5-1-1978

Field Independence and Cognitive Flexibility in Creative Test Performance

Joel Patrick Newman

FIELD INDEPENDENCE AND COGNITIVE FLEXIBILITY IN CREATIVE TEST PERFORMANCE

by
Joel Patrick Newman

Bachelor of Arts with Distinction, Purdue University, 1975

A Thesis

Submitted to the Graduate Faculty

of the

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Arts

Grand Forks, North Dakota

May
1978

This thesis submitted by Joel Patrick Newman in partial fulfillment of the requirements for the Degree of Master of Arts from the University of North Dakota is hereby approved by the Faculty Advisory Committee under which the work has been done.

James A. Clark
(Chairman)

James R Anter

Clifford M Tucker

A William Johnson
Dean of the Graduate School

Permission

Title Field Independence and Cognitive Flexibility in Creative Test Performance

Department Psychology

Degree Master of Arts

In presenting this thesis in partial fulfillment of the requirements for a graduate degree from the University of North Dakota, I agree that the Library of this University shall make it freely available for inspection. I further agree that permission for extensive copying for scholarly purposes may be granted by the professor who supervised my thesis work or, in his absence, by the Chairman of the Department or the Dean of the Graduate School. It is understood that any copying or publication for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of North Dakota in any scholarly use which may be made of any material in my thesis.

Signature Janet P. Newman

Date April 10, 1978

ACKNOWLEDGEMENTS

The patience, support and effort of a number of individuals in the preparation of this thesis deserve recognition. Dr. James A. Clark's influence on my graduate education and training has extended far beyond his role as my committee chairman: he has had a thoroughly positive hand in every aspect of my training as a scientist and clinician, and for that I am truly grateful. Dr. James R. Antes and Dr. Don M. Tucker ably served as committee members and in so doing helped keep me from going too far afield when, on occasion, my inexperience began to show.

Elizabeth Deitz, James Grimm, Roxann Phalen, and James Volk generously gave of their time in the collection of the data.

Finally, for the parents who eyes always shone when I achieved and who unfailingly gave of their love and resources, the more so when that was hard to do, there aren't enough thank-yous.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Much research in recent years has been devoted to the identification and measurement of creative abilities. It was postulated that Werner's orthogenetic principle, in which development is conceptualized as proceeding from a state of relative lack of differentiation of functions to a state of increasing differentiation, articulation, and hierarchic integration of functions, might be applied to cognitive development in order to provide a useful model for investigating such abilities. A parallel interest of the investigator was the use of the Stroop Color-Word Test as a measure of hierarchic integration of cognitive functions (here called cognitive flexibility).

Three hundred and fifty-nine subjects were screened in order to identify three groups of individuals: those both highly differentiated (as inferred from level of perceptual field-independence) and highly flexible (HFI-HCF), who were hypothesized to be the most creative; those highly differentiated but exhibiting low flexibility (HFI-LCF), who were hypothesized to exhibit moderate levels of creativity; those exhibiting low differentiation and low flexibility (LFI-LCF), who were hypothesized to be the least creative. However, when these identified subjects were administered the Torrance Tests of Creative Thinking and the Otis-Gamma intelligence test (to assess the contribution of intelligence

to creativity) this hypothesis was not borne out. In fact, the HFI-LCF subjects performed most creatively, followed by the HFI-HCF and then the LFI-LCF subjects, although none of the five creativity score differences were found to be statistically significant. These results were discussed in terms of possible methodological and conceptual shortcomings and suggestions for future research were advanced.

CHAPTER I

INTRODUCTION

It is a matter of general agreement that individuals vary on a host of dimensions, particular combinations and degrees of those dimensions serving to characterize particular individuals. One variable which has been the subject of vast amounts of research is creativity. This is readily understandable in light of the fact that all innovation and advance is rooted in the desire of some, if not all, human beings to, in some sense, be creative. Much research has focused on attempting to identify what are the core characteristics, the "bottom lines" of the creative process, for it may be possible to separate creativity from its context. Thus we might ask, for example, when a mathematician derives an entirely new algorithm, a poet writes a poem that earns considerable praise from his colleagues and a teenager solves a vexing mechanical problem in an automobile, are there fundamental characteristics that are operable in each of these accomplishments? Might we be able to reduce these fundamental characteristics down to one or two or three which are characteristic of all creative productions?

The first task that arises is to define creativity. It is perhaps advisable to operationalize it at this point by the rhetorical device of saying creativity is what a creativity test measures. More adequate consideration of this question can be

deferred until a sufficient background has been established.

The second task that arises is to develop the means to measure or assess creativity. Schuler (1976) has noted the stages through which this undertaking has progressed. Personal accounts or self-reports were used at an early stage to study creative individuals. Among the more prominent practitioners of this method was Sir Francis Galton (Barron, 1969) who, among other things, surveyed individuals concerning the vividness of their mental imagery. This method gave way to observational studies in which individuals attempted to discern what behaviors characterized creative individuals by observing such individuals engaging in creative undertakings (Torrance, 1962). Finally, there began controlled scientific studies involving experimental manipulation, use of sophisticated statistical techniques, control of extraneous variables and systematic theorization (Guilford, 1959; Torrance, 1962; Wallach and Kogan, 1965 a, b).

Though many standardized measures of creativity (e.g. Torrance, 1974) have been the subject of much research and have been well normed, most suffer from several serious flaws. The first of these is a lack of genuine objectivity. It is often the case that the subject must perform tasks which the scorer must attempt to classify according to apparent degree of creativity in the response. In spite of firm guidelines as to how to score a response, so long as the scorer must make judgements from time to time concerning the quality of the response, the instrument cannot be said to be wholly objective. It is thus not surprising that such instruments usually

exhibit less than overwhelming test-retest and inter-rater reliabilities. For example, one subscore (figural fluency) of the Torrance Tests of Creative Thinking (Torrance, 1974) has shown a test-retest reliability of .50. Even so, most existing measures require considerable training and practice for scorers to achieve the claimed levels of reliability.

Another flaw is the laborious effort required to administer and score some existing measures of creativity. Ideally, such an instrument should be amenable to group administration and rapid scoring. This would greatly reduce the amount of effort necessary to conduct adequate research on this topic and thereby free trained individuals for more pressing pursuits.

Another difficulty with existing measures is their task-specificity. For example, if an instrument required an individual to produce novel block designs, would it be able to assess creativity in an individual with considerable verbal skills?

Davis and Belcher (1971) point out additional problems with existing measures of creativity: performance on them may be in part a function of past experience with particular types of items or past achievement; they may be in part a function of the subject's intelligence; they may bear no relationship to other measures of creativity or what is recognized as creative behavior; they may be dependent upon the subject's truthfulness or willingness to expend adequate effort in taking the test.

In summary, then, an ideal measure of creativity should be objective, highly reliable (both test-retest and inter-rater), easily

administered (preferably in groups), easily scored, able to assess as broad a spectrum of creative abilities as possible, not dependent upon intelligence or past experience, and bear some relationship to other measures of creativity.

One current theory concerning the nature of the creative process owes much to Werner. Over the course of several publications spanning many years (Werner, 1948; 1957; Werner and Kaplan, 1956), he postulated a process of cognitive development in which individuals are thought to progress from a primitive level in which such functions as feeling, perceiving, thinking, learning and language behaviors, at first global, diffuse and lacking in articulation between different areas, become increasingly differentiated from one another. Thus what was once an amorphous whole lacking in structure is broken up into discrete, well-articulated parts, a process he called differentiation. As an example, what we call feeling may have once been experienced as the undifferentiated subjective correlates of sympathetic nervous system arousal. The individual may then move toward differentiation of several subjective feelings; for example, one feeling may be labelled joy, another anticipation, and another rapture. Though the physiological responses in each might be identical, the accompanying cognitions are different.

Werner proposed the further notion that as differentiation proceeds, the various levels of functioning are hierarchically integrated such that "operations characteristic of lower levels of functioning are subordinated to operations characteristic of higher levels. Primitive operations are capable of being inhibited yet

used in the service of operations indigenous to developmentally increased maturity" (Bloomberg, 1967). As the degree of differentiation increased, he believed, the extent of hierarchic integration increased, the one preceeding the other. It is thus characteristic of the highly differentiated person, according to this reasoning, that, in employing available functions, one can move across the developmental levels that have become differentiated. Therefore a perfectly mature adult might, for example, wish to react to the tender attentions of a spouse by permitting the feelings thereby produced to be experienced in much the same way that a hungry infant responds to being fed and cuddled, rather than the more stoical response of feeling warm and tender inside while maintaining a perfectly blank facial expression.

There have been several outgrowths of Werner's theory. One is the work of Witkin and his colleagues (Witkin, et al., 1962) with the field independence-dependence dimension. They operationalize 'field-independence' (FI) as the ability to "deal with part of an organized field independently of the field", as, for example, in breaking up an organized visual field and keeping a part of it separate from the field (Witkin, et al., 1971). Witkin, et al. believe that the hallmark of the field-independent person is a high degree of differentiation, manifested as a greater capacity for selective attention than that of the field-dependent person, or, to use a term that this author feels is more descriptive, the field-constrained person.

Several perceptual tasks have been devised to measure the degree to which individuals are field-independent. The three most widely used are the Embedded Figures Tests, the Rod and Frame Test and the Body Adjustment Test. The first requires the subject to discern simple geometric figures within fields of complex designs. The second requires the subject to adjust a luminous rod to a vertical position in a darkened room under varying degrees of tilt of a luminous surrounding frame. The third requires the subject to adjust his/her body to a vertical position when seated in a tilted chair in a tilted room.

A vast amount of research has been conducted concerning the functioning of field-independent and field-dependent individuals, as well as their background experiences and adjustment. Spotts and Mackler (1967) summarize and integrate this research as follows:

> Field-dependent or "global-field" perceptual performers are described as individuals who lack a well-developed sense of their own identity and separateness from others. During their development these individuals have failed to internalize a stable set of standards with which they can interpret and react to the world. Lacking stable internal frames of reference, field-dependents have great difficulty maintaining their own "direction" in the face of contradictory expressions from other people. Consequently, they look to others for support and reassurance and are highly vulnerable to external influence, particularly from authoritative figures. Global-field persons are postulated as being unable to organize and impose structure upon ambiguous stimuli. When thrown upon their own resources or faced with new and/or unusual situations, they tend to become "disrupted" and respond with ineffectual behavior. These individuals show a low awareness of their own "inner life" and are fearful of their own aggressive and sexual impulses. They characteristically utilize "primitive" modes of defense such as denial and repression. Consequently, they tend to be somewhat

> anxious and "impulsive" and frequently become confused and disorganized under stress. They lack "cognitive clarity" and tend to experience themselves and the world in a vague, blurred, and unorganized fashion.
>
> While diffuse and poorly integrated functioning seems to characterize the adjustment of the field-dependent individual, the field-independent person falls at the other extreme on these personality dimensions. That is, field-independent or "analytic-field" perceptual performers are described as having a highly developed sense of their own self-identity. They tend to be regarded by others as socially more independent than their field-dependent counterparts and evidence a ready capacity to function with little environmental support. Field-independents effectively organize and structure vague or ambiguous stimuli and are likely to adopt a relatively intellectual and impersonal approach to problems. They are not markedly influenced by authorities but tend rather to be guided by their own standards, values, and needs even to the point of being isolated from other people. These individuals evidence a relatively high awareness of their own motives and feelings and are accepting of their own aggressive and sexual impulses. In their adjustment, field-independents tend to use relatively specialized and complex defenses such as isolation and intellectualization. Consequently, they may be somewhat detached and obsessive and are sometimes described as "overcontrolled". They show greater cognitive clarity than global-field individuals and tend to experience themselves and the world in a discrete, organized and articulate fashion.

Another outgrowth of Werner's theory is the concept of adaptive cognitive regression or flexibility postulated by Pine and Holt (1960) and Wild (1965). They hold that some individuals are, to varying degrees, capable of utilizing cognitive operations characteristic of a primitive level of development (akin to what is sometimes referred to as primary process thinking) in a controlled and adaptive manner without sacrificing the accessibility of higher mental processes (akin to so-called secondary

process thinking). This notion is in large part a restatement of Werner's concept of hierarchic integration: as individuals mature, they develop more mature (that is, well-articulated and symbolic) cognitive functions in contrast to the previous more primitive (that is, global, diffuse and concrete) ones. The dimension on which people vary is the ability to regress when appropriate through a hierarchy of cognitive functions to those that are characteristic of a primitive level of development, in contrast to the normal state of hierarchic integration, in which "operations characteristic of lower levels of functioning are subordinated to operations characteristic of higher levels" (Bloomberg, 1967). (A folk adage yields the tidbit that insight and wisdom often proceed "out of the mouths of babes and fools": perhaps it is <u>because</u> they are babes, and can view things as babes, that they experience the insights that others don't).

The nature of the relationships of field-independence and cognitive flexibility (CF) (and, by implication, hierarchic integration) to creativity has been speculated upon by Bloomberg (1967). He hypothesizes that a field-independent orientation should in general serve to facilitate creative productions, for the inability to rise above embedding contexts and perceive units of a field (whether that field be a perceptual field, a mass of competing cognitions, or any other field) as discrete would certainly on the face hamper the emergence of novel productions. However, a field-independent orientation would seem to not be a sufficient condition for the emergence of such productions. As Crutchfield (1961) has

pointed out, "....analytical perception is sometimes the enemy of creative insight. What may be needed is a free, spontaneous look at the phenomenon, a childlike apprehension of what is there, an attitude of what may be called disciplined naivete." Bloomberg (1971) adds:

> While creativity involves the task of dissecting bits of data and making a conscious, determined effort to unravel their meaning, it also involves the task of relaxing and letting the whole problem proceed in the direction it wants to. There comes a time when the problem assumes a momentum of its own and all the creative person needs to do is follow the path along which the problem takes him. Suppose that the individual engages in selective attention very early in the creative process. He focuses on the relevant items of the problem and discards the irrelevant ones prematurely. Considerable damage may be done by this maneuver as elements are tossed irretrievably offstage that later become essential for a creative solution. If, instead, global perception had prevailed for a while longer, it might have had a salutary effect on the subsequent sorting-out process, and elements might have been classified more judiciously. The creative person must involve himself with the details of the problem for clarifying, classifying, and defining, but still obtain detached views of the entire problem from time to time for capturing attributes of the whole phenomenon that cannot be dissected and bringing back into focus elements previously sacrificed. The blending together of these two levels of functioning---involvement and detachment---is an uncommon event because the merger depends upon a developmental stage not attained by everyone---i.e. hierarchic integration.

What this line of reasoning suggests is that, at its core, creative performance consists of both a relatively field-independent orientation and a high degree of hierarchic integration of cognitive tasks by developmental levels such that the individual is capable of cognitive flexibility when appropriate. In order to test this

hypothesis, it is necessary to be able to adequately measure both attributes. Witkin, et. al.'s (1971) Group Embedded Figures Test (GEFT) is a highly reliable, seemingly quite valid measure of field-independence (FI). Comalli, Wapner, and Werner (1962) have proposed the use of the Stroop Color-Word Test (SCWT) as a measure of cognitive flexibility (CF) (and, by inference, hierarchic integration). This instrument requires the subject to respond to three cards. The first (W) consists of three names of colors (red, green and blue) printed in black ink in five columns of 20 each and arranged in a random fashion with the stipulation that no color name appears in succession to itself, on which the subject reads the color names as rapidly as possible. The second card (C) consists of five columns of three X's, 20 per column, in which the subject is asked to name as quickly as possible the color in which the X's are printed, their being printed in either red, green or blue, with the stipulation that no ink color succeeds itself. The third card (CW) consists of the color names of card W printed in the ink colors of the correspondingly positioned item on card C, with the stipulation that the ink color and the color name are never identical, in which the subject must name the ink color in which the color name is printed. Performance on card CW is presumed to measure, on its face, the effect of competing responses (word naming) on the ability to perform the task of color-naming. Since color-naming is a developmental predecessor of word reading, the Stroop Color-Word Test is a face-valid measure of extent of cognitive flexibility, in this case the ability to subordinate

the higher-level ability to read words to the lower-level ability to name colors. (This notion will be considered in greater detail in Chapter II).

Statement of the Problem

Although there exist a number of measures of creativity, many problems exist with them. These problems center primarily around the mechanics of their administration and scoring, and the extent to which they contribute to our understanding of just what characteristics and skills lie at the heart of creative productivity. The investigator proposes to explore the relationships of the variables of field-independence and cognitive flexibility to creative test performance with an eye toward developing a more valid, reliable and basic measure of creativity. It is hypothesized that the Group Embedded Figures Test and the Stroop Color-Word Test, in combination, may yield such a measure.

CHAPTER II

REVIEW OF THE LITERATURE

It shall be the purpose of this chapter to review in detail the existing literature relevant to the variables under consideration in this study. Specifically, the independent variables of field independence and cognitive flexibility (and, by implication, hierarchic integration) shall be considered, in order to explicate their hypothesized relationship to creativity (or creative test performance). This shall be followed by a treatment of the concept of creativity in general. Then the literature concerning the Stroop Color-Word Test shall be reviewed, since it is an experimental instrument, the utility of which is not widely recognized. This literature shall then be summarized and the formal hypotheses presented.

Field Independence

Werner (1957) proposed what he called the orthogenetic principle of development: "...wherever development occurs, it proceeds from a state of relative globality and lack of differentiation to a state of increasing differentiation, articulation, and hierarchic integration". He believed that in spite of a multiformity of specific developmental changes that might occur, the course of development was governed by this general

regulative principle.

An example of this development of increasingly differentiated states may be found in the perception of visual stimuli. Witkin, et al. (1962) state that as this proceeds, "the self is experienced as having definite limits or boundaries. Segregation of the self helps make possible greater determination of functioning from within, as opposed to a more or less enforced reliance on external nurturance and support for maintenance, typical of the relatively undifferentiated state". Thereafter, "the person who experiences in articulated fashion has the ability to perceive items as discrete from their backgrounds, or to reorganize a field, when the field is organized, and to impose structure on a field, and so perceive it as organized, when the field has relatively little inherent structure. In this view the ability to analyze experience and the ability to structure experience are both aspects of increasing articulation". Their research lead them to conclude that "...a field dependent or field-independent way of perceiving is one of a large constellation of interrelated characteristics, which together reflect an individual's level of differentiation" and is a mode that is readily amendable to experimental investigation using the Embedded Figures Tests, which they "have used to define the field-dependence dimension, which in turn, (serves) as a 'tracer element' in identifying level of psychological differentiation more generally".

A logical extension of this notion is whether individual differences in the area of perception might have their counterpart

in intellectual functioning. "Intellectual problems that call for a high degree of creative activity, but do not involve perception directly, often also require that 'parts' be separated from the context in which they are embedded and brought into new relationships. It is likely that if a person has this basic ability to 'break up' a configuration, it will be manifested not only in straightforward perceptual situations but in problem-solving situations as well." (Witkin, et al. 1954).

Two major methods have been employed in attempting to determine the relationship between perceptual field-independence (and, by implication, psychological differentiation in general) and creativity. The first of these methods is to determine personality traits that field independent and creative persons share. Bloomberg (1967) has summarized this research, pointing to six such personality traits. These are summarized in Table 1.

TABLE 1

STUDIES FINDING SIMILAR TRAITS IN FIELD-INDEPENDENT AND CREATIVE PERSONS

Trait	Field-Independent Subjects	Creative Subjects
Low Conformity	Linton (1955)	Barron (1963)
Risk-taking	Kogan & Wallach (1964)	Mackworth (1965) Taylor & Holland (1964)
Relative lack of repression	Witkin (1965)	Myden (1959)

TABLE 1 -- (Continued)

Trait	Field-Independent Subjects	Creative Subjects
High level of incidental learning	Witkin, et al. (1962)	Mendelsohn & Griswold (1964)
Permissive parents	Dyk & Witkin (1965)	Getzels & Jackson (1962)
Low identification with mother among males	Vaught (1965)	Garwood (1964)

In addition, Witkin et al. (1962) cite research suggesting that Thurstone's concept of "flexibility of closure" in the perception of visual stimuli, identified in his factor-analytic study of perception (Thurstone, 1944) and employed also by Podell and Phillips (1959) to describe a cluster emerging in their factor-analytic study, is synonymous with their concept of field-independence. Adcock and Martin (1971) found a high correlation between flexibility of closure and high creativity-test scores.

The characterization that emerges is that of the field-independent and the creative person as both being highly individualistic, relatively unconstrained by external influences, open to new experiences and modes of perception, and more attentive to the totality of their environments and themselves.

The second method used to attempt to determine the relationship between perceptual field-independence and creativity is to directly

correlate scores obtained on instruments presumed to measure both traits. On this score, the track record to date is decidedly mixed. The following studies are suggestive of the existing state of confusion:

Spotts and Mackler (1967) divided 45 subjects into 3 groups of equal size and labelled them field-independent, field-central, and field-dependent; subjects were matched for I.Q. as measured by the Gamma Form of the Otis Quick-Scoring Mental Abilities Test (Otis, 1954). The criterion measures of level of psychological differentiation were the Jackson Short Form of the Witkin Embedded Figures Test (Jackson, 1956), and the Hidden Figures Test (Jackson, et al. 1962). All subjects were then administered 4 tests of creative thinking abilities, 2 verbal ("Ask and Guess", "Tin Cans": Torrance, 1962) and 2 non-verbal ("Circles": Torrance, 1962; "Decorations": Guilford and Merrifield, 1960). These 4 tests yielded a total of 14 subscores. The 14 mean scores for each of the 3 groups were then ranked and Kendall's coefficient of concordance (W) was computed. The field-independent group performed most creatively, followed by the field-dependent and field-central groups, (W=.40, S=156.5, p=.01). They offer no explanation why the field-central group performed least creatively. However, when the same experimental design was employed with 114 subjects (from whom the 45 subjects for the previous study were drawn), unmatched for Otis IQ, the most creative group was the field-independent, followed by the field-central and field-dependent groups (W=.75, S=294, p=.01).

Gensemer (1967) administered the Hidden Figures Test (HFT), a "Field Dependency Index" (consisting of the Picture Completion and Block Design subtests of the Wechsler Adult Intelligence Scale), and the Minnesota Tests of Creativity (forerunners of the Torrance Tests of Creative Thinking) to 66 college seniors majoring in education. While he found no significant main effect, the trend of his data led him to conclude that "a field-independent mode of perception does provide more favorable conditions for creative thinking."

McWhinnie (1967) administered the Embedded Figures Test (EFT) and the figural (non-verbal) tasks of the Torrance Tests of Creative Thinking (TTCT) to 136 6th grade public school students in Newhall, California. He found a significant correlation between EFT and TTCT figural originality scores ($r=.23$, $p < .02$), as well as between EFT and figural elaboration scores ($r=.22$, $p < .02$). No significant correlations were found for EFT and figural fluency or flexibility scores. However, even the significant correlations that were observed were of a relatively low magnitude.

Stevens (1969) employed as subjects 134 7th grade students in Georgia public schools and administered the short form of the EFT and the Torrance tests. Three correlations were significant at or below the .05 level: field-dependence and verbal flexibility: -.31; field-dependence and verbal originality: -.30; field-dependence and figural elaboration: -.31. He concluded, incorrectly, that this provided "limited evidence for a direct relationship" between field-independence and creative test performance, the directness of the relationship being, of course, the major point open to dispute.

Baker (1970) administered the EFT short form to 85 Washington University graduate students from 5 departments and correlated those scores with the results of "Creativity Rating Forms" completed by the students' major professors. Although no significant relationship was found for the overall sample, one was found for engineering students and a trend toward one was found for business administration students. (Magnitudes were unspecified).

Ohnmacht and McMorris (1971), in exploring the relationships of field-independence and dogmatism to creative performance, administered the Hidden Figures Test and Remote Associates Test (Mednick 1967) to 74 subjects; they observed significant main effects for neither independent variable. However, the interaction approached significance ($F=2.86$, $df=1,36$, $p<.1$). Their conclusion was that neither variable was useful singly in explaining variation on a task presumed to reflect creative potential but that in combination predictive power was enhanced somewhat.

Bloomberg (1971) administered that Rod and Frame Test (RFT) to 60 male undergraduates at the University of Michigan to assess degree of field-independence, as well as 3 measures of creative ability: the Revised Art Scale, part of the Welsh Figure Preference Test (Welsh, 1959), the Similes Preference Inventory (Pearson and Maddi, 1966), and the Creative Personality Scale (Fricke, 1963). Intercorrelations among the three creativity measures ranged from .11 to .22; the raw scores were converted to standard (Z) scores and were added for each subject, on the assumption that, since each test had previously been shown to distinguish creative from non-creative subjects, the measures, tapping relatively unrelated components of creative thinking,

would continue to do so when added together. A median split on the basis of composite creativity scores was performed, to distinguish creatives from non-creatives. A median split was then performed on the non-creative group on the basis of RFT scores, on the dubious assumption that non-creatives are as likely to be field-independent as field-dependent. If this were true, Bloomberg reasoned, and all creatives were field-independent, then all creatives should have an RFT below the median score of the non-creative group (that is, be more field-independent). Thus, the non-creatives median RFT score was used to define field-independence vs. dependence in the creative group. However, he observed no significant difference between the number of field-independent and field-dependent subjects in the creative subgroup, and concluded on this basis that creativity is not contingent upon field-independence. It would seem, however, that Bloomberg's logic in operationalizing field-independence and creativity is so strained that his study must be regarded as being fraught with deficiencies and of little utility.

Cognitive Flexibility

The concept of cognitive flexibility, by whatever name, has a long history in psychological literature. Its origins may be traced back at least as far as Freud (1911), who drew a distinction between what he called primary and secondary process, the former being thought of as primitive, non-logical, diffuse in nature, with no differentiation between self and external world, and governed by the attainment of pleasure, and the latter being structured, logical thought,

with a high level of differentiation between self and reality, and governed by an attempt to achieve a concordance between the desires of the organism and the demands of reality. Freud noted that individuals never really renounce primary process functioning; they merely attempt to reconcile it with reality. It is of interest that he particularly saw evidence of this oscillation in artists, in whom he believed it to be an integral part of their propensity toward creative output.

Kris (1952), in exploring the cognitive functioning of artists, spoke of the ability of the ego to exert control over the process of regression and particularly its capacity of control over the primary process. This "shift of psychic levels", he felt, lied at the heart of creative productivity. The distinction between creativity and psychosis was this: in the former, "the ego controls the primary process and puts it into its service"; in the latter, "the ego is overwhelmed by the primary process". Thus arises the concept of "regression in the service of the ego".

Rapaport (1951) refers to Werner's (1948) concept of "physiognomic" perception, in which the quality of an object is experienced prior to any details, that is, a state in which imaging and perceiving are not definitely separated, and calls this a "mobile cathexis of ideational representation", which he believes underlies the primary process. He speaks of:

> "the 'inventive' phase of creative thinking, which abides by the rules of the primary process. The idea...arising in consciousness may take various forms--a vague, general 'feel', a sense of relationship, a schematic pattern, a verbal or visual fragment, and so on. In any case, it is characterized by a paucity of relationships, and turns the

> iodosyncratic 'inventive' product of the individual into the social communication of art or science..... The elaborative phase, in contrast to the inventive, is effortful and operates by the rules of the secondary process."

Werner (1957) elaborates upon the relationship of a flexible mode of functioning to creative productivity: ". . . an organism, having attained highly stabilized structures and operations, may or may not progress further, but if it does, this will be accomplished through partial return to a genetically earlier, less stable level . . . . One has to regress in order to progress." This he calls "the flexibility of a person to operate at different levels depending on the requirements of the situation." He adds:

> This aspect of flexibility is connected with a . . . problem of individuality, namely that of creativity. Now creativity, in its most general meaning, is an essential feature of emergent evolution, and this, in turn, implies progression through reorganization. Since we assume that such progress through reorganization cannot be achieved without "starting anew", that is, without regression, it follows that a person's capacity for creativity presupposes mobility in terms of regression and progression. The hypothesis would be then that the more creative the person, the wider his range of operations in terms of developmental levels, or in other words, the greater his capacity to utilize primitive as well as advanced operations.

Myden (1956) was one of the first individuals to attempt an experimental investigation of these hypotheses. Twenty "recognized creatively productive individuals" in the fields of painting, writing, and choreography were contrasted with twenty "eminently successful industrialists and professional individuals" on the basis

of Thematic Apperception Test, Rorschach, Bender-Gestalt, Vigotsky Concept Formation Test and Human Figures Drawings Test performance; subjects were equated for age, sex, and socioeconomic status. The creative subjects were reported to display "significantly greater amounts of primary thought process" in their performance and to not manifest anxiety in connection with this, presumably demonstrating their ability to control the use of the primary process. Myden concludes that "the key characteristics (of the creative subjects) appear to consist of a personality constellation in which primary thought process is not repressed but is integrated with secondary or intellectualized thought processes".

Pine and Holt (1960) employed the Rorschach Test as a measure of amount of expression of and degree of control over the primary process (using a scoring system described by Holt, 1959 and Holt and Havel, 1960), as well as seven instruments designed to assess creative ability. They found almost complete statistical independence between the amount of primary process expression and the ability to control such expression (Spearman's rho = .01 for males, N = 13: non-significant; rho = .25 for females, N = 14: non-significant). As expected, they found, however, significant correlations between the ability to control primary process expression and the quality of creative productions (rho = .80 for males, $p < .01$; rho = .52 for females, $p < .05$), lending support to their hypothesis that the degree of flexibility of a person to operate at different developmental levels, according to the requirements of the situation, and the extent of a person's creative

ability are related traits.

Hersch (1962) hypothesized that not only would creative subjects show a more ready availability of both developmentally mature and primitive responses to Rorschach stimuli than non-creators, but that there would be reliable differences between the responses of creative and schizophrenic subjects as well, in response to the oft-levelled criticism of operationalizing creativity strictly in terms of frequency of novel productions. Sixty subjects, all male adults equated for age, intellectual ability and Rorschach response productivity, were employed; 20 were individuals who had "achieved prominence as a creator in one of the major cultural domains," 20 were non-pathological individuals who were in no way distinguished for their creative abilities and 20 were hospitalized schizophrenics. Rorschach responses were scored by means of the Genetic Scoring System (Phillips, Kaden, and Waldman, 1959), in which responses are scored as relatively mature or primitive on the basis of the formal properties of differentiation, articulation, and integration vs. diffuseness and syncretism, as outlined by Werner (1948, 1957). Six response categories were used: movement, integrative, form dominant, form subordinate, physiognomic, and primitive thought responses, the first three being considered mature, the latter three being considered primitive. The artists gave significantly more responses than the normals in two of the three mature response categories (M, FD) and two of the three primitive categories (P, PT). They gave significantly more mature responses than the schizophrenic subjects in all three categories; of the three primitive

response categories, only the physiognomic category significantly discriminated between the two groups. Hersch notes that physiognomic Rorschach responses are, in fact, quite rare among schizophrenics (and children as well) and speculates that this points to a fundamental difference between the primitive functioning of schizophrenics and creators: in schizophrenics, the subject-object fusion of physiognomic perception is given the status of objective reality and is acted upon; creators, on the other hand, after perceiving physiognomically, are "able to reflect upon the experience, objectify it, and distinguish between what is within himself and what is valid for the external stimulus. Such a second step implies self-environment differentiation", as Werner's theory suggests should be the case.

Wild (1965) employed 30 students at Yale University's professional art school as creative subjects and compared them with 26 graduate students in education and 26 hospitalized schizophrenics in terms of performance on the Word Association (WA) and Object Sorting (OS) tests (Rapaport, Gill, and Schafer, 1945, 1946) under three conditions: spontaneous performance, as a highly regulated, conventional person in a character sketch read to them might perform, and as a highly unregulated, whimsical person in a character sketch read to them might perform, her hypothesis being that ability to shift from performance under one set of instructions to another "involves both a capacity to engage in unregulated thinking and an ability to return adaptively to more regulated thought, implying some degree of control of regression." Subjects were matched for

age, sex, and intelligence. Responses were classified as either conventional or original according to Rapaport's norms. Group differences for originality under the spontaneous condition were significant for both the WA ($p < .025$) and OS ($p < .05$) tests, with the creative subjects (art students) being the most original, followed by the normals and then the schizophrenics. Group differences for shift scores were also significant for both the WA and OS tests ($p < .025$), with the creative subjects exhibiting the greatest shift, followed by the normals and then the schizophrenics. Follow-up questionnaires also disclosed that the creative subjects were significantly more likely to prefer operating in the unregulated mode than these in the other two groups ($p < .005$).

Gamble and Kellner (1968), following the lead of Wapner (1964), employed the Stroop Color-Word Test as a measure of ability to perform a developmentally more primitive task while subordinating more mature functioning. A total of 130 individuals were administered the Remote Associates Test (RAT); from that pool, 26 high-creative and 26 low-creative subjects were selected (those falling one standard deviation above and below the mean RAT score). The effects of intelligence, scholastic aptitude, and speed-reading ability were controlled. An analysis of covariance revealed that the high creative group performed significantly faster on card CW of the SCWT, i.e., that card assessing primitive functioning, than the low creative group ($p < .05$); adjusted group means on card CW were as follows: high-creative group: 81.3 seconds, low-creative group: 120 seconds. Further, an assessment of perceptual vs. conceptual

dominance of cognitive style (to be discussed later) failed to reveal even marginally significant differences between the two groups, suggesting that the two groups did not substantially differ on the relative strengths of the two cognitive subsystems; the authors interpret these results as evidence for greater cognitive flexibility among the high-creative subjects.

Bloomberg (1971) attempted to determine the relationship between cognitive flexibility and creativity by having 60 male undergraduates at the University of Michigan perform Necker cube reversals under two conditions (passive instructions; instructions to reverse as rapidly and frequently as possible), and performed an analysis of variance with a battery of creativity measures. Bloomberg glibly states his belief that subtracting passive reversal rate from induced rapid reversal rate yields "a yard stick of the ability to shift between global and analytic modes of functioning", but provides no explanation or theoretical formulation underlying this belief. He found no significant differences between the groups he labeled "mobile" (flexible) and "rigid" on the basis of frequency of Necker cube reversal in terms of their performance on the battery of creativity measures.

Bloomberg (1969), although unconcerned with creative ability, employed a median split on the basis of Embedded Figures Test scores to divide 24 female and 14 male subjects into field-independent and field-dependent groups, and then administered the SCWT to determine if the groups differed on level on cognitive flexibility. Although group differences were found for the females, in the predicted

direction of FI subjects having faster card CW reading times, they were not significant. Group differences for the males were slight, non-significant, and in the opposite of the predicted direction. However, as Bloomberg failed to control for card W and card C differences on the SCWT (an issue to be discussed later), employed a median split to dichotomize all subjects as either FI or FD, which tends to mask real group differences, and employed rather small n's, conclusions drawn from the results of his study should perhaps be taken only lightly. In fact, Huckabee and McGown (1971), in an attempted replication employing the same faculty methodology, failed to find even the suggestive trends noted by Bloomberg.

Botkin (1973), although also unconcerned with creative ability, attempted to determine the relationship between "fixity-mobility" (rigidity vs. flexibility) and field-independence. She, however, concerned herself with two types of flexibility: perceptual and cognitive. The former she assessed by employing modifications of the Body Adjustment and Rod and Frame tests (the modifications being unspecified), the latter by the Word Association and Object Sorting tests under the three conditions successfully employed by Wild (1965) and previously mentioned. Subjects were 43 male undergraduates identified as "field-independent" on the basis of an unspecified measure. Although both cognitive measures were significantly correlated with one another, as were both perceptual measures, no one cognitive measure was significantly correlated with one perceptual measure. Further, Botkin found no linear relationships between extent of field-independence and degree of

cognitive or perceptual flexibility. These results tend to support the hypothesis that field-independent perceivers may or may not exhibit cognitive flexibility; thus the former does not necessarily imply the latter.

Creativity

A treatment of the concept of creativity, in order to clarify rather than obfuscate, should perhaps begin with a drawing of distinctions. Anderson and Cropley (1966) distinguish between the notions of originality and creativity. The former, they claim, need only be defined in terms of the statistical infrequency of a response; for the response to be labelled "creative", a value judgment is necessitated in which the response is required to meet the aesthetic or professional criteria established by the label-wielder. Thus, they might fault the defintion of creativity put forth by Rogers (1962) as "the emergency in action of a novel relational product, growing out of the uniqueness of the individual on the one hand, and the materials, events, people, or circumstances of his life on the other." They make the further claim that many existing "creativity" tests are in actuality nothing more than measures of originality. It is to this issue that Jackson and Messick (1965) speak when they note that the unusualness of a response can be only a first step in the definition of creativity. Therefore, they add the criterion of appropriateness, that is, the response must fit its context and make sense in light of the demands of the situation, both internally (when the products are complex) and externally. As the criterion of appropriateness does little to

distinguish between creativity and intelligence, however, they state their belief that creative production also entails the transformation of materials or ideas in order to overcome conventional restraints, as well as condensation of materials or ideas, such that the product yields more information with repeated examination and contemplation.

A second distinction that should be drawn has been noted by Nicholls (1972): whether one conceives of creativity as a unitary trait or as a term which describes a combination of other traits. Those who assume that creativity is a unitary (and normally distributed) trait generally adopt as their research methodology an examination of the psychological significance of the trait and the nature of its contribution to creative production. Nicholls argues that in order to assume a normally-distributed single trait, one must isolate the distinctive characteristics of eminent creators and demonstrate a positive relationship among those characteristics and creative production in unselected samples. But in reviewing the evidence amassed by researchers employing this methodology, Nicholls forcefully argues that the characteristics most commonly identified, namely a propensity toward divergent thinking, generally high intelligence, a high level of intrinsic task-involvement, and a preference for complexity and disorder, bear no systematic relationships to unselected samples. Thus it is that Nicholls advises the adoption of a products-oriented approach to the examination of what is called creativity, in which products are rated on a continuum of creativity and the personal and social factors associated with creative achievements are examined.

Guilford (1971), too, argues against conceiving of creativity in terms of a single ability: he points out that his own factor-analytic studies (e.g. Guilford and Hoepfner, 1966; Guilford, 1967) have been interpreted as demonstrating that even such traits as propensity toward divergent thinking and intelligence, characteristic of eminent creators, are not unitary; rather they load on a variety of types of verbal and figural cognitions derived from his structure-of-intellect model (Guilford, 1956, 1957, 1967). Like Nicholls, Guilford believes that creativity is best conceived of as a combination of abilities or traits.

Khatena (1971), echoes the sentiments of those arguing against conceiving of creativity as a unitary trait and in favor of a multi-dimensional approach, and then inadvertently illustrates the pervasiveness of the problem by using the term "divergent thinking" synonymously with "creativity".

Treffinger, Renzulli, and Feldhusen (1971), note that the failure of past investigators to recognize the multidimensionality of the creative process has led them to ignore affective and motivational influences on creative performance. It should be evident that individuals do not enter the testing situation with identical degrees of interest and motivation.

Yamamoto (1965) summarizes the conceptual problem associated with the study of creativity by distinguishing four types of philosophical orientations that researchers have implicitly or explicitly adopted:

a. <u>non-positivistic holism</u>: the belief that "analytical studies of creativity are simply impossible without

destroying the essence of the act of creation."

b. positivistic holism: the belief that, while empirical investigation is possible, reductionistic approaches are inappropriate; it is necessary to understand a person's creative behavior in its whole.

c. non-positivistic elementarism: the belief of those who "enthusiastically declare their faith in the universal creative potential of man and exhort others to follow certain procedures to foster creativity, basing their arguments on largely intuitive judgment and casual (i.e. uncontrolled) observations."

d. positivistic elementarism: the belief of "those who contend that reductionistic empiricism is the royal road to the understanding of creative behavior."

As "each group has its unique assumptions, adopts its particular definitions, and employs its preferred techniques of inquiry," Yamamoto likens them to blind men among the proverbial elephant. However, the emerging consensus appears to be that, while reductionistic empiricism may not be the royal road to understanding creativity, creative behavior is not a single elephant; rather, it is composed of several elephants ranging through the jungle in the company of one another, and some form of reductionistic empiricism may be the least unsatisfactory method of studying them.

Guilford and his colleagues (Guilford, et. al., 1960; Wilson, Guilford Christensen, and Lewis, 1954; Berger, Guilford and Christensen, 1957; Guilford, Christensen, Frick, and Merrifield, 1957) have attempted

to determine what primary traits and related non-aptitude traits are related to creative productivity. Their factor-analytic studies, involving in the main 53 tests administered to 410 air cadets and student officers, resulted in the following factors (and ways of measuring them):

a. word fluency: the ability to produce words to specification (e.g. words beginning with 'a' and ending with 'f')

b. associational fluency: the ability to produce synonyms

c. expressional fluency: the production of phrases and sentences according to stated grammatical requirements

d. ideational fluency: the production of ideas that fit specified requirements (e.g. uses for a common brick)

e. spontaneous flexibility: the production of a great variety of ideas without inertia

f. adaptive flexibility: the ability to reject conventional but inappropriate solutions in favor of novel ones

g. originality: the production of statistically infrequent responses

h. redefinition: the ability to give up old interpretations of familiar objects in order to use them or their parts in new ways

i. elaboration: the ability to build upon a simple stimulus.

In addition, they implicate the following non-aptitude (i.e. motiviational and temperamental) traits:

a. perseverence

b. tolerance for stimulus ambiguity

c. liking for convergent thinking

d. liking for divergent thinking

What has remained unclear is the extent to which high intelligence is a necessary condition for creative productivity. One of the most extensive treatments of this issue is provided by Getzels and Jackson (1962), who claim that the two are independent in the sense that high intelligence, as conventionally measured, does not imply high creativity, or vice versa. In fact, conventional IQ measures require that the subject "know the common association to a stimulus and the accepted solution to a problem." Measures of creative abilities, on the other hand, seek novel and speculative solutions to problems. The retort of Nicholls (1972) is that, while this may be true, "no one would suggest that individuals with IQ's of 70 are generally as likely to make significant creative achievements as individuals with IQ's of 130."

Wallach and Kogan (1965a) also examined this issue in their administration of 10 creativity and 10 intelligence tests to 151 school-age children. While the average correlation among creativity measures was .4 and the average correlation among intelligence measures was .5, the average correlation between the two was .1. On this

basis, they conclude that they are separate dimensions, or at least can be separated when the testing takes place in the kind of relaxed, play-like atmosphere they provided their subjects. Cronbach (1968) posits a more conservative conclusion in his reanalysis of the Wallach and Kogan data: he believes that the intelligence measures employed are more aptly referred to as achievement measures, and the creative performance instruments more aptly referred to as measures of flexibility and fluency of responses in an open-ended situation, making the appearance of independence more readily explainable. This issue is further complicated by Nicholls' (1971) demonstration that game-like vs. test-like administration may account for considerable variance in divergent-thinking abilities as well. Thus, it would seem advisable to consider the effects of intelligence and testing procedures on creative performance in future research.

Are there sex differences in the quality or frequency of creative behavior? Kogan (1974) has ably summarized the existing literature on this topic and concludes that there are not. Although one must bear in mind that some investigators employ loose definitions of creativity (e.g. "divergent thinking", "originality"), while others employ restrictive definitions (e.g. Nicholls, 1972), and that there are almost as many measures of creativity as there are psychologists studying it, published studies to date indicate no clear trend in favor of any one sex. Some (e.g. Torrance, 1962; Hudson, 1968) have found superior male performance, some have found superior female performance (e.g. Guilford, 1967; Wallach and Wing, 1969), and some have found no differences (e.g. Torrance, 1965,

Wallach and Kogan, 1965b, Feldhusen and Denny, 1965; Klausmeir and Wiersma, 1965). Moreover, the inability to separate the effects of genetic sex from the differential cultural influences on the two sexes would make any emergent trend almost uninterpretable. Thus, Kogan's conclusion of a lack of sex differences in creative ability is perhaps the safest conclusion to draw.

Where clear sex differences have emerged, and this perhaps underscores the necessity of considering cultural influences, is in examining the situational variables attendant in the testing situation. Kogan and Pankove (1972) tested a group of fifth grade students individually with a battery of creativity measures used by Wallach and Kogan (1965a,b). The same subjects were tested five years later, with half being retested individually and half being retested in groups. For males, the correlations between the two administrations was quite high (approximately .50), irrespective of type of administration. For females tested individually both times, the correlation was approximately the same. However, for females retested in groups, the correlation was near zero. Since individual testing was done by a supportive same-sexed examiner, it is difficult to separate the effects of supportiveness from those of a one-on-one relationship with a same-sexed examiner. However, the work of Gall and Mendelsohn (1967) and Mendelsohn and Gall (1970), appear to clarify this. The first study found a pronounced interaction between sex of subject and sex of examiner for females but not for males, with a female examiner resulting in facilitation of performance. In the subsequent study, the authors found no personality differences

for males who were or were not benefitted by training sessions in creative performance. For females, no personality differences were observed when the examiner was female. However, when the examiner was male, the females were more likely to describe themselves as moody, reserved, tense, touchy and withdrawn on the Adjective Check List. Taken in sum, these studies strongly suggest that contextual variables play a significant role in creative performance among females: they perform better when tested individually by a female.

What, then, is creativity? It may perhaps be most adequately described as a constellation of traits (rather than a single trait) that result in productions that have the characteristics of novelty, value, and unconventionality, and which result in a reformulation of vagueness in the original stimuli. Further, they proceed out of persistence and high motivation on the part of the creator (Newell, Shaw & Simon, 1962). Torrance (1974) offers the following definition:

> " . . . a process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypotheses about the deficiencies; testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results."

It is the contention of this author, however, that these specific abilities may be subsumed under (and, in fact, proceed out of) the cognitive variables known as level of psychological differentiation and degree of cognitive flexibility. It would be

futile, however, to claim that any of these specific abilities may be attributed to one or the other of the independent variables under consideration, for it lies at the heart of Werner's theory to suppose that creative behavior proceeds out of their working in combination, given certain non-aptitude traits such as high motivation.

Stroop Color-Word Test

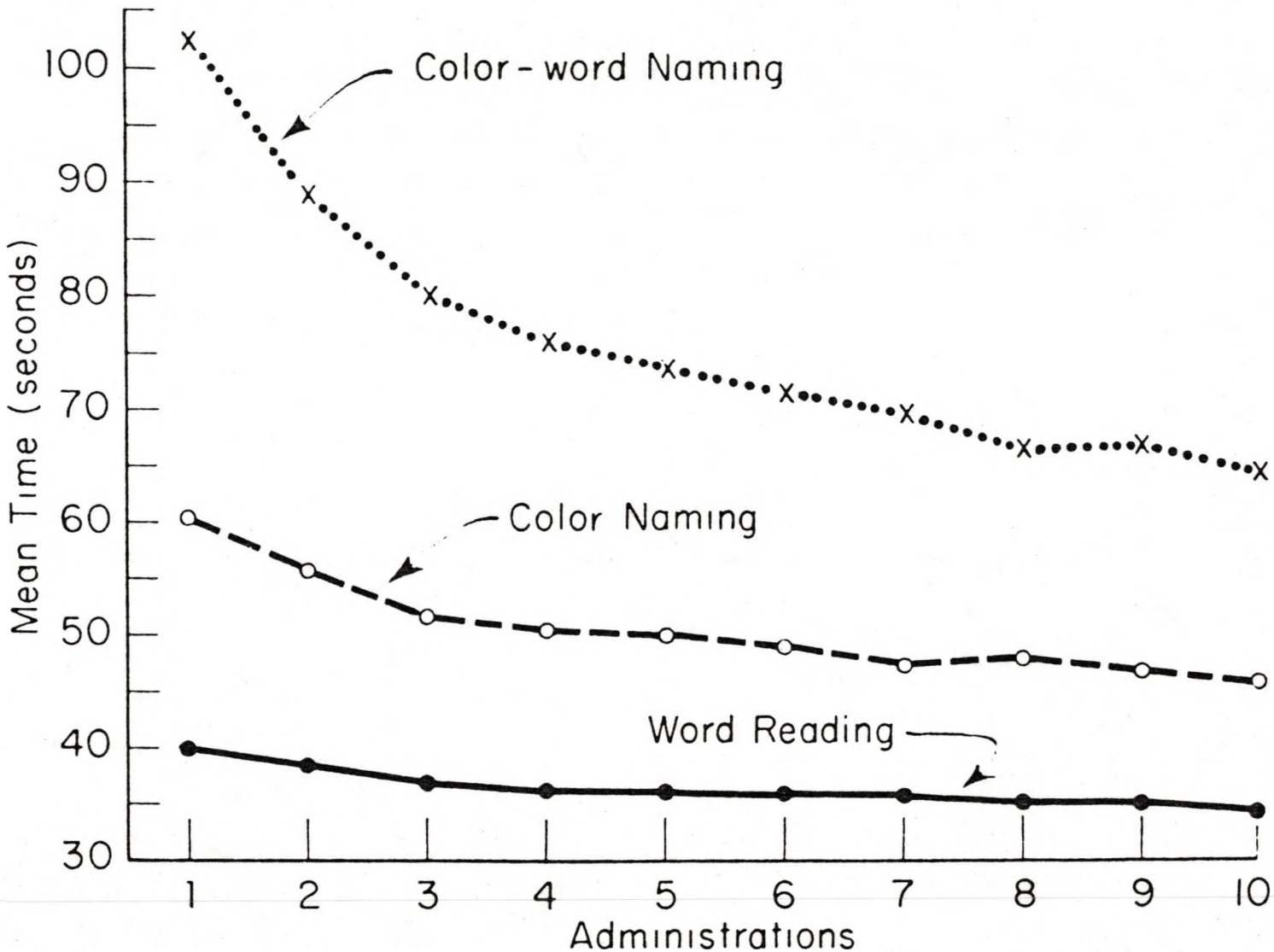
Predecessors of the Stroop Color-Word Test date back at least to 1883, when James McKeen Cattell began his doctoral research under Wilhelm Wundt at Leipzig on the time required to name colors and objects and their corresponding words (Jensen and Rohwer, 1966). He published the first experimental study of the relative speeds of color-naming and color-word reading in Mind three years later (Cattell, 1886). The phenomenon of color-word interference was later investigated by Descoeudres (1914), Brown (1915), and Jaensch (1929), among others. The current form of the color-word test was introduced into American psychology by Stroop (1935), however, and has remained relatively unchanged since. Stroop's version employed three cards, with five colors and color words arranged in a 10 x 10 matrix; most current versions use three cards, three colors (red, green and blue), and a 5 x 20 arrangement.

The Stroop Color-Word Test may be scored in no less than 16 ways (Jensen & Rohwer, 1966), some of which result in scores which are merely linear transformations of other scores. The most commonly used scores are a) the basic scores, consisting of raw reading times

for each of the 3 (W, C, CW) cards, b) the derived interference scores, obtained by subtracting the observed C score from the observed CW, or subtracting the predicted CW score, based on a regression of CW on C, from the observed CW. The pattern that emerges is invariably the same, however: word-reading (W) is quite rapid, color-naming (C) is somewhat slower, and color-word naming (CW) is considerably slower. Further, these differences in reading and naming times are remarkably reliable across repeated administrations, in spite of a known practice effect for the first two or three trials. (See Figure 1) For example, Jensen (1965a), using 436 subjects and 10 administrations, reported composite estimates of reliability for the three basic scores ranging from .89 to .98. His estimates of reliabilities for a single administration, known to be the most unreliable, are W: r=.88, C: r=.79, and CW: r=.71.

Considerable controversy has attended the attempts of Stroop investigators to explain the nature of color-word interference. The fundamental dichotomy centers around explanations in terms of stimulus competition vs. response competition. Stimulus - competition explanations (e.g. Hochman, 1971) are largely discounted today, owing to a multitude of studies (e.g. Gardner, Jackson & Messick, 1960; Gardner & Moriarty, 1968, Dalrymple-Alford & Azkoul, 1972) demonstrating a lack of firm relationships between Stroop performance and performance on other measures shown to measure ability to screen irrelevant stimuli. On the other hand, a number of studies with the Stroop and various analogues of the Stroop, intricately summarized by Dyer (1973), have lent considerable support to

FIGURE 1 MEAN TIME FOR EACH STROOP CARD AS A FUNCTION OF NUMBER OF ADMINISTRATIONS



explanations centering around competition from dominant but inappropriate responses.

Perhaps the first individual to suggest that the Stroop Color-Word Test might be suitable for investigating the variable that has come to be known as cognitive flexibility was Klein (1954). He operationalized the dimension of constricted vs. flexible cognitive control on the basis of Stroop performance, in fact, and noted the differing modes of coping with stimuli containing contradictory or intrusive cues on this and other tasks.

> Constricted control subjects resort to counteractive measures in their attempts to overcome the disruptive effects of intrusive cues. When possible, their responses were guided by the most central or obvious aspect of a field; i.e., they coped with distracting stimuli by ignoring them in favor of a salient, easily confirmable stimulus attribute. When external cues seemed to contradict internal ones, the conflict was resolved in favor of the most obvious external ones. These subjects tended to avoid using feelings or emotional reactions as a source of information. Constricted-control subjects also seemed resistive to change, preferring to maintain sets long after they were appropriate, another indication that they could not take advantage of all available cues.
>
> Flexible-control subjects seemed relatively comfortable in situations that involved contradictory or intrusive cues. They were not overimpressed with a dominant stimulus organization if the instructions rendered another part of the field more appropriate. Thus, they were capable of differential response to specified aspects of a field in the face of explicitly interferring cues. In addition, their responses to a personal inventory suggested that they did not tend to suppress feeling and other internal cues. (Gardner, Holzman, Klein, Linton, & Spence, 1959)

Holt (1960) separated subjects into high - and low - interference groups on the basis of Stroop performance and scored their Rorschach

responses for expression of and control over primary process manifestations, using the scoring procedure discussed earlier. He found that low - interferences subjects (i.e. those exhibiting greater flexibility) exhibited a greater proportion of primary process thought ($p < .1$) and their primary process manifestations tended to be of what he called the Level I (more blatant and directly drive-related) rather than the Level II (more toned-down, derivative, and socially-acceptable) type ($p = .05$). He also noted that high-interference subjects exhibited more signs of tension, e.g., squirming, sighing, nervous laughing, than low-interference subjects while taking the Rorschach, suggesting greater discomfort in dealing with their primary process thought.

In the first real use of the Stroop in a test of Werner's theory concerning the nature of the developmental process, Comalli, Wapner, & Werner (1962) administered the SCWT to 253 subjects ranging in age from several to 80 years. The number of subjects in each age group is listed in Table 2.

TABLE 2

NUMBER OF SUBJECTS IN EACH AGE GROUP IN COMALLI, WAPNER, & WERNER'S (1962) STUDY

Age	7	8	9	10	11	12	13	17-19	25-34	35-44	65-80
No. of Sub-jects	24	20	20	25	29	25	29	18	14	16	15

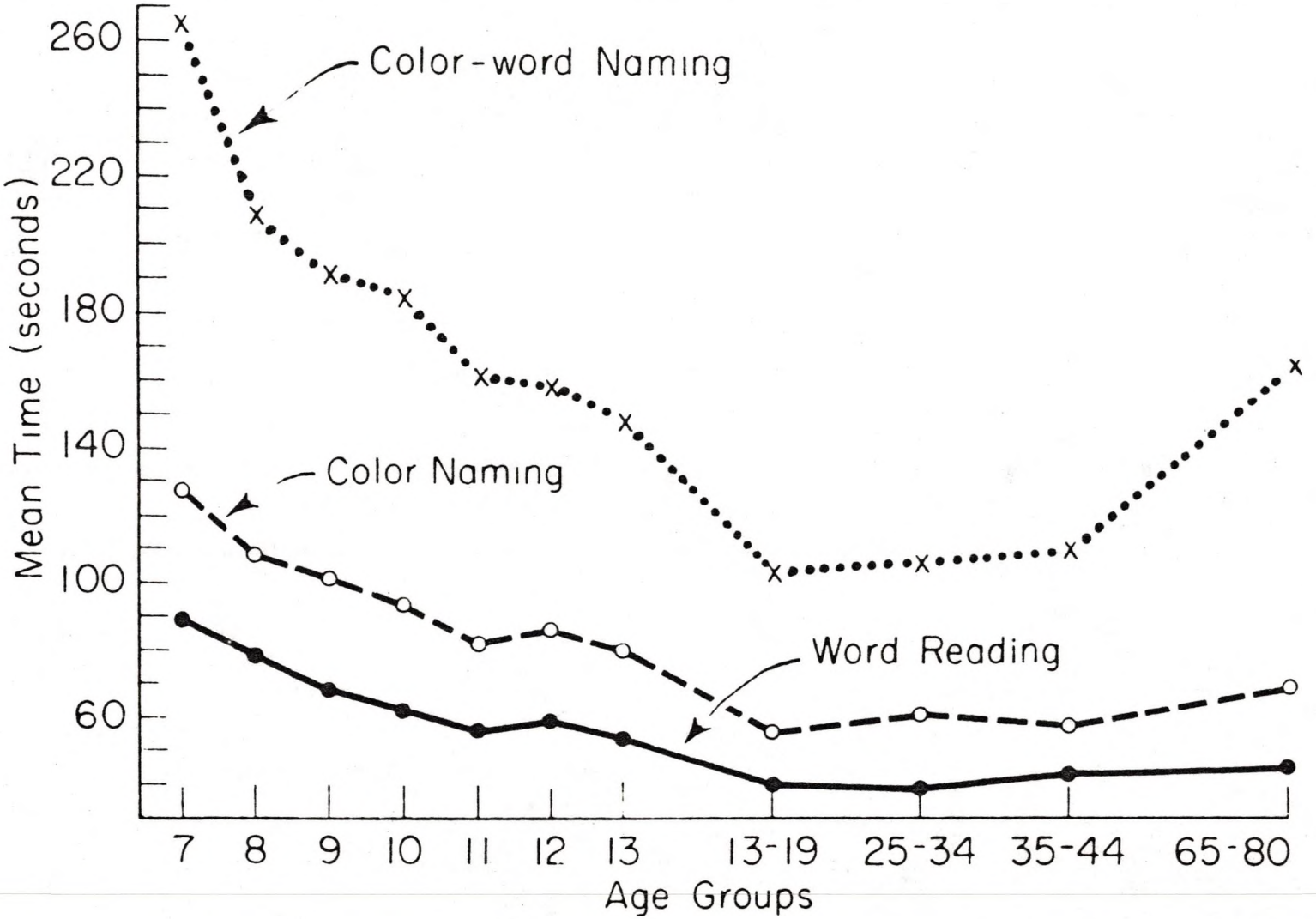
Comalli, et al. predicted that younger subjects would show less differentiation and hierarchic integration (i.e. cognitive flexibility) than those in the middle range, and hence greater interference, and that, since, in their view, old age is characterized by regression and dedifferentiation, less adequate Stroop performance would re-emerge later in life. Their results are presented in Figure 2.

The obtained results conform to the predicted results. Further, an analysis of variance determined that the main effects for age and card, as well as the interaction of age x card, were significant at the level of $p < .01$. It is of interest to note that these results make virtually untenable the original explanation offered by Stroop (1935) for color-word interference in terms of more frequent practice in reading words than in naming colors.

Wapner and Krus (1960) speculated that schizophrenia also is characterized by regression and dedifferentiation, and hence a lesser degree of cognitive flexibility, and that the same process occurs when the psychotomimetic drug lysergic acid diethylamide (LSD-25) is administered; their comparisons of SCWT performance for schizophrenics vs. normals and LSD-25 vs. placebo subjects determined that this is indeed the case.

Rand, Wapner, Werner, and McFarland (1963) employed a novel approach in their study of developmental trends in SCWT performance: they recorded individual responses to each stimulus in order to determine the frequencies of deviant responses to the items (e.g. inappropriate color responses, contaminated responses, and

FIGURE 2 CHANGES IN PERFORMANCE ON THE STROOP COLOR-WORD TEST AS A FUNCTION OF AGE



inarticulate utterances) and deviant responses to the sequences of items (e.g. insertion of words, omissions, inserted linguistic and non-linquistic utterances); their subjects consisted of 40 youths, 10 each in the age groups of 6-7, 9-10, 12-13, and 16-17. Although their specific results are somewhat beyond the scope of this study, it bears noting that certain predictable trends in deviant responses occur as age level increases: five response categories show a general decrease in frequency, one shows an increase, and one shows a decrease followed by an increase. Rand, et al. interpret these results as indicating further the usefulness of the SCWT in assessing developmental changes in cognitive functioning, a sentiment echoed by Wapner (1964) in a lengthy restatement of Werner's organismic-developmental approach to cognition.

Sack and Rice (1974) factor-analyzed the performance of 164 8th-grade students on a battery of attentional measures, including the SCWT. They identified three oblique (but lowly-correlated) factors: selectivity (the capacity to attend selectively to relevant cues),resistance to distraction (distraction being defined as an involuntary change in an established attentional focus), and shifting (voluntarily changing an established attentional focus). Some (e.g. Houston, 1969) have interpreted low Stroop interference scores as indicative of ability to resist distraction. However, in this study, Stroop performance loaded negatively (-.181) on the resistance-to-distraction factor: it loaded .726 on the shifting factor and .576 on the selectivity factor, however, as would be predicted from the model and explanations under consideration.

As might be expected, the measures which loaded most highly on the selectivity factor were measures of perceptual field independence (the Group Embedded Figures and the Hidden Figures Tests). This raises the issue of the extent to which the SCWT is a measure of field-independence as well. From the standpoint of Werner's theory, since increasing cognitive flexibility is presumed to be preceded by increasing differentiation and articulation (and thus high levels of the former would not occur without high levels of the latter), it would seem that any instrument which "picks out" highly flexible individuals would also be selecting out individuals who are relatively field-independent, even though it might not be the most effective instrument for measuring perceptual field independence. The investigations into this question bear this out, although the results are far from unequivocal. For example, Houston (1969) found slightly better performance on the Stroop CW card for FI subjects than for FD subjects, though the difference was not statistically significant; however, his use of the raw reading time on CW, rather than an interference score (which controls for such personal variables as initial color-naming speed in the absence of response competition, as well as reading speed), must be regarded as seriously confounding his results. Similarly, Denmark, Havlena, and Murgatroyd (1971) obtained correlations between scores on the Rod and Frame Test (Witkin, et al., 1962) and the Jackson Short Form of the Embedded Figures Test (Jackson, 1956) and the three raw SCWT scores. When only extreme scores were used, card CW of the SCWT correlated .68 with EFT score ($p < .01$); none of the others were

significant. However, when continuous data were employed, none of the correlations between SCWT and EFT or RFT scores were statistically significant. Again, the use of raw rather than interference scores confounds these results, as does the use of a small (n=24), all-male sample.

Hochman (1971) divided 48 female undergraduates into 3 groups (FT, FC, FD) on the basis of Hidden Figures Test performance and administered only card CW of the SCWT. An analysis of variance determined that there were significant group differences in card CW performance ($F=3.81$, $df=2,45$, $p<.05$). This faculty methodology is highlighted by Hochman's naive conclusion that "field-independent subjects are (thus) less susceptible to stimulus competition than field-dependent subjects." Finally, Ray (1974), in a complex design, the exact nature of which is beyond the scope of this discussion, observed a general tendency for high interference on the Stroop to be associated with a FD orientation, but these trends were not significant. (Parenthetically, her study lent further support to the explanation of Stroop interference in terms of response, rather than stimulus, competition.)

Broverman (Broverman & Lazarus, 1958; Broverman, 1960a, 1960b) has defined a dimension of cognitive organization he calls conceptual vs. perceptual (or sensorimotor) dominance, which he operationalizes on the basis of a ratio of SCWT card C performance to card W performance. His assumption is that word-reading involves the use of a cognitive subsystem different from that used in naming colors, the latter being a developmental predecessor of the former and requiring less reliance on the utilization of concepts. The greater this ratio,

the greater the dominance of the conceptual cognitive subsystem; the closer this ratio approximates unity (it has never occurred, in all published Stroop literature, that C reading time was faster than W reading time for any subject, and hence the ratio would presumably never be less than one), the greater the dominance of the perceptual subsystem. Beyond the differences that Broverman claims to have identified in conceptual vs. perceptual dominance individuals (and there are many; see, e.g. Jensen & Rohwer, 1966), the important one is that a low interference score accompanied by a low W/C ratio would presumably indicate a more pervasive lower level of cognitive functioning, whereas a low interference score accompanied by a high W/C ratio would seem to be indicative of higher levels of cognitive flexibility. Although little Stroop research has included this variable, it would seem beneficial to do so, especially when drawing inferences concerning the variable of cognitive flexibility.

To what extent can SCWT performance be accounted for in terms of intervening and extraneous variables other than cognitive flexibility, such as sex, race, personality correlates, etc.? The evidence to date is hearteningly sparse that such variables appreciably affect Stroop performance.

That there are sex differences in Stroop performance is unequivocal: all studies which have examined this variable (e.g. Stroop, 1935; Jensen, 1965b; Golden, 1974) have found that females perform better on Card C than males; most have found that females perform better on Card CW as well. However, on the crucial

interference scores, sex differences are invariably miniscule and non-significant. Golden (1974), for example, noted the following mean interference scores for 219 subjects: females - 46.24; males - 45.48 ($t = 0.41$, n.s.). Adequate explanation of observed sex differences has, unfortunately, eluded Stroop investigators. Stroop's (1935) hypothesis of differential practice in naming colors for males and females has apparently never been subjects to experimental investigation.

Two early studies with predecessors of the Stroop focused on racial differences. Peterson, Lanier, and Walker (1925) administered variants of cards W and C to 10- and 12-year old Negroes and Caucasians. At 10 years, the Negro children exhibited a 20% lower reading and naming rate on both cards than the Caucasian children ($p < .001$), but by age 12 these differences were small (6 to 8%) and non-significant. Telford (1930) administered C and W 10 times to Negro and Caucasian college students and found no significant racial differences overall or for any one trial.

Intelligence bears a most tenuous relationship to Stroop performance. Ligon (1932) found a correlation of .02 between intelligence and card C reading time (n.s.), and .15 between IQ and card W time ($p < .01$). Three studies have correlated Stroop interference (CW-C) with scores on Raven's Progressive Matrices and found near-zero coefficients (Callaway, 1959; Leedy, 1963; Jensen, 1965b).

Personality factors, too, seem rather unrelated, directly or indirectly, to Stroop performance. Jensen (1965b), using 436 subjects,

found only miniscule correlations between interference and the Maudsley Personality Inventor (MPI) scales. Golden, Marsella, & Golden (1975a), using 210 subjects, found the same results with both the MPI and Cattell's 16 PF. Golden and Golden (1976) report a factor-analytic study of the MMPI performances of 133 subjects administered the Stroop, in which they found that subjects exhibiting low interferences tend to be self-confident, prone to social experimentation, and more aware of their own feelings, as well as to view themselves as more mature than others; the authors note evidence that suggests that these are characteristics often found in creative individuals.

Apart from the previously-mentioned studies with field independence, perceptual abilities, too, seem unrelated to SCWT performance. Thurstone (1944), in his noted factor-analytic study of perception, omitted the Stroop from the body of perceptual tests ultimately subjected to statistical treatment because of its very low correlation with other tests. The results of Podell and Phillips (1959) were so muddled as to defy interpretation. In sum, then the repeated failures of investigators to find relationships between Stroop performance and such variables as intelligence, personality dimensions, and perceptual abilities, as well as sex and race, have led several individuals (e.g. Jensen and Rohwer, 1966; Golden, Marsella, and Golden, 1975b) to conclude that Stroop performance, rather than being a function of highly specific, localized characteristics, taps a very broad and basic, as well as quite stable, dimension. There is ample evidence to suggest that this dimension

may be the extent to which individuals manifest flexibility of employment of developmentally-ordered cognitive functions, and that this dimension is instrumental in determining the extent to which an individual is creative. Golden (1975a), in fact, based upon significant correlational relationships found between SCWT performance and performance on several little-used measures of creativity, has proposed the use of the Stroop in itself as a measure of creative productivity.

The economical use of the Stroop in research settings has been considerably facilitated by the work of Gardner and Lohrenz (1969) and especially Golden (1975b) in developing group-administered versions. These involve printing Stroop stimuli on ordinary paper (rather than paperboard) and allowing subjects 45 seconds per page to silently read each page. Subjects then simply circle the item they are on when the time elapses. Errors are rare and, in general, are noticed and corrected by subjects. Golden (1975b) administered individual forms twice to 30 subejcts and found reliabilities for cards W, C, and CW of .86, .82, and .73. For 450 subjects taking the group version twice, the reliabilities were .89, .84, and .73, respectively. For 60 subjects taking both forms (½ took the group first), the corresponding reliabilities were .85, .81, and .69. The two forms are thus functionally equivalent, especially in light of the marked practice effects for the first two or three administrations.

Summary

There exists a wealth of evidence to suggest that creative productivity is a function of the extent to which an individual has developed a high level of psychological differentiation, that is, moved from global, diffuse and syncretic perception to discrete, articulated and differentiated perception, as well as the extent to which an individual exhibits flexibility of cognitive operations and hierarchic integration of those operations, such that developmentally less mature modes of operation are accessible to use and are employed in situations in which they are appropriate. Level of psychological differentiation may be measured by the Group Embedded Figures Test (Witkin, et al., 1971, 1962); degree of cognitive flexibility may be measured by the group form of the Stroop Color-Word Test (Golden, 1975b; Stroop, 1935). Creative productivity may be measured by the Torrance Tests of Creative Thinking (Torrance, 1962, 1974).

In examining the variable of creativity, it is desirable to account for the effects of intelligence and motivation. In examining the variable of cognitive flexibility with the SCWT, it is desirable to consider the dimension of conceptual vs. perceptual dominance of cognitive operations.

Hypotheses

In light of the evidence amassed to date with respect to the variables under consideration in this study, the following hypotheses are formulated:

I. A weak and perhaps statistically non-significant Pearson product-moment correlation coefficient will be obtained between scores on the measures of perceptual field-independence and cognitive flexibility when computed across all subjects.

II. Subjects exhibiting high levels of both perceptual field-independence and cognitive flexibility will perform significantly better on the measure of creativity than high FI - low CF and low FI - low CF subjects.

III. High FI - low CF subjects will perform slightly better on the measure of creativity than low FI - low CF subjects, although this difference may not be statistically significant.

IV. There will be no low FI - high CF subjects.

V. There will be no significant group differences on the measure of conceptual vs. perceptual cognitive dominance.

VI. Small group differences on the intelligence measure will emerge, in favor of the high FI - high CF group.

VII. Age will not play a significant role in level of psychological differentiation or extent of cognitive flexibility.

Operational Definitions

Field-Independence. Those subjects falling one standard deviation above the mean of the total sample will be classified as high FI; those subjects falling one standard deviation below the mean of the total sample will be classified as low FI. The measure

used will be the Group Embedded Figures Test (Witkin, Oltman, Raskin, and Karp, 1971).

Cognitive Flexibility. Those subjects falling one standard above the mean will be classified as high CF; those subjects falling one standard deviation below the mean will be classified as low CF. The measure used will be the group form of the Stroop Color-Word Test (Golden, 1975a).

Creativity. The measure of creativity will be the combined figural subtests of the Torrance Tests of Creative Thinking (Torrance, 1974).

Conceptual vs. Perceptual Cognitive Dominance. The ratio of card C to card W of the Stroop Color-Word Test (Golden, 1975a) will be used to measure conceptual vs. perceptual cognitive dominance.

Intelligence. The measure of intelligence will be the Revised Gamma Form of the Otis Quick-Scoring Mental Abilities Test (Otis, 1954).

CHAPTER III

METHOD

Phase I

Subjects

Three hundred and fifty-nine students enrolled in introductory psychology during the fall semester at the University of North Dakota participated in phase I of the present study in order to earn five points of credit to be applied to their grades. Of those 359 subjects, 132 were male and 227 were female. Ages ranged from 17 to 33, with a median age of 18.26 and a mean age of 18.89.

Instrument

Group Stroop Color-Word Test (GSCWT). The GSCWT (Golden, 1975b) is a group-administered adaptation of the test first published by Stroop (1935). It consists of three pages of 8½" x 11" white paper, on which are printed, in pica type, the following: page W --- the words 'red', 'blue' and 'green' in black ink, in 5 columns of 20 words per column, with columns spaced 1 1/8" apart, and in a scrambled fashion, with the stipulation that no word succeeds itself in a column; page C --- groups of four X's in red, blue or green ink, also in five columns of 20 groups per column, with columns spaced 1 1/8" apart, and in a scrambled fashion, with the stipulation that no ink color succeeds itself in a column; page CW --- the color names from page W printed in the correspondingly-positioned colors from

page C, in five columns of 20 color-words per column, with columns spaced 1 1/8" apart, with the stipulation that no color name is printed in the ink color which it names.

Procedure

Subjects were tested during the recitation sections of their introductory psychology courses. There were three male and three female experimenters. The following instructions were given: "You are being asked to take a short test of your ability to perform highly specialized tasks. Although they are not terribly difficult, you are asked to do your very best."

> (Page W) On the first page of this test there are names of colors printed in columns. When I say 'Go!', you are to read the names of the colors to yourself, starting at the top of the left column and reading down, and then going on to each of the other columns. Read as quickly as you can. If you make a mistake, correct it and go on. If you finish before the time is up, start all over again. When I say 'Stop!', circle the item you are on. If you are reading the items for the second time, put the number 1 beside your circle. Are there any questions? ....Remember, read down the columns as quickly as you can. Go!

After 45 seconds, the experimenter said "Stop! Circle the item you are on. If you finished the entire page and began again, put the number 1 beside your circle. Turn the page."

> (Page C) On this page there are groups of X's printed in various ink colors. When I say 'Go!', you are to name the ink colors to yourself, starting at the top of the left column and going down, and then going on to each of the other columns. Name then as quickly as you can. If you make a mistake, correct it and go on. If you finish before the time is up, start all over again. When I say 'Stop!', circle the item you are on. If you are reading the items for the

> second time, put the number 1 beside your circle. Are there any questions? ...Remember, name the ink colors as quickly as you can, reading down the columns. Go!

After 45 seconds, the experimenter repeated the instructions given upon completion of page W.

> (Page CW) On this page there are names of colors printed in different ink colors. When I say 'Go!', you are to name the ink colors to yourself, ignoring the meaning of the words, starting at the top of the left column and going down, and then going on to each of the other columns. Name then as quickly as you can. If you make a mistake, correct it and go on. If you finish before the time is up, start all over again. When I say 'Stop!', circle the item you are on. If you are reading the items for the second time, put the number 1 beside your circle. Are there any questions? ...Remember, name the ink colors as quickly as you can, ignoring the meaning of the words. Read down the columns. Go!

After 45 seconds, the experimenter repeated the instructions given upon completion of pages W and C, omitting the phrase "turn the page".

Upon completion of phase I, subjects were debriefed with the following mimeographed note:

> The experiment in which you have participated is part of an ongoing investigation which will not be completed for several months. Thus it is not possible to fully inform participants concerning the nature and purpose of this experiment at this time. However, if you wish to be sent a written explanation at a future date, please print your name and address at the bottom of this sheet and leave it with the experimenter.
>
> A certain number of participants in this experiment will be contacted by telephone in the near future and asked if they are willing to participate in another aspect of this experiment for additional credit. Thank you for your participation.

Statistical Analysis

The color-word interference score (CWI) used was obtained by subtracting the number of items read on page CW from the number of items read on page C. Thus

$$CWI = C-CW.$$

The mean interference score was 38.6; the standard deviation of interference scores was 14.3. The range was 0 to 103.

All subjects whose interference score fell in the upper or lower seventeen percent of interference scores were contacted by telephone and asked to participate in phase II of the experiment. There were 122 such subjects; 111 indicated their willingness to participate further. Seventy-eight of those subjects were female; 33 were male.

Phase II

Instruments

Group Embedded Figures Test (GEFT). The GEFT (Oltman, Raskin, and Witkin, 1971) is a group-administered version of the EFT designed by Witkin, et al. (1962), and is intended to be a measure of extent of psychological differentiation as evidenced by level of field independence. It is published in disposable booklet form and contains three sections, of increasing difficulty, in which subjects are asked to find and trace one of eight simple figures or designs that are embedded in more complex figures. The simple figures are printed on the back of the booklet so that subjects may not simultaneously see the figures for which they are searching and the complex figures. The time limit for the first section, which contains seven complex

figures, is two minutes; however this section is for practice only and is not scored. It does, nonetheless, serve as an indicator of whether or not the subject understood the directions. Sections two and three each contain nine complex figures and have a five-minute time limit. A single score is obtained by adding to number of correctly identified and traced simple figures in sections two and three.

Group Stroop Color-Word Test (GSCWT). The GSCWT was readministered to all subjects during phase II in order to obtain a more reliable estimate of degree of cognitive flexibility, owing to the oft-demonstrated fact that GSCWT performance becomes more stable after two or three administrations (see, e.g., Jensen, 1965b).

Procedure

Subjects selected from phase I were tested during one of two evening or two afternoon sessions in an auditorium-type classroom. The order of test administration was determined by a coin toss; the GSCWT was administered first during the first and third session and the GEFT was administered first during the second and fourth session. There was a three-minute rest break between the two tests. All three sessions were conducted by a male experimenter.

The same GSCWT instructions used in phase I were used in phase II; instructions for the GEFT are printed in the test booklet and the experimenter only needed to ask subjects to read the instructions and then time them on the three sections.

Upon completion of phase II, subjects were debriefed with an oral statement that certain subjects would be asked to participate in the

final phase of the study. All phase II participants received an additional five points of credit.

Statistical Analyses

A single GEFT score and a single CWI score were computed for each subject. The mean GEFT score was 12.25; the standard deviation of GEFT scores was 4.23. The mean high CF group (that is, those falling in the upper 17% with respect to mean performance of all phase I subjects) GSCWT score upon the second administration was 21.2; the mean low CF group (those falling in the lower 17% with respect to mean performance of all phase I subjects) GSCWT score upon the second administration was 45.9.

Those subjects falling one standard deviation above the mean GEFT score were classified as high FI; those subjects falling one standard deviation below the mean GEFT score were classified as low FI. On this basis, three groups were formed; high FI - high CF (n = 11), high FI - low CF (n = 13), and low FI - low CF (n = 12). There were 3 low FI - high CF subjects, an insufficient number to permit the formation of a fourth group.

Phase III

Subjects

The thirty-six subjects selected from phase II were sent a brief letter (Appendix A) advising them that they would be contacted by telephone by a research assistant who would ask them to participate in the final phase of the present study. They were briefly advised of the considerable effort expended to select subjects with particular skills and were asked to participate even if they did not need further

credit for their introductory psychology class. All subjects were, however, offered five additional points to be applied to their grades. All thirty-six subjects agreed to participate; of those, 14 were male and 22 were female.

Instruments

Otis Quick-Scoring Mental Abilities Test, Revised Gamma Form.

The Otis-Gamma (Otis, 1954) is a self-administered intelligence test devised in such a manner as to permit group administration. It is printed in booklet form with a detachable answer sheet; instructions for completing the test are printed on the first page. Although the normative data accompanying the Otis-Gamma are now over 20 years old, its use was deemed permissible since it was to be used to draw inferences concerning intellectual abilities of subjects relative only to other subjects in the present study.

Torrance Tests of Creative Thinking, Figural Form A (TTCT).

Torrance (1974) published both figural (non-verbal) and verbal measures of creativity. The figural form, published in booklet form, contains three subtests. The Picture Construction Activity requires subjects to paste a green egg-shaped figure with an adhesive backing onto a blank page and then construct an elaborate picture which incorporates that figure. This activity is scored in terms of the originality of the basic response and the extent of elaborative detail added to the picture. The Incomplete Figures Activity requires subjects to amplify upon ten incomplete and abstract figures in order to create a meaningful picture. A fluency score is obtained by adding up the

number of figures completed. A flexibility score is obtained by adding up the number of categories into which the completed figures fall. In addition, the originality of an extent of elaborative detail added to the basic response are scored. The Repeated Figures Activity requires the subject to elaborate upon 30 sets of 1½" parallel lines in order to create a meaningful picture. Again, responses are scored in terms of their fluency, flexibility, originality, and extent of elaboration. Each of the three subtests has a ten-minute time limit. Torrance (1972) provides normative data for the scoring of all three activities.

Procedure

All subjects were tested individually by an examiner of the same sex at a time that was mutually convenient. Testing took place in small individual-testing rooms. Although standardized instructions provided by the test authors were adhered to as strictly as possible, examiners were specifically instructed to be warm, open and supportive in their interactions with subjects. If subjects required occasional reassurance regarding their performance, examiners were instructed to give it.

All scoring of phase I and II data was performed by the author, who also assigned subjects to groups and to examiners, in order to guard against the possibility of examiner bias in subsequent testing. In addition, subjects' phase III test booklets were identified only by the last four digits of their telephone numbers and their sexes, in order to guard against scorer bias in the scoring of phase III data, which was also carried out by the author.

Three female and two male undergraduate research assistants served as examiners in the collection of phase III data. The order of administration of the phase III tests was determined in the following manner: each examiner tossed a coin to determine which test to administer first for his/her first subject; thereafter the two tests were alternated.

Statistical Analyses

Analysis of Variance: Age x Cognitive Flexibility. A one-way analysis of variance (Winer, 1971) was performed to test whether or not age played a significant role in color-word interference on the SCWT among the 359 phase I subjects. In addition a Pearson product-moment correlation coefficient was computed between the two variables.

Analysis of Variance: Age x Field Independence. A one-way analysis of variance was also performed to test whether or not age played a significant role in level of field independence on the GEFT among the 111 phase II subjects. In addition, a Pearson product-moment correlation coefficient was computed between the two variables.

Correlation between the Independent Variables. A Pearson product-moment correlation coefficient was computed to determine the correlation between degree of cognitive flexibility and degree of field independence among 109 phase II subjects (two having been omitted because of invalid GSCWT scores).

Analysis of Variance: Group x Perceptual vs. Conceptual Dominance Ratio. A one-way analysis of variance was performed in order to determine whether there were significant group differences in perceptual vs. conceptual cognitive dominance among the phase III subjects.

Multiple Regression: Group and Intelligence x Creativity. Multiple regression analyses (Kerlinger and Pedhazur, 1973) were performed to test the major hypotheses of the study: that performance on the TTCT could be significantly predicted from group assignment and level of intelligence as measured by the Otis-Gamma.

Multiple Regression: Group x IQ and Group x Sex. Further multiple regression analyses were carried out to test whether, as previously suggested, intelligence plays some role in creativity, and whether or not artifactual sex differences in creativity (as a function of testing procedure) were obviated.

CHAPTER IV

RESULTS

Age Distribution of Phase I Subjects; Summary Data for GSCWT Performance. The distribution of Phase I subjects by age, as well as their means and standard deviations of GSCWT performance, are presented in Table 3.

TABLE 3

DISTRIBUTION OF PHASE I SUBJECTS BY AGE AND THEIR MEANS AND STANDARD DEVIATIONS OF GSCWT PERFORMANCE

Age	n	$\bar{X}$	s
17	21	39.24	16.13
18	207	39.27	13.09
19	59	37.02	16.13
20	34	37.94	15.26
21	15	35.8	16.57
22	5	38.4	9.69
23	4	29.0	7.12
24	5	44.2	11.35
25	6	36.0	20.87
26	1	80.	0.
27	1	37.	0.
28	1	41.	0.
33	1	29.	0.

Analysis of Variance: Age x Cognitive Flexibility. The results of the one-way analysis of variance in which the significance of group mean differences in GSCWT performance in phase I was tested on the basis of the ages of the 359 subjects participating in that phase are presented in Table 4.

TABLE 4

ANALYSIS OF VARIANCE: AGE x COGNITIVE FLEXIBILITY

Source	SS	df	MS	F	p
Between	2987.41	12	248.95	1.239	.25
Within	69541.81	346	200.98		
Total	72529.25	358	202.59		

The outcome of the correlational analysis was as follows: $r = -.033$, $p = .269$. These results suggest that age did not play a significant predictive role in GSCWT performance, as predicted in hypothesis VII.

Age Distribution of Phase II Subjects; Summary Data for GEFT Performance. The distribution of Phase II subjects by age, as well as their means and standard deviations of GEFT performance, are presented in Table 5.

TABLE 5

DISTRIBUTION OF PHASE II SUBJECTS BY AGE AND THEIR MEANS AND STANDARD DEVIATIONS OF GEFT PERFORMANCE

Age	n	$\bar{X}$	s
17	4	13.0	1.4
18	65	12.5	4.1
19	22	11.0	4.9
20	11	12.1	4.9
21	4	12.0	3.6
22	1	18.	0.
24	2	11.5	3.5
25	2	15.5	2.1

Analysis of Variance: Age x Field Independence. Table 6 presents the results of the one-way analysis of variance in which the significance of group mean differences in GEFT performance in phase II was tested on the basis of the ages of the 111 subjects participating in that phase.

TABLE 6

ANALYSIS OF VARIANCE: AGE x FIELD INDEPENDENCE

Source	SS	df	MS	F	p
Between	96.78	7	13.83	.751	.63
Within	1896.14	103	18.41		
Total	1992.92	110	18.12		

The outcome of the correlational analysis was as follows: $r = .033$, $p = .366$. These results, too, support the prediction of hypothesis VII that age would not play a significant predictive role in GEFT performance.

Correlation between the Independent Variables. It was predicted in hypothesis I that a weak and statistically non-significant Pearson product-moment correlation coefficient would result when computed between the independent variables of GEFT and GSCWT performance. This prediction was supported: $r = 0.029$, $n = 109$, $p > .70$.

Analysis of Variance: Group x Perceptual vs. Conceptual Cognitive Dominance Ratio. Hypothesis V contained the prediction that there would be no significant group differences on the perceptual vs. conceptual cognitive dominance ratio (CDR). Table 7 contains the results of the one-way analysis of variance performed to test that hypothesis. The means of the three groups were: LFI-LCF --- 1.28, HFI-LCF --- 1.32, HFI-HCF --- 1.41.

TABLE 7

ANALYSIS OF VARIANCE: GROUP X PERCEPTUAL VS. CONCEPTUAL COGNITIVE DOMINANCE RATIO

Source	SS	df	MS	F	p
Between	.104	2	.052	2.675	.084
Within	.64	33	.019		
Total	.744	35	.021		

Although the results are in line with the prediction of hypothesis V, the closeness of the obtained F to statistical significance at the .05 level suggested the need for further analysis. Therefore, multiple t-test comparisons were performed to test for significant differences in the individual means from one another. These results are presented in Table 8. (All comparisons were one-tailed.)

TABLE 8

MULTIPLE t-test COMPARISONS OF MEANS
OF COGNITIVE DOMINANCE RATIOS

Comparison	t	df	p
LFI-LCF:HFI-LCF	.743	23	.283
LFI-LCF:HFI-HCF	-1.944	21	.033
HFI-LCF:HFI-HCF	-1.795	22	.044

That the HFI-HCF group subjects had both the lowest interference scores and the greatest degree of conceptual cognitive dominance suggests that their scores are truly reflective of a high degree of cognitive flexibility, rather than a more pervasive lower level of cognitive functioning. That the LFI-LCF group subjects had both the highest interference scores and the greatest degree of perceptual cognitive dominance suggests that their scores are truly reflective of a more pervasive lower level of cognitive functioning (i.e. low levels of psychological differentiation). The HFI-LCF subjects' scores, having fallen almost mid-way between the other two groups' scores, suggest that they are somewhat more differentiated

than the LFI-LCF subjects but are not as able to flexibly employ operations characteristic of lower levels of functioning as the HFI-HCF subjects. The statistical significance of two of these three group mean differences lends substantial weight to these hypotheses.

Torrance Test Performance. Table 9 presents the means and standard deviations of TTCT subscores for the three groups, as well as means and standard deviations of composite creativity scores, based on T-score conversions and summations within groups, a procedure outlined by Torrance (1974).

That the HFI-LCF group means are all higher than the corresponding means for other groups, followed by those for the HFI-HCF group, is clearly not in conformity with hypotheses II and III. It would, moreover, be inappropriate to attribute these across-the-board discrepancies to random variation or imprecision in the dependent measure, given their extreme consistency. A discussion of these unexpected findings will be deferred until the next chapter.

The obtained TTCT means were subjected to multiple regression analyses, using group membership, intelligence (as measured by the Otis-Gamma), and the interaction between group membership and intelligence as the dependent variables; dummy coding (Kerlinger and Pedhazur, 1973) was employed to identify group membership. The results of these analyses are presented in Tables 10-11.

TABLE 9

MEANS AND STANDARD DEVIATIONS OF GROUP PERFORMANCE ON

THE TORRANCE TESTS OF CREATIVE THINKING

	Fluency		Flexibility		Originality		Elaboration		Creativity	
	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
HFI-HCF	17.09	4.83	13.18	2.72	21.64	8.03	81.0	40.46	187.55	31.81
HFI-LCF	18.08	6.09	15.54	4.11	25.38	10.22	88.15	22.15	202.62	36.21
LFI-LCF	15.67	6.32	12.75	5.31	19.42	13.94	50.67	50.67	170.25	50.77

TABLE 10

MULTIPLE REGRESSION: GROUP, IQ x FLUENCY

Source	Multiple R	R Square	F	df	Source	df	SS	MS	F
Group	.081	.007	.102	2,30	Regression	5	45.65	9.13	.23
IQ	.019	.002	.078	1,30	Residual	30	1206.24		
Group x IQ	.093	.009	.135	2,30					
Regression	.191	.036							

TABLE 11

MULTIPLE REGRESSION: GROUP, IQ x FLEXIBILITY

Source	Multiple R	R Square	F	df	Source	df	SS	MS	F
Group	.09	.008	.135	2,30	Regression	5	65.96	13.19	.63
IQ	.04	.002	.05	1,30	Residual	30	629.60	20.99	
Group x IQ	.11	.o1	.2	2,30					
Regression	.308	.095							

TABLE 12

MULTIPLE REGRESSION: GROUP, IQ x ORIGINALITY

Source	Multiple R	R Square	F	df	Source	df	SS	MS	F
Group	.054	.003	.046	2,30	Regression	5	310.99	62.19	.43
IQ	.058	.003	.107	1,30	Residual	30	1313.75	143.79	
Group x IQ	.063	.004	.064	2,30					
Regression	.259	.067							

TABLE 13

MULTIPLE REGRESSION: GROUP, IQ x ELABORATION

Source	Multiple R	R Square	F	df
Group	.019	.0004	.007	2,30
IQ	.027	.0007	.028	1,30
Group x IQ	.026	.0007	.014	2,30
Regression	.472	.223		

Source	df	SS	MS	F
Regression	5	9864.43	1972.89	1.72
Residual	30	34474.54	1149.15	

TABLE 14

MULTIPLE REGRESSION: GROUP, IQ x CREATIVITY

Source	Multiple R	R Square	F	df	Source	df	SS	MS	F
Group	.063	.004	.066	2,30	Regression	5	7301.25	1460.25	.75
IQ	.004	.000	.000	1,30	Residual	30	58355.50	1945.18	
Group x IQ	.081	.007	.111	2,30					
Regression	.333	.111							

Thus, none of the creativity scores may be significantly predicted, even though the magnitudes of the multiple correlations for them (when all predictors are entered in the regression equations) range from .19 to .47. In part, this may be a function of the high intercorrelations among the predictor variables for each dependent variable, as evidenced by their very low multiple R's when the effects of all other variables are removed from each.

Further multiple regression analyses were carried out in order to determine the directions and magnitudes of the relationships between group membership and IQ and sex. The results of these analyses are presented in Tables 15 and 16.

TABLE 15

MULTIPLE REGRESSION: GROUP x IQ

Source	Multiple R	R Square	Source	df	SS	MS	F
Group	.545	.297	Regression	2	950.76	475.38	6.98**
			Residual	33	2246.13	68.06	

** $p < .01$

TABLE 16

MULTIPLE REGRESSION: GROUP x SEX

Source	Multiple R	R Square	Source	df	SS	MS	F
Group	.242	.059	Regression	2	.501	.251	1.027
			Residual	33	8.054	.244	

Thus, a high and statistically significant degree of correlation existed between group membership and measured intelligence, a finding supportive of previously cited suggestions that creativity and intelligence are not independent of one another. A low and non-significant correlation was observed between group membership and sex, perhaps suggesting the efficacy of eliminating sex differences in measured creativity by testing with same-sexed examiners.

Post-hoc data analyses were carried out in which scatter-plots were constructed between GEFT scores and each of the Stroop scores obtained in this study (W, C, CW, CWI, and CDR), in order to determine by visual inspection whether the summary data for and analyses carried out upon the GEFT and GSCWT masked any relationships between these two variables. In addition, multiple regressions predicting each of the TTCT scores, as well as the summary creativity score, from all other measurement variables under study in this investigation (GEFT, IQ, and the 5 GSCWT scores listed above), were carried out in order to determine whether any other combination of predictor variables significantly enhanced the prediction of TTCT scores. However, as no new relationships of interest were uncovered in those analyses, those data are not included in this report.

In sum, neither age nor sex bore a systematic relationship to the independent variables of field independence or cognitive flexibility; intelligence did, however. A very low correlation between the two independent variables was observed. The three groups formed on the basis of field independence and cognitive flexibility estimates were found to differ significantly on the cognitive dominance ratio but

not on the five dependent variables used to operationalize creative abilities. The HFI-LCF subjects performed most creativity, followed by the HFI-HCF subjects and then the LFI-LCF subjects.

CHAPTER V

DISCUSSION

It would perhaps be helpful at this point to very briefly review the major findings of this investigation and indicate the extent to which they are in accordance with the hypotheses advanced. First, it was found that neither cognitive flexiblity, as measured by the GSCWT, nor field independence, as measured by the GEFT, could be significantly predicted by the ages or sexes of the subjects. Further, a very low correlation was observed between GSCWT and GEFT performance. All of these findings are in accordance with the predictions set forth in Chapter II: good measures of FI and CF should not be in large part a function of such demographic variables as age and sex; furthermore, Wernerian theory predicts that psychological differentiation may or may not be followed by hierarchic integration, leading to the prediction of a low correlation between GEFT and GSCWT scores across a large number of subjects.

The GSCWT cognitive dominance ratio was computed in order to further substantiate the validity of the GSCWT as a measure of cognitive flexibility. HFI-HCF subjects exhibited the lowest degree of interference, coupled with the greatest degree of conceptual dominance, suggesting that they were indeed the most flexible. LFI-LCF subjects had the highest degree of interference and the

greatest degree of perceptual dominance, leading to the conclusion that they were the least flexible subjects. HFI-LCF subjects as a group fell between the other two groups, resulting in the conclusion that they were more differentiated than the LFI-LCF subjects but less flexible than the HFI-HCF subjects. Two of the three individual differences among means were statistically significant ($p < .05$).

It was further observed that group membership (i.e. GSCWT and GEFT scores) could be significantly predicted from IQ scores; this was as predicted, given the common-sense notion that creativity and intelligence are not orthogonal dimensions.

The major hypotheses in this study concerned which subjects would be the most creative performers on the TTCT: it was predicted that the HFI-HCF subjects would be the most creative, followed by the HFI-LCF subjects and then the LFI-LCF subjects. In point of fact, the HFI-LCF subjects were found to have performed most creatively, followed by the HFI-HCF subjects and then the LFI-LCF subjects; these differences were consistent across all four subtests, as well as the composite creativity score. However, none of the TTCT score differences could be significantly predicted; this could have been a function of any of several factors, including the small sample sizes employed, the rather high variability within groups on TTCT performance, the high intercorrelations of the predictor variables, or simply the lack of large discrepancies between the means.

How might the deviations of the creativity scores from the predicted directions be explained? Several hypotheses may be advanced, none of which are entirely convincing or satisfactory in and of

themselves. First, the fault might lie with the construct validity of the Torrance Tests of Creative Thinking. This appears somewhat implausible for two reasons: a) the extreme consistency of relative group standings across subscores observed in this study, which seems to suggest that whatever the Torrance tests measure, they measure it reliably; b) the lengthy array of evidence put forth by Torrance (1974) in support of the validity of his tests.

Second, the fault might lie with the GSCWT as a measure of cognitive flexibility. For example, although the GSCWT requires the subordination of a developmentally more advanced response (word-reading) in favor of a more primitive response (color-naming), the emitted response must be verbally encoded prior to emission. Thus, there are two types of inputs (word name, which is encoded verbally, and color, which is encoded on a visuo-spatial level) but only one type of output, since both word-reading and color-naming require verbal encoding. In order to perform the desired task, subjects must respond to the stimulus (color) in a different mode than that in which it was encoded. This switching between modes for each response to the Stroop stimuli might be viewed as cognitive flexibility. However, as subjects were tested in large groups on the GSCWT, there is no assurance that the high CF were actually performing the translation of the color-name into a verbal form, as they were instructed: they may have moved on to succeeding stimuli after having only processed the color properties of the Stroop stimuli on a non-verbal level. Thus, rather than measuring cognitive flexibility, the GSCWT may have measured the adeptness of some subjects at short-circuiting color-word

interference by processing the Stroop stimuli on a strictly visuo-spatial level. In order to obviate this perversion of the task involved, it would probably be necessary to require vocal responses to the color properties of the stimulus, as is usually done when the test is administered individually.

Another way in which the task might have been perverted would have been to allow one's eyes to go out of focus or (for those with vision defects) to raise one's glasses, in order that the word name not be received as input. However, if a number of low CF subjects were being placed in the high CF group because of their use of any of the above tactics, one would probably expect that the variances of the HFI-HCF group would be higher than those for the other groups on all of the dependent measures, and in fact this is only true for the elaboration subscore. Even so, this may, at a minimum, explain how three subjects came to be categorized as LFI-HCF, in obvious and flagrant contravention of Wernerian theory.

A footnote to the consideration of possible flaws in the GSCWT for use in this type of research: if, indeed, large numbers of high CF subjects were "cheating" on the measure of flexibility, perhaps the predicted ordering of creativity scores could be obtained by suggesting that those subjects deserve to have a few points added on to their TTCT scores for discerning such clever ways of muddling research results. If there is a moral involved, it would seem to be that one should never under-estimate the ingenuity of Psychology 101 students (or the suspiciousness of novice researchers in pursuit of master's degrees).

Third, the fault may lie with the GEFT as a measure of psychological differentiation. It must be remembered that this instrument does not measure differentiation directly; rather, it measures it by way of what Witkin, et al. (1962) called the "tracer element" of perceptual field-independence. Although the various embedded figures tests have a long history of use (and perhaps abuse), usually with apparent success, it must be borne in mind that with each step by which one is removed from the variable of interest, the possibility of invalidity of measurement of that variable increases at an alarming rate. Thus it would be hazardous to speculate what other variables might be measured instead of or along with psychological differentiation. Even so, an opposite stand may be taken: Wernerian theory would predict that FI subjects as a whole would be more creative than FD subjects, and that was decidedly the result obtained in this study.

Fourth, and perhaps not last, it may be that Wernerian theory is inappropriate in the explanation of what underlies the constellation of abilities herin collectively referred to as creativity. Wernerian theory has the advantage of immense intuitive appeal. But intuitive appeal is not enough. To have utility, a theory must predict successfully. An area of growing interest in neuropsychology is the study of the specialization of cerebral hemispheres for different functions, the left for verbal and mathematical functions, the right for spatial and musical functions. There exists a body of literature, both empirical and theoretical, suggesting that creative abilities are predominantly a right-hemisphere function (e.g. Harnad, 1972; Bakan,

1975). It seems logical to hypothesize that Werner's notion of differentiation and articulation of functions may be a function of extent of hemispheric specialization, and that his notion of hierarchic integration may be a function of the extent to which the individual can process information on a dynamic interhemispheric basis, that is, first in one hemisphere and then the other. If this hypothesis is true, the observations that creative abilities are predominantly a right-hemisphere function would be inconsistent with Wernerian theory.

This line of reasoning may be applied to GEFT and GSCWT performance as well. It may be possible to explain performance on the former as a function of extent of hemispheric specialization and the latter as a function of ability to process information first in one hemisphere and then the other, this representing a higher (and not always achieved) level of development. Even so, Tucker (1977) has recently advanced an hypothesis concerning the embedded figures tests in which he speculates that performance on them may be a function of <u>bilateral</u> hemispheric processing, as evidenced by nonlateral eye movements in response to reflective questions (see, e.g., Kinsbourne, 1972) in both college students and adults. An analogous Wernerian explanation might be that the individual must attend to the complex figure as a whole in order to be able to select out a specified part of it, i.e. must attend both globally and analytically simultaneously.

In sum, then, the present research, like so much research, seems to have generated more questions than answers. The predicted results were not obtained; was this a function of any (or all) of the four

previously-offered explanations? Perhaps the most that can be said at this point is that an anomaly has been observed; fully adequate explanation must be deferred until further questions are answered. These include:

a) What is the role of cerebral hemispheric specialization in the application of Werner's orthogenetic principle to creative abilities?

b) What precisely is the locus of the Stroop phenomenon and can it be used as an index of cognitive flexibility?

c) What variables other than perceptual field-independence covary with psychological differentiation and how do they complicate our measurement of such differentiation?

APPENDIX A

LETTER REQUESTING THE PARTICIPATION OF SUBJECTS SELECTED FOR PHASE III TESTING

LETTER REQUESTING THE PARTICIPATION
OF SUBJECTS SELECTED FOR PHASE III
TESTING

Department of Psychology
University of North Dakota
Grand Forks,
North Dakota 58202
October 31, 1977

Dear

Within the next few days you will be contacted by telephone by a member of my research team and asked to participate in the final phase of study #11.

Nearly 400 students have been screened to find 36 individuals who possess certain highly specialized traits. Obviously a great deal of time, effort and money has been expended to select those individuals. Thus, even if you already have accumulated the five hours of research participation you need, I would very much appreciate your spending just one more hour participating in this study. If you still lack the number of hours you need, I would very much appreciate your reserving one of those hours for the final phase of this study.

The final phase of Study #11 will entail your meeting on an individual basis with one of us at a time of your choosing to take a few short tests. Again, I urge you to devote just one more hour to this study. Thank you for your cooperation and patience.

Sincerely,

Joel P. Newman
Graduate Student

REFERENCES

REFERENCES

Adcock, C.J., and Martin, W.A. Flexibility and creativity, Journal of General Psychology, 1971, 85, 71-76.

Anderson, C.C. and Cropley, A.J. Some correlates of originality, Australian Journal of Psychology, 1966, 18(3), 218-227.

Bakan, P. "Dreaming, REM sleep and the right hemisphere: A theoretical integration." Paper presented to the Second International Congress of Sleep Research. Edinburgh, Scotland, June 30, 1975.

Baker, M.A.S. "The Relationship of Creativity to Several Selected Personality Variables," Ph.D. dissertation, Washington University, 1970.

Barron, F. Creativity and psychological health. Princeton: Van Nostrand, 1963.

Barron, F. Creative person and creative process. New York: Holt, Rhinehart, and Winston, Inc., 1969.

Berger, R.M., Guilford, J.P., Christenson, P.R. A factor-analytic study of planning abilities. Psychological Monographs, 1957, 71(6), (Whole No. 435).

Bloomberg, M. An inquiry into the relationship between field independence-dependence and creativity. Journal of Personality, 1967, 67, 127-140.

Bloomberg, M. Differences between field independent and field dependent persons on the Stroop Color-Word Test. Journal of Clinical Psychology, 1969, 25, 45.

Bloomberg, M. Creativity as related to field independence and mobility. Journal of Genetic Psychology, 1971, 118, 3-12.

Botkin, E.B. "Fixity-mobility: Its relationship to field independence and rigidity." Ph.D. dissertation, Yeshiva University, 1973.

Broverman, D.M. Dimensions of cognitive style. Journal of Personality, 1960a, 28, 240-256.

Broverman, D.M. Cognitive style and intra-individual variation in abilities. Journal of Personality, 1960b, 28, 240-256.

Broverman, D.M., and Lazarus, R.S. Individual differences in task performance under conditions of cognitive interference. Journal of Personality, 1958, 26, 94-105.

Brown, W. Practice in associating color names with colors. Psychological Review, 1915, 22, 45-55.

Callaway, E. The influence of amobarbital (amylobarbitone) and methamphetamine on the focus of attention. Journal of Mental Science, 1959, 105, 382-392.

Cattell, J. McK. The time it takes to see and name objects. Mind, 1886, 11, 63-65.

Comalli, P.E., Wapner, S., and Werner, H. Interference effects of Stroop Color-Word Test in childhood, adulthood, and aging. Journal of Genetic Psychology, 1962, 100, 47-53.

Cronbach, L.J. Intelligence? Creativity? A parsimonious reinterpretation of the Wallach-Kogan data. American Educational Research Journal, 1968, 5, 491-511.

Crutchfield, R. The creative process. In. D.W. MacKinnon (Ed.), Conference on the creative person. Berkeley: University of California Institute of Personality Assessment and Research, 1961.

Dalrymple-Alford, E.C., and Azkoul, J. The locus of interference on the Stroop and related tasks. Perception and Psychophysics, 1972, 11, 385-388.

Davis, G.A., and Belcher, T.L. How shall creativity be measured? Journal of Creative Behavior, 1971, 5, 153-161.

Denmark, F.L., Havlena, R.A., and Murtgatroyd, D. Reevaluation of some measures of cognitive styles. Perceptual and Motor Skills, 1971, 33, 133-134.

Descoeudres, A. Couleur, forme ou nombre? Archives de Psychologie, 1914, 14, 305-341.

Dyer, F.N. The Stroop phenomenon and its use in the study of perceptual, cognitive, and response processes. Memory and Cognition, 1973, 1(2), 106-120.

Dyk, R.B. and Witkin, H.A. Family experiences related to the development of differentiation in children. Child Development, 1965, 36, 21-55.

Feldhusen, J.F., and Denny, T. Teachers' and children's perceptions of creativity in high- and low-anxious children. Journal of Educational Research, 1965, 58, 442-447.

Freud, S. Formulations on the two principles of mental functioning. (German ed. 1911) In J. Strachey (Ed.), The standard edition of the complete psychological works of Sigmund Freud. London: Hogarth Press, 1958.

Fricke, B.J. Opinion, attitude, and interest survey handbook. University of Michigan, Evaluation and Examination Division, Ann Arbor, Michigan, 1963.

Gall, M., and Mendelsohn, G.A. Effects of facilitating techniques and subject-experimenter interaction on creative problem solving. Journal of Personality and Social Psychology, 1967, 5, 211-216.

Gamble, K.R., and Kellner, H. Creative functioning and cognitive regression. Journal of Personality and Social Psychology, 1968, 9(3), 266-271.

Gardner, R.W., Holzman, P.S., Klein, G.S., Linton, H.B., and Spence, D.P. Cognitive control: a study of individual consistencies in cognitive behavior. Psychological Issues, 1959, 1, 1-185.

Gardner, R.W., Jackson, D.N., and Messick, S. Personality organization in cognitive controls and intellectual abilities. Psychological Issues, 1960, 2, Monograph 8.

Gardner, R.W., and Lohrenz, L.J. Some old and new group tests for the study of cognitive controls and intellectual abilities. Perceptual and Motor Skills, 1969, 29, 935-950.

Gardner, R.W., and Moriarty, A. Personality development at preadolescence: explorations of structure formations, 1968. Seattle: University of Washington Press.

Garwood, D.S. Personality factors related to creativity in young scientists. Journal of Abnormal and Social Psychology, 1964, 68, 413-419.

Gensemer, I.B. "Psychometric Measures of Creativity and their Relationship to Field Dependence, Teacher Proficiency and Attitudes." Ed. D. dissertation, Temple University, 1967.

Getzels, J.W., and Jackson, P.W. Creativity and intelligence: explorations with gifted students. New York: Wiley, 1962.

Golden, C.J. Sex differences in performance on the Stroop Color and Word Test. Perceptual and Motor Skills, 1974, 39, 1067-1070.

Golden, C.J. The measurement of creativity by the Stroop Color and Word Test. Journal of Personality Assessment, 1975a, 39(5), 502-506.

Golden, C.J. A group version of the Stroop Color and Word Test. Journal of Personality Assessment, 1975b, 39(4), 386-388.

Golden, C.J. and Golden, E.E. Resistance to cognitive interference as a function of MMPI profile. Journal of Consulting and Clinical Psychology, 1975, 43(5), 749.

Golden, C.J. and Golden, E.E. A note on self-reported behavioral correlates of resistance to interference. Journal of Genetic Psychology, 1976, 128, 299-300.

Golden, C.J., Marsella, A.J., and Golden, E.E. Personality correlates of the Stroop Color and Word Test: More negative results. Perceptual and Motor Skills, 1975a, 41, 599-602.

Golden, C.J., Marsella, A.J., and Golden, E.E. Cognitive relationships of resistance to interference, Journal of Consulting and Clinical Psychology, 1975b, 43(3), 432.

Guilford, J.P. The structure of intellect. Psychological Bulletin, 1956, 53, 267-293.

Guilford, J.P. A revised structure of intellect. (Reports of the Psychology Laboratory, No. 19), 1957. Los Angeles: University of Southern California Press.

Guilford, J.P. Traits of creativity. In H.H. Anderson (Ed.), Creativity and its cultivation. New York: Harper, 1959.

Guilford, J.P. The nature of human intelligence. New York: McGraw-Hill, 1967.

Guilford, J.P. Some misconceptions regarding measurement of creative talents. Journal of Creative Behavior, 1971, 5(2), 77-87.

Guilford, J.P., and Hoepfner, R. Creative potential as related to measures of IQ and verbal comprehension. Indian Journal of Psychology, 1966, 41, 7-16.

Guilford, J.P., and Merrifield, D.R. The structure of intellect model. (Reports of the Psychology Laboratory, No. 24), 1960. Los Angeles: University of Southern California Press.

Guilford, J.P., Christensen, P.R., Frick, J.W., and Merrifield, P.R. The relations of creative-thinking abilities to non-aptitude traits. (Reports of the Psychology Laboratory, No. 20), 1957. Los Angeles: University of Southern California Press.

Harnad, S.R. Creativity, lateral saccades, and the nondominant hemisphere. Perceptual and Motor Skills, 1972, 34, 653-654.

Hersch, C. The cognitive functioning of the creative person: a developmental analysis. Journal of Projective Techniques, 1962, 26, 193-200.

Hochman, S.H. Field independence and Stroop Color-Word performance. Perceptual and Motor Skills, 1971, 33, 782.

Holt, R.R. Manual for the scoring of primary process manifestations in Rorschach responses. (Draft 7) New York: Research Center for Mental Health, 1959. (Dittoed.)

Holt, R.R. Cognitive controls and primary processes. Journal of Psychological Researches, 1960, 8, 105-112.

Holt, R.R., and Havel, J. A method for assessing primary and secondary process in the Rorschach. In Maria A. Rickers - Ovsiankina (Ed.) Rorschach psychology. New York: Wiley, 1960.

Houston, K. Field independence and performance in distraction. Journal of Psychology, 1969, 72, 65-69.

Huckabee, M.W., and McGown, W.P. Differences between field independent and field dependent persons on the Stroop Color-Word Test. A failure to replicate. Journal of Clinical Psychology, 1971, 27, 226.

Hudson, L. Frames of mind. New York: Norton, 1968.

Jackson, D.N. A short form of the Witkin Embedded Figures Test. Journal of Abnormal and Social Psychology, 1956, 53, 254-255.

Jackson, D.N., Messick, S., and Meyers, C.T. The role of memory and color in group and individual embedded-figures measures of field independence. New Jersey: Educational Testing Services, 1962.

Jackson, P.W., and Messick, S. The person, the product and the response: conceptual problems in the assessment of creativity. Journal of Personality, 1965, 33, 309-329.

Jaensch, E.R. Grundformen menschlichen Seins. Mit Berucksichtigung ihrer Beziehungen zu Biologie und Medizin, zu Kulturphilosophie und Padagogik, 1929. Berlin: Otto Elsner.

Jensen, A.R. Scoring the Stroop Test. Acta Psychologica, 1965a, 24, 398-408.

Jensen, A.R. Individual differences in learning: inteference factor. Final Report: Cooperative Research Project No. 1867, U.S. Office of Education, 1965b.

Jensen, A.R., and Rohwer, W.D. The Stroop Color-Word Test: A review. Acta Psychologica, 1966, 25, 36-93.

Kerlinger, F.N., and Pedhazur, E.J. Multiple regression in behavioral research. New York: Holt, Rhinehart, and Winston, 1973.

Khatena, J. Some problems in the measurement of creative behavior. Journal of Research and Development in Education, 1971, 4(3), 74-82.

Kinsbourne, M. Eye and head turning indicates lateralization. Science, 1972, 176, 539-541.

Klausmeir, H.J., and Wiersma, W. The effects of IQ level and sex on divergent thinking of seventh grade pupils. Journal of Educational Research, 1965, 58, 300-302.

Klein, G.S. Need and Regulation. In. M.R. Jones (Ed.), Nebraska symposium on motivation. Lincoln: University of Nebraska Press, 1954, 224-274.

Kogan, N. Creativity and Sex Differences. Journal of Creative Behavior, 1974, 8(1), 1-14.

Kogan, N., and Pankove, E. Creative ability over a five-year span. Child Development, 1972, 43, 427-442.

Kogan, J., and Wallach, M.A. Risk-taking: a study in cognition and personality. New York: Holt, Rhine hart, and Winston, 1964.

Kris, E. Psychoanalytic explorations in art. New York: International Universities Press: 1952.

Leedy, H.B. "An investigation of the range of cue utilization as a function of induced and intrinsic drive." Doctoral dissertation, Purdue University, 1963.

Ligon, E.M. A genetic study of color naming and word reading. American Journal of Psychology, 1932, 44, 103-121.

Linton, H. Dependence on external influence: correlates in perception, attitudes, and judgment. Journal of Abnormal and Social Psychology, 1955, 51, 502-507.

Mackworth, N. Originality. American Psychologist, 1965, 20, 51-66.

Mc Whinnie, H.J. Some Relationships Between Creativity and Perception in Sixth-Grade Children. Perceptual and Motor Skills, 1967, 25, 979-980.

Mednick, S.A. Remote associates test. Boston: Houghton-Mifflin, 1967.

Mendelsohn, G.A., and Gall, M. Personality variables and the effectiveness of techniques to facilitate creative problem solving. Journal of Personality and Social Psychology, 1970, 16, 346-351.

Mendelsohn, G.A., and Griswold, B.B. Differential use of incidental stimuli in problem solving as a function of creativity. Journal of Abnormal and Social Psychology, 1964, 68, 431-436.

Myden, W.D. "An interpretation and evaluation of certain personality characteristics involved in creative production." Ph.D. dissertation, New York University, 1956.

Myden, W.D. Interpretation and evaluation of certain personality characteristics involved in creative production. Perceptual and Motor Skills, 1959, 9, 139-158.

Newell, A.J., Shaw, J.C., and Simon, H.A. The processes of creative thinking. In H.E. Gruber, G. Terrell, and M. Wertheimer (Eds.) Contemporary approaches to creative thinking. New York: Atherton Press, 1962.

Nicholls, T.G. Some effects of testing procedure on divergent thinking. Child Development, 1971, 42, 1647-1651.

Nicholls, T.G. Creativity in the person who will never produce anything original and useful: the concept of creativity as a normally distributed trait. American Psychologist, 1972, 27(8), 717-727.

Ohnmacht, F., and McMorris, R.F. Creativity as a function of field independence and dogmatism. Journal of Psychology, 1971, 79, 165-168.

Oltman, P.K., Raskin, E., and Witkin, H.A. The group embedded figures test. Palo Alto: Consulting Psychologists Press, 1971.

Otis, A.S. The Otis quick-scoring mental abilities test. New York: World Book, 1954.

Pearson, P.H., and Maddi, S.R. The Similes Preference Inventory: Development of a structured measure of the tendency toward variety. Journal of Consulting Psychology, 1966, 30, 301-308.

Peterson, J., Lanier, L.H., and Walker, H.M. Comparisons of white and Negro children in certain ingenuity and speed tests. Journal of Comparative Psychology, 1925, 5, 271-283.

Phillips, L., Kaden, S., and Waldman, M. Rorschach indices of developmental level. Journal of Genetic Psychology, 1959, 94, 267-285.

Pine, F., and Holt, R. Creativity and primary process: A study of adaptive regression. Journal of Abnormal and Social Psychology, 1960, 61, 370-379.

Podell, J.E., and Phillips, L. A developmental analysis of cognition as observed in dimensions of Rorschach and objective test performance. Journal of Personality, 1959, 27, 439-463.

Rand, G., Wapner, S., Werner, H., and McFarland, J.H. Age differences in performance on the Stroop Color-Word Test. Journal of Personality, 1963, 31, 534-558.

Rapaport, D. Toward a theory of thinking. In D. Rapaport (Ed.), Organization and pathology of thought. New York: Columbia University Press: 1951.

Rapaport, D., Gill, M., and Schafer, R. Diagnostic psychological testing. Vol. 1, Chicago: Year Book Publishers, 1945.

Rapaport, D., Gill, M., and Schafer, R. Diagnostic psychological testing. Vol. 2, Chicago: Year Book Publishers, 1946.

Ray, C. Some components of color-word interference and their relationship with field dependence. Acta Psychologica, 1974, 38(4), 323-330.

Rogers, C.R., Toward a theory of creativity. In Parnes, S.J., and Harding, H.F. (Eds.), A source book for creative thinking. New York: Scribner's, 1962.

Sack, S.A., and Rice, C.E. Selectivity, resistance to distraction and shifting as three attentional factors. Psychological Reports, 1974, 34, 1003-1012.

Schuler, M.D. "Mental Imaging and Rotation of Mental Images as a Function of Creativity and Field-Independence-Dependence." Master's thesis, Moorhead State University, Moorhead, Minnesota, 1976.

Spotts, J.V., and Mackler, B. Relationships of field-dependent and field-independent cognitive styles to creative test performance. Perceptual and Motor Skills, 1967, 24, 239-268.

Stevens, J.C. "A Study of the Relationships Between Field Independence, Dogmatism, and Creativity in Rural Seventh-Grade Students." Ed. D. dissertation, University of Georgia, 1969.

Stroop, J.R. Studies of interference in serial verbal reactions. Journal of Experimental Psychology, 1935, 18, 643-662.

Taylor, C.W., and Holland, J. Predictors of creative performance. In. C.W. Taylor (Ed.), Creativity: progress and potential. New York: McGraw-Hill, 1964.

Telford, C.W. Differences in responses to colors and their names: some racial comparisons. Journal of Genetic Psychology, 1930, 37, 151-159.

Thurstone, L.L. A factorial study of perception. Chicago: University of Chicago Press, 1944.

Torrance, E.P. Guiding creative talent. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962.

Torrance, E.P. Rewarding creative behavior. Englewood Cliffs, New Jersey: Prentice-Hall, 1965.

Torrance, E.P. Torrance tests of creative thinking: directions manual and scoring guide. Lexington, Massachusetts: Personnel Press, 1972.

Torrance, E.P. Torrance tests of creative thinking - norms, technical manual. Lexington, Massachusetts: Personnel Press, 1974.

Treffinger, D.J., Renzulli, J.S., and Feldhusen, J.F. Problems in the assessment of creative thinking. Journal of Creative Behavior, 1971, 4(3), 74-82.

Tucker, D.M. Hemispheric Integration and Cognitive Style. 1977 (Unpublished Manuscript, University of North Dakota).

Vaught, G.M. The relationship of role identification and ego strength to sex differences in the rod and frame test. Journal of Personality, 1965, 33, 271-283.

Wallach, M.A., and Kogan, N. A new look at the creativity-intelligence distinction. Journal of Personality, 1965a, 33, 348-369.

Wallach, M.A., and Kogan, N. Modes of thinking in young children. New York: Holt, Rhinehart and Winston, 1965b.

Wallach, M.A., and Wing, C.W. Jr. The talented student: a validation of the creativity-intelligence distinction. New York: Holt, 1969.

Wapner, S. Some aspects of a research program based on an organismic-developmental approach to cognition. Journal of the American Academy of Child Psychiatry, 1964, 3, 193-230.

Wapner, S., and Krus, D.M. Effects of lysergic acid diethylamide, and differences between normals and schizophrenics on the Stroop Color-Word Test. Journal of Neuropsychiatry, 1960, 2, 76-81.

Welsh, G.S. Preliminary Manual: Welsh figure preference test (res. ed.). Palo Alto: Consulting Psychologists Press, 1959.

Werner, H. Comparative psychology of mental development. Chicago: Follett, 1948.

Werner, H. The concept of development from a comparative and organismic point of view. In. D.B. Harris (Ed.) The concept of development: an issue in the study of human behavior. Minneapolis: University of Minnesota Press, 1957.

Werner, H. and Kaplan, B. The developmental approach to cognition: its relevance to the psychological interpretation of anthropological and ethnolinguistic data. American Anthropologist, 1956, 58, 866-880.

Wild, C. Creativity and adaptive regression. Journal of Personality and Social Psychology, 1965, 2, 161-169.

Wilson, R.C., Guilford, J.P., Christensen, P.R., and Lewis, D.J. A factor-analytic study of creative-thinking abilities. Psychometrika, 1954, 19, 297-311.

Winer, B.J. Statistical Principles in Experimental Design, New York: McGraw-Hill, 1971.

Witkin, H.A., Heinz Werner: 1890-1964. Child Development, 1965, 36, 307-328.

Witkin, H.A., Dyk, R.B., Faterson, H.F., Goodenough, D.R., and Karp, S.A. Psychological differentiation. New York: Wiley, 1962.

Witkin, H.A., Lewis, H.B., Hertzman, M., Machover, K., Meissner, P.B., and Wapner, S. Personality through perception. New York: Harper, 1954.

Witkin, H.A., Oltman, P.G., Raskin, E., and Karp, S.A. A manual for the embedded figures test. Palo Alto: Consulting Psychologists Press, Inc., 1971.

Yamamoto, K. "Creativity" - a blind man's report on the elephant. Journal of Counseling Psychology, 1965, 12, 428-434.