reports which have been concerned with strategies, hypothesis testing and information processing in general.

Within this rather broad domain of cognitive behavior, however, relatively little attention has been devoted to individual difference variables in comparison to the emphasis given task variables. An individual difference variable which seems likely to influence cognitive behavior is that of cognitive style. The term cognitive style has been used to refer to habitual modes of information processing (Messick, 1971). Although a number of different dimensions have been suggested within the rather general area of cognitive style, there is one characteristic which appears to be common to a number of these dimensions. This characteristic is concerned primarily with the manner in which an individual perceives and analyzes a stimulus configuration. Within the context of the present experiment, performance on the Hidden Figures Test (HFT) was used as an operational method of identifying an individual's cognitive style.

The results of several studies designed to examine the extent to which an individual's cognitive style influences information processing tasks in general show that the learning performance of Ss with an analytic cognitive style is superior to that of Ss with a global cognitive style. Davis and Klausmeier (1970), for example, found that analytic Ss identified concepts at varying levels of complexity in fewer trials than did global Ss. Similarly, Ohmacht (1966) found that analytic Ss were superior to global Ss in a reversal-nonreversal concept identification task. Davis

(1971) also found that analytic Ss did better than global Ss on a conditional concept learning task. Post hoc analysis of S's protocols suggested that global Ss were testing hypotheses from a relatively large hypothesis pool, many of which were irrelevant to the learning task, while analytic Ss sampled hypotheses from a relatively small hypothesis pool, the majority of which were relevant to the learning task. The results of Experiment I showed that global Ss had a significantly greater number of duplicate hypotheses than did analytic Ss which suggests that there is a difference between analytic and global Ss in terms of hypothesis testing behavior. While these studies have generally shown differences in performance as a function of cognitive style, little attention has been directed to the various processes required in these tasks. The primary purpose of the present study, therefore, was to empirically determine whether an individual's cognitive style differentially influenced his hypothesizing behavior.

Method

Subjects. The Hidden Figures Test (HFT) was administered to 10 sections of introductory educational psychology classes and involved testing a total of 404 Ss. One hundred four of the Ss were males and 300 of the Ss were females. Separate distributions of HFT scores, corrected for guessing, were made for males and females with the males having a mean score of 22.22 and a standard deviation equal to 9.49, while the females had a mean of 22.61 with a standard deviation of 7.33. In addition to administrating the HFT,each class was given one of two different sequences of 24, four-trial learning set problems. Each of the 10 classes was randomly assigned to one of the two sequences. Thus five classes received one sequence and five classes received the other sequence. Since the HFT and the learning set problems were administered on separate occasions, several Ss had an incomplete set of data and therefore only the data for Ss with complete data were included in the analysis. A total of 346 Ss served as the sample upon which that data was collected. Analytic and global Ss were distinguished in terms of a median split on the HFT scores. For the males the median was 25.00 and for females the median was 23.00. A total of 128 Ss had complete data for sequence I and were broken down into the following categories: 55 analytic females and nine analytic males, 47 global females and 17 global females. Five Ss, three females and two males, scored at the median and were not included in the analysis. Two hundred twenty-one Ss had complete data for sequence II and were distributed as follows: 89 analytic females, 20 analytic males, 79 global females and 30 global males. Three Ss were dropped from the analysis since they scored at the median, two were females and one was male.

Stimulus Materials. The stimulus materials consisted of 24 pairs of consonants, each varying on four stimulus dimensions; letter (2 consonants), color (purple, blue, green, yellow, brown, red, or white), size (large or small), and position (right or left). Within a given four-trial problem each level of each dimension occurred equally often with each level of every other dimension. Thus the criterion for internal orthogonality was met. Twenty-four such problems were constructed and photographed for use in a slide projector. Figure 4 provides a description of one of the 24 problems along with a description of the eight possible patterns of choices corresponding to each of the four major hypotheses. A detailed description of each of the twenty-four problems is presented in Appendix A.

Procedure. The procedure followed in this experiment was similar to that outlined by Levine (1963). Two groups of analytic and global Ss were constructed by randomly assigning five of the introductory educational psychology classes to sequence I and the other five classes to sequence II. Subjects in each sequence were given the same 24 problems, identical instructions (See Appendix B), and a preliminary demonstration problem of 16 trials in which size was the relevant dimension. Each group received 18 outcome problems, in which the E provided feedback after Ss responded, and six nonoutcome problems, in which E did not provide any feedback. Subjects in sequence I received the nonoutcome problems on Problems 2, 6, 10, 14, 18 and 22; Ss in sequence II received the nonoutcome problems on Problems 4, 8, 12, 16, 20 and 24. The experimental paradigm is illustrated in Table 5. For each of the 18 outcome problems, the E provided feedback by pointing to the correct stimulus after each of the four trials. Subjects were given eight

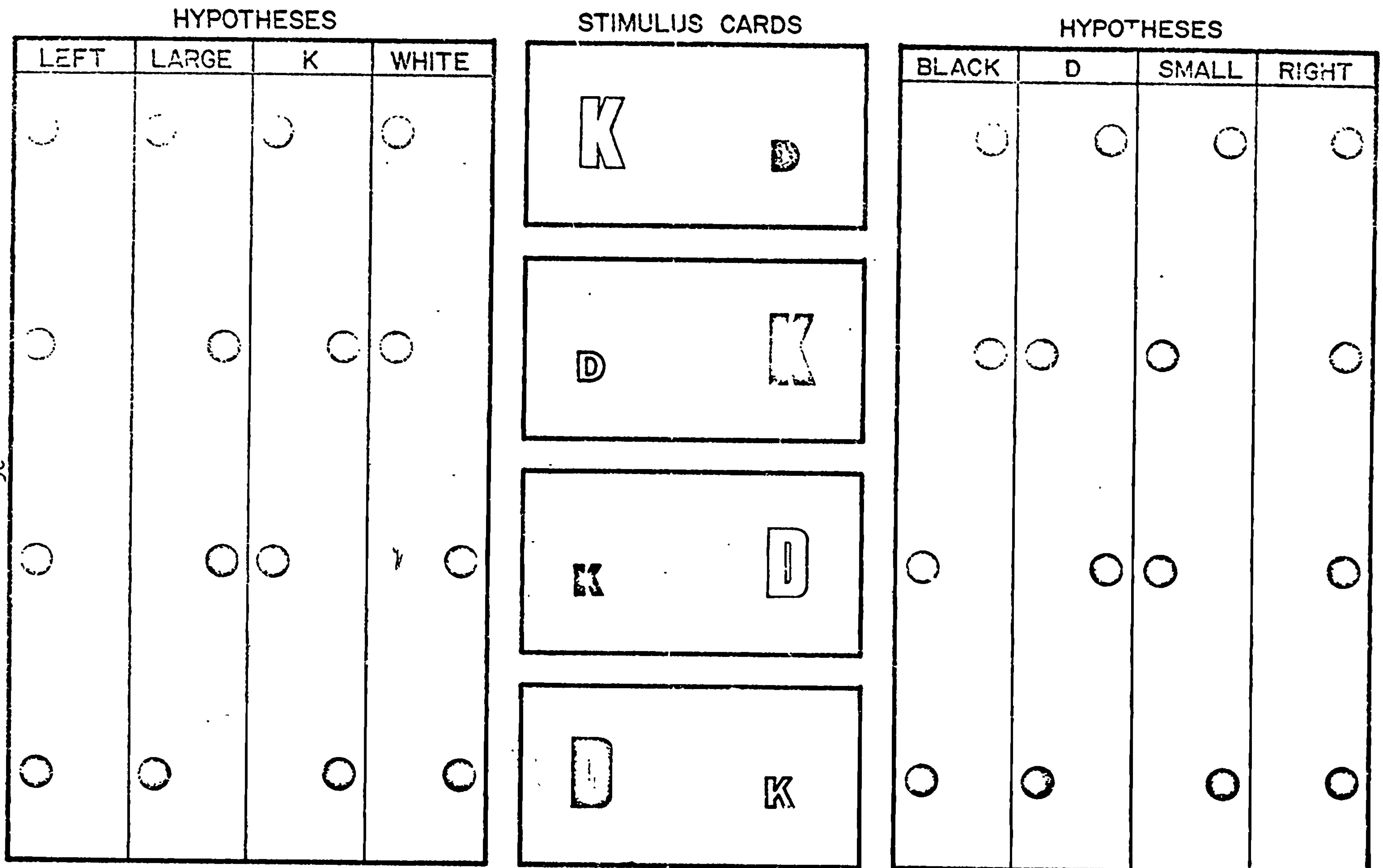

Fig. 4. Sample four-trial problem and response sequences.

TABLE 5

EXPERIMENTAL PARADIGM

	SEQUENCE	N	Relevant Dimension											
			COLOR						LETTER					
			2	4	6	8	10	12	14	16	18	20	22	24
I	ANALYTIC	46	X		X		X		X		X		X	
	GLOBAL	46	X		X		X		X		X		X	
II	ANALYTIC	109		X		X		X		X		X		X
	GLOBAL	109		X		X		X		X		X		X

X Problems on which the nonoutcome procedure was followed seconds to respond (using a specially prepared data sheet) and then the E pointed to the correct stimulus. Total exposure time for the outcome problems was 12 seconds per trial. Before the first nonoutcome problem, the E announced that the next problem would be a test of how much had been learned thus far. The class was told that during the next problem the E would not point to the correct stimulus, but that they should continue to try to get 100 percent correct. These test instructions were given before every nonoutcome problem. The exposure time for each trial of the nonoutcome problems was four seconds and between each trial there was a one second intertrial interval. A tape recorder was used to present the instructions and to control the temporal intervals for both outcome and nonoutcome problems. Color was the correct dimension for outcome Problems 1-12, and letter was the correct dimension for outcome Problems 13-24.

Results. Sex was not treated as a variable in the analysis of this study for several reasons: first, the normal sex differences in HFT performance was not obtained; second, there were relatively fewer males than females in the available sample and; finally, preliminary analysis of the data indicated that there was no significant differences attributed to sex.

The dependent variable in this study was the percent of Ss manifesting a given response pattern which corresponded to one of five possible hypotheses on each of the nonoutcome problems. The specific hypothesis a S used was determined by classifying his sequence of responses over the four trials of a given nonoutcome problem. For each nonoutcome problem there are five possible hypotheses: one for color, one for size, one for letter, one for position and one for error hypotheses. Figure 4 illustrates the eight possible response sequences which conform to one of the four major hypotheses as specified in the instructions to the Ss. For example, a S was classified as using a position hypothesis if he placed all four of his responses in the left hand column of his answer sheet for a given nonoutcome problem. The S was classified as using a color, letter, or size hypothesis if his response pattern matched the respective response pattern for that hypothesis (See examples in Figure 4). In addition to these eight response sequences, there are eight unique response sequences which were classified as error hypotheses. Any response sequence involving a 3-1 pattern was classified as an error hypothesis.

The percent of analytic and global Ss manifesting each hypothesis on each nonoutcome problem is presented in Figure 5. In Figure 5 the solid line represents the performance of analytic Ss and the broken line represents the performance of global Ss. It is important to note that each data point in this graph represents the percent of Ss manifesting a given hypothesis on a nonoutcome problem and that the curves represent changes in the percent of Ss manifesting a given hypothesis recorded on problems when the E did not provide any feedback. Furthermore, the points represent four different groups: 46 analytic Ss and 46 global Ss who received the nonoutcome problem on Problems 2, 6, 10, 14, 18 and 22 (Sequence I); 109 analytic and 109 global Ss who received the nonoutcome problems on Problems 4, 8, 12, 16, 20 and 24 (Sequence II). Despite the difference in the number of Ss in Sequence I and II, and despite this relatively unorthodox method of reporting data, the curves are quite regular.

The increase in the percent of Ss responding to the color hypotheses over Problems 2-12 means that an increasing number of Ss are following a response pattern which corresponds to the color hypothesis on these nonoutcome problems. Likewise the decrease in the proportion of Ss responding to the color hypothesis over Problems 13-24 means that a decreasing number of Ss are following a response pattern which corresponds to the color hypothesis on these nonoutcome problems.

Several features of this graph are noteworthy and will be presented in terms of the relevant dimensions to solution.

Color Learning Set. A higher percentage of analytic Ss responded to the correct dimension during the color learning set problems than did the global Ss. For Problem 2, 72 percent of the analytic Ss and 48 percent of the global S responded on the basis of color and this difference was significant at the .05 level, $t\ (90) = 2.87$. For Problem 4, 80 percent of the analytic Ss and 69 percent of the global Ss responded on the basis of color and this difference approached significance ($t\ (216) = 1.92$; $p < .10$). For Problem 6, 73 percent of the analytic Ss and 69 percent of the global Ss manifested a color hypothesis, but this difference was not

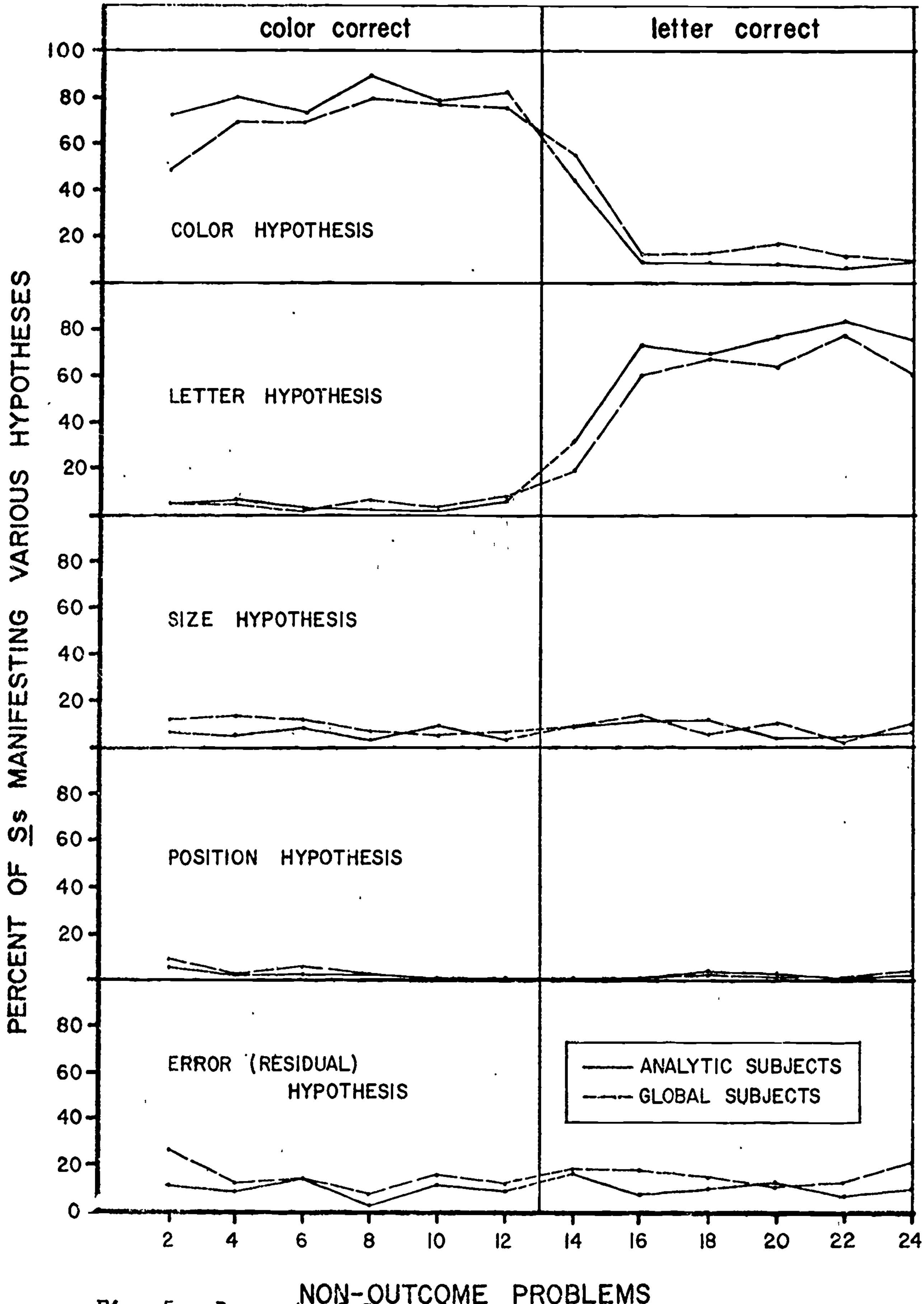

Fig. 5. Percent of Ss manifesting various hypotheses as a function of cognitive style.

reliable, $t < 1$. For Problem 8, 89 percent of the analytic Ss and 79 percent of the global Ss responded on the basis of the color hypothesis and this difference was significant, $t(216) = 2.09$; $p < .05$. For Problems 10 and 12, a greater percentage of analytic Ss responded on the basis of color than did global Ss (78% versus 77% for Problem 10 and 82% versus 75%, for Problem 12),but these differences were not significant.

When color was the correct basis of responding, there was little difference between analytic and global Ss in terms of the proportion of Ss manifesting either a letter or position hypothesis. As can be seen in Figure 5, both of these hypotheses occurred quite infrequently during the color learning set.

In general, global Ss manifested a slightly higher proportion of size hypotheses than analytic Ss and the combined proportion of Ss manifesting a size hypothesis was slightly higher than that obtained for either the letter or position hypothesis.

Global Ss consistently manifested a greater percent of error hypotheses (3-1 pattern) than did analytic Ss. The greatest difference between the two groups occurred on Problem 2, where analytic Ss had 12 percent error hypotheses and global Ss had 25 percent.

Letter Learning Set. At Problem 13 the feedback supplied by E switched from the color dimension to the letter dimension for the outcome problems. As can be seen in Figure 5, a large percent of both analytic and global Ss still maintained the color hypothesis for Problem 14. Fourty-four percent of the analytic and 55 percent of the global Ss manifested the color hypothesis. The percent of Ss following a color hypothesis, however, decreased quite rapidly after Problem 14 and stabilized around 10 percent for the remaining nonoutcome problem. Also, it should be noted that a higher percent of the global Ss consistently responded to the color dimension than did the analytic Ss over the remaining problems.

Analytic Ss showed a greater percentage of Ss manifesting a letter hypothesis than global Ss. Both groups of Ss, however, showed a relatively typical acquisition function of the letter hypothesis. Although the analytic Ss consistently demonstrated a greater percent of Ss manifesting the letter hypothesis, there were significant differences for only two of the problems. For Problem 14, 31 percent of the analytic Ss and 19 percent of the global Ss manifested a letter hypothesis, but this difference was not significant, $t < 1$. For Problem 16, 72 percent of the analytic Ss and 60 percent of the global Ss responded on the basis of the letter hypothesis and this difference approached significance, t (216) = 1.90; $p < .10$. For Problem 18, the percentage of Ss responding of the basis of the letter hypothesis was 69 percent for analytic Ss and 67 percent for global Ss ($t < 1$). For Problem 20, 77 percent of the analytic Ss and 63 percent of the global Ss responded to the letter dimension. This difference was significant at the .05 level, t (216) = 2.30. For Problem 22, there was no significant differences between analytic and global Ss ($t < 1$). For Problem 24, 75 percent of the analytic Ss and 61 percent of the global Ss responded to the letter dimension and this difference was significant at the .05 level, t (216) = 2.24. It should be noted that all of the significant differences occurred on the nonoutcome problems for Ss receiving sequence II.

For the letter learning set problems the percent of Ss manifesting size and position hypotheses was essentially the same as that for the color learning set problems: few Ss demonstrated a position hypothesis and there was little difference between analytic and global Ss in terms of the proportions of Ss responding to the size dimension.

Data for the error hypothesis (3-1 patterns) was similar to that obtained for the color learning set problem. In general, global Ss had a higher proportion of error response sequences than analytic Ss. There was a slight reversal at Problem 20 where global Ss had 9 percent error hypotheses and analytic Ss had 11 percent. There was also a relatively greater increase in error hypotheses for global Ss for the last two nonoutcome problems.

Discussion. The results of the present experiment indicate that Levine's (1963) results have been replicated in several respects. First, both Levine's data and the data of the present study demonstrated that the position hypothesis rarely occurs. The most direct interpretation of this finding is that adult human Ss probably do not regard position as an important dimension in this type of learning situation. Second, both Levine's data and data of the present experiment show a slight increase in the strength of an apparently extinguished hypothesis (e.g. size hypotheses and error hypotheses) when the learning set changed (Problem 13). A minor exception, however, was noted in the present study. Levine reported that the percent of size, position and error hypotheses increased following the switch from a color learning set to a letter learning set. The present study did find a slight increase for both the size and error hypotheses, but did not find any increase in the case of position. Third, as Levine found, more proficiency was obtained on the first learning set (color) than on the second learning set (letter). In the present study, 76 percent of all Ss responded correctly to the color learning set problems while only 64 percent responded correctly to the letter learning set problems. These figures show the same relationship as those reported by Levine, but differ in terms of absolute value in that Levine reported 84 percent and 60 percent, respectively. As suggested by Levine, this finding probably reflects that fatigue, boredom or other sequence effects depressed performance on the latter learning set. Overall then, the results of this study support the findings of Levine.

The primary objective of this study was to consider the individual difference variable of cognitive style as it relates to hypothesizing behavior. In general the conclusion to be drawn from this data is that analytic Ss are more proficient hypothesis testers than are global Ss. This conclusion, however, must be considered

tentatively since the number of Ss receiving sequence I and sequence II differed considerably which may have resulted in measurement which was not totally reliable. Nevertheless, several sources of data support the interpretation that analytic Ss are more efficient than global Ss. For both learning set problems, analytic Ss achieved greater proficiency than global Ss. For all nonoutcome problems involved in the color learning set, analytic Ss' response sequences conformed to a color hypothesis 80 percent of the time, while global Ss responded on the basis of color hypothesis only 71 percent of the time. Similarily, for the letter learning set, analytic Ss achieved an overall percentage of correct responses 70 percent of the time compared to 59 percent for the global Ss.

Consideration of errors may provide some evidence concerning how analytic and global Ss differ in terms of the cognitive processes they employ in the hypothesis testing situation. Two different types of errors are possible when the learning set methodology is employed. The major type of error is reflected when a S follows any of the eight possible 3-1 patterns on the nonoutcome problems. This type of error, hereafter referred to as a type I error, means that a S switched from one stimulus dimension to another stimulus dimension in the absence of any feedback. This behavior may either reflect an overt error in responding (i.e., a careless error due to a loss of memory or lack of attention to the details of a specific stimulus pair), or a covert error (i.e., S providing himself with feedback or a delay in processing information previously presented by E). The methodology employed does not provide a means for identifying the specific reason for a S manifesting a type I error. The second type of error, hereafter referred to as a type II error, is reflected when a S follows a response sequence which corresponds to one of the three irrelevant stimulus dimensions. For example, when color is the relevant dimension a type II error would be made when a S responds on the basis of letter, size or position.

In the present experiment analytic and global Ss differed in terms of the frequency of type I and type II errors. For the color learning set problems, analytic Ss manifested a type I error 9 percent of the time and a type II error 11 percent of the time. Global Ss, for the color learning set problems, manifested a type I error 13 percent of the time and a type II error 16 percent of the time. For the letter learning set problems, analytic Ss had 1(percent type I errors and 20 percent type II errors. Global Ss, on the other hand, had 15 percent type I errors and 27 percent type II errors. Overall, global Ss had a higher percent of both type I and type II errors. Since the method employed in the present experiment does not provide a means for specifying the reason for these type of errors we can only specualte that they are the result of a combination of factors. Additional research is needed to determine if the higher percent of errors of global Ss is due to a memory loss, lack of attention, faulty utilization of feedback or some combination of these factors.

CHAPTER FOUR

EXPERIMENT III: COGNITIVE STYLE AND HYPOTHESIS TESTING, II

Introduction. The results of both Experiments I and II demonstrated that global Ss were less efficient than analytic Ss in learning to identify concepts. Part of the global Ss' deficiency in learning to identify concepts may be due to a general inability to process certain types of information. In general, two types of informtion may be distinguished: positive and negative. In the case of positive information (E says "right" or the S selects a positive instance), the S either has to retain his working hypothesis (Levine, 1963, 1966), or conclude that the stimulus dimension varied is irrelevant (if a focusing strategy is employed). In the case of negative information (E says "wrong" or a S selects a negative instance), the S has to drop his working hypotheses and resample from the pool of potential hypothesis (Levine, 1963, 1966), or conclude that the stimulus dimension varied is relevant (if a focusing strategy is employed).

Some support for this supposition was derived from the results of Experiments I and II. In Experiment I, it was found that global Ss had a higher frequency of repeating previous card choices and offering duplicate hypotheses. It might be that the higher incidence of duplicate card choices and hypotheses reflects a tendency on the part of the global Ss to reject the feedback of the E once they have erroneously arrived at a solution. Given that a global S has arrived at a solution which he feels is warrented by the information he had, he may still cling to that solution and simply go through the same sequence of card choices or hypotheses to verify to himself that his solution is consistent with the information he has processed. This hypothesis could be tested by varying the type of information a S receives and then determining the influence of this upon his hypothesis testing behavior.

In Experiment II, global Ss had a higher percentage of error hypotheses than did analytic Ss. This finding also suggests that global Ss are not as efficient as analytic Ss in terms of utilizing the feedback provided by E during the outcome problems.

Levine (1966) developed a methodology which provides a means of assessing the influence of feedback upon a Ss hypothesizing behavior. This technique, which was employed in the present study, involves presenting a S with several 16-trial problems. Within each problem the E can vary the type of feedback Ss receives by either saying "right" or "wrong" after certain responses. In essence this procedure involves presenting all possible combinations of feedback to Ss across the various problems. Within a given problem, the E provides feedback on the first trial and every fifth trial thereafter. Interspersed between the feedback trials is a series of four trials which comform to those used in Experiment II. Performance on the nonoutcome problems can be used to determine the specific hypothesis a Ss is testing following one of the two types of feedback. Therefore, the major purpose of the present study was to determine if there is a difference between analytic and global Ss in terms of the effects of positive and negative feedback upon a S's hypotheses.

Method

Subjects. The HFT was administered to six sections of introductory educational psychology classes and involved testing 320 Ss. Of the 320 Ss tested, 112 were males and 208 were females. Scores on the HFT were corrected for guessing by subtracting the number wrong divided by four from the number right. Since previous research using the HFT has reported sex differences, separate distributions of the HFT scores were made for males and females. The mean score for the male Ss was 23.78 with a standard deviation equal to 8.07. Fifteen analytic male Ss were selected from the pool of Ss who scored +1 standard deviation above the mean (score of 32 or higher) and 15 global male Ss were selected from the pool of Ss who scored -1 standard deviations below the mean (score of 15.75 or less). The mean score for the female Ss was 23.43 with a standard deviation equal to 7.65. Fifteen analytic females Ss were selected from the pool of Ss who scored +1 standard deviation above the mean (score of 31 or higher) and 15 global females Ss were selected from the pool of Ss who scored -1 standard deviation below the mean (score of 15.50 or lower). Each of the 60 Ss were tested individually on the 24 16-trial problems.

Stimulus Materials. The stimulus materials used in this experiment were identical to those used in Experiment II with the following exceptions. The stimuli were drawn in color on 3 x 5 cards and each card contained a pair of consonates which varied on four stimulus dimensions: letter (2 consonants), color (purple, blue, yellow, green, brown, red, or black), size (large or small), and position (left or right). Each problem consisted of 16 cards rather than the four used in Experiment II. In a four-dimensional problem there are exactly eight different stimulus pairs which may be presented. These stimulus pairs may be grouped into two different internally orthogonal sets. Figure 4 (page 36) shows the four stimulus pairs which, as has been noted, are internally orthogonal. The remaining set of four stimulus pairs were produced by simply interchainging the position of each stimulus within a given pair. For the top pair, for example, the large white "K" would be placed on the right and the small black "D" on the left. Reversing each of the stimulus pairs in Figure 4 would generate a new set of four pairs which would also be internally orthogonal and would not be identical to any of the original set. Referring to one set as Set A and the interchanged set as Set B, Set A was used for all nonoutcome trials. In the 16 trial problems an outcome (E says "right" or "wrong") was always presented on the first, sixth and eleventh trial. Thus, trials 2-5, 7-10, 12-15 were composed of the four Set A stimuli, Figure 6 shows a summary of a 16 trial problem.

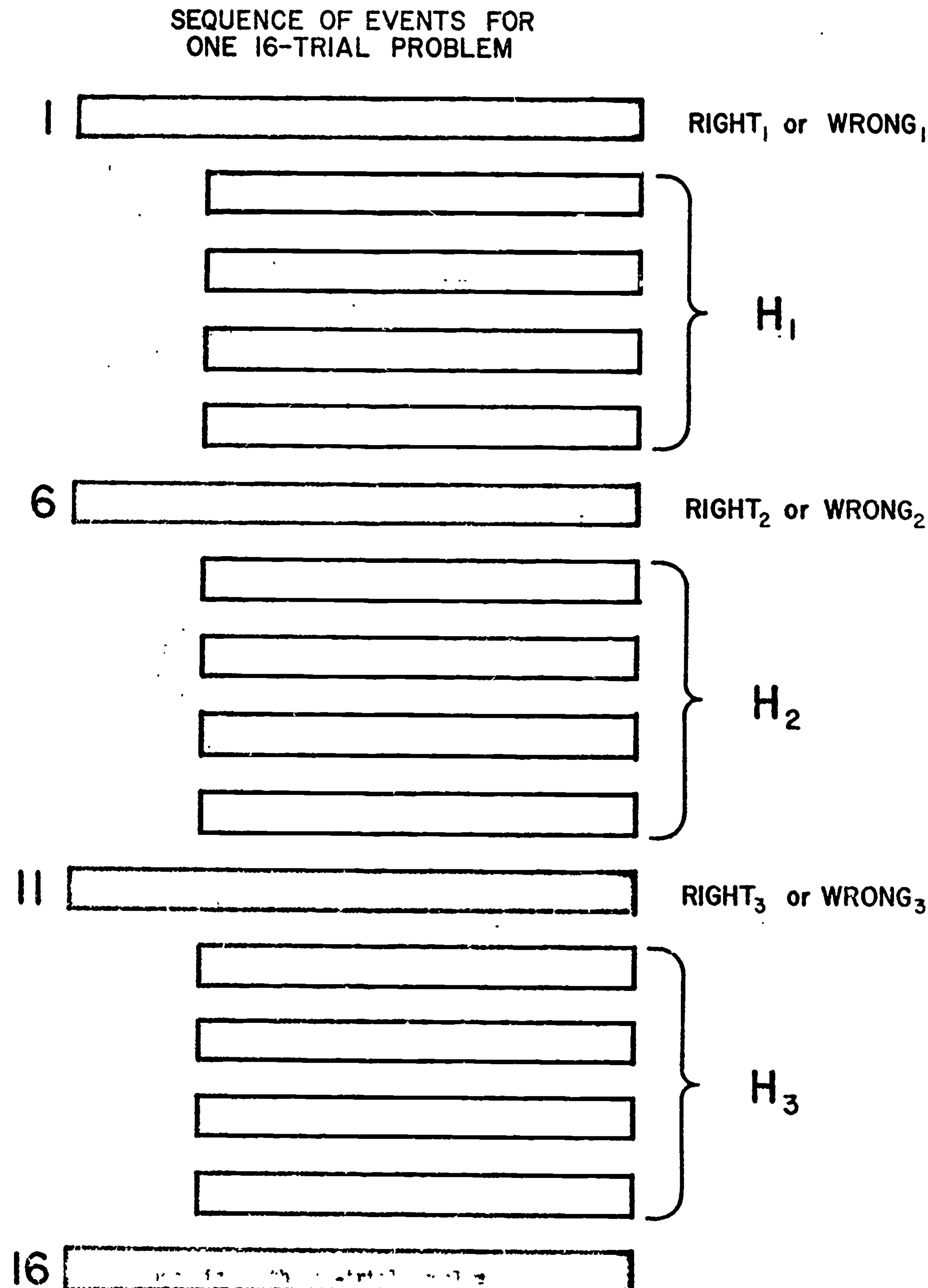

Fig. 6. A schematic of the 16-trial problem.

Procedure. The procedure followed in this experiment was similar to that outlined by Levine (1966). Each S was fully instructed concerning the nature of the task and Appendix C presents the complete set of instructions. In order to insure that each S was selecting hypotheses from a limited pool of known hypotheses, an extensive pretraining program was presented to each S. Four pretraining problems were presented. The first problem consisted of 10 trials in which complete feedback was provided to Ss and in which color was the correct basis for responding. The second problem consisted of 28 trials with an outcome given at the first trial and at every third trial thereafter and large was the basis of correct responding. The third problem consisted of 28 trials in which outcomes were presented after every third trial and letter was the basis of correct responding. The fourth problem consisted of 46 trials in which feedback was given on the first and every fifth trial thereafter. Position was the basis of correct responding. Following the four preliminary problems each S was presented 24 16-trial problems. The feedback was presented on trials 1, 6, and 11 and was predetermined on an a priori basis. That is, the E said "right" or "wrong" on these trials according to a prearranged schedule regardless of the S's response. Each of the eight possible right-wrong sequences which could occur on the three outcome trials was randomly assigned to each of the first eight problems and then randomly assigned to each of the remaining two blocks of eight problems each. Trial 16, the last trial on each problem, was treated separately. Each S was told "right" on half of the problems and told nothing on the other half.

Results

Blank Trials Data. Within each of the 24 problems, there were three sets of four cards to which the Ss responded but did not receive any feedback. Each of these sets was analyzed in terms of the response sequences Ss manifested. As in Experiment II, there were two general categories to which the various response sequences across the four trials could be categorized: any one of the eight possible sequences conforming to the experimentally defined hypotheses--two for position, two for letter, two for size, and two for color; or any one of the possible 3-1 patterns (errors). Response sequences conforming to the experimentally defined hypotheses occurred on 91.4 percent of the four-trial sets (3,948 out of 4,320). Thus there were 8.6 percent of the four-trial sequences in which Ss followed a 3-1 pattern. It would appear, therefore, that the percent of errors is relatively small.

The figure of 8.6 percent error response sequences, however, may be somewhat misleading. Within the context of the procedures employed in the present experiment, a S is initially presented a card which contains two letters which vary in terms of size, position and color. This trial-one card comes from set B which was constructed by reversing the position of each letter within a given set (Set A) of four cards which in turn were constructed so that they were internally orthogonal. Furthermore, the S received feedback on trial one and if we can assume that he perfectly processed the information following feedback on trial 1, then he should know that only four of the eight possible stimulus attributes can lead to a correct solution. According to Levine's (1970) subset-sampling model, a S should respond in such a way on the next four nonoutcome trials (Set A) that he manifests a response sequence which is consistent with one of the four remaining hypotheses. It is possible, however, for a S to perfectly process the information and still manifest a 3-1 pattern of responding and not be erroring. This situation would occur if a S chose the particular stimulus which had three of the four possible attributes for each of the cards within Set A (trials 2-5). In other words, Ss would be responding in a way which is analogous to a scanning strategy in a standard concept learning situation which employs a selection procedure. That is, responding in such a way that the probability of being correct for any given trial is maximized. It is not unreasonable, therefore, to expect a S to perform in this way particularly if he is attempting to follow the directions provided in the instructions where it was explicitly stated that for the nonoutcome set of trials his "... job was to be correct as often as you can, even when I am not saying anything."

An illustrative example may help clarify these points. Consider Figure 4 on page 36. Assume that these four cards represent the first set of blank trials and that trial one consisted of a card which had a small, black, "D" on the left and a large, white, "K" on the right. Assume further that a S chose the stimulus on the right, was told that his choice was correct, and that he processed this information correctly--that is, he correctly concluded, after the feedback, that large, white, "K" and right are the only remaining possible solutions. Next, our S is presented with the first card illustrated in Figure 4 and he selects the stimulus which has the highest probability of being correct--the large, white, "K", on the left. This stimulus was chosen, by the S because it had three of the four stimulus attributes which could possibly represent the solution of the problem. In other words, this stimulus varied only in terms of position from the stimulus chosen on trial one. Following the same line of reasoning for the second card (trial 3 in a 16-trial problem) of the nonoutcome set, our S would choose the stimulus on the left, the large, black, "K" on the right. This stimulus has three of the four attributes which could be the basis for a correct solution. On the third trial of the nonoutcome set our S would choose the stimulus which was large, white, "D" on the right and again this stimulus would contain three of the four attributes which could be the basis of correct responding. On the final trial, trial four of the nonoutcome set of stimuli, the S would choose the small, white, "K" on the right. Following this sequence of responses our S would have a 1-3 pattern of responses, but would have also been responding in such a way that he maximized the probability of being correct on each trial. If a S responded in this fashion, his response sequence should not be counted as an error, but rather should be consider d as a correct response since it represents a mode of responding which is entirely consistent with the information he has. Thus, it should be recognized that of the eight possible 3-1 patterns, there is one which should not be classified as an error. Ir effect the S maximized the probability of being correct but manifested a maximizing error. Levine (1970) refers to this as the majority-rule phenomena and it should be noted that this maximizing error can occur only on the first set on nonoutcome trials.

When the data of the present experiment was reanalyzed in such a way that the maximizing error was treated as a correct response sequence, it was found that 95.3 percent of the four trial sequences were consistent with the experimentally defined hypotheses or followed the 3-1 pattern which was also consistent with all previously presented information. There was, therefore, only a 4.7 percent of the sequences which represented errors.

It is also necessary to reanalyze the data which conform to the experimentally defined hypotheses. If a S is correctly processing all information, he should reduce his hypothesis pool from eight to four following the first outcome. Thus only four hypothesis patterns should be considered as being correct after the first outcome. In the example previously referred to, our S chose the large, white, "K" on the right and was told that his response was correct. Therefore, only these four response patterns should be considered as correct responses along with the maximizing error. If a S manifested a response sequence which corresponded to small, black, "D" or left they should be counted as an error along with the other 3-1 patterns. Likewise, the same situation prevails following the second and third outcomes. If a S is processing all information he should reduce the number of possible hypotheses from four to two following the second outcome and from two to one following the third outcome. Thus, it is possible for a S to manifest a response pattern which conforms to one of the eight experimentally defined hypotheses and still be inconsistent with the outcome information. When the data was reanalyzed taking into account the inconsistent response patterns, it was found that 80 percent of the nonoutcome sets conformed to all previously presented information and that errors occurred on 20 percent of the nonoutcome sets. When this analysis was broken down by cognitive style, it was found that the analytic Ss had 82.5 percent of the nonoutcome sets which were consistent with previously presented information and 17.5 percent of the nonoutcome sets which were inconsistent with previously presented information. The global Ss had 77.1 percent consistent response patterns on the nonoutcome sets and 22.9 percent inconsistent response patterns on the nonoutcome sets.

Problem Solution. Each of the 60 Ss solved 24, 16-trial problems. A problem was considered as being correctly solved if each of the three nonoutcome sets within a problem followed a response sequence which was consistent with the feedback information presented on the outcome trials. Each of these problems were scored as correctly solved and then the total number of problems correctly solved was analyzed by means of an analysis of variance with the variables of sex and cognitive style. Table 6 presents the results of this analysis. As can be seen, there was a significant effect of cognitive style (F = 3.73; df = 1/56; p .05). Analytic Ss solved an average of 15.18 problems while global Ss solved an average of 13.13 problems. Neither the effect of sex nor the interaction of cognitive style by sex were significant.

TABLE 6

ANALYSIS OF VARIANCE FOR NUMBER OF

PROBLEMS CORRECTLY SOLVED

Source	df	MS	F	P
Cognitive Style (CS)	1	62.016	3.73	.05
Sex (S)	1	4.816	<1	
CS x S	1	.15	<1	
Error	56	16.619		

Within each of the 24 problems, there were eight different sequences of feedback. The percent of problems correctly solved under the eight conditions of feedback is presented in Table 8. The problems in which the outcome trials resulted in the E saying "right" were solved by both analytic and global Ss with a good deal of proficiency. There seems to be a trend which shows that problem solution becomes more and more difficult as the number of negative feedbacks increase. When all three outcome trials resulted in a "wrong" feedback, performance was very poor, but analytic Ss seem to be better able to process this negative feedback then do global Ss.

TABLE 7

PERCENT OF PROBLEMS SOLVED AS

A FUNCTION OF SEQUENCE OF FEEDBACK

Cognitive Style	Reinforcement Patterns							
	R R R	R R W	R W R	W R R	R W W	W R W	W W R	W W W
Analytic	93	73	76	73	48	48	58	39
Global	90	58	58	82	31	44	53	23
Total	92	66	67	78	39	46	56	31

The Effects of Outcomes. Levine (1970) has postulated a general model of hypothesis testing which predicts that Ss will retain their working hypothesis when it is confirmed and will reject the working hypothesis when it is disconfirmed. These hypothesized effects of right and wrong may be directly determined by comparing the hypothesis a S manifests before and after each outcome. This analysis involved only those response patterns which were interpretable (i.e., did not consider any of the 3-1 patterns). The percent of Ss who kept their working hypothesis was determined by counting the response patterns which were the same on two successive sets of nonoutcome trials (the first and second or the second and third) when the intervening outcome trial resulted in the E saying "right." The overall percentage, based on 1286 cases, was 97.5 percent. Thus 97.5 percent of the time a S kept his working hypothesis when he received a confirmation outcome. Two-and one half percent of the time a S switched his working hypothesis. It should be noted, however, that 11.5 percent of the time Ss manifested a response sequence which was inconsistent with previous information. When these results were determined separately for analytic and global Ss, similar findings were obtained. For analytic Ss, 97.3 percent of the hypothesis patterns were the same when Ss received confirmation on the outcome trials and 2.7 percent of the response patterns changed. Twelve and one-tenth of the time Ss responded inconsistently.

Levine's model (1970) predicts that when a S is told "wrong" on an outcome trial, that he will drop his working hypothesis and switch to another hypothesis. When the effects of a wrong feedback were assessed, the overall percentage of switches, based on 1267 cases, was 99 percent. Thus 99 percent of the time a S switched his working hypothesis when he received a disconfirming outcome. It should be noted, however, that 32.4 percent of the time Ss switched to a working hypothesis which was inconsistent with previously obtained information. When these results were determined separately for analytic and global Ss, similar findings were obtained. For analytic Ss, 99 percent of the hypothesis patterns changed following a "wrong" outcome. Inconsistent hypothesis patterns, however, were adopted 25.8 percent of the time. For global Ss, 98.9 percent of the time a S switched his working hypothesis following a "Wrong" outcome, but 38.9 percent of the time these switches resulted in the adoption of an inconsistent hypothesis pattern.

Discussion. In general the results of this experiment support the model of hypothesis testing developed by Levine (1966, 1970), but also extend the method of analyzing data and suggest some qualifications of the findings reported by Levine. Levine's model makes the following assumptions:

1. At the outset of a trial S selects a hypothesis from some set. This hypothesis is a state, and may be thought of as a prediction by S. Thus, S may predict that

the larger stimulus is correct (regardless of its shape, color, etc.) or that the stimulus on the left side is always correct, etc.

2. The set of hypotheses from which S samples is finite and is known exhaustively to E.

3. If no outcome is given following S's choice he keeps the same hypothesis for the next trial. During consecutive blank (i.e., no outcome) trials only one hypothesis will be maintained.

4. The S makes his choices in such a way that, if his hypothesis were if fact correct, he would always be right.

5. On any trial S has a certain constant probability of choosing incorrectly (of the order of .02). Levine (1966) p. 332.

Levine (1966) found that hypothesis patterns occurred on 92.4 percent of the four trial sets while the present study found that hypothesis patterns occurred on 91.4 percent of the four trial sets. While the results of the two studies are quite close, subsequent analysis of the data of the present study indicated that a more adequate estimate of the consistency of Ss' behavior was obtained by considering inconsistent and consistent hypothesis patterns. When this analysis was made it was found that only 80 percent of the hypothesis patterns were consistent with previously presented information. These findings provide support for Levine's first four assumptions, but indicates that the support is not as strong at that reported by Levine (1966).

Levine's fifth assumption predicts that the probability of an error on any trial is relatively small and he obtains a value of .02 for that probability. If this assumption is tested, as Levine did by calculating it from the proportion of 3-1 patterns, then the probability of an error on a given trial, calculated from the result that 8.6 percent of the patterns are 3-1 patterns, was .021. If, however, this value is calculated by considering the inconsistent hypothesis patterns as well as the 3-1 patterns, then the obtained value is .05 which is better than twice as high as the value obtained by Levine. These findings do not refute Levine's model, but they do suggest that a better understanding of hypothesis testing behavior is obtained when a distinction is made between consistent and inconsistent hypotheses.

The finding that analytic Ss are more efficient hypothesis testers than global Ss supports the findings of Experiments I and II. Perhaps the most striking finding was that global Ss seem to have considerably more difficulty processing negative information than do analytic Ss. This finding may suggest that part of the deficit in the global Ss performance is due to a faulty encoding process. Certainly additional research is needed to further clarify the process of encoding stimulus information as it relates to an individual's cognitive style.

CHAPTER FIVE

DISCUSSION, CONCLUSIONS, AND IMPLICATIONS

In this chapter, the results of these experiments will be examined in relation to the specific objectives of this project, and interpreted in relation to the body of research summarized in Chapter One. The major results will be summarized, and conclusions and implications for future research will be drawn. Also, a brief discussion of these results and their implication for educational research and practice will be presented.

General Summary of Results. The results of these experiments, in the most general form, are summarized in the following statements:

(1) A S's strategy can be reliably identified through the use of a concept learning set procedure which requires a S to identify several concepts of the same type. In general, this finding suggests that Ss do not begin the concept identification task with a fully developed strategy, but rather the strategy that is developed is, in part, learned within the context of the experiences provided by the learning task itself.

(2) Analytic and global Ss differ in the efficiency with which they identify concepts such that analytic Ss are the most efficient. Both analytic and global Ss adopted the same strategy (a conservative focusing strategy) but analytic S adopted it sooner and in general were more efficient in its use than were global Ss.

(3) There is a difference between analytic and global Ss in terms of the efficiency with which they test hypotheses in a conept learning situation which employs a fixed choice procedure. Analytic Ss manifest a greater percentage of correct hypotheses than do global Ss.

(4) Different types of feedback also influence analytic and global Ss in different ways. Both cognitive style levels have little trouble processing positive information, but global Ss have greater difficulty

processing negative types of information than do analytic Ss.

The Results in Context. These results provide further evidence that an individual's cognitive style is an influential variable in conceptual learning situations. It seems appropriate, therefore, to inquire how these findings may contribute to our understanding of this individual difference variable in a general research sense and what these results might mean in the broader context of education.

Recently, several excellent articles have reviewed the topic of cognitive style (Messick, 1970; Kagan & Kogan, 1970; Kogan, 1971) and each of these articles concluded that cognitive style is a viable individual difference variable which needs additional research, but also has some practical implications for educational practice. Furthermore, these authors agree that it is necessary to distinguish between the various dimensions of cognitive style. The specific dimension of cognitive style employed in the present studies was that of analytic-global functioning which is most closely related to the construction of psychological differentiation of Witkin and his colleagues (Witkin, et al., 1962). Considerable research effort has been invested in identifying, and describing the major characteristics of this dimension of cognitive style. In general, four characteristics related to this dimension of cognitive style can be distinguished: the stability of cognitive style, developmental differences in cognitive style, sex differences in cognitive style, and intellectual differences in cognitive style. Each of these characteristics will be described briefly and related to the results of the present series of experiments.

The Stability of Cognitive Style. The stability of an individual's cognitive style can be assessed in two ways. First, the stability of an individual's performance across situations can be evaluated; a S who responds in an analytic or global fashion in one situation would be expected to respond in a like manner in similar or related situations. Second, the stability of an individual's performance over time can be evaluated; a S who responds in an analytic or global manner would be expected to maintain this level of analysis over time. The extent to which individual differences in this dimension of psychological differentiation were self-consistent was assessed by Witkin et. al., (1954) by intercorrelating performance on a series of tasks which were designed to identify an individual's cognitive style. Three tasks were developed -- the Rod and Frame Test (RFT), Body Adjustment Test (BAT), and the Embedded Figures Test (EFT). In the RFT the S was presented an illuminated frame containing an illuminated rod. Both the rod and frame could be rotated independently, and the S's task was to orient the rod to the true vertical. In the BAT, the S sat on a chair in a room designed in such a way that both the chair and room could be tilted independently. The S's task was to orient the chair or the room to an upright position. The S's task on the EFT was to locate a simple figure embedded in a complex design, the dependent variable being the amount of time taken to locate the simple figure.

Witkin et al., (1954) presented intercorrelations between these tasks as evidence indicating the stability of his dimension of cognitive style. In general, he found that global Ss adjusted the rod more or less to the axes of the tilted frame in the RFT and tended to align their chairs with the surrounding field in the BAT and took longer to locate the simple figure in the EFT. Analytic Ss, on the other hand, adjusted the rod more or less to the true vertical regardless of the orientation of the frame in the RFT, tended to align their chairs with the true vertical in the BAT and located the simple figures in the EFT in a relatively short period of time.

Data derived from longitudinal studies also support the contention that Witkin's dimension of cognitive style is relatively stable over a given time period. Witkin et al., (1962) reported that test-retest correlations for the test battery remained relatively stable over 1 to 3 years. The correlations reported ranged from .66 to .97. Dana and Goocher (1959) reported stability coefficients of .94 for the EFT after a 1-week interval which is in agreement with the 3-year correlation of .89 reported by Witkin et al., (1962). In summary, then, the evidence suggests that individual differences in Witkin's measures of cognitive style are relatively stable acorss various situations and over various time intervals. Witkin et al., (1962) also suggested that their measures remained relatively stable even when experimental techniques designed to alter performance were employed. Neither drugs (Witkin et al., 1962) nor special training techniques (Elliott & McMichael, 1963) were successful in producing significant changes in performance on some of the measures of cognitive style.

The relevance of the stability of cognitive style for the present studies involves the consideration of the identifying instrument employed. The operational measure of cognitive style employed in the present series of studies was the HFT which is similar in formate to the Witkin's EFT. The HFT is a group test and is similar to a modification of Witkin's original EFT which Jackson, Messick, and Myers (1964) showed to be correlated (r = .62) with the individually administered EFT.

Developmental Differences. Concern with developmental differences in cognitive style is closely related to the problem of stability and only indirectly related to the present studies. The primary question is whether a child, compared with other children of his age, maintains his relative position on the continuum of cognitive style as he progresses through more advanced developmental levels. In a cross-sectional study, Witkin et al.,(1954) found thatyounger children as a group tended to be more field dependent than older children. With increases in age, however, there was a tendency to be more analytic. This trend stabilized during early adulthood (20 years old). Furthermore, a wide range of individual differences in performance on the battery of tests employed by Witkin was observed at each age level, but within any given age level was self-consistent. Witkin et al., (1962) cited an unpublished longitudinal study by Witkin, Goodenough, and Karp in which these same trends were observed.

The importance of this characteristic to the present studies stems from the fact that those Ss who participated in the studies were at the most stable end of the continuum of cognitive style.

Sex Differences in Cognitive Style. In general, the work stemming from Witkin's laboratory indicated that females as a group were more variable in their performance and more global than males. Although this observation was reported to be consistent at all developmental levels, it was not until adulthood that differences between the sexes became pronounced (Witkin _et al_., 1954). Others (Gardner _et al_., 1959; Kagan _et al_., 1963; Kagan _et al_., 1964) also reported sex differences in the analytic-global dimension of cognitive style.

In the present studies an analysis of sex differences was performed on the HFT scores. Overall, a total of 1246 _Ss_ took the HFT, 335 males and 911 females. The mean score for the male _Ss_ was 22.73 with a standard deviation of 8.49, while the mean for females was 21.49 with a standard deviation of 7.92. Males were found to be more analytic than females ($t = 1.71$; $df = 1244$; $p < .05$)[1] which is consistent with the findings of Witkin, but the females as a group were less variable in their HFT performance than males which is not consistent with Witkin's results. It should also be noted that there were no significant differences between mean HFT scores for males and females within the samples used for each of the three experiments. In fact, for Experiment II, females had a slightly higher mean score than did the males. Furthermore, there were no major sex differences in performance on the learning tasks. These findings may reflect that the sample of _Ss_ employed in the present experiments is not representive of the population in general. It might be that there is within the educational system a selection factor which is negatively biased toward those individuals with a global cognitive style. Implicit with these findings, is the implication that with college _Ss_ sex differences in cognitive style are not as important as they are with either younger _Ss_ or _Ss_ drawn from a more representative sample.

Intellectual Differences in Cognitive Style. Early observations of a significant relationship between general intelligence and the measures of cognitive style suggested to Witkin _et al_., (1962) that the individual differences which they had been exploring might simply be a function of differences in general intelligence. This assumption was predicted on the finding that intelligence, as measured by the Revised Stanford Binet, was correlated with a weighted index of cognitive style (involving the RFT, BAT and EFT) for boys (.57)

[1] one-tailed test

and girls (.76). Similar observations were reported when the Wechsler Intelligence Scale for Children was used as a measure of intelligence and correlated with the measures of cognitive style.

A number of factor-analytic studies have examined the relationship between measures of intelligence and cognitive style (Goodenough & Karp, 1961; Karp, 1963; Witkin et al., 1962). In general, the results of these studies are quite consistent. Three clusters of subtests on the Wechsler have been identified in these factor analyses: one cluster represented subtests dealing with verbal comprehension; another represented subtests dealing with attention and concentration; and the third, the analytic cluster, was represented by the Block Design, Object Assembly and Picture Completion subtests. Furthermore, this analytic cluster of subtests was found to define a factor which also consisted of heavy factor loadings from measures of cognitive style such as the EFT, RFT and BAT. Witkin et al., (1962) concluded that analytic Ss are intellectually superior to global Ss only in terms of the analytic subtests--there was no difference between these two groups of Ss on the verbal comprehension and attention-concentration subtests.

The role of intelligence as a determining factor of performance on measures of cognitive style is one of the most controversial aspects of Witkin's conception of cognitive style. Zigler (1963a, 1963b), for example, argues that general intelligence (i.e., the g factor) mediates the majority of findings reported by Witkin et al., (1962). The issue of the relationship between intellectual abilities and cognitive style is extremly important and cannot be dismissed lightly in that it has important implications for both research methodology and educational practices.

With respect to the problem this relationship poses for research, particularly research such as the present study which was interested primarily in the relationship between cognitive style and learning performance, the implication is that there needs to be some control for intelligence. The problem, however, is what aspect of intelligence does one control for -- general intelligence or verbal intelligence? Studies by Crandall and Sinkeldam (1964) and Wachtel (1968) reported a significant correlation between Witkin's measure of cognitive style and subtests of the WISC which load on the factor of verbal comprehension. Haueisen (1972), however, reported that for 141 Ss (110 females and 31 males) enrolled in introductory educational psychology courses performance on HFT was correlated - .01 with the verbal scale and .29 on the quantitative scale of the SAT.

Clearly these findings suggest that additional research on the relationship between intelligence and cognitive style is needed. Until clarification of this issue is available, however, the recommendation of Kagan and Kogan (1970) should be implimented. These authors recommended that "the control of verbal IQ becomes imperative" p. 1327.

Another factor relating to the issue of the relationship between cognitive style and intelligence has to do with the pattern of results of the first two experiments reported in the present study. In Experiment I, it was found that analytic individuals were more efficient in learning to identify concepts than were global Ss. The superior performance of the analytic Ss was most dramatic on the early problems and the difference between analytic and global Ss was minimal for the terminal problems. Similar findings were obtained in Experiment II, where it was found that the largest difference in performance between analytic and global Ss was at the beginning of each of the learning set problems. These findings strongly suggest that one of the major differences between the learning performance of analytic and global Ss is due to the rate at which these two groups learn. The pattern of results obtained in the present series of studies bears a strong resemblance to the findings of Osler and colleagues (Osler & Fivel, 1961; Osler & Trautman, 1961; Osler & Weiss, 1962 and Osler & Shapiro, 1964). These investigators were primarily concerned with the variables of intelligence and age as they relate to concept learning. The variable of intelligence was concerned primarily with normal and above average intelligence groups while the age variable was concerned with children ranging in age from 6 through 14. In essence, the results of this series of experiments indicated that Ss with higher levels of intelligence made fewer errors in learning concepts, and for the most part were more rapid learners than Ss with lower levels of intelligence. Despite the fact that the present series of experiments and those of Osler were employing different variables, the findings suggest that the variables of cognitive style and intelligence primarily result in rate differences while learning concepts. One possible implication of these findings for education is that methods of instruction such as mastery learning should be adopted which accommodate these rate differences whether they are due to differences in cognitive style, intelligence or some combination of the two variables.

Recommendations. As previously mentioned, the reviews of cognitive style (Messick, 1970; Kagan & Kogan, 1970; Kogan, 1971) have suggested several implications for education stemming from the research on cognitive style. It should be noted, however, that the vast majority of research concerned with cognitive style has focused primarily on normative, descriptive and demographic factors and that there is a paucity of research directed at learning either in a laboratory setting or the classroom. The major conclusion drawn from the studies reported in this report is that an individual's cognitive style is a significant variable in concept learning situations. While there are a limited number of studies dealing with the relationship between cognitive style and the learning process, a very consistent pattern of results is beginning to emerge: individuals with an analytic cognitive style learn more efficiently than individuals with a global cognitive style. Occasionally, a study will report that there are no significant differences between analytic and global Ss (e.g. Mulgrave, 1965), but to date there seems to be no studies which report that global Ss learn more efficiently than analytic Ss.

Based upon these findings the following recommendations seem to be warrented:

1. Additional research is needed on the relationship between an individuals cognitive style and the learning process. Specifically, three main research efforts are called for: First, additional research is needed for outcomes of learning other than concept learning such as factual learning, problem solving, creativity, etc. Second, a more detailed process analysis (e.g. attention, perception,

encoding, memory, deduction) is needed within each of the outcomes of learning. Third, consideration needs to be directed toward classroom learning and academic achievement.

2. Additional work is needed in which a systematic approach is taken with respect to studing the implications of the relationship between learning and cognitive style. Given that analytic Ss are more efficient learners than are global Ss, then three methods or procedures are possible which can help solve this problem. Each of these possibilities suggests a research effort for thier own sake.

    a. Attempts could be made to change an individuals cognitive style. This possibility is perhaps the least appealing for two reasons. One, limited research efforts have suggested that this is not very likely, but these studies have represented a short duration of time devoted to change. Two, this solution involves making a value judgment that the global cognitive style is undesirable.

    b. The precise process or processes could be identified which contribute to the global Ss' deficit and then training procedures and programs can be developed which will help overcome these specific deficiencies.

    c. Attempts could be made to design instructional materials which are compatible with an individuals existing cognitive style.

CHAPTER SIX

PROJECT SUMMARY

A series of three experiments were conducted in order to provide information concerning how an individual's cognitive style influences the development of a strategy in a concept identification task and how an individual tests his hypotheses in a concept learning set task.

In the first experiment, 40 Ss each solved 80 conjunctive concept identification problems following a selection paradigm. The Hidden Figures Test was used as a means of identifying an individual's cognitive style. One half of the Ss were identified as being global (scored a -1 SD below the mean) and one half of the Ss were analytic (scored a + 1 SD above the mean). The major results showed that analytic Ss solved the concept learning problems in fewer trials, less time, and in fewer trials beyond sufficient information; solved a greater percent of problems with a perfect conservative focusing strategy; and had a higher mean focusing score than did global Ss. Both analytic and global Ss, however, improved considerably across the 80 problems and both groups of Ss adopted a conservative focusing strategy.

In the second experiment, 310 Ss solved a total of 24, four-trial learning set problems. Across all problems, there were four bi-valued dimensions (color, letter, size and position). Within each problem, each value of each dimension appeared an equal number of times with every value of every other dimension. Two groups of Ss solved a total of 18 outcome problems (E informed S of the correctness of S's response) and six nonoutcome problems (S received no feedback). Each group consisted of an equal number of analytic and global Ss which were determined on the basis of a median split. Also each group of Ss had the nonoutcome problems distributed over a different sequence of problems. For both groups of Ss, color was the correct dimension during the first 12 problems and letter was the correct dimension during the last 12 problems. A comparison between analytic and global Ss was made in terms of the frequencies of occurrence of certain experimentally defined hypotheses. A higher percentage of analytic

Ss responded to the correct dimension during the learning set problems than did the global Ss, and global Ss consistently manifested a greater percent of error hypotheses than did analytic Ss.

In the third experiment, 30 analytic and 30 global Ss received 24, 16-trial problems with intermittent reinforcement, i.e., E said "right" or "wrong" only after every fifth response. Results of this experiment were consistent with the findings of the first two experiments. In general, analytic Ss solved more problems correctly than did the global Ss. Furthermore, there was some suggestion that both analytic and global Ss had little trouble with problems which provided positive feedback, but on problems with negative feedback global Ss seemed to have considerably more difficulty than did analytic Ss.

These experiments clearly demonstrate that cognitive style is an important variable in concept learning. The results of these studies were discussed in relation to the body of knowledge concerning cognitive style and implications for future research and educational practice were identified.

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Pretraining Problem		Left	Right
	card 1.	Small Red A	Large Green B
	card 2.	Large Red B	Small Green A
	card 3.	Large Green A	Small Red B
	card 4.	Small Green B	Large Red A

Problem #1		Left	Right
	card 1.	Large Brown V	Small Purple R
	card 2.	Small Brown R	Large Purple V
	card 3.	Small Purple V	Large Brown R
	card 4.	Large Purple R	Small Brown V

Problem #2		Left	Right
	card 1.	Small Green Y	Large White H
	card 2.	Large Green H	Small White Y
	card 3.	Small White H	Large Green Y
	card 4.	Large White Y	Small Green H

Problem #3		Left	Right
	card 1.	Large Yellow G	Small Blue F
	card 2.	Large Blue F	Small Yellow G
	card 3.	Small Blue G	Large Yellow F
	card 4.	Small Yellow F	Large Blue G

Problem #4		Left	Right
	card 1.	Small Yellow F	Large Brown W
	card 2.	Large Brown F	Small Yellow W
	card 3.	Large Yellow W	Small Brown F
	card 4.	Small Brown W	Large Yellow F

Problem #5		Left	Right
	card 1.	Large Yellow H	Small White B
	card 2.	Small Yellow B	Large White H
	card 3.	Large White B	Small Yellow H
	card 4.	Small White H	Large Yellow B

Problem #6		Left	Right
	card 1.	Large Red G	Small Blue N
	card 2.	Small Blue G	Large Red N
	card 3.	Large Blue N	Small Red G
	card 4.	Small Red N	Large Blue G

APPENDIX A:

SEQUENCE OF PROBLEMS FOR

EXPERIMENT II

		Left	Right
Problem #7	card 1.	Large Brown F	Small Green K
	card 2.	Small Green F	Large Brown K
	card 3.	Small Brown K	Large Green F
	card 4.	Large Green K	Small Brown F
		Left	**Right**
Problem #8	card 1.	Small Purple H	Large Red [illegible]
	card 2.	Large Red H	Small Purple [illegible]
	card 3.	Large Purple [illegible]	Small Red L
	card 4.	Small Red [illegible]	Large Purple H
		Left	**Right**
Problem #9	card 1.	Small White R	Large Brown L
	card 2.	Small Brown L	Large White R
	card 3.	Large White L	Small Brown R
	card 4.	Large Brown R	Small White L
		Left	**Right**
Problem #10	card 1.	Small Brown R	Large Yellow J
	card 2.	Large Yellow R	Small Brown J
	card 3.	Small Yellow J	Large Brown R
	card 4.	Large Brown J	Small Yellow R
		Left	**Right**
Problem #11	card 1.	Large Brown B	Small Green V
	card 2.	Large Green V	Small Brown B
	card 3.	Small Green B	Large Brown V
	card 4.	Small Brown V	Large Green B
		Left	**Right**
Problem #12	card 1.	Small Green S	Large White T
	card 2.	Small White T	Large Green S
	card 3.	Large White S	Small Green T
	card 4.	Large Green T	Small White S
		Left	**Right**
Problem #13	card 1.	Large Green K	Small Purple D
	card 2.	Small Green D	Large Purple K
	card 3.	Small Purple K	Large Green D
	card 4.	Large Purple D	Small Green K

		Left	Right
Problem #14	card 1.	Small Purple T	Large Blue X
	card 2.	Large Blue T	Small Purple X
	card 3.	Large Purple X	Small Blue T
	card 4.	Small Blue X	Large Purple T

		Left	Right
Problem #15	card 1.	Large Yellow [illegible]	Small White J
	card 2.	Small Yellow J	Large White [illegible]
	card 3.	Small White [illegible]	Large Yellow J
	card 4.	Large White J	Small Yellow [illegible]

		Left	Right
Problem #16	card 1.	Large Blue P	Small Red K
	card 2.	Small Blue K	Large Red P
	card 3.	Large Red K	Small Blue P
	card 4.	Small Red P	Large Blue K

		Left	Right
Problem #17	card 1.	Small Brown D	Large Yellow J
	card 2.	Small Yellow J	Large Brown D
	card 3.	Large Brown J	Small Yellow D
	card 4.	Large Yellow D	Small Brown J

		Left	Right
Problem #18	card 1.	Small Red [illegible]	Large White Y
	card 2.	Large Red Y	Small White [illegible]
	card 3.	Small White Y	Large Red [illegible]
	card 4.	Large White M	Small Red Y

		Left	Right
Problem #19	card 1.	Large Purple Z	Small Green Q
	card 2.	Large Green Q	Small Purple Z
	card 3.	Small Green Z	Large Purple Q
	card 4.	Small Purple Q	Large Green Z

		Left	Right
Problem #20	card 1.	Large Purple G	Small White T
	card 2.	Small White G	Large Purple T
	card 3.	Large White T	Small Purple G
	card 4.	Small Purple T	Large White G

Problem #21		Left	Right
	card 1.	Large Red B	Small Yellow C
	card 2.	Large Yellow C	Small Red B
	card 3.	Small Yellow B	Large Red C
	card 4.	Small Red C	Large Yellow B

Problem #22		Left	Right
	card 1.	Large Blue C	Small Green Q
	card 2.	Large Green Q	Small Blue C
	card 3.	Small Blue Q	Large Green C
	card 4.	Small Green C	Large Blue Q

Problem #23		Left	Right
	card 1.	Large Red T	Small Purple M
	card 2.	Small Purple T	Large Red M
	card 3.	Small Red M	Large Purple T
	card 4.	Large Purple M	Small Red T

Problem #24		Left	Right
	card 1.	Large Brown Z	Small Yellow X
	card 2.	Small Brown X	Large Yellow Z
	card 3.	Large Yellow X	Small Brown Z
	card 4.	Small Yellow Z	Large Brown X

APPENDIX B

INSTRUCTIONS FOR EXPERIMENT II

INSTRUCTIONS FOR EXPERIMENT I

The tape recorded instructions were as follows:

In this experiment you will be presented with several easy problems. Each problem consists of a series of slides like this one. (The first slide was projected on the screen.) During this experiment your task will be to decide which of the two stimuli is the correct stimulus. Indicate in the first answer space on your answer sheet the stimulus you think is correct. Do this by either circling the + column for the left-hand stimulus or by circling the - column for the right-hand stimulus. You will be shown which stimulus was correct after you have indicated your answer. There is going to be a series of stimuli like this first slide. You are to follow the same procedure on them as you are following on this pair of stimuli. Please mark your first answer.

(Five second pause.)

By now you should have marked your choice on your answer sheet. Throughout this experiment do not change your answer when the correct answer is given. The correct stimulus on this slide is the stimulus on the right. (Experimenter pointed to the correct stimulus.) You should have circled the - in the first answer space if you were correct. Please answer as soon as possible after each stimulus is presented. For each slide, I will point to the correct stimulus after you have filled in your answer. For the next 15 slides you are to circle either the + or -. You should begin on blank number 2. (The remaining 15 example slides were now presented.)

The larger letter was the correct stimulus for each of these first 16 slides. These slides were a demonstration problem. The stimuli in this problem varied on the four dimensions of size, position, color, and shape. A given stimulus was either large or small, either on the right or on the left, either red or green, and either an 'A' or an 'E'.

In each of the remaining problems, one of these cues will always give the correct answer. For each slide I want you to tell me which of these two you think is correct and I'll tell you whether or not you are correct. In this way you can learn the basis for my designating which stimulus is correct. You can figure out whether it is because of the color, the letter, the size, or the position. The object for you is to figure this out as fast as possible so that you can choose correctly as often possible.

Before all nonoutcome problems the following instructions were given:

The next problem will be a test of how much you have learned thus far. During the next problem I will not point to the correct stimulus on each slide presentation. Because this is a test, you are to continue to try to get 100 percent correct. (The appropriate space on the answer sheet was specified for each nonoutcome problem).

APPENDIX C

INSTRUCTIONS FOR EXPERIMENT III

In this experiment you will be presented with several easy problems. Each problem consists of a series of cards like this one. (E places the pre-training deck in front of S and points to the top card) Each card will contain two letters, and the letters will be of two colors. You will also notice that the letters are of two different sizes, and, of course, that one letter is on the left and one is on the right. Every card will be like this one except that the letters and the colors will be different. One of these two is "correct" in the sense that I've marked it here on my sheet. For each card I want you to tell me which of these two you think is correct and I'll tell you whether you're right or wrong. Then you go on to the next card, again you make a choice, and again I'll tell you whether you are right or wrong. In this way you can learn the basis for my saying "right" or "wrong." You can figure out whether it's because of the color, the letter, the size or the position. The object for you is to figure this out as fast as possible so that you can choose correctly as often as possible.

I'll give you a demonstration problem first, so that you can get the idea. Then if you have any questions, we can answer them. Is it clear? You go through the cards one at a time, making a choice for each one.

E presents Pre Problem #1
10 trials

(At the conclusion of this problem E ask S for the solution of the problem. If S says "green" then continue. If any other response repeat the problem.)

On this last problem I said "right" whenever you chose the green letter. This is typical of all the problems you are to solve. Either the left position or the right position; the large or small letters; one of the two colors or one of the two letters will consistently be correct. There are only these possibilities. Your job is to figure out which it is and to be correct as often as possible.

Now, are there any questions? If this is clear I want to add one more detail. In the last problem I said right or wrong after each card. For the next problem I will not always tell you whether you are right or wrong. After some cards, I'll say nothing. I'll mark here on my sheet whether you have made the correct response or not but I won't tell you. Don't let that disturb you. Try to be right all the time. This next problem will show you how it works.

E gives Pre training problem #2
Outcome on 1st, 3rd, 6, 9 ----28

Then give problem #3
Outcome on 1st, 3rd, 6, 9 ----28

Now I will give you one more practice problem. It will be just like the last two except that I will tell you whether or not you are correct after the first card and every fifth card thereafter.

E gives Pre training problem #4

In that problem the solution was the left side. From here on we will go through all the problems without stopping. The problems will all be like the ones you've just had, always with one of these simple solutions. That is, one of the colors, sizes, letters, or positions will be correct. Also, I'll continue to tell you whether you are right or wrong on every fifth trial. Your job is to be correct as often as you can, even when I am not saying anything.

Any last questions?