

THE RELATIONSHIP BETWEEN COGNITIVE STYLES,
SCHOLASTIC ABILITY AND THE LEARNING OF
STRUCTURED AND UNSTRUCTURED MATERIALS

Thesis for the Degree of Ph. D.

MICHIGAN STATE UNIVERSITY

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1969



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thesis entitled

The Relationship Between Cognitive Styles,
Scholastic Ability and the Learning of
Structured and Unstructured Materials
presented by

Lawrence William Lezotte

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Education

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ABSTRACT

THE RELATIONSHIP BETWEEN COGNITIVE STYLES, SCHOLASTIC ABILITY AND THE LEARNING OF STRUCTURED AND UNSTRUCTURED MATERIALS

BY

Lawrence William Lezotte

Couched in two components of the basic systems model for teaching, this study was conducted to determine whether entry behavior of students interacts with instructional procedures. Measured scholastic verbal and quantitative ability and the selected cognitive styles of reflection/impulsivity (R-I), field-dependence/independence (FDI), and extraversion/introversion (E-I) defined the scope of the entry behaviors. Structured and unstructured learning materials defined the scope of the instructional procedures.

A second purpose of this study was to determine whether the various entry behaviors represented independent or interdependent constructs. Similarly, an analysis of the learning material was conducted to determine whether individual differences (IDs) in student performance on one set of materials correlated with IDs on the second set of materials.

The Hidden Figures Test was used to measure FDI; the Matching Familiar Figures Test to measure R-I, and the Junior Eysenck Personality Inventory was used as the measure of E-I. Scholastic ability was measured by the Preliminary Scholastic Aptitude Test (PSAT). Each of these tests was administered to the fifty male and fifty female high school juniors serving as subjects for this study. These students

also learned two sets of materials, structured and unstructured. Each set of materials consisted of thirty common English nouns. The two lists differed only on the inter-item associative strength. The unstructured list consisted of words with an inter-item associative strength of zero. The structured lists consisted of six relational categories of five words per category. For the structured list, the inter-item associative strength of the words within a category was substantially above zero, while the inter-item associative strength of the words between categories was zero.

The students were given five exposures to each list. The words on a list were randomly re-ordered after each trial. The students were told after each exposure that they should recall and write as many of the words as they could remember.

The learning materials were scored four different ways: total recall per trial, forward chaining across trials, backward chaining across trials, and, for the structured list, clustering scores per trial.

The first phase of the analysis consisted of factor analyzing the entry behaviors to determine whether the various constructs were independent. A factor analysis of the five total recall scores from the structured and unstructured materials was also conducted. The purpose of this factor analysis was to determine whether IDs in performance on one set of materials was independent of IDs in performance on the second set of materials.

The factor analysis of the cognitive style and ability scores yielded a three-factor varimax solution accounting for 71 percent of the variance. Verbal and quantitative ability and the Hidden Figures

Test defined the first factor, the Matching Familiar Figures Test total time and error scores defined the second factor, and E-I defined the third factor. On the basis of these data, ability, R-I and E-I were defined as independent constructs but FDI was dropped as an independent construct since it loaded significantly on the ability factor. The factors were labeled ability, R-I, and E-I respectively.

The factor analysis of the five total recall scores for each set of material yielded a four-factor varimax solution accounting for 85 percent of the variance. Manipulation of inter-item associative strength had the effect of re-ordering the subjects, mitigating against the notion that lists of relational words are easier to learn than non-relational words.

The finding of a clear separation of the factors on the basis of list type provided a basis for making the predictions concerning the differential relationship between the cognitive styles and the learning of structured and unstructured materials.

The sets of forward, backward, and clustering scores were each factor analyzed. The purpose for including these scores and conducting these analyses was an attempt to illustrate that IDs in total recall can be predicted from IDs in ability to "subjectively organize" the materials as reflected in forward, backward, and clustering measures. Furthermore, these scores were included to show that if the entry behaviors related to recall, this relationship is best understood as the relationship between "subjective organization ability" and entry behaviors.

The data from the various factor analyses are summarized as follows:

1. Ability, R-I and E-I define independent constructs.
2. Manipulation of the inter-item associative strength of common English nouns has the effect of defining different learning tasks as was reflected in the factor analyses of total recall scores, forward chaining, backward chaining, and clustering scores.
3. The students' performance in the early trials of both the structured and unstructured materials defines a factor (span memory) which is separate from the factor which emerges for the later trials (rote memory).

Factor scores were generated for each subject from the various factor analytic solutions. These normalized scores served as a basis for testing the hypothesis that: 1) ability and reflection relate positively and extraversion negatively to the learning of structured materials, and, 2) ability and extraversion relate positively and reflection negatively to the learning of unstructured materials. These hypotheses were tested at .05 probability level using the multiple regression analysis procedure.

The results of the multiple regression analyses revealed the following:

1. With one exception, the entry behaviors revealed no significant relationship to any of the indices of learning on the unstructured materials. The one exception was that low ability students achieved greater success than high ability students and male students achieved greater success than female students on the backward chaining rote memory scores ($R=.25$).

2. The entry behaviors of ability and R-I along with sex as a variable did relate to the learning of structured materials. Contrary to the prediction, impulsive students achieved greater success than reflective students on both the structured recall rote memory and structured forward chaining rote memory scores. Girls performed better than boys on the structured recall rote memory and span memory scores. Ability was positively related to both the structured recall span memory and structured forward chaining rote memory scores. E-I did not correlate with any of the learning indices for the structured materials.
3. Structured and unstructured recall rote memory scores correlated with the forward and backward chaining scores for each set of materials. The variables of structured and unstructured forward chaining rote memory, structured and unstructured backward chaining correlated $R=.82$ with structured recall rote memory. The variable of sex also correlated positively with the structured recall rote memory. Girls were found to perform better than boys on the structured recall rote memory scores.

Unstructured recall rote memory scores were found to be positively related to the variables of unstructured forward chaining rote and span memory and unstructured backward chaining rote memory ($R=.65$). No sex difference was observed for learning unstructured materials.

4. Cluster rote memory was found to be positively related to structured recall rote memory, structured forward and backward chaining rote memory scores.

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A THESIS

**Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of**

DOCTOR OF PHILOSOPHY

**Department of Counseling, Personal Services
and Educational Psychology**

1969

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3-10-10

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CHAPTER I

THE PROBLEM

An analysis of teaching strategies reveals techniques identified with such diverse sources as Socrates and the modern computer. There are at least four basic teaching methods: the Socratic, the classical humanist, the personal development, and the systems model. This research study is couched in the systems model because it is both an uncomplicated, accurate conceptualization of the teaching process, and amenable to controlled study.¹

The systems model divides the teaching process into four components:

1. Instructional Objectives: those behaviors the student should attain upon completion of a segment of instruction;
2. Entering Behaviors: those attributes or characteristics which the learner brings to the instructional setting;
3. Instructional Procedures: the procedures and processes the teacher employs to facilitate the achievement of the instructional objective;
4. Performance Assessment: tests and observations which are used to determine to what extent the students have

¹John P. DeCecco, The Psychology of Learning and Instruction; (New Jersey: Prentice Hall, Inc., 1968) pp. 1-83.

achieved the instructional objectives.²

The most demanding aspects of the systems model for the classroom teacher are identifying the relevant entering behavior of students, developing alternate instructional procedures, and matching these procedures to the entering behaviors, thus maximizing the likelihood that each student will achieve the instructional objective.

Purpose of the Study

The purpose of this study is to determine whether selected entry behaviors interact differentially with alternate instructional procedures. The particular entry behaviors focused on within the scope of this study are scholastic ability and cognitive styles. The question is, do characteristics a student brings to different types of learning situations relate to how well he'll perform.

Research Hypothesis

The research hypothesis is that cognitive styles have either a facilitating or inhibiting effect on how a student performs on structured and unstructured learning materials.

Theory

Teachers are continually being told that an effective teacher adapts the instruction to the students' needs and abilities. Unfortunately these teachers are neither told how to adapt instructional

²Robert Glaser, "Psychology and Instructional Technology," in Training Research Education, R. Glaser, ed., (Pittsburgh: University of Pittsburgh Press, 1962) pp. 1-30.

procedures nor which individual differences they should take into consideration. This study considers whether the three individual difference variables of field-independence/dependence, reflection/impulsivity, and extraversion/introversion should be considered as relevant entry behavior of students as they approach different learning situations.

The hypothesis for this study originates with the research of Herman Witkin, Hans Eysenck, and Jerome Kagan. Witkin is closely aligned with the cognitive style of field-dependence/independence (FDI). He states that a field-independent person perceives his surroundings analytically with object experiences as discrete from their backgrounds. The field-dependent person perceives his surroundings in a relatively global fashion, passively conforming to the influence of the prevailing field or context.³

Witkin's prediction is that field-independent individuals ought to experience less interference than their field-dependent counterparts on the unstructured learning materials. However, on the structured materials, field-dependent individuals ought to perceive the inherent structure and capitalize on this information as they learn the materials. Such behavior manifests itself in differential performance on the two tasks.

The extraversion/introversion (E-I) continuum has been linked, by Eysenck, to the Hullian construct of reactive inhibition. Eysenck hypothesized that a relatively slow rate of build-up and a relatively fast dissipation of cortical inhibition manifests itself behaviorally as introversion. Conversely, a relatively fast rate of build-up and

³Herman Witkin, et al., Psychological Differentiation, (New York: John Wiley and Son, Inc., 1962).

slow dissipation of cortical inhibition manifests itself in behavioral terms as extraversion.⁴ Within this theoretical framework Eysenck hypothesizes that introverts perform better on associative tasks, i.e., paired associate or conditioning, whereas extraverts perform better on successive ordering tasks, i.e., serial learning and digit span tasks.⁵ Since the structured material is analogous to an associative task, and the unstructured material to a serial task, then Eysenck hypothesizes that extraversion will relate positively to unstructured learning and negatively to structured learning.

The hypothesis that extraverts will perform better on unstructured material and introverts will perform better on the structured material attempts to replicate Eysenck's findings using verbal associative and serial tasks.

The third cognitive style to be examined, reflection/impulsivity, (R-I), is closely linked to Jerome Kagan's research. Kagan defines reflection/impulsivity as a person's consistent tendency to display slow or fast response time in problem situations with high response uncertainty.⁶ He hypothesizes that impulsives are more prone to make incorrect responses in fairly complex task situations.

⁴H. J. Eysenck, The Dynamics of Anxiety and Hysteria, (London: Routledge and Kegan Paul, 1957).

⁵H. J. Eysenck, "Extraversion and the Acquisition of Eyeblink and GSR Conditioned Responses," Psychological Bulletin, No. 4, 1965, pp. 258-270.

⁶Jerome Kagan, "Impulsive and Reflective Children; the Significance of Conceptual Tempo," in Learning and the Educational Process edited by J. D. Krumboltz, Rand McNally and Co., 1965, pp. 133-161.

The structured material, because of its structure, presents less task complexity to the subject. Whereas the unstructured material by its very nature manifests a high degree of response uncertainty, the characteristic of a complex task. Kagan's prediction is that reflection will relate positively to structured learning and negatively to unstructured learning.

These particular stylistic variables are included in this study for two reasons; to determine the relationships between each of these variables and the learning of structured and unstructured materials, and to determine whether these variables represent independent or interdependent constructs.

Behaviorally, these variables share many common characteristics. However, these variables have never been included concurrently in a single study and the relationships between the variables are not known. The first phase of this study will determine empirically whether FDI, R-I, and E-I share a substantial amount of common variance or whether each represents an independent construct.

Overview

In Chapter II a more detailed examination of the basic systems model of teaching will be presented and each of the cognitive styles considered in this study will be discussed from two points of view. The literature establishing each as a "cognitive style," and the literature relating the various styles to learning will be reviewed.

Chapter III will include a discussion of the procedures, instruments, subjects, and statistical analyses used in this study.

Chapter IV will include the analyses of the relationships among the cognitive styles and also the learning materials. The specific research hypotheses are also presented in Chapter IV. Finally, Chapters V and VI will include the statistical tests of the hypotheses and a discussion of these results.

CHAPTER II

REVIEW OF LITERATURE

The purpose of Chapter II is fourfold: to examine in some detail Glaser's concept of entering behavior, to relate cognitive styles to this component of the systems model, and to demonstrate that the cognitive styles under study do meet the criteria of both a cognitive style and an entering behavior. Finally, the chapter is concluded with a review of the research relating these styles to learning.

Entry Behavior The student represents a complex constellation of traits and abilities. Fortunately for the teacher, not all are relevant to the impending instructional sequence. However, some characteristics do indeed affect the student's learning as he proceeds through the instructional sequence. The teacher's task is to react to those characteristics having an immediate effect on learning and modify the instructional procedures to accommodate these characteristics.

Entering behavior is defined as those relevant behaviors which the teacher assumes the student possesses and/or predisposes the student to act and react differentially to the instructional sequence.¹

Cognitive Styles Cognitive styles are defined by Sigel as any consistency of behaviors, perceptual, intellectual, or expressive,

¹ John P. DeCecco, The Psychology of Learning and Instruction: Educational Psychology, (New Jersey: Prentice Hall, Inc., 1968) pp. 1-83.

over a variety of tasks and situations.² By Sigel's definition, a cognitive style would qualify as an entering behavior if observed differences in styles are found to significantly affect other psychological functions, particularly learning. Cognitive styles may manifest themselves as a directive influence on behavior; or as an ability to resist disruption under interference conditions such as distraction.³

Reflection/Impulsivity (R-I) Consistency of behaviors across similar tasks and over time is the essential characteristic of a cognitive style.⁴

The reliability of R-I has been established on concurrent measures across two or more tasks, test-retest measures taken after varying lengths of time, and measures of internal consistency.⁵

R-I has been measured by the Matching Familiar Figures test (MFF) or the Haptic Visual Matching (HVM) tests developed by Kagan. On the MFF the subject studies a standard figure and six variants of the standard. The subject's task is to select the one variant which is identical to the standard. Similarly, on the HVM the subject is given a geometric form and/or familiar objects and without seeing either the object or the variants, the subject, by tactual

²Irving Sigel, "Cognitive Style and Personality Dynamics," Interim Progress Report, National Institute of Mental Health, 1961, p. 1.

³Irving Sigel, et al., "Styles of Categorization and their Intellectual and Personality Correlates in Young Children," Human Development, October, 1967, pp. 1-17.

⁴Sigel, op. cit., p. 1.

⁵Jerome Kagan, "Impulsive and Reflective Children; the Significance of Conceptual Tempo," in Learning and the Educational Process, edited by J.D. Krumboltz, Rand McNally and Co., 1965, pp. 133-161.

manipulation, must find the variant which is identical to the standard. Both tests yield two scores: decision time, (the elapsed time to selection of a first variant) and the total errors (number of incorrect variants chosen). After each response the subject is told whether he is correct or incorrect. If the choice was incorrect he is instructed to try again. The tests have varied in length from twelve to thirty items.⁶

Internal Consistency Measures Kagan and Moss co-directed a study using sixth grade children as subjects and found odd-even reliability coefficients on the MFF test of $r=.90$ and $r=.91$ for boys and girls they categorized as analytical and relational.⁷ In a second study, Kagan, et al., again using early elementary students as subjects, found split-half reliability estimates on a 30 item version of the MFF to be $r=.94$.⁸

Concurrent Tasks Kagan, et al., reported that when the MFF and the HVM tests were given concurrently to third and fourth graders, correlations ranging between $r=.50$ and $r=.70$ with an average of $r=.64$ were found. They also report the tendency to reflect over alternative hypotheses generalizes not only across tasks where all response

⁶Kagan, ibid.

⁷Jerome Kagan and Howard A. Moss, "Psychological Significance of Styles of Conceptualization," in Monographs of the Society for Research in Child Development, edited by John C. Wright, et al., No. 86, Vol. 2, 1963, pp. 73-112.

⁸Jerome Kagan, et al., "Information Processing in the Child: Significance of Analytic and Reflective Attitudes," Psychological Monographs, No. 1, Vol. 78, 1964, pp. 1-37.

alternatives are given, but also shows generalizability on tasks where the subject must generate his own alternatives.⁹

Test-Re-Test Reliabilities The most rigorous test for the existence of cognitive style is the degree of stability of the construct over time. In a study of 104 boys and girls in grades three and four, Kagan found that when a slightly different version of the MFF was administered one year later, the correlations averaged $r=.62$. In a second study using 102 third and fourth grade boys and girls, Kagan found one year test-re-test correlations on the MFF of $r=.48$ for boys and $r=.52$ for girls.¹⁰ In still a third study, Kagan and Moss found test-re-test correlations for reflective and impulsive boys and girls to be $r=.42$ for boys and $r=.67$ for girls.¹¹

These data establish that R-I does indeed meet the criteria of behavioral consistency across tasks and on similar tasks across time.

Reflection/Impulsivity and Learning A review of the highlights of the research relating R-I to learning is presented. This review is intended to acquaint the reader with how R-I has been employed in research studies and the outcome of these studies.

The tendency to show fast or slow decision times was not highly related to verbal ability. However, the direction of the relationship

⁹Kagan, et al., ibid.

¹⁰Kagan, op. cit.

¹¹Kagan and Moss, op. cit.

goes counter to the common stereotype belief that bright children think quickly in problem situations.¹²

Impulsivity was related to the number of errors of commission in an oral reading situation.¹³

With six and seven year old subjects, word recognition errors were related to recognition errors on the MFF and HVM for both sexes. Further, although verbal ability predicted reading performance, the reflective orientation related to reading errors even after the influence of verbal skills had been partialled out. ($r_p = .28$ both boys and girls)¹⁴

The influence of reflective delay is maximal when the subject has already learned the rudiments of the skill necessary to perform a task but has not overlearned the skill.¹⁵

Reflective children demonstrate higher standards of mastery on intellectual tasks, greater persistence with such tasks, choose more difficult tasks, and work longer on them than do impulsive children.¹⁶

Analytic versus non-analytic conceptual styles were found to be related to R-I. Analytic response styles were associated with longer response times. Non-analytic responses were associated with impulsive responses.¹⁷

¹²Kagan, op. cit.

¹³Kagan, op. cit.

¹⁴Kagan, op. cit.

¹⁵Kagan, op. cit.

¹⁶Kagan and Moss, op. cit.

¹⁷Kagan and Moss, op. cit.

Kagan, et al., in a single Psychological Monograph, report on a series of studies attempting to uncover the antecedent and significant correlates of analytic style in conceptual behavior. The major implications of their data are that the consistency of an analytic attitude across situations suggests that the fundamental processes of reflection versus impulsivity and visual analysis of complex arrays are primary determinants of the production of analytic concepts.¹⁸

Impulsive children make more errors of inductive reasoning than do reflectives. This individual difference variable places the impulsive child at a disadvantage in the discovery learning situation. The impulsive is likely to make more wrong inferences, experience a negative reinforcement, and, over time, become discouraged about his ability to extract insightful principles.¹⁹

A study designed to test the relation between impulsivity and errors of commission on a verbal learning task and greater deterioration of serial learning performance for reflectives was reported. The results revealed no relation between verbal ability and intrusion errors for either sex or reflective or impulsive subjects.²⁰ The data did reveal a moderate positive relationship between recall of non-concept words and reflection. In summarizing this study, Kagan states that reflectives recalled more words than impulsives, but this differential performance does not appear to be a function of either longer delays before beginning

¹⁸ Kagan, et al., op. cit.

¹⁹ Jerome Kagan, "Learning Attention and the Issue of Discovery," in Lee Shulman and Evan Keislar, *Learning by Discovery*, (Chicago, Rand McNally and Co., 1966), pp. 151-161.

²⁰ Jerome Kagan, "Reflection/Impulsivity: the Generality and Dynamics of Conceptual Tempo," Journal of Abnormal Psychology, February, 1966, pp. 17-24.

to recall words or the characteristic of the initial words reported. However, the superior recall of reflective children seems to occur because they persisted longer in their attempt to produce better cognitive products, suggesting that they are highly motivated.²¹

Shulman, et al., measured and related R-I to the inquiry process and concluded that "The construct invented by Kagan relates moderately to the variables central to the inquiry process in the predicted direction."²² Furthermore, they observed that reflectives were generally more effective inquirers than impulsives, as would be predicted by the theory. They concluded that whether due to the reflection component, the perceptual accuracy component, or most likely the combination of both, their adult version of the Kagan MFF R-I test correlates with the predictors and measures of inquiry.²³

A related area of research centers around the modifiability of the "cognitive tempo" by teachers or training procedures. These studies are of interest because they demonstrate that adults can be reliably scaled on R-I and also, the studies support the notion that teacher and student inputs do affect the progress of the student as he moves through the instructional sequence.

The first study of this type attempted to slow down the tempo of impulsive children. Kagan reported that the brief training period (about 60 minutes total) produced longer response latencies. Unfortunately,

²¹
Ibid.

²²
Lee S. Shulman, et al., "Studies of the Inquiry Process," Final Report, U.S. Department of Health, Education and Welfare, July, 1968, p. 167

²³
Ibid.

the training did not have any strong effect on error scores and did not generalize to an inductive reasoning test.²⁴

A direct examination of the effects of teacher tempo on the child revealed a significant relationship between teacher tempo and children's change in tempo over time. Again, however, no significant relationship between children's errors and their respective teachers' tempo was found. The authors concluded that the capacity to delay or to inhibit a response is more malleable than the ability to perform perceptual discriminations.²⁵

Finally, a study was reported by Kagan in 1965 in which reading performance was used as the criterion variable and measures of verbal ability and MFF response time and errors were used as predictor variables. They found that the number of reading errors was positively related to verbal ability and reflection. Also, they found multiple correlations of $r=.51$ for boys and $r=.59$ for girls when both measures were included in a single correlation with the criterion.²⁶ The MFF error score and verbal abilities predicted reading performance for girls, whereas MFF response times and verbal abilities were better predictors for boys.

Kagan states that subjects with long response latencies are actively considering alternative answers during the delay period and are not merely sitting paralyzed in their seats.²⁷ He finds support for

²⁴ Kagan, op. cit.

²⁵ Regina Yando, and Jerome Kagan, "The Effect of Teacher Tempo on the Child," Child Development, March, 1968, pp. 27-34.

²⁶ Ibid.

²⁷ Jerome Kagan, "Reflection, Impulsivity and Reading Ability in Primary Grade Children," Child Development, September, 1965, pp. 609-638.

this hypothesis by relating the number of eye movements (between standard and variants) to response times and errors. He found a correlation between error and eye movements of $r = -.26$ for boys and $r = -.58$ for girls. The correlations between eye movement and response times were $r = .50$ for boys and $r = .56$ for girls.²⁸

In summarizing the research on R-I, Kagan states that reflection increases with age; is stable over reasonably long periods of time, and manifests generality across similar situations. Also, R-I is significantly related to several types of verbal tasks, i.e., reading, concept learning, serial learning, and is subject to modification if specific training to that effect is administered.²⁹

Field-Dependence/Independence (FDI) Witkin characterizes the field-dependent person as:

taking a long time to locate a familiar figure hidden in a complex design;

less likely to structure ambiguous stimuli and more likely to report such stimuli as vague and indefinite;

having difficulty with block design, picture completion, and object assembly parts of standard intelligence tests;

being even a little better than field-independent persons on portions of intelligence tests concerned with vocabulary, information, and comprehension.³⁰

²⁸ Ibid.

²⁹ Ibid.

³⁰ Herman Witkin, et al., Psychological Differentiation, (New York: John Wiley and Son, Inc., 1962), pp. 1-268.

About the field-independent person, Witkin states that such a person:

tends to experience his surroundings analytically with object experiences as discrete from their backgrounds;
demonstrates a capacity to analyze his experiences as is demonstrated in his superior ability in overcoming an embedding context; imposes structure on a field which lacks it.³¹

The pre-1954 work in FDI is summarized by Witkin as follows:

So far the research has established that people vary widely in their manner of perception as demonstrated in a series of orientation tests. Specifically, it showed that in perceiving position with relation to the vertical direction people differed from one another in the relative extent of ability to utilize bodily experiences in overcoming the influence of the field.

Moreover, the evidence suggested that each person tended in different orientation situations to exhibit a characteristic way of perceiving, which was not readily subject to change, and which associated with other more general aspects of his psychological structure.³²

Until 1954, the apparatus necessary to measure this perceptual phenomena was elaborate and complex. Witkin used three basic test situations: the rod-frame test, the tilting room/tilting chair, and the rotating room. Using these measures, Witkin, et al., found inter-correlations between the three tests were all significant.³³ These results provide evidence of stability in the individual's manner of perception.

Using these elaborate testing procedures, Witkin and his colleagues felt they had evidence to support their hypothesis about the existence

³¹ Ibid., pp. 1-60.

³² Herman Witkin, et al., Personality Through Perception, (New York: Harper and Brothers, 1954) p. 13.

³³ Ibid.

of a reliable perceptual style. With the complex apparatus tests as the criterion, they then set about to develop a more practical test to assess FDI. Their research efforts led to the development of the Embedded Figures Test (EFT).³⁴ The original EFT contained 24 complex figures, each of which had a simple figure embedded within it. In administering the test, the subject is first shown a complex colored figure, then a copy of the simple figure it contains. Finally, he is shown the complex figure again. Simple and complex figures are never shown together. The test is scored on the subject's mean amount of time to find the simple figure. In their original work, test performance on the EFT correlated significantly with the results for the elaborate procedures in 19 of 26 cases ($\text{mdn. } r = .49$)³⁵ They concluded that it was clear from these results that dependence on the visual field in the orientation situation is significantly related to difficulty in extracting a hidden item from its complex visual content.³⁶

Reliability of EFT Studies involving FDI report no problem with the reliable measurement of this construct.

Witkin reported the following test-re-test reliabilities over a three year period.³⁷

TABLE 2.1 Three Year Test-Re-Test Correlations on Three Measures of Field-Dependence/Independence Reported by Witkin

	<u>Men</u>	<u>Women</u>
Rod-Frame	$r = .84$	$r = .66$
Body Adjustment	$r = .77$	$r = .74$
Embedded Figures	$r = .89$	$r = .89$

³⁴Witkin, et al., op. cit.

³⁵Witkin, et al., op. cit.

³⁶Witkin, et al., op. cit.

³⁷Witkin, op. cit.

A short form of the EFT was designed by Jackson in 1956. He found correlations with the longer test, 12 items rather than 34 items, of $r=.96$ for both males and females.³⁸ These data further suggest the basic reliability of this dimension.

In a critique of the EFT in Buros' 6th Mental Measurements Yearbook, Gough states that the reliability coefficients, whether computed by the odd-even, test-re-test, or analysis of variance methods are excellent, the medium coefficient in ten studies was found to be $r=.905$.³⁹ In discussing test-re-test reliability over extended periods of time, Witkin concludes that performance over a period of time is about as stable as performance from trial to trial within the same test.⁴⁰ Together these results provide striking evidence of marked stability in the individual's manner of perception.

The EFT as well as the original methods of assessing FDI gives strong support for establishing this dimension as a cognitive style.

FDI, General Observations Beginning at about age ten there is a significant decrease in the mean time scores on the EFTs for both males and females. However, the variability about the respective means for each age tends to remain fairly constant, $SD = 35$ seconds for both sexes across ages. At all ages males tend to be more field-independent than females. However, Witkin reports that it is not until adult age that the observed sex differences in perception are

³⁸Douglas N. Jackson, "A Short Form of Witkin's Embedded Figures Test," Journal of Abnormal and Social Psychology, No. 53, 1956, pp. 254-255.

³⁹O. K. Buros, The Sixth Mental Measurements Yearbook, (New Jersey: Gryphon Press, 1965).

⁴⁰Witkin, 1954, op. cit.

established in a pervasive and consistently significant way.⁴¹

The differences between sexes, though clear-cut and consistent, tend to be small compared to the range of individual differences within each sex.⁴²

The basic characteristics of the individual's perceptual approach are established relatively early in life and tend to persist through the changes that accompany development and altered relations with the environment.⁴³

No fundamental changes in perceptual approach, in the sense of alteration of the subject's characteristic way of perceiving, could be found as a result of training specifically for that purpose.⁴⁴

In attempting to explore sex differences in perceptual behavior, Bieri, et al., concluded that two factors seem to account for the observed differences: 1) superior mathematical aptitude of males, and 2) males more effectively than females combine this mathematical aptitude with a conceptual approach to social and objective stimuli, a combination which facilitates EFT performance.⁴⁵

Field-Independence and Learning Witkin, et al., have been more concerned with the clinical aspects of F-I dimension and they have not been directly concerned with the relationship between learning and FDI. However, they do offer some hypotheses which have yet to be tested. They predict that memory would be poorer among field-dependent children

⁴¹Witkin, op. cit.

⁴²Witkin, op. cit.

⁴³Witkin, op. cit.

⁴⁴Witkin, op. cit.

⁴⁵J. Bieri, et al., "Sex Differences in Perceptual Behavior," Journal of Personality, No. 26, 1958, pp. 1-12.

when compared to field-independent children. They did cite some evidence pertaining to the relationship between this stylistic dimension and learning but conclude that the whole area remains confused but worth re-working. They predict that approaching classical learning situations in terms of individual differences in ability to structure experiences will prove fruitful.⁴⁶

Some learning studies of the type advocated by Witkin have been reported. One study relates EFT performance to retention in a classical retroactive inhibition learning paradigm. Borrowing from the Gestalt psychologist's orientation, Gollin and Baron make the analogy between original and interpolated learning and field and ground separation. They reported that field-independent subjects were less susceptible to retroactive interference. The correlation between the EFT and re-learning of the original lists following the interpolated task was $r=.51$.⁴⁷

Gardner, et al., found a significant relationship between EFT performance and the amount recalled and rate of relearning in a retroactive inhibition learning experiment involving nonsense syllables. In the same monograph they reported on the significant relationship between associative memory tasks and FDI. They concluded that behaviors sampled by the associative memory tests are in part determined by behaviors reflected in tests measuring field-articulation.⁴⁸

⁴⁶Ibid.

⁴⁷E. S. Gollin and A. Baron, "Response Consistency in Perception and Retention," Journal Experimental Psychology, Vol. 47, 1954, pp. 259-262.

⁴⁸Riley W. Gardner, et al., "Personality Organization in Cognitive Controls and Intellectual Abilities," Psychological Issues, 1960, Vol. II, pp. 289-200.

In another study involving the EFT, Gardner and Long give further evidence for relationship between FDI and learning. They developed the rationale that recall was presumed to involve selective deployment of attention to relevant versus irrelevant cues in two ways: 1) in the requirement to recall words in order under conditions of high within-list similarity, and 2) in the simultaneous requirement to identify which of two highly similar lists contained each word recalled. They required the subjects to learn multiple lists of words and then recall as many of the words as possible after the final list had been learned. Finally the subject had to identify which of the original lists contained the words they recalled. They reported a correlation between recall accuracy and EFT of $r=.43$ and Rod-Frame test of $r=.55$.⁴⁹ Probably the most startling fact about these correlations was that the EFT and the Rod-Frame test were administered to these subjects three years prior to the learning tasks. The authors did not find this fact surprising because they note that Witkin himself found test-re-test correlations of $r=.89$ with a three year elapsed time.⁵⁰

Gardner and Long did suggest an additional study designed to test whether performances on EFT are associated with selectivity in recall and recognition rather than learning per se. They were not able to test this since they did not require that their subjects learn the lists of words to some set criteria, a necessary prerequisite to test their suggested hypothesis.

⁴⁹Riley W. Gardner and Robert I. Long, "Field-Articulation in Recall," Psychological Record, No. 11, 1961, pp. 304-310.

⁵⁰Ibid.

These studies do suggest that FDI does have a significant relationship to the learning and retention of verbal materials. Further, the reliability data reported earlier along with the learning data qualifies FDI as a cognitive style.

Introversion/Extraversion (E-I) The scale of E-I used in this study was developed by Eysenck. The E-I scale comes from Eysenck's personality theory developed over the last thirty years by him and his collaborators at the Maudsley Institute of Psychiatry, London, England. Eysenck's personality theory began with an extensive review of the personality literature after which he concluded the existence of two basic and inclusive personality dimensions, E-I and Neuroticism (N).

In his subsequent work with these two dimensions Eysenck states that N, as he measures it, is closely related to the inherited degree of lability of the autonomic nervous system, while E-I is closely related to the degree of excitation and inhibition prevalent in the central nervous system.⁵¹

An enormous amount of personality literature is available on these dimensions as they are postulated and measured by Eysenck. However this review will be limited to the literature relating E-I to classical learning studies.

Reliability of the Eysenck Scales Eysenck reports that test-retest reliability correlations were between $r=.84$ and $r=.94$ for the various scales of the inventory. These correlations were reported in a study of 120 subjects with an elapsed time of one year. Similar split-half reliability coefficients were reported for the various scales;

⁵¹H.J. and Sybil Eysenck, Manual of the Eysenck Personality Inventory, (London: University of London Press, 1964).

these data were based on the results gathered from 2200 subjects.

Eysenck concludes that:

there seems to be little doubt that questionnaire responses given under the usual conditions give a reasonably valid picture of the subject's habitual behavior patterns.⁵²

As part of a larger study, Jensen administered the Maudsley Personality Inventory (MPI) and the Eysenck Personality Inventory (EPI) to a group of 50 college students on two separate occasions. The MPI extraversion scale was found to have a test-re-test reliability of $r=.81$ and the EPI extraversion scale $r=.76$.⁵³

Extraversion/Introversion and Learning The theoretical interest in the MPI and Eysenck's theory is based upon the correlations of the Eysenck scales with fundamental processes such as perception and learning.⁵⁴

The predicted correlations between E-I and various learning phenomena is derived from a combination of Eysenck's theory of E-I and a Hullian type of learning theory.⁵⁵

Eysenck has postulated that extraverts build up reactive inhibition more rapidly and dissipate it more slowly than do introverts, and, according to Hull's theory of learning, reactive inhibition depresses performance. Therefore, under certain inhibiting conditions, extraverts and introverts should be expected to differ in their learning. Generally, the "certain inhibiting conditions" include

⁵²H.J. Eysenck, "Extraversion and the Acquisition of Eyeblink and GSR Conditioned Responses," Psychological Bulletin, No. 4, 1965, p. 268

⁵³Arthur Jensen, "Extroversion, Neuroticism, and Serial Learning," Acta Psychologica, Vol. 20, 1962, pp. 69-77

⁵⁴Ibid.

⁵⁵Jensen, op. cit.

tasks which are associative versus serial in nature. The former type, according to Eysenck, would favor the introvert, and the latter, the extravert.⁵⁶

There are few studies designed to test the predictions coming from Eysenck's E-I hypothesis. Jensen states that the predictions between E-I and classical learning are borne out only tentatively by the research emanating from the Maudsley laboratory.⁵⁷

A review of the relationship between extraversion and the acquisition of eyeblink and GSR conditioned responses included the following summary statements:

1. the median correlation between conditioning and extraversion was found to be $r = -.31$. This conclusion comes as a result of examination of some 13 different studies;
2. introverts are approximately twice as easy to condition as extraverts;
3. male introverts condition relatively quicker than female introverts, and male extraverts less quickly than female extraverts;
4. differences between Is and Es in eyeblink conditioning tend to appear early in the experiment, suggesting that inhibitory potential is produced quickly.⁵⁸

Eysenck, in reviewing the studies failing to substantiate his hypothesis, states that a correlation between conditioning and E can only be demonstrated when care is taken to arrange experimental conditions such

⁵⁶Eysenck, op. cit.

⁵⁷Jensen, op. cit.

⁵⁸Eysenck, op. cit.

that sufficient inhibition is produced during the experiment.

From the Eysenck predictions one would expect a significant interaction between the introverted and extraverted groups learning under the two-versus four-second exposure rates since a two-second exposure rate should precipitate greater reactive inhibition build-up. Jensen tested the Eysenck hypothesis and reported no significant difference between introverts and extraverts learning of serial lists under two- and four-second exposure rates. He did find a significant positive correlation between speed of serial learning and extraversion when the list was presented at a two-second exposure rate. However, no significant relationship between extraversion and serial learning was found when the materials were presented at a four-second exposure rate.⁵⁹

In his study "Individual Differences in Learning: Interference Factor" Jensen included extraversion measures along with a number of serial learning tests. In factor analyzing these data he found extraversion loading with other measures on the factor he called resistance to response competition.⁶⁰

Jensen also describes another study in which he found that 48 percent of the variance in extraversion scores could be predicted from performance in a single serial learning task. In summarizing these data, Jensen concludes that there can be little doubt that extraversion is in some way involved in serial learning. Further, these findings make it important that measures of extraversion be

⁵⁹ Jensen, op. cit.

⁶⁰ Jensen, Arthur R., Individual Differences in Learning: Interference Factor, Cooperative Research Project, No. 1897, U.S. Office of Education, 1965.

included in future studies of individual differences in serial learning.⁶¹

In summary, these data substantiate that E-I meets the basic criteria of a cognitive style. Furthermore, these data suggest that E-I ought to be included in studies designed to predict for individual differences in learning.

Conclusions

The literature reviewed in Chapter II has established the fact that R-I, E-I and FDI each meet the criterion of a cognitive style. Furthermore, the literature relating these styles to learning suggests that R-I, E-I, FDI ought to interact with certain instructional procedures. If these predictions are borne out by the data, then teachers ought to consider the relevancy of these styles when assessing the entry behaviors of the students and modify their planned instructional procedures accordingly.

⁶¹ Jensen, op. cit.

CHAPTER III

DESIGN OF THE STUDY

The specific procedures and statistical methods used to test the research hypotheses of this study are presented in Chapter III.

Whenever possible, the instruments and procedures conformed to those used in the previous studies involving the cognitive styles of Reflection/Impulsivity, Field-Dependence/Independence or Extraversion/Introversion. Departures from the previously used procedures or instruments are reported.

Sample

A sample of fifty boys and fifty girls ranging from 16 to 17 years of age served as subjects for this research study. Separate samples of boys and girls were selected because the evidence indicates sex differences in cognitive styles. The subjects were selected from the population of junior level students attending two Catholic high schools located in a midwestern city of about 100,000 people.

This sample should not be considered representative of all high school juniors since private high schools typically attract students from higher socioeconomic levels. These students also tend to be somewhat above average on measured ability when compared to public high school students.

Instruments

The reflection/impulsivity (R-I) dimension was measured using Shulman et al.'s adult version of the Matching Familiar Figures test (MFF).¹ The twelve test items used were more difficult than those developed by Kagan for younger children. As in the previous research, two separate scores were computed; the total amount of elapsed time in seconds to the subject's first response to an item, and the total number of errors made by the subject. Kagan reports that with his version of the MFF test the correlation between total time and errors range from $-.40$ to $-.60$.² Shulman, et al., found a correlation between time and errors of $-.54$.³ The correlation between total time and errors for this present sample of subjects was $r = -.47$.

The reliability of the scores on the MFF was calculated using the Hoyt's Analysis of Variance procedure.⁴ This internal consistency measure yielded reliability coefficients of $r = .76$ for total time and $r = .51$ for total errors. The mean reflection time for the subjects was 34.72 seconds per item and the mean number of errors was 1.59 per item.

¹Lee S. Shulman, et al., "Studies of the Inquiry Process," Final Report U. S. Department of Health, Education, and Welfare, July, 1968, pp. 157-167.

²Jerome Kagan, "Impulsive and Reflective Children; the Significance of Conceptual Tempo," in Learning and the Educational Process, edited by J. D. Krumboltz, Rand McNally and Co., 1965, pp. 133-161.

³Shulman, et al., op. cit.

⁴Cyril H. Hoyt, "Test Reliability Estimated by Analysis of Variance," Psychometrika, 1941, Vol. 6, pp. 153-160.

The introversion/extraversion (E-I) dimension was measured by the Junior Eysenck Personality Inventory, (Junior EPI). This inventory, containing sixty items written in a yes-no format, was designed to measure neuroticism, extraversion/introversion, and contains a 15-item lie scale. The reported split-half reliability coefficients for this age group are presented in Table 3.1⁵

TABLE 3.1 Split-half Reliability Coefficients on the Junior EPI for High School Juniors

	<u>Boys</u>	<u>Girls</u>
Extraversion	.86	.87
Neuroticism	.81	.89
Lie Scale	.74	.67

Although only the extraversion measure is included within the scope of this study, reliability estimates for all scales were computed by sex to determine if the subjects performed as reliably as those reported in the manual. The reliability of the Junior EPI using the Kuder Richardson-21 formula were computed and are reported in Table 3.2

TABLE 3.2 Junior EPI Reliability Coefficients for Male and Female High School Juniors (N=100)

	<u>Boys</u>	<u>Girls</u>
Extraversion	.71	.82
Neuroticism	.78	.81
Lie Scale	.69	.45

⁵Sybil B. G. Eysenck, Manual for the Junior Eysenck Personality Inventory, (San Diego: Educational and Industrial Testing Service, 1963).

The only difference between the reliability coefficients in Table 3.2 and the reported reliabilities was that the boys in the sample performed less reliably.

By necessity, the field-dependence/independence dimension was measured by the Hidden Figures Test (HFT) published by the Educational Testing Service as part of their package of experimental Reference Tests for Cognitive Factors. Witkin's Embedded Figures Test was not available because it was being revised and no copies of the original form were available. The HFT was a reasonable substitute for Witkin's test since it was developed in connection with a project designed to study field-independence. In that study, Gardner, et al., found that the number correct on the Hidden Figures Test correlated $r = -.60$ with Witkin's original Embedded Figures Test (mean log time).⁶ Another study testing the relationship between Witkin's EFT and the Hidden Figures tests reported correlations between the two tests of $r = .75$ for females and $r = .84$ for males.⁷

The HFT, an adaptation of the Gottschaldt Figures Test, requires the subject to determine which of five simple geometrical figures is embedded in a complex pattern. The HFT contains two parts with sixteen items in each part. The subject is allowed ten minutes per part. The measure of reliability used was an equivalent form reliability coefficient which determined the strength of relationship between part one and part two of the test. This correlation coefficient

⁶R. W. Gardner, et al., "Cognitive Control: A Study of Individual Consistencies in Cognitive Behavior," Psychological Issues, No. 4, 1959, p. 67.

⁷D. N. Jackson, et al., "Evaluation of Group and Individual Forms of Embedded Figures Measures of Field Independence," Educational and Psychological Measurement, Vol. 24, No. 2, 1964, pp. 174-192.

was found to be $r=.41$. In addition, split-half reliability coefficients were computed for each part. The results were as follows:

TABLE 3.3 Computed Split-half Reliability Coefficients on the HFT (n=100)

	<u>Part I</u>	<u>Part II</u>
Total Score	.84	.83

Because of the speeded nature of the test, the subjects were told that guessing was not appropriate unless they were reasonably sure of their answer. The scores on the HFT were corrected for guessing by subtracting one fourth of the wrong responses from the total number of correct responses.

Ability Measure The Preliminary Scholastic Aptitude Test (PSAT) was used to assess verbal and quantitative ability. This test is an abbreviated adaptation of the College Entrance Examination Board Scholastic Aptitude Test (SAT). The PSAT was administered in October, 1968, under the auspices of the Educational Testing Service. The PSAT is parallel to the SAT both in content and form. The items are drawn from the same item pool as the SAT. The PSAT consists of verbal and quantitative subtests. The reliabilities, which are reported, are based on the Kuder Richardson-20 formula and the estimates range from $r=.86$ to $r=.91$ for the verbal scores, and from $r=.88$ to $r=.91$ for the mathematical scores.⁸ Zimmerman, in reviewing the PSAT, states that

⁸O.K. Buros, The Sixth Mental Measurements Yearbook, (New Jersey: Gryphic Press, 1965).

it has no competing test, but it does the job it was designed to do and it does this job well.⁹

Learning Tasks Two lists (unstructured and structured) of thirty common English nouns were used as the experimental learning tasks. The lists were systematically constructed for this study so that the inter-item associative strength among the words was controlled.

The sixty words were selected from the Palermo, Jenkins Word Association Norms Grade School Through College.¹⁰ Constraints were placed on the words used by Palermo and Jenkins, and additional constraints were imposed on the words finally used in the structured and unstructured learning materials. The constraints were:

1. Palermo and Jenkins only included words in their norming study which were, in their root form, A or AA words according to the general Thorndike Lorge list. All words were also above 100 on the juvenile count also contained in the Thorndike Lorge list.
2. In their norming process, Palermo and Jenkins instructed students to give the first response which occurred to them when each stimulus word was presented. The norms which resulted give an indication of the relative associative strength existing between the various words included in the norming study.
3. The thirty words included in the unstructured materials were not offered as a response to any of the other words in the list. The inter-item associative strength among the words included in the unstructured materials was zero based on responses of high school juniors serving as subjects in Palermo Jenkins' study.¹¹
4. The thirty words included in the structured materials consisted of six relational categories of five words per

⁹Ibid.

¹⁰David S. Palermo, and James J. Jenkins, Word Association Norms Grade School Through College, (Minneapolis: University of Minnesota Press, 1964).

¹¹Ibid.

category. Each of the words in a relational category was offered as a response to the other words in that category with a reported frequency substantially above zero. The words from one relational category were not given as associates to any of the words in the other categories.

5. The words used in the structured and unstructured materials had the same frequency of usage in the English language. However, to insure that inter-item associative strength was the only attribute differentiating the two sets of materials, additional tests were conducted. First, the average word length for each list was computed. The mean word length for the unstructured list was 5.9 letters, and the structured list was 5.2 letters.

6. The frequency of occurrence of each letter of the alphabet for each list revealed no difference between the lists.

Appendix I includes the thirty words constituting the unstructured and structured materials. The inter-item associative strength for each relational category of words from the structured materials is also included in Appendix I.

Procedure

Three separate testing sessions were used to administer the various instruments to each subject. The MFF test was individually administered in a quiet room. The average testing time for this test was twenty minutes. A second forty minute session was used to administer the Junior EPI and the HFT to groups of about twenty subjects. Finally, the third testing session of about one hour was devoted exclusively to the learning task.

Each of the words from the structured and unstructured materials was individually photographed on 16 millimeter film. An animation stand was used to control the number of exposures of each word. The filming consisted of exposing a word for twenty-four frames (1.5 seconds)

followed by twenty-four frames of dark film. At the conclusion of each presentation of a list, two minutes and thirty seconds of dark blank film was added. Including the dark film as part of the total film allowed the projector to run continuously throughout the five presentations of each list type, thus providing for standardization of the procedures across all student groups tested.

The words were presented to the students at a rate of 1.5 seconds per word. All students received five exposures to each list. Following each exposure, the students were given a two-minute recall period followed by a thirty-second rest period. The students were instructed to recall and write as many words as possible during the recall period. The students were further instructed not to look back at their work on previous recall trials. They were told not to be concerned about recalling the words in the order they were presented. The students were encouraged to use any mnemonic devices which would help recall the words.

The words were randomly re-ordered across the five trials. This was done to minimize the usual serial learning position effects of primacy and recency. In order to eliminate ordering effects, the administration of the structured and unstructured lists was counter-balanced across the groups of subjects tested.

Several scores were computed from the learning data.

Total Recall Per Trial This score was the simple sum of the total number of words recalled correctly on each of the five trials for the two lists.

Total Forward Chaining Per Trial The total number of times a recalled word from a preceeding trial was recalled on the subsequent

trial with the forward adjacent word from the preceeding list also appearing in the forward adjacent position on the subsequent list. Only four scores could be computed since the first trial serves as the base by which the forward chain score on the second trial could be computed.

Total Backward Chaining Per Trial The total number of times a recalled word from a preceeding trial was recalled on the subsequent trial with the forward adjacent word from the preceeding list being recalled in the backward adjacent position on the subsequent list. This scoring procedure, like forward chaining, yields only four scores per list.

Clustering Scores The structured list provided a unique opportunity to score the recall performance on the a priori associations known to exist within this list on each trial. This score was computed in the following manner. The longest unbroken string of words from a relational category was taken as the clustering for that category on that trial. The score then represents the sum of the longest chain for each of the six relational categories. Five scores, one for each trial, were computed for each subject on this basis.

Analysis of the Data

The statistical analysis consisted of two separate stages. The first stage used factor analytic procedures and the second multiple regression procedures. The former was used to determine empirically the degree of interrelationship between the cognitive styles and ability. Factor analysis techniques were also used to determine whether the learning of structured and unstructured materials was correlated.

The multiple regression procedures were used to test the specific hypotheses. Chapter IV includes a review of the results of the factor analyses and Chapter V includes the results of the regression analyses used to test the hypotheses.

Rationale for Factor Analytic Procedures The three cognitive styles considered in this study (reflection/impulsivity (R-I), field-dependence/independence (FDI), and extraversion/introversion (E-I)) had not been concurrently employed in a single study. Therefore, the empirical relationship among these variables and between these variables and measured ability could not be stated. From the behavioral characterizations offered by the various researchers, one is led to speculate that the three cognitive styles do share a substantial amount of common variance. Factor analytic procedures provide a sound strategy for determining the degree of inter-independence among the various measures.

The factor analysis of the total recall scores was conducted to determine whether learning of the two tasks (structured and unstructured) represented different abilities or whether the structured list learning represented a similar learning task as the unstructured list learning, differing only in the ease with which it could be learned. If the two lists differed only in the ease with which they could be learned, the factor structure would approximate the characteristic solution reported by Games.¹² He found that regardless of the type of material learned and the specific procedures used, two factors emerge. The strongest factor was a rote memory factor, with a second factor, labeled the span memory factor. Games found that the span

¹²P. A. Games, "A Factorial Analysis of Verbal Learning Tasks," Journal of Experimental Psychology, No. 63, 1962, pp. 1-11.

memory factor emerges in the early trials of learning task, whereas the rote memory factor emerges in the later trials. Based on the Game's findings the prediction is that manipulating inter-item associative strength would not change the basic factor structure. However, if the regression analysis testing the differential predictions between learning and the cognitive styles is to be meaningful, the factor analysis of the recall scores must reveal that manipulation of inter-item associative strength changes the task. If Games' two-factor solution were found with the later trials from both lists defining the rote memory factor and the early trials from both lists the span memory factor then the conclusion would be that manipulation of inter-item associative strength simply makes the lists easier without affecting the correlations. If this were the case differential predictions between cognitive styles would be futile, because if the styles correlated with learning at all, the direction and strength of the relationship would be likely to be similar with both lists.

Factor Analysis Procedure A principal components analysis of the various correlation matrices with ones in the main diagonal was conducted. Only factors having eigenvalues equal to or greater than one were rotated. The varimax orthogonal rotation procedure was used in an attempt to achieve simple structure.¹³

¹³ Harry H. Harman, Modern Factor Analysis, 2nd. ed. revised, (Chicago: University of Chicago Press, 1967) pp. 293-313.

Normalized factor scores were computed for each subject on each factor for each analysis. These scores were computed from the varimax factor loading matrix which conformed to the above-mentioned eigenvalue threshold. The hypotheses were tested using the derived factor scores as they have the desirable property of being uncorrelated with one another. Such orthogonality is a desirable prerequisite for measures considered simultaneously in multiple regression analyses.

Rationale for the Multiple Regression Analysis The hypothesis for this study examines the relationship between learning as reflected in recall scores and cognitive styles. Multiple regression, using the factor scores from the factor analysis of the free recall scores as the criterion, simultaneously tests the contribution of each of the predictor variables (cognitive styles and ability) in accounting for individual differences in the criterion. This procedure has the advantage of testing a hypothesis in a single operation.

A modification of the multiple regressions procedure, stepwise deletion of variables, was also used. The decision to use this procedure was based on the desire to achieve the most parsimonious, yet precise, solution possible. This procedure systematically deletes those variables in the original equation which do not contribute significantly to the overall prediction. The stepwise deletion procedure provides a basis for achieving the most accurate prediction with the least number of predictor variables. A stepwise addition of variables procedure could also have been used. However, the final results from the stepwise deletion procedure would have been identical to the results from the stepwise addition procedure because the predictor variables are uncorrelated. Therefore the order of addition or deletion of variables will not have

any influence on the other variables included in the equation.

Multiple Regression Procedures The hypotheses were tested using the multiple regression procedure. Two types of tests can be used. First, the multiple correlation coefficients can be tested against the hypothesis that the squared multiple correlation coefficients (R^2) is equal to zero. This technique, according to Hayes, assumes that the N cases represent a sample of cases from a multivariate normal distribution, each case representing an occurrence of some joint event.¹⁴ With this assumption it can be shown that the ratio

$$F = \frac{R^2}{(1-R)} \frac{(N-K)}{(K-1)}$$
 is distributed as F with K-1 and N-K degrees of freedom (K is equal to the number of variables, and N is the number of subjects in the sample).

A second, more meaningful, test can be used to determine whether the decrease in the R^2 is significant when variables are deleted from the equation by the stepwise deletion process described earlier. This test, described by McNemar, is designed to test whether the inclusion or exclusion of additional variables in the multiple regression equation leads to a significant increase or decrease in the accuracy of prediction.¹⁵

The inclusion of additional variables in the equation always tends to reduce the error of estimate somewhat and thus leads to some increase in observed R. The question becomes whether the observed

¹⁴William L. Hays, Statistics for Psychologists, (New York: Holt, Rinehart and Winston, 1964) pp. 570-573.

¹⁵Quinn McNemar, Psychological Statistics, (New York: John Wiley and Sons, Inc., 1962) pp. 283-284.

increase in R is significant. The tests for determining the significance between Rs takes the following form:

$$F = \frac{\frac{(R_1^2 - R_2^2)}{m_1 - m_2}}{\frac{1 - R_1^2}{(N - m_1 - 1)}}$$

In the equation, m_1 equals the number of variables in R_1 , m_2 the number of variables in R_2 . R_2 equals some subset of variables contained in R_1 and N equals the number of Ss.¹⁶

The statistical hypotheses were tested using the two procedures above. This decision was made for two reasons. First, the second procedure offers a rational basis for arriving at the most parsimonious solution possible. Second, testing whether the deletion of a variable or variables from an equation significantly decreases the multiple R is only meaningful when the multiple R with all variables included in the equation is significantly greater than zero. If the multiple R is not significantly greater than zero, then removing all the predictor variables from the equation will not significantly reduce the multiple R.

Research Hypothesis

The general hypothesis is stated in terms of the statistical procedures to be used. The assumption is made that the results of the factor analysis will reveal that the cognitive styles exhibit substantial independence from one another and that the two learning tasks exhibit similar independence from one another. This assumption is to be tested and the results will be reported in Chapter IV. If these

¹⁶ Ibid.

assumptions are met the research hypotheses take the following form.

The multiple correlation coefficient between free recall of the structured and unstructured materials across trials and the cognitive style and ability scores will be significantly greater than zero.

Further, the deletion of some of the style or ability scores from multiple regression equations will not significantly reduce the multiple correlation coefficients.

The predicted interaction of the cognitive styles with the two learning tasks comes with the following restrictions placed on the direction of the relationships.

The correlation coefficients in the structured material hypothesis will have the following signs:

The field-dependence/independence and reflection/impulsivity variables will be positive and the extraversion/introversion measure will be negative.

The correlation coefficients included in the unstructured material hypothesis will be the reverse:

The field-dependence/independence and reflection/impulsivity will be negative; and the extraversion/introversion dimension will be positive.

The sign predictions are made a priori because orthogonal factor scores will be used in the multiple regression equations to test the research hypotheses. Because the factor scores are uncorrelated, if any of the variables relate to the criterion, the direction and/or the magnitude of the relationship will not be influenced by the other variables included in the regression equation or by the order in which the variables are entered in the regression equation.

Summary

One hundred high school juniors were measured on three cognitive styles, verbal and quantitative ability, and on a structured and unstructured learning task. Four types of scores were computed from each of the learning tasks: recall, forward chaining, backward chaining, and clustering.

The rationale for the factor analysis and multiple regression analysis procedures as well as the analysis procedures themselves were discussed. Finally, the general research hypotheses were restated in terms of the statistical models designed to test them.

CHAPTER IV

FACTOR ANALYSES

The research hypotheses for this study depend on separately establishing that the cognitive styles of reflection/impulsivity, field independence/dependence, and extraversion/introversion are independent of one another and measured scholastic ability. Likewise, the research hypotheses are also dependent upon empirically determining that different intrinsic individual difference variables are required for learning the unstructured versus structured materials. Separate factor analyses were conducted to determine the degree of independence among the cognitive style variables and between the learning of structured and unstructured material.

Similar factor analyses were separately computed for the learning indices of forward chaining, backward chaining, and clustering. The results of the various factor analyses are presented in this Chapter.

Cognitive Styles and Ability Measures

The four cognitive styles and two scholastic ability measures were subjected to a principal components analysis followed by a varimax orthogonal rotation factor analysis. Two factors were found to have eigenvalues greater than one, and a third factor with an eigenvalue of .98 were computed as a result of the principal components analysis. The three factor solution was used even though the previously stated eigenvalue threshold was not met since the third factor accounted for a substantial proportion of the variance (17%) and extraversion/introversion

did not load on either of the two factors resulting from the two factor varimax solution.

The three factors accounting for 71 percent of the variance were subjected to the varimax rotation procedure which yielded a three factor solution. The factor loading matrix for the three factor varimax solution is presented in Table 4.1.

TABLE 4.1 Loading Matrix for Three Factor
Varimax Solution of Four Cognitive Style
and Two Ability Measures

	<u>Factor 1</u>	<u>Factor 2</u>	<u>Factor 3</u>
PSAT: V	.79	.17	.02
PSAT: Q	.83	.19	.02
Reflection Time	.04	.86	-.02
Reflection Errors	-.07	-.83	-.02
Extra/Introversion	-.05	-.01	.99
Hidden Figure	.62	-.27	-.12
Percent of Variance			
Accounted for	28%	26%	17%
Eigenvalues	1.87	1.39	.98

Examination of Table 4.1 reveals three reasonably independent factors. Factor 1, Ability, accounted for 28 percent of the variance with verbal (.79) and quantitative (.83) ability and the Hidden Figure Test (.62) loading highest on that factor. The reflection/impulsivity, (RI) scores defined Factor 2, and accounted for 26 percent of the variance with only reflection time and errors loading above .26 on that factor. The third factor, extraversion/introversion, accounts for 17 percent of the variance and the I-E measure clearly stands alone in defining this factor.

With the exception of the Hidden Figures Test, the measure of field-dependence/independence, each of the remaining two cognitive

styles do define factors which are independent of each other and measured ability. Clearly, field-dependence/independence as measured does not exist as a separate construct from ability.

Trial Recall Scores

The total recall score for the five trials on the structured and unstructured lists were subjected to the principal components analysis and varimax factor analysis procedure. The three factors with eigenvalues of greater than one and a four factor with an eigenvalue of .63 were found. The four factor solution was used in the varimax solution even though the eigenvalue threshold was not met since the fourth factor accounted for a substantial amount of the variance (10 percent) and the variable definition on the four factor solution permitted a clear understanding of the underlying structure. The factor loading matrix for the four-factor solution is presented in Table 4.2

TABLE 4.2 Varimax Factor Loading Matrix for the Four Factor Solution of Total Recall Scores

		Factor 1	Factor 2	Factor 3	Factor 4
Unstructured Material	Trial 1	.31	.18	.14	.92
	" 2	.77	.04	.42	.21
	" 3	.87	.24	.21	.18
	" 4	.82	.44	-.00	.10
	" 5	.77	.41	.10	.20
Structured Material	Trial 1	.26	.10	.89	.12
	" 2	.06	.73	.55	.02
	" 3	.23	.79	.27	.19
	" 4	.25	.87	.05	.13
	" 5	.39	.82	-.13	.05
Percent of Variance					
Accounted for		30%	31%	14%	10%
Eigenvalues		5.53	1.38	1.02	.63

As previously stated, Games analyzed a series of recall scores from classical learning situations and found only two factors.¹ One factor he called span memory and tasks on which the material had not been repeated (i.e., digit span) load on the span memory. Materials which had been repeated (i.e., serial learning) define the second factor, which Games called rote memory. The top and bottom halves of the matrix included in Table 4.2, when considered separately, tend to conform to Games' findings. Factor 4 would be defined as span memory on the unstructured materials and factor three the span memory for structured materials. Similarly, factor one would conform to Games' rote memory factor for the unstructured material whereas factor two would conform to rote memory factor for structured material.

Games found that the two factor solution transcends differences in the learning tasks (i.e., types of materials, rate of presentation). However, the factor loading matrix presented in Table 4.2 clearly demonstrates that manipulation of inter-item associative strength of the words to be learned changes the fundamental task such that the recall of structured and unstructured materials define different pairs of factors.

The four factors are labeled as Games labeled them, structured and unstructured span and rote memory. Factor one is defined as unstructured rote memory; two as structured rote memory; three as structured span memory, and four unstructured span memory. These four factors accounted for 85 percent of the variance in the correlation matrix.

¹ P. A. Games, "A Factorial Analysis of Verbal Learning Tasks," Journal of Experimental Psychology, No. 63, 1962, pp. 1-11.

Forward and backward chaining scores were computed for each subject for trials two through five for each list. These scores were included to determine whether individual differences (IDs) in total recall could be predicted from IDs in ability to organize the lists as they were learned. The hypothesis was that such IDs are related to the cognitive styles under study. The logic of this assumption, if true, would manifest itself in the following manner. Any correlation between recall and cognitive styles would disappear when the chaining ability is partialled out of the recall scores. This analysis strategy is intended to clarify how cognitive styles relate to learning as it is being measured in the recall scores on the structured and unstructured materials.

Forward and backward chaining scores were each subjected to separate principal component and factor analytic procedures.

Forward Chaining Scores

The principal components analysis of the forward chaining scores yielded two factors with eigenvalues greater than one and again a third factor accounting for a substantial proportion of the variance (20 percent) with eigenvalues less than one. The three factor solution was rotated even though the eigenvalue on the third factor (.82) was less than one because the three factor solution represented a parsimonious interpretation of the data. The factor loading matrix from the three factor varimax solution is presented in Table 4.3

TABLE 4.3 Factor Loading Matrix for the Three Factor Varimax Solution of Forward Chaining Scores

		Factor 1	Factor 2	Factor 3
Unstructured Material	Trial 2	.10	.89	-.02
	" 3	-.03	.76	.35
	" 4	-.11	.43	.74
	" 5	.34	.04	.76
Structured Material	Trial 2	.35	.03	.54
	" 3	.80	-.01	.09
	" 4	.87	.03	.23
	" 5	.84	.10	.16
Percent of Variance Accounted for		30%	20%	20%
Eigenvalues		3.01	1.73	.82

Examination of Table 4.3 reveals that the varimax three factor solution accounts for 70 percent of the variance. The factor structures for forward chaining and the recall scores for the structured list are similar. The correlations of forward chaining scores from trial to trial were strong as were the correlations for recall scores from trial to trial on the structured list. However, the forward chaining scores from trial to trial for the unstructured list define two separate factors; the early trials form one factor and the later trials a second.

Two additional observations of the chaining data are worth noting. First, the early trial forward chaining scores on the structured list share some common variance with the latter trial scores on the unstructured list. This finding makes sense because the literature by Tulving and others has shown that subjects begin to "subjectively organize" unassociated materials across repeated exposures to the

materials.² By the later trials the unstructured list subjects appear to be "acting on" the unstructured materials, as if they were structured, at least as reflected in the factor structure. For purposes of naming these factors, Factor 1 will be referred to as Structured Forward Chaining Rote Memory, Factor 2 as Unstructured Forward Chaining Span Memory, and Factor 3 Unstructured Forward Chaining Rote Memory.

Backward Chaining Scores

The backward chaining scores were analyzed like the forward chaining scores. The principal components analysis yielded three factors with eigenvalues greater than one, accounting for 61 percent of the total variance. The factors were subjected to the varimax orthogonal rotation procedure. The factor loading matrix for this three factor varimax rotated solution is presented in Table 4.4.

TABLE 4.4 Loading Matrix for Three Factor
Varimax Solution of Backward Chaining Scores

		<u>Factor 1</u>	<u>Factor 2</u>	<u>Factor 3</u>
Unstructured Back- ward Chaining	2	.50	-.38	.13
	3	.17	-.36	.75
	4	.00	-.86	-.14
	5	.14	-.74	.26
Structured Back- ward Chaining	2	.69	.01	-.18
	3	.37	-.31	-.66
	4	.85	.04	.09
	5	.68	-.21	-.04
Percent of Variance Accounted for		26%	21%	14%
Eigenvalue		2.51	1.43	1.01

²E. Tulving, "The Effect of the Order of Presentation on Learning of 'unrelated' Words," Psychonomic Science, 1965, No. 8, pp. 337-338.

The factor structure resulting from the analysis of backward chaining is not as clearly delineated as that of the forward chaining analysis. With the exception of the third backward chaining factor, the solution continues to separate the scores on the basis of list type. The first factor is defined by the structured backward chaining trial scores. The second factor is primarily defined by the last two trials on the unstructured list. The third factor is defined, interestingly enough, by the third trial backward chaining scores on both the structured and unstructured lists. No ready interpretation is available for this finding. For purposes of labeling these factors they will be referred to as 1) Factor 1, Structured Backward Chaining Rote Memory, 2) Factor 2, Unstructured Backward Chaining Rote Memory, 3) Factor 3, Trial Three Backward Chaining.

The factor analysis of the backward chaining scores is the only analysis in which the delineation of list type is not reflected in the data.

Structured List Clustering Scores

On the structured list, clustering scores were computed for each subject on each of the five trials. These scores were analyzed by means of the principal components and varimax rotation procedures. The results of the principal component analyses yielded a strong first factor with an eigenvalue of 3.4 and moderate second factor with an eigenvalue of .77; these factors which accounted for 83 percent of the total variance when rotated yielded a meaningful two factor solution. The factor loading matrix resulting from this two factor solution is presented in Table 4.4.

TABLE 4.5 Factor Loading Matrix for the Two Factor Varimax Solution of Five Clustering Scores from the Structured Material

	<u>Factor 1</u>	<u>Factor 2</u>
Trial 1	.20	-.96
" 2	.75	-.32
" 3	.78	-.48
" 4	.87	-.22
" 5	.93	-.07
Percent of Variance Accounted for	57%	26%

Examination of Table 4.4 reveals a clear separation of first trial performance from the performance on the subsequent trials of the structured learning task. These two factors will be labeled as Clustered Rote Memory and Clustered Span Memory, respectively.

Factor scores were computed from the factor loading matrices presented in Tables 4.1 through 4.4 in this Chapter. These factor scores and the labels given to them serve as the basis for the specific statistical hypothesis tested in this study.

Implications of the Factor Analysis on the Research Hypothesis

As noted in Chapter III, the research hypotheses were based on the assumptions that, 1) the various cognitive styles were independent of one another and scholastic ability, and 2) different intrinsic learning abilities were required to learn the structured and unstructured materials.

1) The results of the factor analysis of the total recall scores support the assumption that different intrinsic abilities were manifest in the learning of structured and unstructured materials.

Constructing a list of words in which inter-item associative strength was manipulated had the effect of re-ordering the subjects as they learned the two list types. This finding mitigates against the hypothesis that lists containing relational categories of words are simply easier for all subjects. Had the lists differed only in the ease with which they were learned, only two factors would have emerged because the list difference would have approximated an additive constant. Intercorrelations between variables are not affected by adding a constant to any or all of the variables.

The results of the factor analysis of the recall scores provides a basis for making the differential predictions pertaining to the relationship between cognitive styles and the learning of structured and unstructured materials.

The hypotheses are modified to include predictions concerning the relationship between cognitive styles and the two span memory factors in addition to the two rote memory factors.

2) The results of the factor analysis of the cognitive style and ability scores requires a major modification of the original research hypothesis. Two of the three cognitive style variables, E-I and R-I, emerged as independent factors. However, the cognitive style of FDI as measured by the Hidden Figures test is deleted as an independent style since the factor analysis revealed that it loaded on the ability factor.

The research hypothesis pertaining to the relationship between R-I and E-I and the learning of structured and unstructured material remain as originally stated. The predictions pertaining to the relationship between scholastic ability and learning follow.

3) Sub-hypotheses specific to the forward and backward chaining data are added. These hypotheses include predictions pertaining to the relationship between total recall and chaining on the one hand and to the relationship between chaining, cognitive styles and scholastic ability on the other. The specific statistical hypotheses are derived from the general research hypothesis that IDs in recall are related to IDs in both forward and backward chaining ability. Furthermore, IDs in forward and backward chaining ability are in turn related to the cognitive styles under study.

4) Research hypotheses resulting from the factor analysis of the cluster scores are developed. Similar to chaining scores, clustering ability should be significantly related to total recall and differentially related to the cognitive styles under study. Furthermore, a relationship between clustering and both forward and backward chaining on the structured list should be found.

Testable Hypotheses

Based on the factor analysis results reported in this Chapter and using the factor scores generated from the various reported solutions, the specific hypotheses for this study are stated and subsequently analyzed.

Structured Recall Rote Memory

Null Hypothesis Neither sex, ability, Reflection/Impulsivity (R-I), Extraversion/Introversion (E-I), nor any subset of these variables, when simultaneously included in a multiple regression equation, will correlate with structured recall rote memory scores.

Alternate Hypothesis Sex, ability, and R-I will correlate positively and E-I negatively or some subset of these variables will correlate with structured recall rote memory.

Unstructured Recall Rote Memory

Null Hypothesis Neither sex, ability, R-I, E-I, nor any subset of these variables, when simultaneously included in a multiple regression equation, will correlate with unstructured rote memory scores.

Alternate Hypothesis Sex, ability, and E-I correlate positively and R-I negatively or some subset of these variables will correlate with unstructured recall rote memory.

Structured Recall Span Memory

Null Hypothesis Neither sex, ability and R-I nor any subset of these variables, when included simultaneously in a multiple regression equation, will correlate with structured recall span memory.

Alternate Hypothesis Sex, ability and R-I or some subset of these variables will correlate positively with structured recall span memory.

Unstructured Recall Span Memory

Null Hypothesis Neither sex, ability, R-I nor any subset of these variables, when included simultaneously in a multiple regression equation, will correlate with the unstructured recall span memory scores.

Alternate Hypothesis Sex and ability will correlate positively and R-I negatively or some subset of these variables will correlate with unstructured span memory scores.

Structured Forward Chaining Rote Memory

Null Hypothesis Neither sex, ability, R-I, E-I, nor any subset of these variables, when included simultaneously in a multiple regression equation, will correlate with the structured forward chaining scores rote memory.

Alternate Hypothesis Sex, ability and R-I will correlate positively and E-I negatively or some subset of these variables will correlate with structured forward chaining scores rote memory.

Unstructured Forward Chaining Rote Memory

Null Hypothesis Neither sex, ability, R-I, E-I, nor any subset of these variables, when included simultaneously in a multiple regression equation, will correlate with unstructured forward chaining rote memory scores.

Alternate Hypothesis Sex, ability, and E-I will relate positively and R-I negatively or some subset of these variables will correlate with unstructured forward chaining rote memory scores.

Unstructured Forward Chaining Span Memory

Null Hypothesis Neither sex, ability, R-I nor any subset of these variables, when included simultaneously in a multiple regression equation, will correlate with unstructured forward chaining span memory scores.

Alternate Hypothesis Sex and ability will correlate positively and R-I negatively or some subset of these variables will correlate with unstructured forward chaining span memory scores.

Structured Backward Chaining Rote Memory

Null Hypothesis Neither sex, ability, R-I and E-I nor any subset of these variables, when included simultaneously in a multiple regression equation, will correlate with the structured backward chaining rote memory scores.

Alternate Hypothesis Sex, ability, and R-I will correlate positively and E-I negatively or some subset of these variables will correlate with the backward chaining rote memory scores.

Unstructured Backward Chaining Span Memory

Null Hypothesis Neither sex, ability, R-I, E-I, nor any subset of these variables, when simultaneously included in a multiple regression equation, will correlate with the unstructured backward chaining span memory scores.

Alternate Hypothesis Sex, ability and E-I will correlate positively and R-I negatively or some subset of these variables will correlate with the unstructured backward chaining span memory scores.

Structured Recall Rote Memory

Null Hypothesis Neither sex, ability, R-I, E-I, structured and unstructured forward chaining rote memory and structured span memory, structured backward chaining nor any subset of these variables, when included simultaneously in a multiple regression equation, will correlate with structured recall rote memory.

Alternate Hypothesis Sex, ability, R-I and structured and unstructured forward rote memory and structured span memory and structured backward chaining will correlate positively and E-I negatively or some subset of these variables will correlate with structured recall rote memory scores.

Unstructured Recall Rote Memory

Null Hypothesis Neither sex, ability, R-I, E-I, structured and unstructured forward and backward chaining rote memory, and unstructured forward chaining span memory nor any subset of these variables, when included simultaneously in a multiple regression equation, will correlate with unstructured recall rote memory.

Alternate Hypothesis Sex, ability, E-I, unstructured forward chaining span and rote memory and unstructured backward chaining rote memory will correlate positively and R-I negatively or some subset of these variables will correlate with unstructured recall rote memory.

Unstructured Recall Span Memory

Null Hypothesis There is no significant relationship between unstructured recall span memory and unstructured forward and backward chaining rote memory or unstructured forward chaining span memory.

Alternate Hypothesis Unstructured span memory will correlate positively with unstructured forward and backward chaining rote memory and unstructured forward chaining span memory.

Structured Recall Span Memory

Null Hypothesis Structured recall span memory will not correlate with structured forward and backward chaining rote memory.

Alternate Hypothesis Structured recall span memory will correlate with structured recall forward and backward chaining rote memory.

Cluster Recall Rote and Span Memory

Null Hypothesis Cluster recall rote and span memory scores will not correlate with structured recall rote and span memory scores or structured forward and backward chaining scores.

Alternate Hypothesis Cluster recall rote and span memory scores correlate positively with structured recall rote and span memory and structured forward and backward chaining scores.

Summary

The factor analyses revealed that Extraversion/Introversion and Reflection/Impulsivity exist as separate factors from one another, and from measured ability. However, field-dependence/independence correlated with the ability measures and was therefore deleted as an independent cognitive style.

Two sets of distinct factors emerged when the trial recall scores were factor analyzed. The factors differentiated on the basis of the two sets of materials learned; structured and unstructured. The differentiation between the two sets of materials was further verified in the factor analytic solutions of the forward and backward chaining scores.

The results of these factor analyses served as a basis for the specific research hypotheses which were stated earlier in this Chapter.

The hypotheses are designed to test the general research hypothesis that individual differences in learning as measured by recall factor scores can be accounted for primarily by individual differences in forward and backward chaining and clustering. Furthermore, individual differences in measured ability, E-I and R-I are significantly related to chaining and clustering and therefore to total recall.

Chapter V will present the analysis of the data designed to test these hypotheses.

CHAPTER V

ANALYSES AND RESULTS

The statistical hypotheses were tested using the multiple regression procedure. Two separate test procedures were used; first, each multiple correlation coefficient was tested to determine whether the magnitude was greater than zero, and second, variables were deleted from the multiple regression equation to determine whether some subset of the variables in the original equation could be used with no resulting decrease in the multiple correlation coefficient. All hypotheses were tested using the .05 alpha level with the appropriate degrees of freedom.

Structured Recall Rote Memory

Null Hypothesis Neither sex, ability, Reflection/Impulsivity (R-I), Extraversion/Introversion (E-I) nor any subset of these variables, when simultaneously included in a multiple regression equation, will correlate with structured recall rote memory scores.

Alternate Hypothesis Sex, ability and R-I will correlate positively and E-I negatively or some subset of these variables will correlate with structured recall rote memory.

The multiple regression equation was computed and the multiple correlation coefficient $R=.30$ was significant ($F=2.36$, $df_4, 95$). The null hypothesis of no correlation was rejected. Ability and E-I were deleted from the multiple regression equation with no resulting decrease

in the multiple correlation coefficient. Sex and R-I correlated with structured rote memory ($R=.29$). The correlation was significant ($F= 4.41$ df 2, 97). Sex correlated positively; however, R-I, contrary to the prediction, correlated negatively with structured rote memory scores. Girls performed better than boys and impulsive subjects scored higher than reflective subjects on structured rote memory.

Unstructured Recall Rote Memory

Null Hypothesis Neither sex, ability, R-I, E-I, nor any subset of these variables, when simultaneously included in a multiple regression equation, will correlate with unstructured rote memory scores.

Alternate Hypothesis Sex, ability, and E-I correlate positively and R-I negatively or some subset of these variables will correlate with unstructured recall rote memory.

A multiple regression analysis including sex, ability, R-I and E-I was computed, yielding a multiple correlation coefficient ($R=.24$). The multiple correlation coefficient was not significant ($F=1.41$ df 4, 95) and the null hypothesis was not rejected. Unstructured rote memory did not correlate with any subset of sex, ability, R-I or E-I for the students included in this study.

Structured Recall Span Memory

Null Hypothesis Neither sex, ability and R-I nor any subset of these variables when included simultaneously in a multiple regression equation will correlate with structured recall span memory.

Alternate Hypothesis Sex or ability and R-I or some subset of these variables will correlate positively with structured recall span memory.

A multiple regression analysis including sex, ability, and R-I was conducted, yielding a multiple correlation coefficient ($R=.30$),

($F=4.73$ $df = 2,97$). The null hypothesis was rejected and the alternate hypothesis was accepted. Sex and ability were found to correlate positively with structured recall span memory. Girls scored higher than boys, and high ability students achieved greater success than low ability students on the structured span memory dimension.

Unstructured Recall Span Memory

Null Hypothesis Neither sex, ability, R-I nor any subset of these variables when included simultaneously in a multiple regression equation will correlate with the unstructured recall span memory scores.

Alternate Hypothesis Sex and ability will correlate positively and R-I negatively or some subset of these variables will correlate with unstructured span memory scores.

A multiple regression equation including all the variables was computed and the resulting multiple correlation coefficient ($R=.19$) was not significant ($F=.88$ df 4, 95). Each variable was deleted from the equation and the resulting multiple correlation coefficients were not significant. Therefore, the null hypothesis of no relationship was not rejected. Unstructured recall span memory did not correlate with sex, ability, or R-I.

Structured Forward Chaining Rote Memory

Null Hypothesis Neither sex, ability, R-I, E-I nor any subset of these variables when included simultaneously in a multiple regression equation will correlate with the structured forward chaining scores.

Alternate Hypothesis Sex, ability and R-I will correlate positively and E-I negatively or some subset of these variables will correlate with structured forward chaining scores.

The multiple regression equation including all the variables was computed yielding a multiple correlation coefficient $R=.37$, which was significant; ($F=3.78$ df 4,95). Sex and E-I were deleted from the regression equation with no resulting decrease in the multiple correlation coefficient ($R=.34$). The null hypothesis of no relationship was rejected, sex and ability were found to correlate with the structured forward chaining scores. High ability students achieved greater success than low ability students on the structured forward chaining scores. Likewise, impulsive students achieved greater success than reflective students on the structured forward chaining rote memory scores.

Unstructured Forward Chaining Span Memory

Null Hypothesis Neither sex, ability, R-I nor any subset of these variables, when included simultaneously in a multiple regression equation, will correlate with unstructured forward chaining span memory scores.

Alternate Hypothesis Sex and ability will correlate positively and R-I negatively or some subset of these variables will correlate with unstructured forward chaining span memory scores.

A multiple regression equation including all the variables was computed yielding a multiple correlation coefficient $R=.20$ which was not significant; ($F = 1.01$ df 4, 95). The multiple correlation coefficients which resulted as each variable was systematically deleted from the equation were not significant. The null hypothesis of no relationship was not rejected. Unstructured forward chaining span memory scores were found to be uncorrelated with sex, ability, and R-I.

Unstructured Forward Chaining Rote Memory

Null Hypothesis Neither sex, ability, R-I, E-I, nor any subset of these variables, when included simultaneously in a multiple regression equation, will correlate with unstructured forward chaining rote memory scores.

Alternate Hypothesis Sex, ability, and E-I will relate positively and R-I negatively or some subset of these variables will correlate with unstructured forward chaining rote memory scores.

The multiple correlation coefficient $R=.09$ was found when all variables were included in the multiple regression equation predicting unstructured forward chaining rote memory scores. The multiple correlation coefficient was not significant ($F=.93$, $df\ 4, 95$). Furthermore, the systematic deletion of each of these variables from the regression equation did not yield a significant multiple correlation coefficient. The hypothesis of no relationship between sex, ability, E-I, R-I and unstructured forward rote memory scores was not rejected. Unstructured forward chaining rote memory was not found to correlate with any of the predictor variables.

Structured Backward Chaining Rote Memory

Null Hypothesis Neither sex, ability, R-I and E-I nor any subset of these variables, when included simultaneously in a multiple regression equation, will correlate with the structured backward chaining rote memory scores.

Alternate Hypothesis Sex, ability, and R-I will correlate positively and E-I negatively or some subset of these variables will correlate with the backward chaining rote memory scores.

The multiple regression equation including sex, ability, R-I, and E-I was computed and a multiple correlation coefficient ($R=.14$) was found. The regression equations were computed systematically deleting

each variable and no significant multiple correlation coefficients were found. Therefore, the null hypothesis of no relationship between sex, ability, R-I, E-I, and structured backward chaining rote memory was not rejected. Structured backward chaining rote memory was found to be uncorrelated with the cognitive style and ability measures.

Unstructured Backward Chaining Span Memory

Null Hypothesis Neither sex, ability, R-I, E-I, nor any subset of these variables, when simultaneously included in a multiple regression equation, will correlate with the unstructured backward chaining span memory scores.

Alternate Hypothesis Sex, ability and E-I will correlate positively and R-I negatively or some subset of these variables will correlate with the unstructured backward chaining span memory scores.

The multiple regression equation including sex, ability, R-I and E-I as predictors of unstructured backward chaining span memory yielded a multiple correlation coefficient ($R=.28$) which was not significant ($F=1.96$ $df = 4, 95$). However, the multiple regression equation including sex and ability yielded a multiple correlation coefficient ($R=.25$) which was significant ($F=3.31$ $df 2,97$). Therefore, the null hypothesis of no relationship is rejected. The alternate hypothesis is accepted, the subset of variables including sex and ability was found to correlate negatively with unstructured backward chaining span memory. Boys performed better than girls and low ability students achieved greater success than high ability students on unstructured backward chaining span memory. A summary of the various multiple regression equations is presented in Table 5.1

TABLE 5.1 Summary of the Various Multiple Regression Equations Predicting Learning Scores from Cognitive Style and Ability Measures

Predictor		Sex	Ability	R-I	E-I	Multiple R
Criterion						
Structured Recall Rote Memory		+	0	-	0	R = .29 *
Unstructured Recall Rote Memory		0	0	0	0	R = .24
Structured Recall Span Memory		+	+	0	N-I	R = .30 *
Unstructured Recall Span Memory		0	0	0	N-I	R = .19
Structured Forward Chaining Rote Memory		0	+	-	0	R = .34*
Unstructured Forward Chaining Span Memory		0	0	0	0	R = .20
Unstructured Forward Chaining Rote Memory		0	0	0	0	R = .09
Structured Backward Chaining Rote Memory		0	0	0	0	R = .14
Unstructured Backward Chaining Rote Memory		-	-	0	0	R = .25 *

* Correlation significant at .05 level

+ Positive relationship

- Negative relationship

0 No relationship

N-I Not included

Structured Recall Rote Memory

Null Hypothesis Neither sex, ability, R-I, E-I, structured and unstructured forward chaining rote memory and structured span memory, structured backward chaining nor any subset of these variables, when included simultaneously in a multiple regression equation, will correlate with structured recall rote memory.

Alternate Hypothesis Sex, ability, R-I and structured and unstructured forward rote memory and structured span memory and structured backward chaining will correlate positively and E-I negatively or some subset of these variables will correlate with structured recall rote memory scores.

The multiple regression equation including all the variables was computed yielding a multiple correlation coefficient ($R=.84$) which was significant ($F = 20.53$ $df = 10, 89$). Furthermore, the subset of variables including sex, structured forward and backward rote memory and unstructured rote memory was found to correlate $R=.82$ with structured recall rote memory ($F= 48.63$ $df = 4, 95$). The null hypothesis was rejected and the alternate hypothesis was accepted. The variables of sex, forward and backward chaining rote memory and unstructured rote memory were found to correlate positively with structured recall rote memory. Boys with high scores on these variables achieved greater success than girls with comparable scores on the structured recall rote memory measure.

Unstructured Recall Rote Memory

Null Hypothesis Neither sex, ability, R-I, E-I, structured and unstructured forward and backward chaining rote memory, and unstructured forward chaining span memory nor any subset of these variables, when included simultaneously in a multiple regression equation, will correlate with unstructured recall rote memory.

Alternate Hypothesis Sex, ability, E-I, unstructured forward chaining span or rote memory and unstructured backward chaining rote memory will correlate positively and R-I negatively or some subset of these variables will correlate with unstructured recall rote memory.

The multiple regression equation including these variables was computed and yielded a multiple correlation ($R=.67$) which was significant ($F= 7.21$ df 9, 89). Furthermore, a subset of these variables, unstructured forward chaining span and rote memory and unstructured backward chaining rote memory was found to yield a multiple correlation coefficient $R=.65$. The null hypothesis of no relationship was rejected and the alternate hypothesis was accepted. Unstructured forward chaining rote and span memory correlated positively and unstructured backward chaining rote memory negatively with unstructured recall rote memory. A summary of the multiple regression equations predicting structured and unstructured rote memory and the various chaining and cognitive styles measures is presented in Table 5.2.

Unstructured Recall Span Memory

Null Hypothesis There is no significant relationship between unstructured recall span memory and unstructured forward and backward chaining rote memory or unstructured forward chaining span memory.

Alternate Hypothesis Unstructured recall span memory will correlate positively with unstructured forward and backward chaining rote memory and unstructured forward and backward chaining rote memory and unstructured forward chaining span memory.

TABLE 5.2 Predictor Variables Correlating Significantly
with Structured and Unstructured Recall Rote Memory Scores

Criterion	Predictor		Structured		Unstructured		Forward		Unstructured		Structured		Backward		Unstructured		Sex	Ability	R-I	E-I	Multiple R
	Forward	Chaining	Forward	Chaining	Forward	Chaining	Forward	Chaining	Forward	Chaining	Forward	Chaining	Forward	Chaining	Forward	Chaining					
Rote Memory Structured Recall	+		+		0		+		0		+		0		+		0	0	0	R=.82*	
Rote Memory Unstructured Recall	0		+		+		0		+		0		+		0		0	0	0	R=.65*	

* Correlation significant .05 level
+ Positive relationship
- Negative relationship
0 No relationship

Unstructured recall span memory did not correlate with either unstructured forward or backward rote memory or unstructured backward chaining span memory. The null hypothesis of no relationship was not rejected.

Structured Recall Span Memory

Null Hypothesis Structured recall span memory will not correlate with structured forward and backward chaining rote memory.

Alternate Hypothesis Structured recall span memory will correlate with structured recall forward and backward chaining rote memory.

Structured recall was found to significantly correlate $R=.24$ with structured forward chaining rote memory and $R=.22$ with structured backward chaining rote memory. The null hypothesis of no relationship is rejected. Individual differences (IDs) in performance on trial one of the structured list are positively related to IDs in forward and backward chaining rote memory abilities.

Cluster Recall Rote Memory

Null Hypothesis Cluster recall rote and span memory scores will not correlate with structured recall rote and span memory scores or structured forward and backward chaining scores.

Alternate Hypothesis Cluster recall rote and span memory scores correlate positively with structured recall rote and span memory and structured forward and backward chaining scores.

The correlations between these variables and clustered span and rote memory are included in Table 5.3.

TABLE 5.3 Correlations between the Various Structured Chaining Scores and Cluster Span and Rote Memory Scores

	Cluster Rote Memory	Cluster Span Memory
Structured Recall Rote Memory	.76 *	.26 *
Structured Recall Span Memory	.03	.67 *
Structured Forward Chaining Rote Memory	.48 *	.01
Structured Backward Chaining Rote Memory	.59 *	-.36 *

* Significant .05 level

Examination of Table 5.3 reveals that cluster rote memory ability correlated with structured forward and backward chaining rote memory and extremely high with structured recall rote memory. Furthermore, cluster span memory was negatively related to structured recall span memory and positively related to structured backward chaining rote memory ability. The null hypothesis of no relationship was rejected and the alternate hypothesis is accepted.

Appendix II includes computed intercorrelations among all derived factor scores analyzed in this Chapter.

Summary

Each hypothesis was tested using the multiple regression procedure with the .05 level and appropriate degrees of freedom as the basis for determining significance.

Sex and ability was found to correlate positively with structured recall span and rote memory. Sex was found to correlate positively and Reflection/Impulsivity (R-I) negatively with structured recall span memory. Structured forward chaining rote memory was found to correlate positively with ability and negatively with R-I. (See Table 5.1)

With the exception of unstructured backward chaining rote memory, no significant correlations were found with any of the measures pertaining to unstructured list learning. Sex and ability were found to correlate negatively with unstructured backward chaining rote memory. (See Table 5.1)

Structured recall rote memory was found to correlate positively with structured and unstructured forward chaining rote memory, structured backward chaining rote memory and sex. The multiple correlation between these variables as predictors and structured recall rote memory as the criteria was $R=.82$ (See Table 5.2)

Unstructured recall rote memory was found to correlate significantly with unstructured forward chaining rote memory unstructured forward chaining span memory and unstructured backward chaining rote memory. The multiple correlation coefficient, when these variables were included as predictors and unstructured recall rote memory the criterion was $R=.65$. (See Table 5.2)

Cluster recall rote memory was found to correlate positively with structured recall rote memory ($R=.76$) and structured forward ($R=.48$) and backward ($R=.59$) chaining rote memory. Cluster span memory was found to correlate positively with structured recall rote memory ($R=.26$) structured recall span memory ($R=.67$) and negatively with structured backward chaining rote memory ($R=-.36$).

Unstructured recall span memory did not correlate with unstructured forward or backward rote memory or unstructured backward chaining span memory. However, structured recall span memory correlated positively with both structured forward chaining rote memory ($R=.24$) and structured backward chaining rote memory ($R=.22$).

CHAPTER VI

SUMMARY AND CONCLUSIONS

Couched in two components of the basic systems model for teaching, this study was conducted to determine whether entry behavior of students interacts differentially with instructional procedures. Measured scholastic verbal and quantitative ability and the selected cognitive styles of reflection/impulsivity (R-I), field-dependence/independence (FDI), and extraversion/introversion (E-I) defined the scope of the entry behaviors. Structured and unstructured learning materials defined the scope of the instructional procedures.

A second purpose of this study was to determine whether the various entry behaviors represented independent or interdependent constructs. Similarly, an analysis of the learning material was conducted to determine whether individual differences (IDs) in student performance on one set of materials correlated with IDs on the second set of materials.

A review of the literature revealed that R-I, E-I, and FDI meet the criteria of both cognitive styles and entry behaviors. The criteria for a cognitive style was defined as a consistency of behaviors, perceptual, intellectual or expressive over a variety of tasks and situations.¹

¹Irving Sigel, "Cognitive Style and Personality Dynamics," Interim Progress Report, National Institute of Mental Health, 1961, p. 1

The criteria for an entry behavior was defined as those behaviors a student possesses which predisposes him to react differentially to instructional sequences.²

The Hidden Figures Test was used to measure FDI; the Matching Familiar Figures Test to measure R-I, and the Junior Eysenck Personality Inventory was used as the measure of E-I. Scholastic ability was measured by the Preliminary Scholastic Aptitude Test (PSAT). Each of these tests was administered to the fifty male and fifty female high school juniors serving as subjects for this study. These students also learned two sets of materials, structured and unstructured. Each set of materials consisted of thirty common English nouns. The two lists differed only on the inter-item associative strength. Inter-item associative strength was defined as the relative probability that a word will be given as a free response to some stimulus word. The unstructured list consisted of words with an inter-item associative strength of zero. The structured lists consisted of six relational categories of five words per category. For the structured list, the inter-item associative strength of the words within a category was substantially above zero, while the inter-item associative strength of the words between categories was zero.

The students were given five exposures to each list. The words on a list were randomly re-ordered after each trial. The students were told after each exposure that they should recall and write as many of the words as they could remember.

² John P. DeCecco, The Psychology of Learning and Instruction: Educational Psychology, (New Jersey: Prentice Hall, Inc., 1968) pp. 1-83.

The learning materials were scored four different ways: total recall per trial, forward chaining across trials, backward chaining across trials, and, for the structured list, clustering scores per trial.

The first phase of the analysis consisted of factor analyzing the entry behaviors to determine whether the various constructs were independent. A factor analysis of the five total recall scores from the structured and unstructured materials was also conducted. As was the case for the entry behaviors, the purpose for this factor analysis was to determine whether IDs in performance on one set of materials was independent of IDs in performance on the second set of materials.

The factor analysis of the cognitive style and ability scores yielded a three-factor varimax solution accounting for 71 percent of the variance. Verbal and quantitative ability and the Hidden Figures Test defined the first factor, the Matching Familiar Figures Test total time and error scores defined the second factor, and E-I defined the third factor. On the basis of these data, ability, R-I and E-I were defined as independent constructs but FDI was dropped as an independent construct since it loaded significantly on the ability factor. The factors were labeled ability, R-I, and E-I respectively.

The factor analysis of the five total recall scores for each set of material yielded a four-factor varimax solution accounting for 85 percent of the variance. Contrary to Games' prediction, the two sets of material defined independent pairs of factors.³ Games found

³ P. A. Games, "A Factorial Analysis of Verbal Learning Tasks," Journal of Experimental Psychology, No. 63, 1962, pp. 1-11.

that regardless of the procedure or materials used, a factor analysis of performance scores yielded only a span and a rote memory factor. However, manipulation of inter-item associative strength had the effect of re-ordering the subjects, mitigating against the notion that lists of relational words are easier to learn than non-relational words. If the difference in learning in the two different situations had been merely a matter of one being easier than the other, the performance difference between the two situations would have been reflected as an additive constant. The inclusion of an additive constant would not have affected the intercorrelation but simply increased the subjects' scores on the structured material relative to unstructured materials scores.

The finding of a clear separation of the factors on the basis of list type provided a basis for making the predictions concerning the differential relationship between the cognitive styles and the learning of structured and unstructured materials.

The sets of forward, backward, and clustering scores were each factor analyzed. The purpose for including these scores and conducting these analyses was an attempt to illustrate that IDs in total recall can be predicted from IDs in ability to "subjectively organize" the materials as reflected in forward, backward, and clustering measures. Furthermore, these scores were included to show that if the entry behaviors related to recall, this relationship is best understood as the relationship between "subjective organization ability" and entry behaviors.

The data from the various factor analyses are summarized as follows:

1. Ability, R-I and E-I define independent constructs.
2. Manipulation of the inter-item associative strength of common English nouns has the effect of defining different learning tasks as was reflected in the factor analyses of total recall scores, forward chaining, backward chaining, and clustering scores.
3. The students' performance in the early trials of both the structured and unstructured materials defines a factor (span memory) which is separate from the factor which emerges for the later trials (rote memory).

Factor scores were generated for each subject from the various factor analytic solutions previously discussed. These normalized scores served as a basis for testing the hypothesis that: 1) ability and reflection relate positively and extraversion negatively to the learning of structured materials, and, 2) ability and extraversion relate positively and reflection negatively to the learning of unstructured materials. These hypotheses were tested at .05 probability level using the multiple regression analysis procedure.

The results of the multiple regression analyses revealed the following:

1. With one exception, the entry behaviors revealed no significant relationship to any of the indices of learning on the unstructured materials. The one exception was that low ability students achieved greater success than high ability students and male students achieved greater success than female students on the backward chaining rote memory scores ($R=.25$).

2. The entry behaviors of ability and R-I along with sex as a variable did relate to the learning of structured materials. Contrary to the prediction, impulsive students achieved greater success than reflective students on both the structured recall rote memory and structured forward chaining rote memory scores. Girls performed better than boys on the structured recall rote memory and span memory scores. Ability was positively related to both the structured recall span memory and structured forward chaining rote memory scores. E-I did not correlate with any of the learning indices for the structured materials.
3. Structured and unstructured recall rote memory scores correlated with the forward and backward chaining scores for each set of materials. The variables of structured and unstructured forward chaining rote memory, structured and unstructured backward chaining correlated $R=.82$ with structured recall rote memory. The variable of sex also correlated positively with the structured recall rote memory. Girls were found to perform better than boys on the structured recall rote memory scores.

Unstructured recall rote memory scores were found to be positively related to the variables of unstructured forward chaining rote and span memory and unstructured backward chaining rote memory ($R=.65$). No sex difference was observed for learning unstructured materials.

4. Cluster rote memory was found to be positively related to structured recall rote memory, structured forward and backward chaining rote memory scores.

Methodological and Theoretical Implications

The theoretical and methodological implications of this study for future research will be discussed from three points of view: 1) the implications of considering cognitive styles as relevant entry behaviors; 2) the implications of considering reflection/impulsivity (R-I) extraversion/introversion (E-I), and field-dependence/independence (FDI) as predictors of learning of structured and unstructured materials, and 3) the implications of using factor analytic techniques to study individual differences in learning.

Cognitive Styles as Relevant Entry Behaviors

The results of this study, with the exception of R-I revealed that cognitive styles had no relationship to the learning of structured and unstructured materials as they were defined as measured in this study. These findings have at least three feasible implications for future research. First, cognitive styles in the broadest sense of the term may indeed exist but have little relationship to learning; or 2) cognitive styles are related to higher order learning such as learning concepts and principles but have little relationship to more basic learning such as stimulus-response chaining or verbal associations;⁴ or, 3) specific cognitive styles relate to specific kinds of learning.

Each of these possible interpretations could be tested empirically. However, the scope of this study permits only limited speculation as to which of these three states may exist. Because the structured material as defined in this study represent a higher level of learning than the unstructured material, and because a relationship was observed between R-I and structured material, the prediction is that cognitive styles have a relationship to higher levels of learning but do not relate to more basic learning tasks. To test this hypothesis or any other pertaining to the relationship between cognitive styles and learning, an inclusive list of styles measuring independent constructs is needed.

⁴ Robert M. Gagné, The Conditions of Learning, (New York: Holt, Rinehart, and Winston, Inc., 1965) pp. 1-61.

R-I, E-I, FDI, and Learning Structured and Unstructured Materials

The research hypothesis was that each of these constructs existed independent of one another and each was differentially related to structured and unstructured materials learning. A relationship was found in only one dimension, R-I, but the direction was contrary to the prediction and this low correlation may have been a chance occurrence.

The theoretical and methodological implications of these findings specific to each construct need clarification.

Field-Dependence/Independence (FDI) The relationship between FDI and structured and unstructured material learning was not tested and should not be tested unless FDI can be established as a construct separate from measured scholastic ability. It makes little sense to test the relationship between FDI and any other dimension if FDI actually exists only as a subset of measured scholastic ability as was revealed in these data. However, before the relationship between FDI and learning is abandoned, FDI should be measured by the Witkin's Embedded Figures Test rather than the highly speeded Hidden Figures Test. The original test was not available at the inception of this study and a second, supposedly equivalent, measure was substituted.

If FDI were to be included in future studies along with ability, a careful examination of the correlation between FDI and measured ability is in order. The criteria that FDI exist relatively independent of other measures should be maintained.

Extraversion/Introversion (E-I) The E-I dimension as measured was found to exist independent of the other stylistic variables and its relationship to structured and unstructured materials learning was tested. E-I did not relate to the learning indices. The measure of E-I reliably assessed the students on this dimension. The failure to find relationships between learning and E-I can not readily be attributed to instrumentation. More plausible explanations seem to be that either Eysenck's hypothesis is not sound, or the learning of the unstructured materials failed to create the inhibiting conditions necessary to test the hypothesis. Further research should include some separate provision for establishing whether the rate of build-up and dissipation of reactive inhibition is being effectively manipulated. Without such provisions Eysenck's hypothesis can not be tested and therefore supported or rejected.

Reflection/Impulsivity (R-I) The learning of structured materials was found to be negatively related to R-I. A review of the literature revealed that impulsive students do not perform as effectively as reflective students on analytic learning tasks. Previous research has also revealed that impulsive subjects make more errors of commission on learning and reading tasks. A plausible explanation for the findings contradictory to other research is that either the correlation was a chance occurrence or the absolute quantity of performance of impulsive students is greater than that of reflective students on all learning tasks. The larger quantity includes more incorrect as well as correct responses. The design of this study did not include a provision for adjusting the number of correct relative to the number of incorrect responses. Future research relating R-I to various learning tasks should include provision for checking the relationship

between total performance and total correct performance indices. Such studies may reveal that reflective subjects are actually more efficient learners than impulsive subjects, and reflective subjects demonstrate a higher quality of performance than impulsive subjects.

These data revealed that R-I does relate moderately to learning performance. This stylistic variable should be included in future studies attempting to understand individual differences in learning.

Factor Analysis as a Methodology for
Studying Individual Differences (IDs)
in Learning

Individual differences (IDs) can be studied from the point of view of their effects 1) on learning, or 2) in learning.⁵ Traditionally the strategy has been to study the effects of IDs on learning. The researchers using this strategy have only had limited success because IDs in learning, the criterion variable, are multidimensional and the number and nature of the various dimensions is unknown. Jensen suggests that the identification of the various IDs in learning is a necessary prerequisite to studying the effects of IDs on learning.

The purpose of this study was to manipulate one attribute of the materials to be learned, inter-item associative strength, and empirically determine whether such manipulation resulted in learning measures which reflect two or more IDs in learning. The second purpose of this study was to examine whether observed IDs in learning could be predicted from ID variables extrinsic to the learning materials.

⁵ Arthur Jensen, "Varieties of Individual Differences in Learning," R. M. Gagne, ed., (Ohio: Charles E. Merrill Books, Inc., 1967) pp. 117-136.

The research strategy employed in this study was consistent with Jensen's suggestion. The use of factor analysis as the technique for empirically examining the IDs in learning structured and unstructured materials was effective

Future researchers should not attempt to correlate extrinsic individual difference variables (i.e., anxiety, motivation) with learning unless they have a clear understanding of the intrinsic IDs which are reflected in performance on their learning tasks.

One model for attacking the problem of IDs in learning is to plan a study which includes learning tasks at all levels of Gagne's hierarchy.⁶ A factor analysis of the performance measures on such a broad range of tasks would reveal whether IDs in learning transcend various levels of learning or are idiosyncratic to each of the learning levels.

Within this study methodology and materials were used which attempted to merge correlational and experimental psychology. The results were encouraging. Future research using this methodology will contribute substantially to educators in their quest to serve all students.

⁶Gagne, op. cit.

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APPENDICES

APPENDIX I

STRUCTURED WORD LIST

	Mean Inter-item Associative Strength		Mean Inter-item Associative Strength
Bullet		Bike	
Fire		Car	
Guns		Motor	
Pistol		Truck	
Weapon	20.50	Wheel	12.25
Earth		Amount	
Land		Figure	
Sun		Money	
Moon		Number	
Universe	15.15	Words	10.50
Bowl		Bed	
Fruit		Blanket	
Juice		Mattress	
Salad		Night	
Vegetable	14.50	Pillow	9.25

UNSTRUCTURED WORD LIST

Butterfly	Needle
Carpet	Ocean
Cheese	Priest
Children	Scissors
City	Shoes
Doctor	Soldiers
Doors	Stem
Eagle	Stomach
Fingers	Stove
Hammer	Street
Kittens	Table
Lion	Thief
Memory	Tobacco
Music	Whiskey
Mutton	Whistle

APPENDIX II

TABLE IIa. Complete Intercorrelation Matrix for all Derived Factor Score Variables Included in the Study*

	No.	
Sex	1	100
Ability	2	-09 100
Reflection/Impulsivity	3	02 04 100
Extraversion/Introversion	4	06 -07 02 100
Unstructured Recall Rote Memory	5	16 14 04 -06 100
Structured Recall Rote Memory	6	19 01 -22 08 05 100
Structured Recall Span Memory	7	27 -00 01 14 12 03 100
Unstructured Recall Span Memory	8	10 06 07 14 06 00 02 100
Cluster Recall Rote Memory	9	05 03 -07 03 27 76 -05 03 100
Cluster Recall Span Memory	10	-28 -19 02 -16 -26 -10 -67 -12 -02 100
Structured Forward Chaining Rote Memory	11	08 14 -30 09 03 69 24 -02 58 -29 100
Unstructured Forward Chaining Span Memory	12	14 -06 14 03 43 -01 18 13 13 -19 -01 100
Unstructured Forward Chaining Rote Memory	13	-04 09 00 01 42 33 08 00 48 -12 15 14 100
Structured Backward Chaining Rote Memory	14	06 09 -04 06 15 61 22 11 59 -23 36 10 22 100
Unstructured Backward Chaining Rote Memory	15	-21 -13 06 -08 -46 -14 -10 -01 -19 09 -09 -26 -26 -12 100
Trial Three Backward Chaining	16	10 01 02 -03 19 -16 -01 12 -21 -04 -17 90 -03 -02 -06
		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

* Decimal points were omitted

APPENDIX II

Table IIb. Intercorrelation Matrix for
Scholastic Ability and Cognitive Style
Variables (N=100)*

	No.						
PSAT Verbal	1	100					
PSAT Quantitative	2	55	100				
Reflection Time	3	12	17	100			
Reflection Errors	4	-14	-17	-48	100		
Extraversion/Introversion	5	05	-05	-00	-02	100	
Hidden Figures	6	20	28	-07	-04	-07	100
		1	2	3	4	5	6

*Decimal points were omitted

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